

BRACHIOPODS OF THE  
ONONDAGA LIMESTONE  
IN CENTRAL AND  
SOUTHEASTERN NEW YORK

HOWARD R. FELDMAN

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## ABSTRACT

Thirty-nine species of brachiopods from central to southeastern New York are systematically described. This monograph is based upon 7030 specimens collected from 30 localities and includes silicified as well as nonsilicified faunas. The following members of the Onondaga Limestone were sampled: Edgecliff, Nedrow, Moorehouse, and Seneca. The Onondaga thickens considerably toward the east with the greatest net change occurring in the Moorehouse Member (19 ft. near Syracuse to 92 ft. at Saugerties). The Seneca Member disappears just east of Cherry Valley and is not found in any strata of the mid-Hudson Valley. Crinoid columnals up to about 1 inch in diameter are characteristic of the Edgecliff Member across the state but become less abundant in the east. Brachiopod diversity is greatest in the Moorehouse Member and least in the Edgecliff Member. Of the 26 species of brachiopods in the underlying Bois Blanc Formation in western New York, nine

occur in the Onondaga and show no evolutionary change. Morphologic variability in the Onondaga faunas was greater laterally than vertically. For the species studied here, the high degree of stasis in the Bois Blanc-Onondaga (Emsian-Eifelian) time interval may support a punctuational model as an evolutionary mode. During Eifelian time the faunas found in central and southeastern New York belonged to the Appohimchi Subprovince of the Eastern Americas Realm and were part of the larger suite extending westward across the continent. The Onondagan brachiopods reviewed here were provincial in character with the following genera endemic to the Appohimchi Subprovince: *Chario-noides*, "*Pacificocoelia*," and *Pentagonia*. *Atribonium halli* and *Discomyorthis?* sp. are the only species described herein not previously reported from Onondaga strata. No new species or genera were erected.

## INTRODUCTION

My purpose in this monograph is to systematically describe the brachiopods of the Onondaga Limestone of central and southeastern New York. By so doing I provide data which can enhance our understanding of brachiopod lineages from the Lower Devonian (e.g., Helderberg) through Middle Devonian (e.g., Hamilton) strata, as well as aid in paleobiogeographic studies of Eifelian age faunas of New York and adjacent areas. Also, these data will be useful in resolving some of the problems inherent in correlating the Onondaga Limestone with the Detroit River Group (Anderdon Limestone, Lucas Dolomite, Amherstburg Dolomite, Sylvania Sandstone) of the Michigan Basin, southwestern Ontario, and central Ohio.

The Onondaga Limestone in New York State crops out from Buffalo, eastward to the Helderbergs, then southward toward Kingston and Port Jervis. I visited more than 100 outcrops from the Syracuse area to Wawarsing (fig. 1), but I studied only 30 in detail. Collecting in the Onondaga is difficult because of the density of the rock, especially in the central part of the state (excluding the shaly beds of the Nedrow Member), but occasional silicified and partly silicified faunas

made this taxonomic study possible and provided internal morphologies much needed for specific identifications and comparisons. Silicification appears to increase in direct proportion to the occurrence of jointing and faulting, being most noticeable in the mid-Hudson Valley near Leeds and Saugerties, New York. North and southwest along the outcrop belt, silicification decreases in intensity and occurrence. Silicified faunas were recovered in Upper Moorehouse strata along the New York State Thruway, at the Saugerties interchange and at Leeds near route 23B and the Catskill Creek. They also occur sporadically throughout the entire section in the mid-Hudson Valley region. Degree of silicification varies greatly within the formation.

Large limestone blocks were retrieved and submersed in vats of commercial grade hydrochloric acid (muriatic acid). After etching, the silicified fossils were washed in a sodium sulfate solution, dried, and sorted biologically. An acid-proof resin (Alvar) was gently brushed on the more fragile shells to facilitate handling and prevent breakage.

Stratigraphic (Oliver, 1954, 1956) and paleocommunity (Feldman, 1980; Lindemann

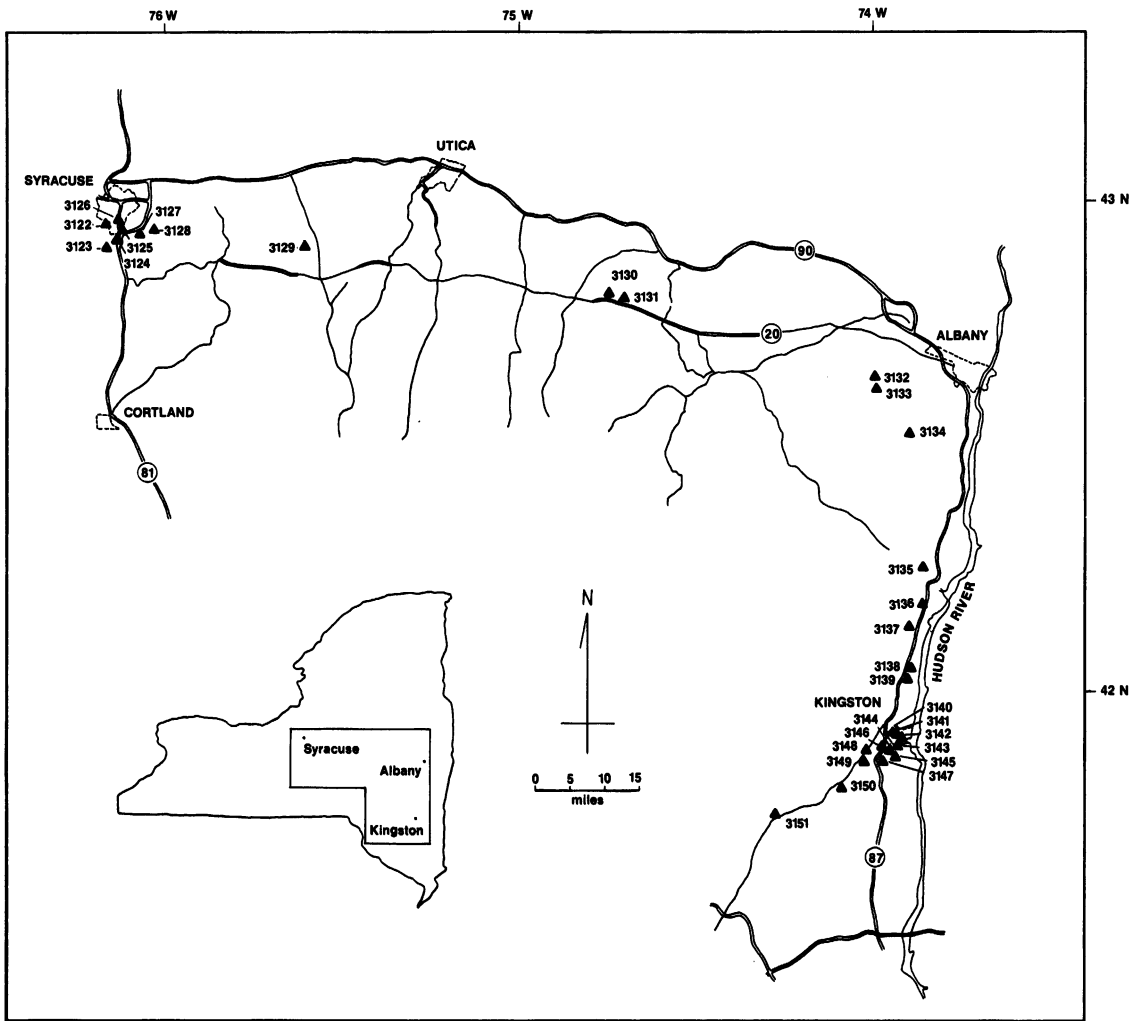


FIG. 1. Index map of collecting localities and described sections in the Onondaga Limestone, central and southeastern New York.

and Feldman, 1981) studies relating to non-reefal aspects of the Onondaga Limestone have resulted in a fairly complete understanding of Onondaga stratigraphy across the state. The area from southwest of Kingston to Port Jervis, however, is in need of more detailed analysis. Outcrops in this area are few, and complete stratigraphic sections have yet to be recognized.

**PREVIOUS WORK:** Simeon De Witt, Surveyor-General of the State of New York, provided the first published illustration of a New York Devonian fossil in 1807 (Wells, 1963,

p. 14). The fossil was illustrated by a woodcut showing a gyrogonic nautiloid from the Onondaga Limestone. Eaton (1832, table 4) made the first real attempt to analyze the fossils of the New York Devonian and mentioned 12 Onondagan species of a total of 41 listed, although none were brachiopods. Wells (1963, p. 63) points out that the end of these pioneer, "amateur," days of New York Devonian geology came in 1836 when Governor Marcy signed a bill establishing a geological survey of the state. Detailed studies of the New York Devonian began in earnest in the



summer of 1836 when the geologists of the new State Survey (Conrad, Emmons, Hall, Mather, and Vanuxem) began fieldwork.

The first major published description of the Onondaga Limestone, including representative brachiopods, was made by Vanuxem (1842) in which he described the geographic extent (e.g., outcrop belt) of the formation in New York State's Third Geological District. In his Fourth Annual Report, Vanuxem (1840, p. 378) noted that the Onondaga Limestone "abounds in Testaceous fossils, the most characteristic ones have to yet be named." He also referred to the "Corniferous Limerock" of Prof. Eaton and mentioned the occurrence of *Cyrtoceras* (= *Foordites*?), found in the Nedrow Member (Feldman, 1980). Vanuxem (1840) also briefly described the Seneca Limestone, the "characteristic fossil of the Seneca being *Strophomena lineata* (= *Chonetes lineata*)."<sup>1</sup> Hall (1840, p. 454) listed *Atrypa wilsoni*, *Strophomena rugosa*, and *Leptaena indenta* from the Onondaga Limestone of the Fourth District but also stated (p. 453) that the list represents only "a few of the most common and characteristic fossils. The list will be greatly increased when we have succeeded in ascertaining the names of species." Vanuxem noted (1842, p. 132) that the Onondaga Limestone "rarely exceeds ten or fourteen feet in thickness" and that it is "readily recognizable by its light grey color, crystalline structure, toughness, and its organic remains, which are very numerous." He also mentioned the occurrence of "smooth encrinal stems" ranging from 1/2 to 1 inch in diameter. In addition, Vanuxem (1842, p. 133) referred to an "elongated pentamerus" found in the formation. From the above it appears as though Vanuxem was describing the Edgecliff Member of the Onondaga Limestone. The thickness of the Edgecliff in central New York ranges from 8 ft. near Syracuse to 25 ft. at Chittenango Falls (Oliver, 1956, p. 1446), and 12 ft. at Nedrow (AMNH Loc. 3124, present report) to 19 ft. at Jamesville (including the "sandy facies" AMNH Loc. 3128, present report). The member also typically contains thick crinoid stems and *Amphigenia* sp. in the central New York area (Oliver, 1954; Feldman, 1980). Three brachiopods were illustrated by Vanuxem (1842,

p. 132): (1) *Pentamerus elongata* (= *Amphigenia*); (2) *Consimilar hipparionix* (probably = *Rhipidomella*); (3) undulated delthyris (= *Megakozlowskiella*). *Amphigenia*? sp. has been found in the Edgecliff (Feldman, 1980); *Rhipidomella* was reported from the Edgecliff (Oliver, 1956); and *Megakozlowskiella* was found in the lowermost Nedrow (present report, AMNH Loc. 3123, just above the Edgecliff-Nedrow contact near Syracuse). Vanuxem (1842) referred to the "Corniferous Limestone" in which he included the "Seneca Limestone." He described this formation as achieving its maximum thickness of 60 to 80 ft., in Cherry Valley. This appears to include the Nedrow, Moorehouse, and Seneca members (measured in this report to a total thickness of between 64.5 ft. to 74.5 ft., AMNH Loc. 3131). Vanuxem (1842, p. 139) illustrated an "undulated cyrtoceras" from the Corniferous Limestone which strongly resembles *Foordites* sp. found in Nedrow strata of the *Leptaena-Megakozlowskiella* Community (Feldman, 1980, p. 37). Vanuxem (1842, p. 141) indirectly refers to the *Chonetes* Zone when he mentioned *S. lineata*, a "small fossil so abundant in the upper part of the rock, which has heretofore been known by the name of Seneca Limestone," and directly (p. 144): "The reason for considering it to be a district rock was . . . finding . . . *S. lineata* in great abundance." Vanuxem mentioned further that the Corniferous Limestone possessed parallel nodules of flint (= chert) "upon which is the Seneca Limestone." Thus, he differentiated the Seneca Limestone from the underlying Corniferous Limestone and considered the Seneca as being the terminal part of the Corniferous Limestone.

Hall (1843), in his review of the geology of the Fourth District in New York (comprising the following counties: Wayne, Monroe, Orleans, Niagara, Seneca, Ontario, Yates, Livingston, Genesee, Erie, the western part of Tompkins, Chemung, Steuben, Allegany, Cattaraugus, and Chautauqua) described the lithology and faunas of the Onondaga and Corniferous limestones. Hall stated (p. 156) that the formation is much more "developed in the First and Third districts where it contains a greater number of fossils and as a

distinct mass is more persistent." Hall's (1843) stratigraphical nomenclature appears to conform to that of Vanuxem's (1842). He mentioned the occurrence of *Atrypa* and *Delthyris*, but stated (p. 160) that the "characteristic fossils of the Onondaga Limestone in the Third District, figured by Mr. Vanuxem on page 132 of his Report, cannot be considered as typical of this rock in the Fourth District. The *Pentamerus elongatus* occurs at Vienna, but I have not seen it elsewhere in the district." Hall (1843) described a more extensive brachiopod fauna from the Corniferous Limestone including: *Atrypa scitula*, *A. prisca*, *Paracyclas elliptica*, *Strophomena acutiradiata*, *S. crenistria*, *S. undulata*, *S. lineata* (= *Chonetes lineata*), *Delthyris duodenaria*, *Orthis lenticularis*, and *Orthis lentiformis*.

**PURPOSE OF INVESTIGATION:** The present report consists of systematic descriptions of brachiopods recovered from the Onondaga Limestone of central and southeastern New York State. All genera described here were previously reported or described from New York except for *Atribonium halli* which is known from the Detroit River Group, an Onondaga correlative and *Discomyorthis?* sp. The Onondaga brachiopod fauna has been previously described by other workers (Eaton, 1832; Vanuxem, 1839, 1842; Hall, 1840, 1843, etc.) but the illustrations in all cases are lithographic plates and figures from woodcuts rather than photographs. This is the first paper describing the Onondaga brachiopod fauna using photographs. Also, most of the specimens described herein are silicified, whereas past workers' material was not. Silicified faunas enable a more detailed study of morphology since covered structures are exposed after etching.

The purposes of the present study are to: (1) Systematically describe and characterize the large and significant brachiopod fauna of the Onondaga Limestone which has not been redescribed since the days of James Hall. (2) Provide data which can be utilized to evaluate lineages and evolutionary change (stasis or lack thereof) between Lower Devonian Halderberg and Schoharie age faunas and those of the Hamilton. (3) Enable further pa-

leobiogeographic implications to be drawn regarding Eifelian age faunas of New York, especially with regard to the westerly advance of these faunas in eastern North America. (4) Help pinpoint and resolve some of the problems faced in correlating the Detroit River Group with the Onondaga Limestone.

## STRATIGRAPHIC CONSIDERATIONS

Four members of the Onondaga Limestone are recognized in the study areas (fig. 2): Edgecliff, Nedrow, Moorehouse, and Seneca. Detailed descriptions of these members may be found in Oliver (1954, 1956), but some additional comments are provided below.

**EDGECLIFF MEMBER:** In southeastern New York the Edgecliff Member is finer-grained than in the central part of the state and is typified by abundant light-weathering chert seams often in a crinoidal matrix. Large crinoid columnals are occasionally present although they are more numerous in the Syracuse area. The Edgecliff varies in thickness from 12 to 19 ft. in the Syracuse area, depending on the presence or absence of the basal (quartzose) sandy zone (see Oliver, 1966, p. 35, for a discussion of the age of the basal sandy zone), to a maximum of 48 ft. near Saugerties, New York. Brachiopods are relatively scarce in the Edgecliff and collecting is difficult due to the massive nature of the rock, its density and lack of joints, and slow weathering of the matrix. The following brachiopods have been collected from the Edgecliff for this study:

*Amphigenia?* sp.  
*Atrypa* "reticularis"  
*Elytha fimbriata*  
*Leptaena* aff. "rhomboidalis"  
*Levenea* aff. *subcarinata*  
*Levenea* sp. A  
*Pentamerella arata*

**NEDROW MEMBER:** Characterized by shaly beds, especially in the central part of the state, which, when weathered, result in recessed ledges along which fossils may be easily collected. In the east the Nedrow becomes thicker-bedded, less argillaceous, and coarser-



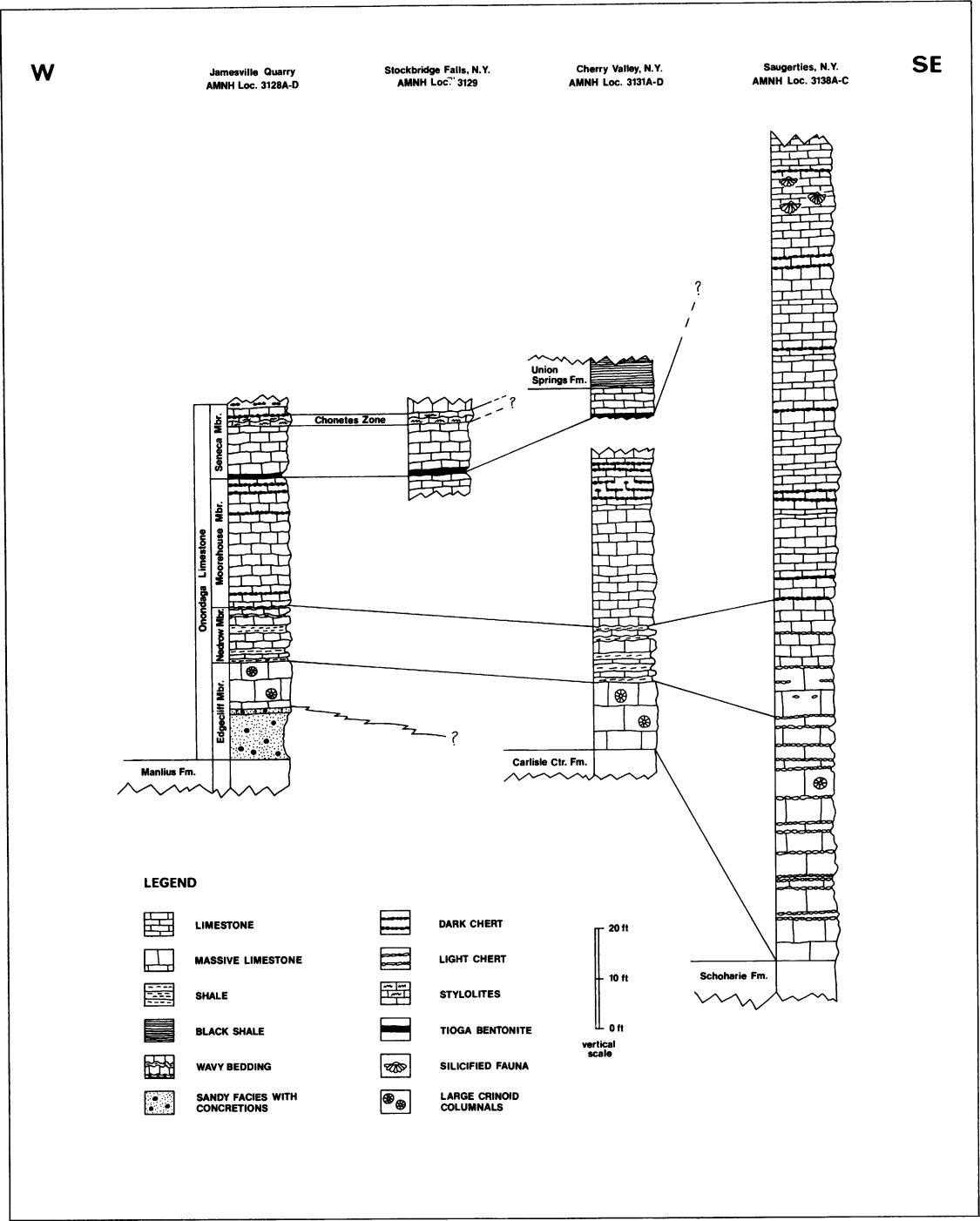


FIG. 2. Measured stratigraphic sections of key outcrops on a west-east-southeast transect along the outcrop belt of the Onondaga Limestone in central and southeastern New York.

grained. Collecting is more difficult in the eastern part of the outcrop belt. The following brachiopods have been collected from the Nedrow for this study:

*Athyris* sp. A  
*Atrypa* "reticularis"  
*Charionoides* aff. *doris*  
*Coelospira* *camilla*  
*Costistrophonella* cf. *punctulifera*  
*Cupularostrum* sp. A  
*Dalejina* aff. *alsa*  
*Gypidula* sp.  
*Leptaena* aff. "rhomboidalis"  
*Levenea* aff. *subcarinata*  
*Megakozlowskiella* *raricosta*  
*Megastrophia* sp.  
*Nucleospira* aff. *ventricosa*  
*Orthotetacid* indet.  
*"Pacifcocoelia"* *acutiplicata*  
*Pentagonia* *unisulcata*  
*Pentamerella* *arata*  
*Stropheodontid* indet.  
*Strophodonta* *demissa*  
*Trematospira?* sp.

MOOREHOUSE MEMBER: The eastern part of the outcrop belt is typified by dark-weathering chert seams which occur sporadically throughout the member. In the Syracuse area the chert is a bit lighter in color and concentrated more in the upper one-third of the member. Toward the southeast the Moorehouse becomes noticeably darker, finer-grained and highly argillaceous. The greatest change in thickness in the Onondaga Limestone occurs from Syracuse to the mid-Hudson Valley and is found within the Moorehouse Member. Collecting is difficult in the uniformly bedded central area, but easier in the east where silicified faunas are accessible. The following brachiopods have been collected from the Moorehouse Member in this study:

*Acrospirifer* *duodenaria*  
*Ambocoelia* sp.  
*Athyridacean* indet.  
*Athyris* sp. A  
*Athyris* sp. B  
*Atribonium* *halli*  
*Atrypa* "reticularis"  
*"Chonetes"* aff. *lineata*  
*Coelospira* *camilla*

*Cupularostrum* sp. A  
*Cupularostrum* sp. B  
*Cyrtina* *hamiltonensis*  
*Cyrtina* sp. A  
*Dalejina* aff. *alsa*  
*Dalejina* sp. A  
*Discomyorthis?* sp.  
*Elytha* *fimbriata*  
*Eospiriferid?* indet.  
*Gypidula* sp.  
*Leptaena* aff. "rhomboidalis"  
*Levenea* aff. *subcarinata*  
*Megakozlowskiella* *raricosta*  
*Megastrophia* sp.  
*Meristina* *nasuta*  
*Mucrospirifer* cf. *macra*  
*Nucleospira* aff. *ventricosa*  
*Orthotetacid* indet.  
*"Pacifcocoelia"* *acutiplicata*  
*Pentagonia* *unisulcata*  
*Pentamerella* *arata*  
*Rhynchospirina* sp.  
*Schizophoria* cf. *multistriata*  
*"Schuchertella"* sp.  
*Stropheodontid* indet.  
*Strophodonta* *demissa*

SENECA MEMBER: The base of the Seneca Member in central New York is marked by the Tioga Bentonite, 10 ft. above which occurs a zone of chonetid brachiopods (=Zone J of Oliver, 1954). East of Cherry Valley, the Tioga Bentonite and Chonetid Zone have not yet been observed in the field. The Seneca Member is a highly argillaceous limestone in which fossils are not generally abundant (except for "*Chonetes*" aff. *lineata*). The following brachiopods have been collected from the Seneca Member in this study:

*Atrypa* "reticularis"  
*Athyris* sp. A  
*"Chonetes"* aff. *lineata*  
*Leptaena* aff. "rhomboidalis"  
*Megakozlowskiella* *raricosta*  
*Megastrophia* sp.  
*Orthotetacid* indet.  
*Pentamerella* *arata*

BIOSTRATIGRAPHY: Boucot and Johnson (1968) report the occurrence of *Amphigenia elongata* from the Bois Blanc Formation of western New York which directly underlies



the Onondaga Limestone. Boucot (1959) mentions the occurrence of *A. preparva*, the earliest known species of the genus, from the Highland Mills Member of the Esopus Formation as well as from the lower York River Sandstone in Gaspe. Grabau's (1906) faunal list for the Onondaga Limestone in eastern New York includes *A. elongata* as does Oliver's (1956) faunal list for the western part of New York. I have found poorly preserved fragments of *Amphigenia?* sp. in the basal sandy zone of the Edgecliff Member in the Syracuse area. The genus has not been recovered from any of the silicified rocks of the mid-Hudson Valley. Thus, additional collecting and study is indicated for refinement of Rensselaerid zones in the eastern part of New York, specifically *Amphigenia* zonation in the post-Edgecliff rocks of the mid-Hudson Valley.

During the course of field studies specimens of *Rhipidomella?* and *Cymostrophia?* have been observed in Moorehouse rocks in the vicinity of Saugerties, New York. The specimens were fragmentary, poorly preserved, nonsilicified, and impossible to extract. Attempts to crack out the occasional representatives of these genera resulted in destruction of the fossils. Additional work is needed to collect enough material for generic and specific assignment, although it may be stated with a fair amount of certainty that these forms occur rarely in the Onondaga.

The pre-Eifelian Bois Blanc Formation in western New York directly underlies the Onondaga Limestone. (See House, 1962 and Klapper, 1971 for further information on the Eifelian age of the Onondaga Limestone.) Oliver (1967) notes that the presence of key corals and the profusion of brachiopods is sufficient to separate the Bois Blanc from the coral-crinoid debris assemblage of the overlying Edgecliff Member of the Onondaga Limestone in western New York and the Niagara Peninsula of Ontario. Boucot and Johnson (1968) studied the brachiopods of the Bois Blanc Formation (USGS Loc. Nos. 4671-SD, 4672-SD) from western New York and provided a list of brachiopods from the Bois Blanc and its correlatives in eastern North America (table 1). The following brachiopod species, occurring in the Bois Blanc, also occur in the Onondaga Limestone:

*Acrospirifer duodenaria*  
*Atrypa "reticularis"*  
*Coelospira camilla*  
*Dalejina* aff. *alsa*  
*Megakozłowskiella raricosta*  
*Meristina nasuta*  
*"Mucrospirifer"* cf. *macra*  
*Pentamerella arata*  
*Strophodonta* cf. *demissa*

The following brachiopod genera from the Bois Blanc also occur in the Onondaga Limestone:

*Ambocoelia*  
*Cupularostrum*  
*Elytha*  
*Leptaena*  
*Nucleospira*  
*"Schuchertella"*

*Amphigenia elongata* from the Bois Blanc has been identified in this report as *Amphigenia?* in the Onondaga. Apparently there are nine species (possibly 16 species if the genera listed above prove to be conspecific with the Onondaga forms) that occur in the Onondaga. Three species range through the Seneca Member:

*Atrypa "reticularis"*  
*Megakozłowskiella raricosta*  
*Pentamerella arata*

The six remaining species are found through the upper Moorehouse Member:

*Acrospirifer duodenaria*  
*Coelospira camilla*  
*Dalejina* aff. *alsa*  
*Meristina nasuta*  
*"Mucrospirifer"* cf. *macra*  
*Strophodonta* cf. *demissa*

The above tabulations indicate a significant degree of stasis in terms of speciation (or lack thereof) in the Bois Blanc-Onondaga time interval. Although the present study is basically taxonomic and no attempt is made to specifically analyze evolutionary trends, the following generalizations are offered with regard to future evolutionary studies of Bois Blanc-Onondaga brachiopod faunas, as suggested by Gould and Eldredge (1977):

(1) The morphologic variability of the brachiopods is greater laterally than vertically.

(2) Of the 26 species of brachiopods in the Bois Blanc Formation, nine (34%) occur in the Onondaga and show no evolutionary change.

(3) The high degree of stasis present in the Bois Blanc-Onondaga (Emsian-Eifelian) interval may support Eldredge and Gould's (1972) idea of punctuated equilibrium rather than phyletic gradualism for the species described in this study.

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of Natural History for allowing me to use Museum facilities, especially the acid room, before I was appointed Research Associate.

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### ABBREVIATIONS

#### INSTITUTIONS AND LOCALITIES

AMNH, American Museum of Natural History, Department of Invertebrates  
AMNH Loc., American Museum of Natural History locality number  
USNM, United States National Museum of Natural History, Department of Paleobiology, Smithsonian Institution  
USNM Loc., United States National Museum locality number  
USGS, United States Geological Survey

#### MEASUREMENTS

(L), maximum length of shell  
(W), maximum width of shell  
(T), maximum thickness of shell  
mm, millimeters  
est., estimated  
b.v., brachial (dorsal) valve  
p.v., pedicle (ventral) valve  
def., deformed  
art., articulated

## SYNOPTIC CLASSIFICATION

Phylum Brachiopoda

Class Articulata

Order Orthida

Suborder Dalmanelloidea

Superfamily Dalmanellacea

Family Dalmanellidae Schuchert, 1913

Subfamily Isorthisinae Schuchert and Cooper, 1931

*Levenea* aff. *subcarinata* (Hall, 1857) ..... (183)<sup>1</sup>

Geographic occurrence—AMNH Locs. 3124B, 3128B, C, 3130, 3131B–D, 3134, 3137, 3138A–C, 3139, 3141, 3142, 3143, 3151A.

Stratigraphic occurrence—Edgecliff, Nedrow, Moorehouse members.

*Levenea* species A ..... (2)

<sup>1</sup> Numbers in parentheses are sample sizes.

Geographic occurrence—AMNH Loc. 3143.

Stratigraphic occurrence—Edgecliff Member.

Family Rhipidomellidae Schuchert, 1913

Subfamily Rhipidomellinae Schuchert, 1913

*Dalejina* aff. *alsa* (Hall, 1963) ..... (61)

Geographic occurrence—AMNH Locs. 3121B, C, 3124A, B, 3128C,  
3130, 3131B, 3133, 3135, 3137, 3138A, 3139, 3141, 3142, 3144A.

Stratigraphic occurrence—Nedrow, Moorehouse members.

*Dalejina* species A ..... (2)

Geographic occurrence—AMNH Loc. 3137.

Stratigraphic occurrence—Moorehouse Member.

*Discomyorthis?* sp. .... (4)

Geographic occurrence—AMNH Locs. 3135, 3137.

Stratigraphic occurrence—Moorehouse Member.

Family Schizophoriidae Schuchert and LeVene, 1929

Subfamily Schizophoriinae Schuchert and LeVene, 1929

*Schizophoria* cf. *multistriata* Hall (1859–1861) ..... (65)

Geographic occurrence—AMNH Locs. 3130, 3131B, 3133, 3134, 3137,  
3138A, 3141, 3142, 3144A.

Stratigraphic occurrence—Moorehouse Member.

Order Pentamerida

Suborder Pentameroidea

Superfamily Pentameracea

Family Gypidulidae Schuchert and LeVene, 1929

Subfamily Gypidulinae Schuchert and LeVene, 1929

*Pentamerella arata* (Conrad, 1841) ..... (75)

Geographic occurrence—AMNH Locs. 3123A–D, 3124A, B, 3125A, 3128B, C,  
3130, 3131B, 3137, 3138A, 3139, 3140, 3143, 3144A.

Stratigraphic occurrence—Nedrow, Moorehouse members.

Order Strophomenida

Suborder Strophomenoidea

Superfamily Strophomenacea

Family Strophomenidae King, 1846

Subfamily Leptaeninae Hall and Clarke, 1895

*Leptaena* aff. "*rhomboidalis*" (Wilckens, 1769) ..... (172)

Geographic occurrence—AMNH Locs. 3123B–D, 3124A, B, 3125A, 3128A–C,  
3130, 3131B, 3134, 3137, 3138A, B, 3140, 3141, 3142, 3143.

Stratigraphic occurrence—Edgecliff, Nedrow, Moorehouse, Seneca members.

Superfamily Davidsoniacea

Family Schuchertellidae Williams, 1953

Subfamily Schuchertellinae Williams, 1953

"*Schuchertella*" sp. .... (3)

Geographic occurrence—AMNH Loc. 3137.

Stratigraphic occurrence—Moorehouse Member.

Orthotetacids indet. .... (73)

Geographic occurrence—AMNH Locs. 3123B–D, 3124A, B, 3125A, 3128A–C,  
3130, 3131B, C, 3133, 3134, 3135, 3137, 3139, 3142, 3144A.

Stratigraphic occurrence—Nedrow, Moorehouse, Seneca members.

Superfamily Stropheodontacea

Family Strophonellidae Caster, 1939

*Costistrophonella* cf. *punctulifera* (Conrad, 1838) ..... (4)

Geographic occurrence—AMNH Locs. 3123C, 3131C.

Stratigraphic occurrence—Nedrow Member.

- Family Stropheodontidae Caster, 1939  
*Megastrophia* sp. .... (43)  
 Geographic occurrence—AMNH Locs. 3123A–C, 3124B, 3125A, 3128C, 3131B, C, 3134, 3135, 3138A.  
 Stratigraphic occurrence—Nedrow, Moorehouse, Seneca members.  
*Strophodonta* cf. *demissa* (Conrad, 1842) .... (13)  
 Geographic occurrence—AMNH Locs. 3124B, 3130, 3131B, 3133, 3135, 3137.  
 Stratigraphic occurrence—Nedrow, Moorehouse members.  
 Stropheodontid indet. .... (9)  
 Geographic occurrence—AMNH Locs. 3123B, C, 3135.  
 Stratigraphic occurrence—Nedrow, Moorehouse members.  
 Suborder Chonetoidea  
 Superfamily Chonetacea  
 Family Chonetidae Bronn, 1862  
 Subfamily Chonetinae Bronn, 1862  
 “*Chonetes*” aff. *lineata* Hall, 1867 .... (4554)  
 Geographic occurrence—AMNH Locs. 3123A, 3128A, 3129, 3131B.  
 Stratigraphic occurrence—Moorehouse, Seneca members.  
 Order Rhynchonellida  
 Suborder Rhynchonelloidea  
 Superfamily Stenoscismatacea  
 Family Atriboniidae Grant, 1965  
 Subfamily Atriboniinae Grant, 1965  
*Atribonium halli* (Fagerstrom, 1961) .... (2)  
 Geographic occurrence—AMNH Locs. 3135, 3137.  
 Stratigraphic occurrence—Moorehouse Member.  
 Superfamily Camarotoechiacea  
 Family Trigonirhynchiidae Schmidt, 1965  
*Cupularostrum?* species A .... (40)  
 Geographic occurrence—AMNH Locs. 3131C, 3135, 3137, 3138A.  
 Stratigraphic occurrence—Nedrow, Moorehouse members.  
*Cupularostrum?* species B .... (5)  
 Geographic occurrence—AMNH Loc. 3138A.  
 Stratigraphic occurrence—Moorehouse Member.  
 Order Spiriferida  
 Suborder Atrypoidea  
 Superfamily Atrypacea  
 Family Atrypidae Gill, 1871  
 Subfamily Atrypinae Gill, 1871  
*Atrypa* “*reticularis*” (Linnaeus, 1767) .... (617)  
 Geographic occurrence—AMNH Locs. 3122, 3123A–D, 3124A–C, 3125A–B, 3127, 3128C–D, 3139, 3131A–D, 3132, 3133, 3134, 3135, 3136, 3137, 3138A–C, 3139, 3140, 3141, 3142, 3143, 3144A, B, 3145, 3146, 3147, 3148, 3149, 3150, 3151B.  
 Stratigraphic occurrence—Edgecliff, Nedrow, Moorehouse, Seneca members.  
 Superfamily Dayiacea  
 Family Anoplothecidae Schuchert, 1894  
 Subfamily Coelospirinae Hall and Clarke, 1895  
*Coelospira camilla* Hall, 1867 .... (180)  
 Geographic occurrence—AMNH Locs. 3123C, 3128B, C, 3133, 3135, 3137, 3138A, B, 3139, 3141, 3142, 3144A.  
 Stratigraphic occurrence—Nedrow, Moorehouse members.



- Family Leptocoeliidae Boucot and Gill, 1956  
*"Pacifcocoelia" acutiplicata* (Conrad, 1841) ..... (141)  
 Geographic occurrence—AMNH Locs. 3123B, C, 3124B, 3125A, 3128B, C, 3133.  
 Stratigraphic occurrence—Nedrow, Moorehouse members.
- Suborder Athyroidae  
 Superfamily Athyridacea  
 Family Athyrididae M'Coy, 1844  
*Athyris* species A ..... (38)  
 Geographic occurrence—AMNH Locs. 3123B, C, 3124B, 3125A, 3128A–C, 3130, 3131B, 3133, 3135, 3137, 3139.  
 Stratigraphic occurrence—Nedrow, Moorehouse, Seneca members.  
*Athyris* species B ..... (2)  
 Geographic occurrence—AMNH Loc. 3138A.  
 Stratigraphic occurrence—Moorehouse Member.
- Family Meristellidae Waagen, 1883  
 Subfamily Meristellinae Waagen, 1883  
*Meristina* cf. *nasuta* (Conrad, 1842) ..... (3)  
 Geographic occurrence—AMNH Locs. 3123B, 3137.  
 Stratigraphic occurrence—Moorehouse Member.  
*Charionoidea* aff. *doris* (Hall, 1860) ..... (1)  
 Geographic occurrence—AMNH Loc. 3123C.  
 Stratigraphic occurrence—Nedrow Member.
- Pentagonia unisulcata* (Conrad, 1841) ..... (81)  
 Geographic occurrence—AMNH Locs. 3130, 3131B, C, 3133, 3134, 3137, 3138A, 3139, 3140, 3141, 3142, 3144A.  
 Stratigraphic occurrence—Nedrow, Moorehouse members.
- Family Nucleospiridae Davidson, 1881  
*Nucleospira* aff. *ventricosa* (Hall, 1857) ..... (152)  
 Geographic occurrence—AMNH Locs. 3130, 3131B, 3133, 3135, 3137, 3138A, B, 3139, 3140, 3141, 3142, 3144A.  
 Stratigraphic occurrence—Nedrow, Moorehouse members.
- Athyridacean indet. .... (3)  
 Geographic occurrence—AMNH Locs. 3137, 3138A.  
 Stratigraphic occurrence—Moorehouse Member.
- Suborder Retzioidae  
 Superfamily Retziacea  
 Family Retziidae Waagen, 1883  
*Trematospira?* sp. .... (2)  
 Geographic occurrence—AMNH Loc. 3124B.  
 Stratigraphic occurrence—Nedrow Member.
- Family Rhynchospiridae Schuchert and LeVene, 1929  
*Rhynchospirina* sp. .... (1)  
 Geographic occurrence—AMNH Loc. 3137.  
 Stratigraphic occurrence—Moorehouse Member.
- Suborder Spiriferoidea  
 Superfamily Delthyridacea  
 Family Delthyrididae Phillips, 1841  
 Subfamily Delthyridae Phillips, 1841  
*Acrospirifer duodenaria* (Hall, 1843) ..... (100)  
 Geographic occurrence—AMNH Locs. 3130, 3131B, 3135, 3137, 3138A, 3144A.  
 Stratigraphic occurrence—Moorehouse Member.

- Family Mucrospiriferidae Pitrat, 1965  
 Subfamily Mucrospiriferinae Boucot, 1959  
*"Mucrospirifer" cf. macra* (Hall, 1857) ..... (34)  
 Geographic occurrence—AMNH Locs. 3130, 3131B, 3135, 3137, 3138A.  
 Stratigraphic occurrence—Moorehouse Member.  
 Subfamily Kozłowskiellinae Boucot, 1957  
*Megakozłowskiella raricosta* (Conrad, 1842) ..... (284)  
 Geographic occurrence—AMNH Locs. 3123A–D, 3124A, B, 3125A, 3128B, C,  
 3130, 3131B, 3133, 3134, 3135, 3137, 3138A, 3139, 3140, 3141, 3144A.  
 Stratigraphic occurrence—Nedrow, Moorehouse, Seneca members.  
 Family Reticulariidae Waagen, 1883  
*Elytha fimbriata* (Conrad, 1842) ..... (21)  
 Geographic occurrence—AMNH Locs. 3131B, 3135, 3137, 3138A, C, 3139.  
 Stratigraphic occurrence—Edgecliff, Moorehouse members.  
 Eospiriferid? indet. .... (3)  
 Geographic occurrence—AMNH Loc. 3135.  
 Stratigraphic occurrence—Moorehouse Member.  
 Family Ambocoeliidae George, 1931  
 Subfamily Ambocoeliinae George, 1931  
*Ambocoelia* sp. .... (6)  
 Geographic occurrence—AMNH Locs. 3135, 3137.  
 Stratigraphic occurrence—Moorehouse Member.  
 Superfamily Cyrtinacea  
 Family Cyrtinidae Frederiks, 1912  
*Cyrtina hamiltonensis* (Hall, 1857) ..... (30)  
 Geographic occurrence—AMNH Locs. 3133, 3135, 3137, 3138A, 3141, 3144A.  
 Stratigraphic occurrence—Moorehouse Member.  
*Cyrtina* species A ..... (2)  
 Geographic occurrence—AMNH Loc. 3135.  
 Stratigraphic occurrence—Moorehouse Member.  
 Order Terebratulida  
 Suborder Terebratuloida  
 Superfamily Terebratulacea  
 Family Centronellidae Waagen, 1882  
 Subfamily Amphigeniidae Cloud, 1942  
*Amphigenia?* sp. .... (12)  
 Geographic occurrence—AMNH Loc. 3126.  
 Stratigraphic occurrence—Edgecliff Member.  
 TOTAL SPECIMENS STUDIED ..... 7030

## SYSTEMATIC PALEONTOLOGY

### PHYLUM BRACHIOPODA

#### ORDER ORTHIDA

#### SUBORDER DALMANELLOIDEA

#### SUPERFAMILY DALMANELLACEA

#### SCHUCHERT, 1913

#### FAMILY DALMANELLIDAE SCHUCHERT, 1913

#### SUBFAMILY ISORTHINAE SCHUCHERT AND

#### COOPER, 1931

#### GENUS *LEVENEA* SCHUCHERT AND

#### COOPER, 1931

TYPE SPECIES: *Orthis subcarinata* Hall,  
 1857, p. 43.

*Levenea* aff. *subcarinata* (Hall, 1857)

Figure 3

*Orthis subcarinata* Hall, 1857, p. 43; 1859, p. 169,  
 pl. 12, figs. 7–21.

*Levenea subcarinata* Schuchert and Cooper, 1932,  
 p. 123, pl. 18, figs. 19–23, 25–32; Cooper, 1944,  
 p. 353, pl. 138, figs. 21–23.

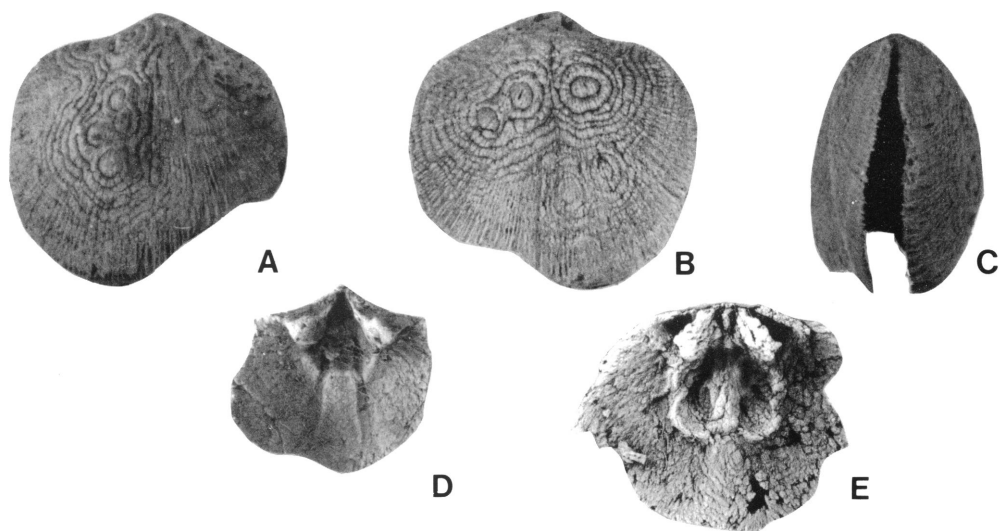


FIG. 3. *Leveneia* aff. *subcarinata* (Hall, 1957). A–C AMNH Loc. 3134. Ventral, dorsal and lateral views, AMNH 42756,  $\times 3$ . D. AMNH Loc. 3141. Pedicle valve interior, AMNH 39870,  $\times 2.5$ . E. AMNH Loc. 3141. Brachial valve interior, AMNH 39871,  $\times 2.5$ .

**EXTERIOR:** The shells are small to medium-sized, transversely suboval in outline, and ventribiconvex in lateral profile. The brachial valve bears a shallow, rounded sulcus which broadens anteriorly. Length is slightly greater than width. Maximum width is attained at or just anterior to midlength. The ventral interarea is short, slightly incurved, and apsacline. A triangular delthyrium is present which encloses an angle of approximately 60 degrees. On many specimens the delthyrium widens apically into a small, circular foramen. The dorsal interarea is poorly preserved.

Ornamentation consists of indistinct, rounded, radial costellae which appear to increase in number anteriorly by bifurcation. Cross sectional shape is unclear.

**PEDICLE VALVE INTERIOR:** The hinge teeth are short, blunt, and subtriangular in cross section. They are supported by subpyramidal deposits of shell material in place of true dental lamellae. The muscle field is about one-third the valve length and subpentagonal in outline. The anterior rim of the muscle field is raised, separating it from the valve floor. The diductor tracks are represented by two longitudinal striae which extend past the anterior rim of the muscle field almost to the anterior commissure. On smaller specimens

no rim is present and the diductor tracks are not impressed.

**BRACHIAL VALVE INTERIOR:** The sockets are short, deeply excavated, widely divergent, and slightly covered posteriorly by the dorsal interarea. The brachioophores project ventrally and slightly anteriorly. The cardinal process is set in a raised mound of secondary shell material within the notothyrial cavity and varies in shape from a simple longitudinal ridge to a bilobed process. Two specimens appear to be quadrilobed. A low, broad, rounded myophragm divides the adductor impressions medially. The adductor impressions are elongate suboval, fairly deeply impressed and bounded laterally and anteriorly by muscle-bounding ridges. No clear differentiation is evident between the anterior and posterior adductors.

**COMPARISON:** *Leveneia* aff. *subcarinata* is smaller than Johnson's (1970, p. 77, pl. 2, figs. 8–18) *L. fagerholmi* and has a flatter pedicle valve. *Leveneia navicula* (Johnson, 1970, p. 75, pl. 2, figs. 19–22; pl. 3, figs. 1–19) is more biconvex and has subparallel diductor tracks, whereas *L. aff. subcarinata* has diductor tracks which are somewhat divergent anteriorly. Johnson's (1970, p. 74, pl. 2, figs. 1–7) *Leveneia* sp. A differs from *L. aff.*

*subcarinata* in its stronger costation and dorsal interior which has a more elongate muscle field.

The ventral muscle field of *Levenea* cf. *subcarinata* (Boucot, Gauri, and Southard, 1970, p. 8, pl. 2, figs. 3–5) has subparallel diductor tracks and is less divergent anteriorly while the dorsal muscle field is slightly more elongate. The specimens are similar to *L. aff. subcarinata* in that they also possess sulcate brachial valves (although the Onondaga forms are very slightly sulcate), suboval outlines, and fine costae. In addition to specimens from the Kalkberg Limestone (USNM Loc. 11321), the New Scotland Formation (USNM Loc. 11317), and the Coeymans Limestone (USNM Loc. 11259) Boucot, Gauri, and Southard (1970, p. 9) briefly mentioned and described *Levenea* sp. from the Esopus Formation, Mountainville Member (USNM Loc. 11251) but due to a lack of available specimens were unable to assign a specific identification. Their specimens differ from *L. aff. subcarinata* in their subcircular outline and wider muscle fields. Helderberg age *Levenea* sp. from the Moose River Synclinorium (Boucot, 1973) resembles *L. aff. subcarinata* in general outline, but the material is too fragmentary for further comparison.

COMMUNITY OCCURRENCE: Feldman (1980) found this species in the *Leptaena-Megakozlowskiella*, *Levenea* Community I, and *Levenea* Community II communities.

FIGURED SPECIMENS: AMNH 3970, 39871, 42756.

#### *Levenea* sp. A

##### Figure 4

REMARKS: A single, well-preserved pedicle valve interior is available for study. It is concave, with a subcircular outline slightly worn on the edges. The hinge line is short, interarea fairly high, apsacline, and moderately incurved. The delthyrium is triangular and encloses an angle of approximately 60 degrees. The beak is suberect. No fine ornament has been preserved.

A broad, flat, median ridge extends from deep in the umbonal cavity, increasing slightly in height until the anterior extremity of the muscle field is reached, then slopes off sharply until merging with the valve floor just short

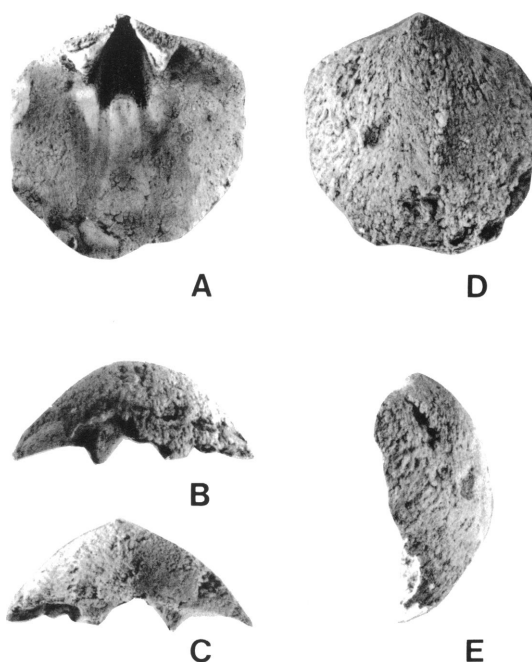


FIG. 4. *Levenea* sp. A. A–E. AMNH Loc. 3143. Pedicle valve interior, lateral view, AMNH 39872,  $\times 1.5$ .

of midlength. The umbonal cavity, including the median ridge, is horizontally striated with what appear to be internal growth lamellae. Diductor impressions are impressed upon the lateral margins of the umbonal cavity. The hinge teeth are large, pointed, and dorsally directed. They are supported by obsolescent dental lamellae.

This specimen of *Levenea* sp. A may be distinguished from *L. aff. subcarinata* by its larger size, larger, more pointed hinge teeth, and shorter muscle field.

COMMUNITY OCCURRENCE: Feldman (1980) found this species in the *Levenea* Community I.

FIGURED SPECIMEN: AMNH 39872.

#### FAMILY RHIPIDOMELLIDAE

SCHUCHERT, 1913

#### SUBFAMILY RHIPIDOMELLINAE

SCHUCHERT, 1913

#### GENUS *DALEJINA* HAVLICEK, 1953

TYPE SPECIES: *Dalejina hanusi* Havlicek, 1953, p. 5.



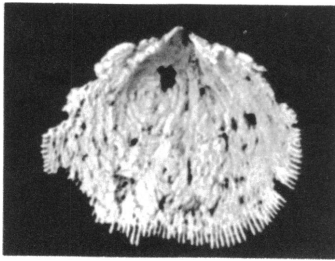


FIG. 5. *Dalejina* aff. *alsa* (Hall, 1863). AMNH Loc. 3137. Pedicle valve interior, AMNH 42747,  $\times 2$ .

*Dalejina* aff. *alsa* (Hall, 1863)  
Figures 5, 6, 7, 8A–D

*Orthis alsus* Hall, 1863, p. 33

*Rhipidomella alsa* Hall, 1867, p. 36, pl. 4, figs. 2–7; Grabau, 1906, p. 181, fig. 95.

*Dalejina alsa* Boucot and Johnson, 1968, p. B7, pl. 1, figs. 11–27; Fagerstrom, 1971, pl. 1, figs. 1, 2.

**EXTERIOR:** The shells are transversely sub-oval to subcircular in outline, and ventribi-convex, with the pedicle valve slightly flatter and the brachial valve deeper, especially in the umbonal region. The hinge line is very short and straight in the apical area but becomes rounded as the lateral margins are approached. Maximum width (table 1) is reached at or just anterior to midlength. The pedicle valve bears a slight median depression which rarely reaches the anterior commissure. The brachial valve often bears a corresponding median ridge. However, both of these features are variable. The anterior com-

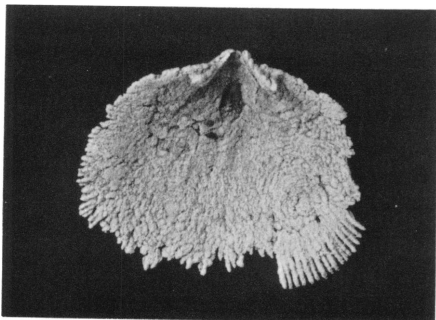


FIG. 6. *Dalejina* aff. *alsa* (Hall, 1863). AMNH Loc. 3137. Pedicle valve interior, AMNH 42748,  $\times 3$ .

TABLE 1  
Measurements (in Millimeters) of Pedicle Valves  
of *Dalejina* aff. *alsa* (Hall, 1863)

AMNH Locality	(L)	(W)	(L)/(W)
3135	11.9	15.3	0.77
3137	5.8	6.6	0.88
3137	5.2	6.1	0.85
3137	10.3	12.5	0.82

missure is most often rectimarginate but can be slightly sulcate if the influence of the ventral median depression is strong enough. The ventral interarea is short, narrow, and apsa-cline. The dorsal interarea is anacline.

Radial ornamentation consists of numerous radial costellae which increase anteriorly both by intercalation and bifurcation. There are 18 to 20 costellae per 5 mm at the anterior commissure, near midline. The costellae are occasionally crossed by concentric growth lines near the anterior margins.

**PEDICLE VALVE INTERIOR:** Short, somewhat obscure, dental lamellae support the widely divergent, pointed, hinge teeth, which are subelliptical in cross section. Shallow crural fossettes are present. On specimens whose apical region is preserved there is usually a small pedicle callist. The umbonal cavity is fairly shallow and bounded laterally by the dental plates which sometimes extend an-

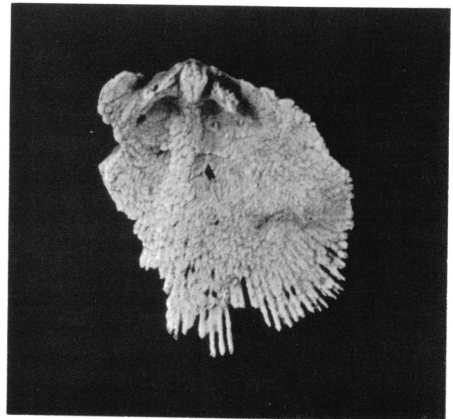


FIG. 7. *Dalejina* aff. *alsa* (Hall, 1863). AMNH Loc. 3137. Brachial valve interior, AMNH 42749,  $\times 3$ .

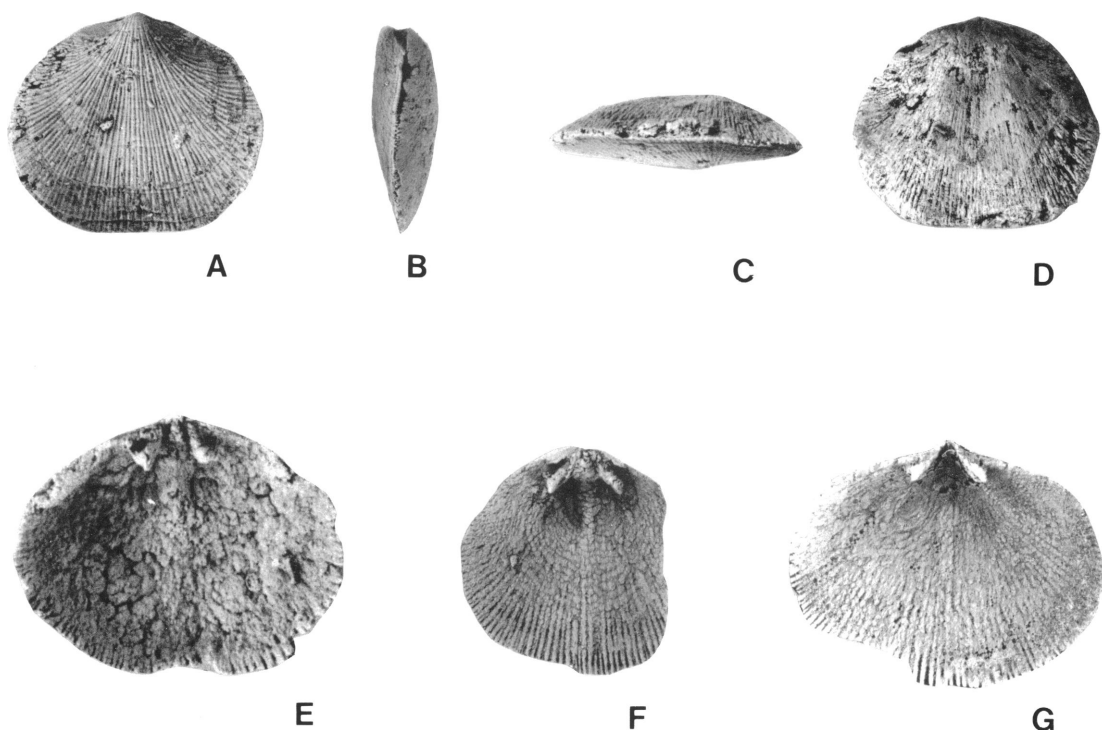


FIG. 8. *Dalejina* aff. *alsa* (Hall, 1863). A-D. AMNH Loc. 3135. Ventral, lateral, anterior and dorsal views, AMNH 39874,  $\times 2$ . *Discomyorthis?* sp. E. AMNH Loc. 3137. Brachial valve interior, AMNH 39876,  $\times 5$ . F. AMNH Loc. 3137. Brachial valve interior, AMNH 39873,  $\times 2$ . G. AMNH Loc. 3135. Pedicle valve interior, AMNH 39875,  $\times 2$ .

terolaterally as poorly defined ridges encompassing the posterior one-half to one-third of the muscle field. The muscle impressions of small specimens are indistinct, but definitely nonflabellate. On larger individuals the diductor scars, although not well preserved, are flabellate and take up approximately one-third of the valve floor. No adductor impressions were preserved. A vague median ridge is present on some specimens. The muscle scars merge anteriorly with the valve floor such that no definite boundary between the two may be delineated. The valve floor is crenulated at the periphery by the impress of the medially grooved costellae.

**BRACHIAL VALVE INTERIOR:** The sockets are fairly deep and broaden anterolaterally. The brachioophores attach directly to the valve floor and diverge from the beak at an angle of approximately 80 degrees. They are stout and subrectangular in cross section. The medially located cardinal process consists of a variably shaped protuberance, often poorly

preserved, resting on a deposit of secondary shell material in the notothyrial cavity. A low, broad myophragm extends from deep in the notothyrial cavity to about one-half to one-third the valve length. Muscle scars are generally faintly impressed but are more clearly defined as suboval pits on either side of the posterior portion of the myophragm (adductors?). The internal periphery is crenulated in the same manner as that of the pedicle interior.

**COMPARISON:** *Dalejina alsa* from the Bois Blanc Formation (Boucot and Johnson, 1968, p. B7, pl. 1, figs. 11-27) differs from *D. aff. alsa* in that the adductor scars are suboval with their anterior margins at approximately the center of the muscle field with a thickening along their anterior edges that continues anteriorly as a myophragm (see pl. 1, figs. 11, 12 above). This is true only of larger shells. In small shells of both the Bois Blanc and Onondaga specimens the muscle field is not well impressed, and there is only a vague in-

dication of flabellate muscle scars (especially in *D. aff. alsa*). The brachial interiors of *D. aff. alsa* (all silicified) are not preserved well enough to make meaningful comparisons with *D. alsa* other than to state that they appear to be almost identical.

*Dalejina cf. oblata* from the Green Pond Outlier in southeastern New York (Boucot, Gauri, and Southard, 1970, p. 6, pl. 1, figs. 7–13) may be differentiated from *D. aff. alsa* by the outline of the ventral adductors (narrower in *D. cf. oblata*).

*Dalejina emarginata* from the Keyser Limestone of Pennsylvania, Maryland, and West Virginia (Bowen, 1967, p. 21, pl. 1, figs. 9–14) differs from *D. aff. alsa* in its more triangular ventral muscle field and the presence of feeble, radial myophragms within the diductor field and smaller size. The outlines of the adductors are remarkably similar to Boucot and Johnson's (1968) *D. alsa* (see Bowen, 1967, pl. 1, fig. 14). *Dalejina emarginata* spans the upper *Eccentricosta jerseyensis* Zone the lower *Meristella praenuntia* Zone of the Keyser. The Silurian-Devonian boundary is placed by Bowen (1967, p. 17) between these two faunal zones based upon, in part, the occurrence of *Megakozłowskiella*, *Meristella*, and *Nanothyris*, genera known only in the Lower Devonian or younger strata in other areas of North America.

Boucot, Johnson, and Walmsley (1965), in a revision of the Rhipidomellidae, discuss the affinities of *Dalejina* which is succeeded by *Rhipidomella* and *Aulacella* in the Middle Devonian. J. G. Johnson (1970, p. 80), in describing *Dalejina* sp. A, B, and C from central Nevada, mentions that the Nevadan forms appear to be distinct from the lineage that developed in the Appalachian Province and which is exemplified in the Helderbergian of the Appalachian Province by *Dalejina oblata*. Johnson further points out that the Appalachian lineage is characterized by an increase in size and degree of flabellation of the ventral muscle scar as pointed out by Amsden and Ventress (1963, text-fig. 21, p. 64).

COMMUNITY OCCURRENCE: Feldman (1980) found this species in the *Leptaena-Megakozłowskiella*, *Atrypa-Coelospira-Nucleospira*, *Atrypa*, *Atrypa-Megakozłowskiella*, and "Pacificocoelia" communities.

FIGURED SPECIMENS: AMNH 42747, 42748, 42749.

*Discomyorthis?* sp.

Figure 8E–G

DISCUSSION: Two pedicle and two brachial valves of *Discomyorthis?* sp. were recovered from Upper Moorehouse strata in the mid-Hudson Valley. They differ from *Dalejina aff. alsa* in their more circular outline and larger ventral diductor scars. The pedicle valve bears a well-developed pedicle callist and short, triangular hinge teeth. The internal periphery is well preserved and distinctly shows the medially grooved costellae. There is an indication of a low, broad myophragm. The brachial valve bears a triangular cardinal process and poorly developed brachiophores which diverge at an angle of about 40 degrees. The sockets are short and deeply excavated anteriorly. Indistinct linear muscle scars are present along with a suggestion of a broad myophragm. Although the internal periphery is poorly preserved, medially grooved costellae are evident. Aside from the morphological variances discussed above, the shells are identical with *Dalejina aff. alsa*. Further collecting and study is necessary in order to determine a specific assignment.

COMMUNITY OCCURRENCE: Feldman (1980) found this species in the *Atrypa-Coelospira-Nucleospira* Community.

FIGURED SPECIMENS: AMNH 39873, 39875, 39876.

#### SUPERFAMILY ENTELETACEA

WAAGEN, 1884

FAMILY SCHIZOPHORIIDAE SCHUCHERT  
AND LEVENE, 1929

SUBFAMILY SCHIZOPHORIINAE SCHUCHERT  
AND LEVENE, 1929

GENUS *SCHIZOPHORIA* KING, 1850

TYPE SPECIES: *Conchylolithus Anomites resupinatus* Martin, 1809, pl. 49, figs. 13, 14.

*Schizophoria cf. multistriata* Hall  
(1859–1861)

Figures 9, 10

*Conchylolithus Anomites resupinatus* Martin,  
1809, pl. 49, figs. 13, 14.

*Schizophoria multistriata* Grabau, 1906, p. 156,  
fig. 69; Goldring, 1935, p. 119, fig. 41J, K; 1943,

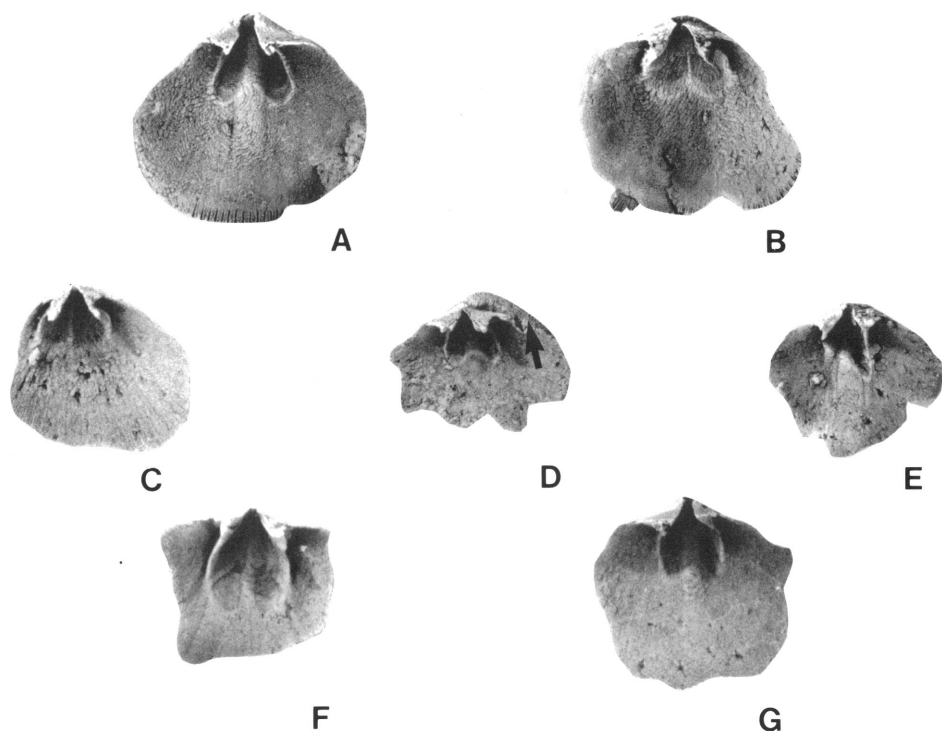


FIG. 9. *Schizophoria* cf. *multistriata* Hall (1859–1861). A, B. AMNH Loc. 3138A. Pedicle valve interior, brachial valve interior (articulated specimen), AMNH 39880a, 39880b,  $\times 1.5$ . C. AMNH Loc. 3135. Brachial valve interior, AMNH 42740,  $\times 2$ . D. AMNH Loc. 3138A. Pedicle valve interior externally encrusted by the trepostome bryozoan *Dyoidophragma?* sp. (arrow), AMNH 42760,  $\times 1$ . E. AMNH Loc. 3146. Brachial valve interior, AMNH 42739,  $\times 1.2$ . F, G. AMNH Loc. 3138A. Brachial valve interior (articulated specimen), AMNH 42738a, 42738b,  $\times 2$ .

p. 183, fig. 33n, o; Cooper, 1944, p. 357, pl. 140, figs. 10, 11.

**EXTERIOR:** The shells are medium-sized, suboval to subquadrate in outline, and unequally biconvex. The brachial valve is deeper and more uniformly convex. In younger

specimens both valves become almost equally biconvex. The pedicle valve develops a broad, shallow sulcus on ephebic specimens, whereas the brachial valve bears an even more indistinct fold. The hinge line is short and slightly rounded. Maximum width is attained at or just past midlength. The ventral inter-

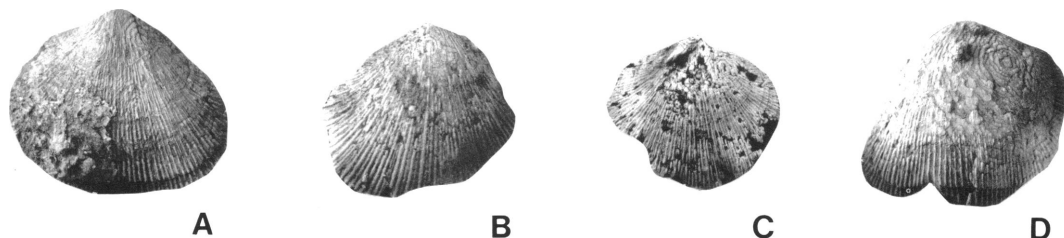


FIG. 10. *Schizophoria* cf. *multistriata* Hall (1859–1861). A, D. AMNH Loc. 3138A. Pedicle and brachial exteriors (articulated specimen), AMNH 39880a, 39880b,  $\times 1.2$ . B. AMNH Loc. 3155. Brachial valve exterior, AMNH 42740,  $\times 2$ . C. AMNH Loc. 3146. Brachial valve exterior, AMNH 42739,  $\times 1.2$ .

area is apsacline, triangular, and fairly high in larger specimens and relatively narrow in younger ones. The dorsal interarea is narrower and ranges from orthocline to apsacline. The interareas of both valves are equal to about one-half the width.

Ornamentation consists of rounded to subangular radial costellae with broad, flat interspaces which are usually preserved only at the anterior half of the valves. There are about 11 costellae in a 5 mm space near the anterior commissure at midline.

**PEDICLE VALVE INTERIOR:** The hinge teeth are small and subrectangular in cross section. They are supported by stout, anterolaterally diverging dental lamellae which join the valve floor at about one-third the length. The dental lamellae form the lateral margins of the pyriform diductor impressions which are bisected by a median, raised adductor platform that terminates slightly before the anterior extremity of the diductor scars is reached, thus giving a bilobed appearance to the entire muscle field. The delthyrium encloses an angle of about 45 degrees and opens into a small foramen apically. The anterior internal periphery is finely crenulated due to the impress of the costellae.

**BRACHIAL VALVE INTERIOR:** Only one specimen in the collection possesses a preserved cardinal process. Located deep in the notothyrial cavity, the process is rectangular in outline and slightly worn. The posterior portion appears to be bilobed but not enough shell material is present to make additional conclusions regarding the morphology of the structure. The sockets are short, deep, curved and widely divergent. They are bounded anterolaterally by small fulcral plates. The interarea conceals the posterior portion of the socket. Attached to the posterior ends of the fulcral plates are the brachiophore bases which project ventrally and are concave at their extremities. On the end of each brachiophore there is a posterolaterally directed hooklike apophysis.

The muscle field is subcircular to suboval and bisected by a poorly defined myophragm which separates the adductor scars. In some instances the dorsal muscle field is pyriform in outline and appears to be bilobed, as does the ventral muscle field. The anterior rim of the field is often raised above the valve floor.

The anterior internal periphery is finely crenulated due to the impress of the costellae.

**COMPARISON:** Imbrie (1959) described three species of *Schizophoria* from the Traverse Group of Michigan: *S. ferronensis* (p. 364, pl. 48, figs. 1–7), *S. traversensis* (p. 364, pl. 48, figs. 8–14), and *S. mescarina* (p. 365, pl. 48, figs. 15–21). The ventral muscle field of *S. ferronensis* (also illustrated in Kesling and Chilman, 1975, pl. 24, figs. 12–14; pl. 64, figs. 1–5) is more lobate and shorter than that of *S. cf. multistriata*. In addition, *S. cf. multistriata* is subquadrate in outline, whereas *S. ferronensis* is smaller and subelliptical in outline. *Schizophoria traversensis* possesses a more pyriform ventral muscle field and is subelliptical in outline and *S. mescarina* may be distinguished from *S. cf. multistriata* by its elongate ventral muscle field.

Fragmentary specimens of *Schizophoria?* sp. ventral valves were described briefly by Boucot, Gauri, and Southard (1970, p. 91, pl. 2, fig. 2a, b) from the Coeymans Limestone (USNM Loc. 11259) of the Green Pond Outlier, New York, which differ from *S. cf. multistriata* in their elongate muscle fields with subparallel lateral margins.

Johnson's (1970, pl. 8, figs. 1–12) *S. parafragilis* from the McMonnigal Limestone of the Great Basin may be differentiated from *S. cf. multistriata* mainly by its ventral muscle field, which is less bilobate anteriorly, more elongate, and subparallel to midline at the lateral margins.

*Schizophoria cf. paraprima* from the Lower Lochkovian and Pragian beds (sections 1, 2, 4) of Royal Creek, Yukon, described by Lenz (1977, p. 62, pl. 4, figs. 11, 12, 15–37, 40, 42–44) show close affinities to Johnson's (1970) *S. parafragilis* of Nevada, but Lenz believes that the Yukon specimens are more closely related to *S. paraprima* (Johnson, Boucot, and Murphy, 1973). *Schizophoria cf. paraprima* differs from *S. cf. multistriata* in its narrower, more elongate ventral muscle field and ovate outline.

**COMMUNITY OCCURRENCE:** Feldman (1980) found this species in the *Atrypa-Coelospira-Nucleospira*, *Atrypa*, and *Atrypa-Megakozlowskiella* communities.

**FIGURED SPECIMENS:** AMNH 39880a, 39880b, 42738a, 42739, 41740.



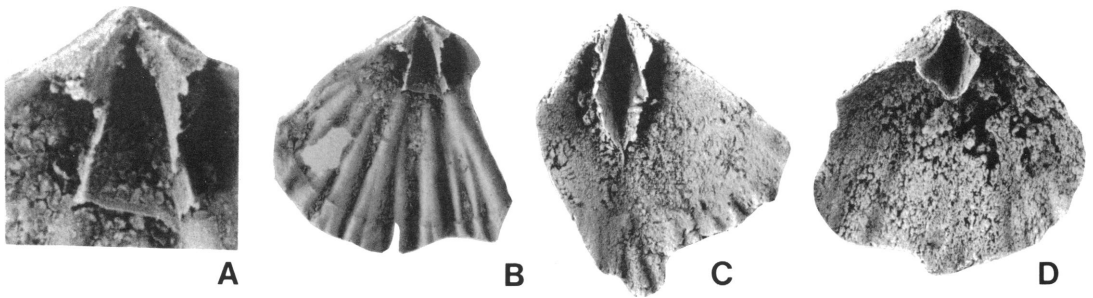


FIG. 11. *Pentamerella arata* (Conrad, 1841). A, B. AMNH Loc. 3137. Pedicle valve interior, AMNH 39877,  $\times 4$ ,  $\times 1.5$ . D. AMNH Loc. 3137. Pedicle valve interior, AMNH 39878,  $\times 3$ . *Gypidula* sp. C. AMNH Loc. 3141. Pedicle valve interior, AMNH 39879,  $\times 3$ .

ORDER PENTAMERIDA

SUBORDER PENTAMEROIDEA

SUPERFAMILY PENTAMERACEA M'COY, 1844

FAMILY GYPIDULIDAE SCHUCHERT AND  
LEVENE, 1929

SUBFAMILY GYPIDULINAE SCHUCHERT  
AND LEVENE, 1929

GENUS *PENTAMERELLA* HALL, 1867

Type species: *Atrypa arata* Conrad, 1841,  
p. 55.

*Pentamerella arata* (Conrad, 1841)

Figures 11A, B, D, 12A–D, 13

*Atrypa arata* Conrad, 1841, p. 55.

*Pentamerella arata* Hall, 1867, p. 375, pl. 58, figs.  
1–12; Kindle, 1901, pl. 615; Grabau, 1906, p.  
184, fig. 100; Amsden, 1964, p. 233, pl. 40, figs.  
9–14, text-fig. 5; Boucot and Johnson, 1968, p.  
B8, pl. 1, figs. 28–36.

**EXTERIOR:** The shells are subglobose and broadly pyriform in outline with a strongly convex pedicle valve and a weakly convex brachial valve. The hinge line is short, curved, and narrow with no interarea evident. The maximum width is attained at or about mid-length. The pedicle valve beak is short, strong, incurved, and appears not to be closely pressed against the brachial beak. The brachial beak is small, not as erect, and less incurved. A weak sulcus becoming more distinct as the anterior commissure is approached is present on the anterior half of the pedicle valve. A corresponding fold on the single brachial valve in the collection is barely discernible. The anterior commissure is probably slightly sulcate (uniplicate?) and crenulate, although no specimens preserved

this feature. Both valves are ornamented with numerous, rounded, bifurcating plications, which become narrower on the lateral slopes than near midline. The interspaces between plications are U-shaped and generally wider than the plications, which tend to become slightly V-shaped in cross section on some specimens. Approximately five plications are located in the sulcus and six on the fold. The plications extend back to the beak in most instances, on both valves. Concentric growth lines, concentrated toward the anterior of the shells, are present on many of the pedicle exteriors studied.

**PEDICLE VALVE INTERIOR:** The hinge teeth are small and V-shaped with the apex posteriorly directed. They attach directly to the lateral and anterior margins of the triangular delthyrium. A strong, elongate, deeply excavated spondylium is supported by a median septum such that the anterior nine-tenths of the spondylium projects out over the valve floor unsupported. The median septum is thin and bladelike and is confined to the posterior portion of the valve. In some specimens the median septum extends past midlength. The valve floor is crenulated anteriorly due to the impress of the plications. No muscle scars were observed.

**BRACHIAL VALVE INTERIOR:** The sockets are slight indentations, posterolaterally directed and well-worn. No cardinal process is present. A well-formed, triangular, spoon-shaped cruralium, shaped by the medial fusion of the outer plates, extends anteriorly and unites with the valve floor dorsally. The cruralium is the site for the attachment of the adductors. The notothyrial cavity is shallow and empty.

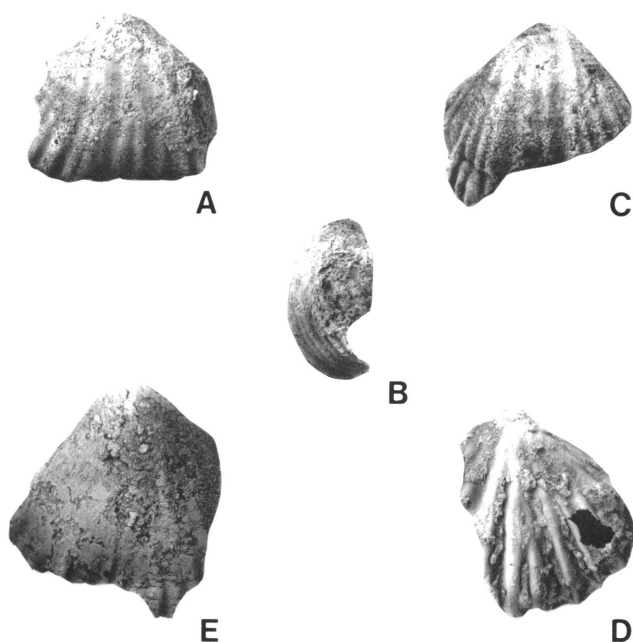


FIG. 12. *Pentamerella arata* (Conrad, 1841). A, B. AMNH Loc. 3137. Pedicle valve exterior and lateral view, AMNH 42770,  $\times 1.5$ . C. AMNH Loc. 3135. Pedicle valve exterior, AMNH 42771,  $\times 1.5$ . D. AMNH Loc. 3137. Pedicle valve exterior, AMNH 39877,  $\times 1.5$ . *Gypidula* sp. E. AMNH Loc. 3141. Pedicle valve exterior, AMNH 39879,  $\times 3$ .

The valve floor is strongly crenulated by the impress of the plications.

DISCUSSION: Hall (1867, p. 375, pl. 58, figs. 1–21) describes *Pentamerella arata* from the Schoharie Grit and limestones of the Upper Helderberg Group in Albany and Schoharie counties, New York. Hall mentions additional occurrences without providing specific localities: Cherry Valley, Waterville, and Babcock's Hill in Oneida County; Lima in Ontario County; Caledonia in Livingston County; Leroy and Stafford in Genesee County; Clarence Hollow and 5 miles east of Buffalo in Erie County; Canada West and at the Falls of the Ohio. In Hall's (1867) illustrated specimens only figures 1–12 (pl. 58) resemble the Onondagan forms of *P. arata*. *Pentamerella* cf. *arata*, described from the Bois Blanc Formation in New York by Boucot and Johnson (1968, p. B8, pl. 1, figs. 28–36, Boucot and Johnson Locality number 4672-SD), is identical with *P. arata* from the Onondaga except for a shallower and smaller spondylium.

COMMUNITY OCCURRENCE: Feldman (1980)

found this species in the *Leptaena-Megakozlowskiella*, *Atrypa-Coelospira-Nucleospira*, *Atrypa*, *Atrypa-Megakozlowskiella*, *Levenea* Community I, "*Pacificocoelia*," and "*Chonetes*" communities.

FIGURED SPECIMENS: AMNH 39877, 39878, 42770, 42771, 42772, 42773, 42774.

#### GENUS *GYPIDULA* HALL, 1867

##### *Gypidula* sp.

Figures 11C, 12E

REMARKS: Only two fragmentary brachial valves are available for study. They both possess brachial plates which are lyre-shaped in cross section, a spoon-shaped cruralium which unites with the valve dorsally, and a weak dorsal fold. Not enough material is at hand for a specific identification. Bowen (1967, p. 24, pl. 1, figs. 34–38; pl. 2, figs. 1–4) describes *Gypidula prognostica* from the Keyser Limestone (Bowen Localities 1, 3), which is similar to the Onondagan forms, but smaller. Boucot, Gauri, and Southard (1970, p. 10, pl. 4, figs. 2–6) report *G. coeymanensis*

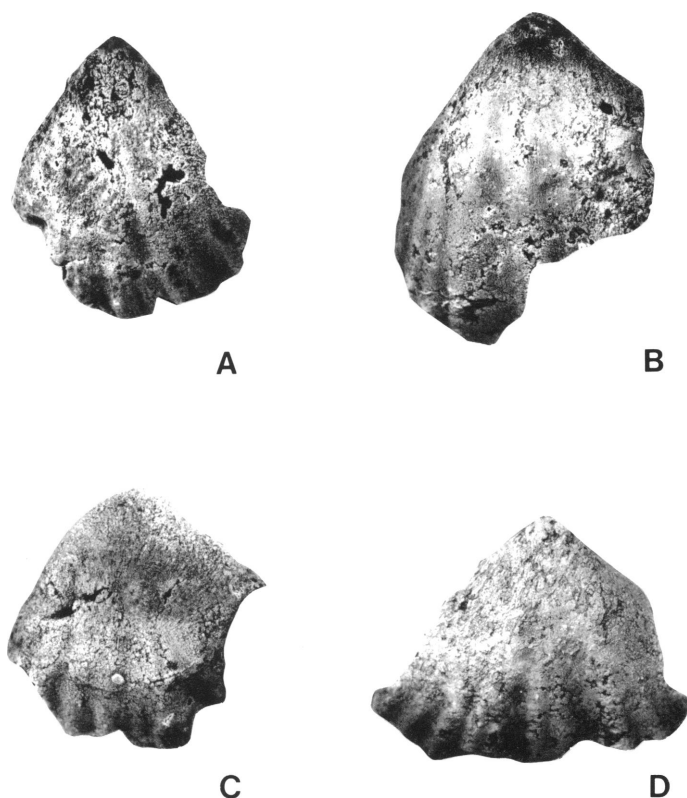


FIG. 13. *Pentamerella arata* (Conrad, 1841). A. AMNH Loc. 3137. Pedicle valve exterior, AMNH 42772,  $\times 3$ . B. AMNH Loc. 3135. Pedicle valve exterior, AMNH 42773,  $\times 3$ . C. AMNH Loc. 3137. Pedicle valve exterior, AMNH 42774,  $\times 3$ . D. AMNH Loc. 3137. Pedicle valve exterior, AMNH 39878,  $\times 3$ .

from the New Scotland and Coeymans formations (USNM Locs. 11270, 11259) of the Green Pond Outlier in southeastern New York. Their specimens approach the material recovered from the Onondaga in size and morphology but at this point I am unable to determine any affinity due to partial silicifi-

cation and poor preservation. Anderson and Makurath (1973) also report *G. coeymanensis* from the Coeymans Formation at Sharon Springs, New York. Their specimens, although not described are illustrated and closely resemble *Gypidula* sp. described above.



FIG. 14. *Leptaena* aff. "*rhomboidalis*" (Wilckens, 1769). AMNH Loc. 3128C. Impression of pedicle valve, AMNH 42758,  $\times 1$ .

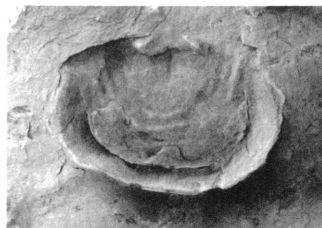


FIG. 15. *Leptaena* aff. "*rhomboidalis*" (Wilckens, 1769). AMNH Loc. 3128C. Impression of pedicle valve, AMNH 39881,  $\times 1$ .



FIG. 16. *Leptaena* aff. "*rhomboidalis*" (Wilckens, 1769). AMNH Loc. 3124A. Impression of pedicle valve interior, AMNH 39886,  $\times 1.5$ .

COMMUNITY OCCURRENCE: Feldman (1980) found this species in the *Leptaena-Megakozlowskiella*, *Atrypa*, and *Atrypa-Megakozlowskiella* communities.

FIGURED SPECIMEN: AMNH 39879.

ORDER STROPHOMENIDA  
SUBORDER STROPHOMENOIDEA  
SUPERFAMILY STROPHOMENACEA  
KING, 1846

FAMILY STROPHOMENIDAE KING, 1846  
SUBFAMILY LEPTAENINAE DALMAN, 1828  
GENUS *LEPTAENA* DALMAN, 1828

Type species: *Leptaena rugosa* Dalman, 1828, pl. 1, fig. 1.

*Leptaena* aff. "*rhomboidalis*"  
(Wilckens, 1769)  
Figures 14–16

*Leptaena rugosa* Dalman, 1828, p. 93.

*Leptaena* aff. "*rhomboidalis*" Boucot, 1973, p. 20, pl. 6, figs. 12–16.

EXTERIOR: The shells are medium to large, and transversely subquadrate in outline with the anterior margin often parallel to the hinge line. They range from concavoconvex to slightly biconvex with the pedicle valve strongly geniculate at the anterior and lateral commissure. The brachial valve is correspondingly geniculate within the pedicle trail. The hinge line is straight and is the place of maximum width. The pedicle interarea is linear, flat, and apsacline. No delthyrium was preserved although there are indications of a delthyrial margin on one silicified specimen. The brachial interarea is linear and anacline. Ornamentation consists of radial costellae

(about 12 in a distance of 5 mm at midline, near the anterior margin and posterior to the point of geniculation) which extend past the point of geniculation and continue on the trail of the valves. Concentric rugae cross the costellae (six to 10 per valve) becoming larger and more pronounced anteriorly.

PEDICLE VALVE INTERIOR: The hinge teeth were partially preserved on few specimens. The teeth appear to be widely spaced, blunt, and stout, and anterolaterally directed. The muscle field is oval and bisected by a low, broad myophragm which terminates at the anterior margin of the muscle field. The myophragm bears a low, longitudinal ridge which ends just past the end of the myophragm, at about midlength. The myophragm and ridge are the sites for attachment of the adductors while the diductors are attached to the oval area bounded by a slightly raised, arcuate rim. The valve floor is crenulated due to the impress of the concentric rugae. Also, the impressions of the costellae are visible on thin-shelled specimens.

BRACHIAL VALVE INTERIOR: The only brachial interior in the collection is lacking the cardinalia and muscle impressions. The interior is crenulated in an identical manner with that of the pedicle interior described above.

COMPARISON: The Onondagan specimens are similar to the ubiquitous *Leptaena rhomboidalis* in general morphology; however, material recovered is lacking in critical morphologic details, such that a definite specific assignment cannot be made at present. Bowen's (1967, p. 32, pl. 4, figs. 3–5) species from the Keyser Limestone of Pennsylvania and Maryland are also subquadrate in outline and about the same size. Rugae in both Onondaga and Keyser specimens weaken posteriorly. Specimens of *Leptaena* sp. from the Bois Blanc Formation described by Boucot and Johnson (1968, p. B8, pl. 2, figs. 1–6) are poorly preserved and serve only to record the presence of the genus in strata directly underlying the Onondaga in western New York (Boucot and Johnson Locality 4672-SD). Boucot's (1959, p. 752, pl. 96, figs. 1, 2) fragmentary "wrinkled" forms of *L. "rhomboidalis"* from the Esopus Formation at Highland Mills, New York, appear to be closely related to the Onondagan forms but are too

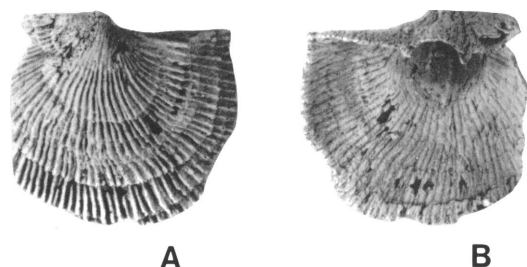


FIG. 17. "*Schuchertella*" sp. A, B. AMNH Loc. 3137. Pedicle valve exterior, pedicle valve interior, AMNH 39882,  $\times 1.5$ .

poorly preserved to make further significant comparison.

COMMUNITY OCCURRENCE: Feldman (1980) found this species in the *Leptaena-Megakozlowskiella*, *Atrypa-Coelospira-Nucleospira*, *Atrypa*, *Atrypa-Megakozlowskiella*, *Levenea* Community I, *Pacificocoelia* and "*Chonetes*" communities.

FIGURED SPECIMENS: AMNH 39881, 39886, 42758.

SUPERFAMILY DAVIDSONIACEA KING, 1850

FAMILY SCHUCHERTELLIDAE

WILLIAMS, 1953

SUBFAMILY SCHUCHERTELLINAE

WILLIAMS, 1953

GENUS *SCHUCHERTELLA* GIRTY, 1904

"*Schuchertella*" sp.

Figure 17

DESCRIPTION: The taxon is represented in the collection by a single, fairly well-preserved ventral valve, damaged on one lateral extremity, along with miscellaneous shell fragments. The valve is medium-sized, transversely subelliptical in outline but subpyramidal in the umbonal region. The anterior of the valve is almost flat. The shell exterior is multicostellate; there are nine costellae in a space of 5 mm measured along the anterior commissure at midline. Concentric growth lamellae are present originating at a distance of 10 mm from the beak, along midline. The valve is twisted apically. The interarea is apsacline, flat, and broadly triangular when viewed posteriorly. The delthyrium is covered by a convex pseudodeltidium. The hinge teeth are small, pointed, dorsally directed, and not supported by dental plates but act as

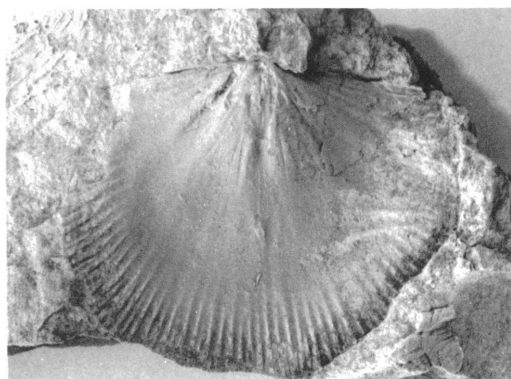


FIG. 18. Orthotetacid indet. AMNH Loc. 3125A. Impression of pedicle valve interior, AMNH 39884,  $\times 2$ .

extensions of longitudinal ridges lining the inner margins of the delthyrial cavity. The muscle scars are faintly impressed upon the floor of the valve and are defined by a circular field unequally divided by three slight ridges (probably sites of adductor attachment). There is no real median septum.

REMARKS: "*Schuchertella*" sp. has coarser costae and a broader interarea than "*Schuchertella*" sp. A of Boucot and Johnson (1968, p. B9, pl. 2, figs. 17–30) from the Bois Blanc Formation in western New York (Boucot and Johnson Localities 4671-SD, 4672-SD). Boucot and Johnson (1968, p. B9, pl. 2, figs. 31–36) also describe "*Schuchertella*" sp. B from the Bois Blanc Formation (Boucot and Johnson Locality 4671-SD) which closely resembles "*Schuchertella*" sp. in that the costae are coarser and the growth lines are similarly spaced. However, since the Bois Blanc specimen is a dorsal valve the internal morphologies are not readily comparable.

Boucot, Gauri, and Southard (1970, p. 23, pl. 8, fig. 5a–c; pl. 8, figs. 6–8) describe *Schuchertella*? sp. A and sp. B from the Green Pond Outlier in southeastern New York. *Schuchertella*? sp. A (USNM Loc. 11259) is represented only by dorsal valves and is similar to "*Schuchertella*" sp. from the Onondaga in its relatively coarse costae. *Schuchertella*? sp. B (USNM Loc. 11245) more closely resembles "*Schuchertella*" sp. internally (see fig. 6b, rubber replica of ventral internal mold) in that the dental plates in the ventral interior are absent, the hinge teeth

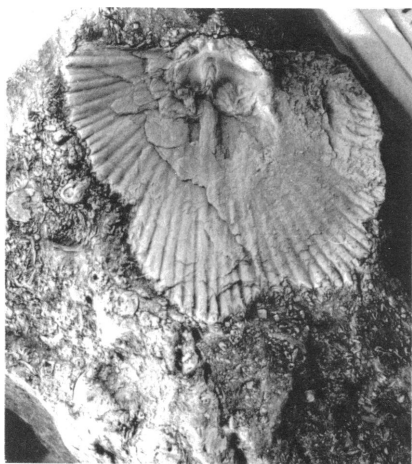


FIG. 19. Orthotetacid indet. AMNH Loc. 3122. Impression of pedicle valve interior, AMNH 39885,  $\times 2$ .

are small, and the interarea appears to be relatively broad.

Boucot (1973, p. 24, pl. 9, figs. 1–11) describes "*S.*" *becraftensis* from the Moose River Synclinorium but cannot assign a definite generic name due to the lack of modern consideration of taxonomy and morphology of Silurian-Devonian orthotetaceans. The Maine shells are similar to "*S.*" sp. in costation and general internal morphology (compare pl. 9, fig. 11).

COMMUNITY OCCURENCE: Feldman (1980) found this species in the *Atrypa-Coelospira-Nucleospira* Community.

FIGURED SPECIMEN: AMNH 39882.

#### Orthotetacid indet.

Figures 18, 19

REMARKS: Several poorly preserved impressions of orthotetacid fragments are in the collection and many more have been observed in the field. The muscle fields appear to be small, and limited to the umbonal region. One cardinal process observed seemed to be an extension of a median partition. There is a well-developed hinge line but no preserved interareas. Ornamentation is finely costellate. Generic identification is not possible with the material at hand.

COMMUNITY OCCURRENCE: Feldman (1980) found this species in the *Leptaena-Megakoz-*

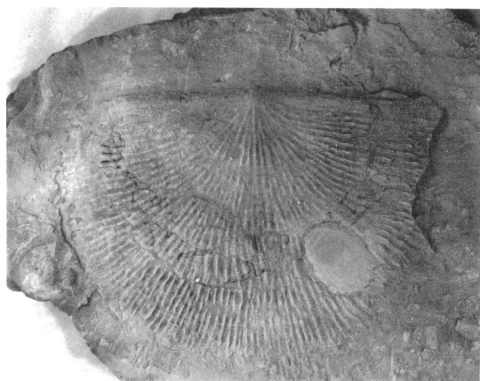


FIG. 20. *Costistrophonella* cf. *punctulifera* (Conrad, 1838). AMNH Loc. 3131C. Impression of pedicle valve with camerate crinoid scar, AMNH 39883,  $\times 1$ .

*lowskiella*, *Atrypa-Coelospira-Nucleospira*, *Atrypa*, *Atrypa-Megakozlowskiella*, *Pacificocoelia*, and "*Chonetes*" communities.

FIGURED SPECIMENS: AMNH 39884, 39885.

#### SUPERFAMILY STROPHEODONTACEA

CASTER, 1939

(nom. transl. Sokolskaya, 1960,

ex *Stropheodontidae* Caster, 1939)

FAMILY STROPHONELLIDAE CASTER, 1939

GENUS *COSTISTROPHONELLA* HARPER AND

BOUCOT, 1978

TYPE SPECIES: *Strophomena semifasciata* Hall, 1863, p. 210.

#### *Costistrophonella* cf. *punctulifera*

(Conrad, 1838)

Figure 20

*Strophomena punctulifera* Conrad, 1838, p. 117.

*Strophodonta punctulifera* Hall, 1859, p. 188, pl. 21, fig. 4; pl. 23, figs. 4, 5, 7e.

*Strophonella* cf. *punctulifera* Boucot, 1973, p. 23, pl. 8, figs. 14–18.

*Strophonella punctulifera* Hall and Clarke, 1892, p. 291, pl. 12, figs. 10–12; Schuchert et al., 1913, p. 323, pl. 59, figs. 8–10; Cooper, 1944, p. 339, pl. 130, figs. 19, 20; Johnson, 1970, p. 113, pl. 20, figs. 1–6; pl. 21, figs. 13, 14.

*Costistrophonella punctulifera* Harper and Boucot, 1978, p. 99, pl. 17, figs. 5–9; pl. 18, figs. 1–6.

DESCRIPTION: This species is represented in the collection by a single, poorly preserved



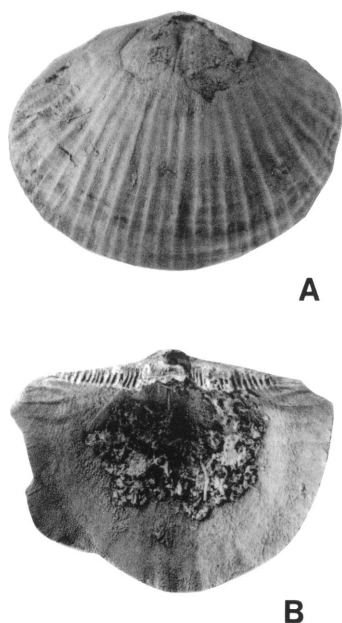


FIG. 21. *Megastrophia* sp. A. AMNH Loc. 3135. View of exfoliated pedicle valve exterior, AMNH 39887,  $\times 1.5$ . B. AMNH Loc. 3138A. Pedicle valve interior, AMNH 39891,  $\times 2.5$ .

pedicle valve exterior which is relatively large, wider than long, and subsemicircular in outline. Due to compression the valve is completely flattened. The hinge line is long and straight; no interarea is discernible. The ornamentation consists of numerous, subangular, radiating costae which increase anteriorly both by bifurcation and intercalation. The interspaces are quite broad and shallow. There are 11 to 12 costae per 5 mm near the anterior commissure at midline. The costae are crossed by about seven fairly evenly spaced, concentric growth lines.

REMARKS: *Costistrophonella* was erected as a new genus by Harper and Boucot (1978; see p. 99 for diagnosis). They report the geographic distribution of the genus in New York as follows. *Costistrophonella* cf. *punctulifera* occurs in Lower Helderberg rocks of Gedinian age; *Costistrophonella* sp. has been reported from the New Scotland Formation, of Gedinian age, and *C. ampla* has been found in the Schoharie Grit, of Emsian age. Until now *C. punctulifera* has not been found in rocks of Onondagan age in New York State.

COMMUNITY OCCURRENCE: Feldman (1980)

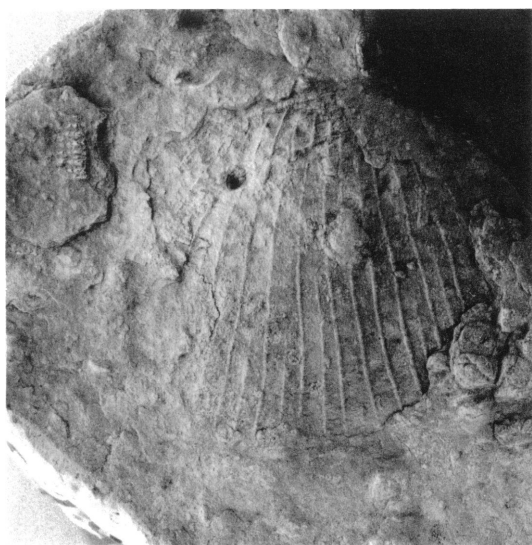


FIG. 22. *Megastrophia* sp. AMNH Loc. 3123A. Pedicle valve exterior showing detail of ornament, AMNH 39888,  $\times 2$ .

found this species in the *Leptaena-Megakozlowskiella* and *Atrypa* communities.

FIGURED SPECIMEN: AMNH 39883.

FAMILY STROPHEODONTIDAE CASTER, 1939  
GENUS *MEGASTROPHIA* CASTER, 1939  
SUBGENUS *MEGASTROPHIA* (*MEGASTROPHIA*)  
CASTER, 1939

*Megastrophia* sp.

Figures 21, 22

DESCRIPTION: The shells are medium-sized to large, subsemicircular to transversely sub-oval in outline, somewhat alate, and concavoconvex in lateral profile. Maximum width is attained at the hinge line. No free brachial valves were recovered and the only articulated specimen is poorly preserved. The pedicle interarea is weakly apsacline and denticulate along its entire length. The delthyrium appears to be partially covered by a pseudodeltidium, but that general region is also not well preserved. The dorsal interarea is chipped off from the only articulated specimen in the collection. Its ventral umbo is exfoliated, exposing some of the muscle field which appears to be identical with that of one other well-preserved (silicified) pedicle valve, namely, subpyriform and bisected by a low

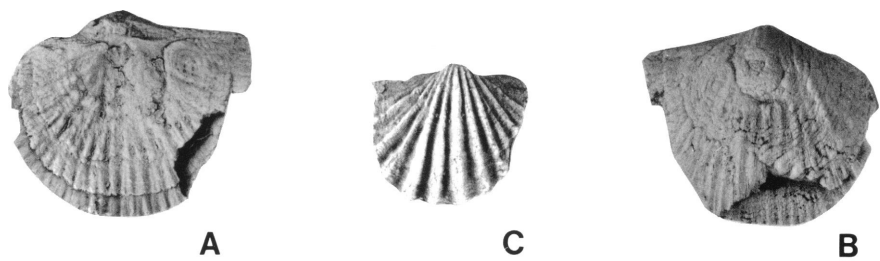


FIG. 23. *Strophodonta* cf. *demissa* (Conrad, 1842). A, B. AMNH Loc. 3137. Dorsal and ventral views, AMNH 39890,  $\times 2$ . C. AMNH Loc. 3135. Ventral view, AMNH 42767,  $\times 2$ .

myophragm which extends to about mid-length. Suboval adductor impressions are located just ventral and anterior to the ventral process, which is bilobed and pustulose, and lie on either side of the posterior portion of the myophragm, which, at that point, is bladeliike. Anteriorly, however, the myophragm becomes broader and flatter. The diductors were not impressed clearly but there are vague indications of a broadly pyriform scar anterolateral to the adductor scars. On only one specimen is there a trace of the dorsal muscle field, and that is extensively ex-foliated. However, there is a large, almost flabellate region in the center of which lies a narrow, suboval, longitudinally grooved scar. The ornament is finely parvicostellate, commonly with one or two secondary costellae between the primaries. Occasional specimens have as many as four secondary costellae associated with one larger, secondary costella.

COMPARISON: *Megastrophia* sp. is similar to *M. concava* (Hall) in its alate appearance and ornamentation. It is not as convex as *M. hemisphaerica* (Hall) and not as uniformly costellate. Harper and Boucot (1978, p. 20, pl. 39, fig. 16; pl. 40, figs. 1–4) report on the occurrence of *Megastrophia* (*Megastrophia*) Caster, 1939 from the Kanouse Sandstone (see Boucot, 1959, p. 752), the Schoharie Grit (see Hall, 1867), the Onondaga Limestone (see Hall, 1867, pp. 91, 92), and the Moscow Shale of the Hamilton Group (see Hall, 1867, p. 91).

COMMUNITY OCCURRENCE: Feldman (1980) found this species in the *Leptaena-Megakozlowskiella*, *Atrypa-Coelospira-Nucleospira*, *Atrypa*, *Atrypa-Megakozlowskiella*, *Pacificocoelia* and “*Chonetes*” communities.

FIGURED SPECIMENS: AMNH 39887, 39888.

GENUS *STROPHODONTA* HALL, 1850

TYPE SPECIES: *Strophomena demissa* Conrad, 1842, p. 258.

*Strophodonta* cf. *demissa* (Conrad, 1842)  
Figure 23

*Stropheodonta* cf. *demissa* Boucot and Johnson, 1968, p. 89, pl. 1, figs. 7–16; Boucot, 1973, p. 21, pl. 6, figs. 17–19.

REMARKS: Two moderately well-preserved, articulated specimens are available for study (table 2) along with several fragmentary pieces which are so poorly preserved that it is impossible to determine whether they represent pedicle or brachial valves. One fragment bears what appears to be a well-worn, bilobed cardinal process. The shells are subcircular to shield-shaped in outline and concavoconvex in lateral profile. Both shells are wider than long. The point of maximum

TABLE 2  
Measurements (in Millimeters) of Articulated Specimens of *Strophodonta* cf. *demissa* (Conrad, 1842)

AMNH Locality	(L)	(W)	(T)	No. of Costellae per 5 mm at Anterior Commis-sure
3137	13.0	15.5	3.5	8
3135	6.4	7.0 est.	1.5	5

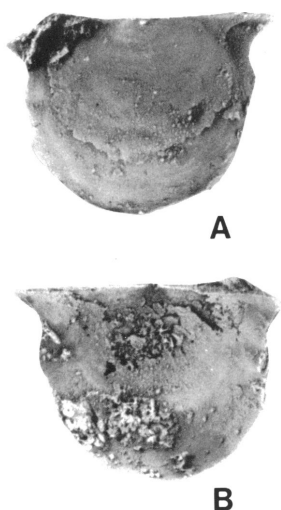


FIG. 24. *Stropheodontid* indet. A, B. AMNH Loc. 3137. Pedicle valve exterior and pedicle valve interior, AMNH 39892,  $\times 3.5$ .

width is at the hinge line. The lateral margins are almost straight posteriorly, whereas the anterior margins are evenly rounded. All margins are crenulate and the anterior commissure is rectimarginate. The smaller specimen (neanic) bears coarser costellae, angular in cross section. On both shells the costellae are bifurcating with narrow interspaces, also angular in cross section.

COMPARISON: Specimens of *S. demissa* from the Kanouse Sandstone described by Boucot (1959, p. 751, pl. 95, figs. 1–4) are almost identical in outline. Costation in the Onondaga forms is generally coarser (especially AMNH 42767, fig. 18c). Boucot and Johnson's (1968, p. B9, pl. 2, figs. 7–16) *S. cf. demissa* from the Bois Blanc Formation

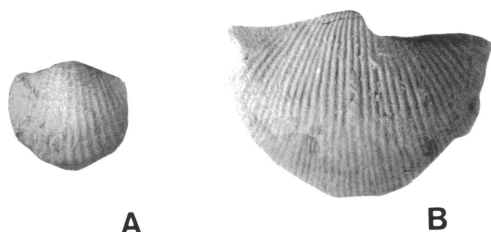


FIG. 25. "*Chonetes*" aff. *lineata* Hall, 1867. A. AMNH Loc. 3138A. Ventral view, AMNH 42745,  $\times 2$ . B. AMNH Loc. 3129. Ventral view, AMNH 42744,  $\times 3$ .

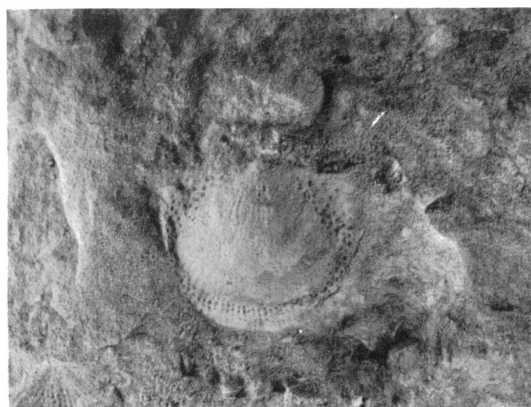


FIG. 26. "*Chonetes*" aff. *lineata* Hall, 1867. AMNH Loc. 3129. Impression of pedicle valve, AMNH 42755,  $\times 4$ .

(Boucot and Johnson Loc. 4672-SD) are almost identical in size but due to poor preservation further comparison must be deferred.

Hall (1867) reports *S. demissa* from the Schoharie Grit, Onondaga Limestone, and Hamilton Group of New York. Hall also reports a continuation of the species in the Chemung Group where, found in arenaceous beds, it strongly resembles Schoharie specimens. *Stropheodonta demissa* from the Onondaga Limestone is reported by Hall (1867, p. 103) to be smaller than average for the species but are thick and robust with a high degree of convexity.

COMMUNITY OCCURRENCE: Feldman (1980) found this species in the *Leptaena-Megakozlowskiella*, *Atrypa-Coelospira-Nucleospira*, and *Atrypa-Megakozlowskiella* communities.

FIGURED SPECIMENS: AMNH 39890, 42767.

#### *Stropheodontid* indet.

##### Figure 24

REMARKS: This is represented by six fragmentary, silicified specimens which fit the general description of stropheodontids but are so poorly preserved that generic assignment is impossible. The shells are subcircular in outline, alate, and have a smooth exterior with irregularly spaced growth lines. In these respects they are similar to *Lissostrophia*



FIG. 27. "*Chonetes*" aff. *lineata* Hall, 1867. AMNH Loc. 3129. View of poorly preserved slab of fine-grained, "muddy" limestone of the "*Chonetes*" Zone (see Feldman, 1980, p. 29). Exfoliation and extensive weathering preclude positive generic identification. Note fairly well-preserved pedicle valve impression with median septum (arrow) and papillose internal surface, AMNH 42768,  $\times 2.5$ .

(Harper and Boucot, 1978, p. 39, pl. 36, figs. 10, 11, 14–16) but differ in their flatter umbo which does not project posteriorly to overhang the hinge line. The Onondaga shells are also similar to *Pholidostrophia* (*Mesopholidostrophia*) (Harper and Boucot, 1978, pp. 41–42, pl. 50, figs. 13a, 23a) and *Pholidostrophia* (*Pholidostrophia*) (Harper and Boucot, 1978, p. 42, pl. 50, fig. 7) in their smooth exteriors but differ in their smaller size. *Teichoostrophia* (Harper and Boucot, 1978, pp. 43–44, pl. 49, figs. 23, 25, 29) also has a smooth exterior but is subrectangular in outline.

COMMUNITY OCCURRENCE: Feldman (1980) found this species in the *Leptaena-Megakozlowskiella* and *Atrypa-Nucleospira-Coelospira* communities.

FIGURED SPECIMEN: AMNH 39892.

SUBORDER CHONETOIDEA  
SUPERFAMILY CHONETACEA SHROCK AND  
TWHOFEL, 1953  
FAMILY CHONETIDAE BRONN, 1862  
SUBFAMILY CHONETINAE BRONN, 1862  
GENUS *CHONETES* FISCHER  
DE WALDHEIM, 1830

"*Chonetes*" aff. *lineata* Hall, 1867  
Figures 25–28

*Strophomena lineata* Conrad, 1839, p. 64; Vanuxem, 1842, p. 139, fig. 6 (should be emended to read 5a); Hall, 1843, p. 175, fig. 8.  
*Chonetes glabra* Hall, 1857, p. 117, figs. 1–8.  
*Chonetes lineata* Hall, 1867, p. 121, pl. 20, fig. 3; Hall and Clarke, 1892, pl. 16, fig. 34.

REMARKS: Since the material at hand is poorly preserved and worn, and the few brachial interiors that were recovered were un-



FIG. 28. "*Chonetes*" aff. *lineata* Hall, 1867. View of same slab of poorly preserved limestone as illustrated in figure 24. In both figures note absence of identifiable brachial valve impressions and presence of exfoliated surfaces (arrow). The limestone at this locality contains numerous stylolites, AMNH 42768,  $\times 2.5$ .

suitable for identification at the generic level, the specimens are questionably assigned to the genus "*Chonetes*."

**EXTERIOR:** The shells are small, subsemicircular in outline, and concavoconvex in lateral profile. The interareas are very narrow. No delthyrial structures were preserved. Greatest width is attained at the hinge line or anterior to midlength. Spines were not observed. The valves are covered with fine capillae which increase anteriorly by bifurcation.

**PEDICLE VALVE INTERIOR:** The pedicle valve interior bears a strong median septum often extending two-thirds the valve length, broadening at midlength, and tapering off anteriorly. The internal surface is papillose and impressed anteriorly by the external ornament.

**BRACHIAL VALVE INTERIOR:** The only cardinal process observed was a faint longitudinal ridge at the posterior end of the valve. No alveolus was present but one faint lateral groove (=anderidium?) was evident. No other structures were preserved.

**COMPARISON:** "*Chonetes*" aff. *lineata* is smaller than *Chonetes scitula* which has a less convex pedicle valve and is more finely capillate (AMNH 5164/1 from the Hamilton of Cumberland, Maryland). Cooper (1944, pl. 134, fig. 11) also illustrates a specimen of *C. scitula* but does not give the exact location. In all other respects the two species appear to be identical.

Grabau (1906) illustrates three species of "*Chonetes*": (1) *C. coronatus* is larger than "*Chonetes*" aff. *lineata*; (2) *C. mucronatus*

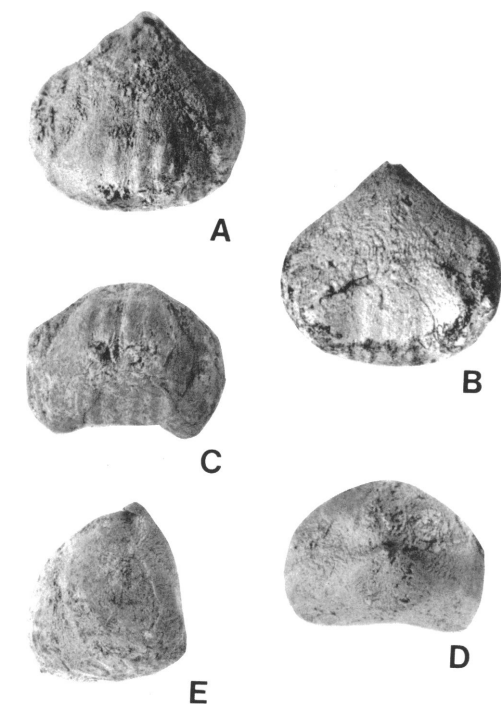


FIG. 29. *Atribonium halli* (Fagerstrom, 1961). AMNH Loc. 3137. Dorsal, ventral, anterior, posterior and lateral views, AMNH 39893,  $\times 3$ .

has coarser plications; and (3) *C. deflectus* resembles “*C.*” aff. *lineata* in its striae and convexity.

Boucot (1959, p. 757, pl. 98, figs. 1–5) describes “*Chonetes*” sp. from the Esopus Formation at Highland Mills, New York, which differs from “*Chonetes*” aff. *lineata* in its larger size, more transverse outline (width is one and one-half times length), and straighter hinge line.

DISCUSSION: Hall (1867) describes *Chonetes lineata* from the Onondaga (=Corniferous) Limestone at Oneida Falls, between Jamesville and Manlius in Onondaga County and in the northern part of Seneca County in New York. Hall reports that the abundance of *C. lineata* decreases as one progresses east and west of the Jamesville–Oneida Falls area (that is, Onondaga County). The last easterly occurrence of the species (in the “*Chonetes*” Zone of the Seneca Member) observed in the field is in Cherry Valley, New York, along route 20 (L. V. Rickard, personal commun.).

COMMUNITY OCCURRENCE: Feldman (1980)

TABLE 3  
Measurements (in Millimeters) of *Atribonium halli* (Fagerstrom, 1961)

AMNH Locality	(L)	(W)	(T)	Number of Plications		Length of b.v.
				Sulcus	Fold	
3137	9.0	9.4	6.7	5	4	8.2
3135						
(crushed)	9.2	10.6	—	5 est.	4 est.	8.1

found this species in the *Atrypa-Megakozlowskiella* and “*Chonetes*” communities.

FIGURED SPECIMENS: AMNH 42744, 42745, 42755, 42768.

ORDER RHYNCHONELLIDA  
SUBORDER RHYNCHONELLOIDEA  
SUPERFAMILY STENOSCISMATACEA  
OEHLERT, 1887 (1883)  
FAMILY ATRIBONIIDAE GRANT, 1965  
GENUS *ATRIBONIUM* GRANT, 1965

TYPE SPECIES: *Stenoscisma halli* Fagerstrom, 1961, p. 29, pl. 9, figs. 48–51.

*Atribonium halli* (Fagerstrom, 1961)  
Figure 29

*Stenoscisma halli* Fagerstrom, 1961, p. 29, pl. 9, figs. 48–51.

*Stenoscisma rhomboidalis* (Hall and Clarke) Fagerstrom, 1961, p. 29, pl. 9, figs. 45–47.

*Atribonium halli* (Fagerstrom) Grant, 1965, p. 52.

REMARKS: The following description is based upon only two specimens, one of which was crushed. Although the complete specimen is silicified and well preserved, no adequate description of the internal morphology can be given here since the valves are articulated with no gape angle.

The shell is small (table 3), rostrate, non-strophic, impunctate, and subpentagonal in outline. When viewed in lateral profile it is gently biconvex with a noticeable flexure in the pedicle valve at the beginning of the sulcus. The beak is short, rounded, and suberect. The commissure is uniplicate with a high-crested brachial fold and deep pedicle sulcus. The costae are weak and rounded, becoming indistinct as the beak is approached, disappearing on the brachial valve at about mid-

TABLE 4  
Measurements (in Millimeters) of Articulated Specimens of *Cupularostrum* sp. A and *Cupularostrum* sp. B

AMNH Locality	(L)	(W)	(T)	Number of Plications		
				Fold	Sul- cus	Sulcus Begins <sup>a</sup>
Species A						
3131C	5.8	7.1	3.9	4	3	3.0
3135	5.1	5.8	2.8	6	5	2.9
3135	5.6	5.9	3.1	4	3	3.2
3137	6.4	6.5	3.6	5	4	3.1
3138A	4.8	4.2	2.5	4	3	2.5
3138A	4.9	4.7	2.7	4	3	2.6
3138A	4.8	4.5	2.7	5	4	3.0
Species B						
3138A	4.0	3.1	2.2	—	—	—
3138A	3.7	3.4	2.3	—	—	—
3138A	4.0	3.1	2.4	—	—	—
3138A	4.1	3.6	2.1	—	—	—
3138A	4.5	4.4	2.2	—	—	—

<sup>a</sup> Measured from the beak.

length. On the pedicle valve the costae disappear at about one-third the valve length. Two to three moderately strong costae are found on the flank. No growth lines are evident. Both valves are geniculate and butt against one another in a vertical plane at the anterior commissure, a generic character of the *Stenosismataceae*. At the lateral and posterior margins the valves also abut against each other showing no overlap. There are no indications of any incipient frills at the commissure. The beak is curved with short, blunt, beak ridges. There is a small pedicle foramen and triangular delthyrium constricted by what appear to be nearly conjunct deltidial plates.

COMPARISON: Grant (1965, p. 52) notes that *Atribonium halli* differs from all other species of the genus in having few (two or three) costae on the fold, and normally the same or a greater number on each flank. He distinguishes *A. halli* from Hall and Clarke's Indiana species (assigned to the genus *Coledium*, 1965, p. 97) in their smaller size, lower convexity, trigonal rather than ovate outline, weaker costae that begin farther anteriorly, and geniculation of each valve.

*Atribonium halli* is narrower and more

convex than *A. simatum* and the height of its fold is similar to that of *A. cooperorum*. *Atribonium halli* is larger than *A. kernahani* and thinner than *A. rostratum* and *A. succiduum*. *Atribonium gregari* is larger, more globose, and lacks a flattened anterior. *Atribonium pauperum* differs in its strong, sharp plications which fold both valves and the commissure (see Grant, 1965, pl. 3, fig. 3). *Atribonium pingue*, *A. simatum*, and *A. gregari* are the only known species of *Atribonium* that attain a maximum size significantly larger than the other species.

COMMUNITY OCCURRENCE: Feldman (1981) found this species in the *Atrypa-Coelospira-Nucleospira* Community.

FIGURED SPECIMEN: AMNH 39893.

SUPERFAMILY CAMAROTOECHIACEA  
SCHUCHERT AND LEVENE, 1929  
FAMILY TRIGONIRHYNCHIIDAE  
McLAREN, 1965  
GENUS *CUPULAROSTRUM* SARTENAER, 1961

*Cupularostrum* sp. A  
Figure 30A-F

EXTERIOR: The shells are small, equibiconvex, and subtrigonal to transversely suboval in outline. The posterolateral margins are straight, whereas the anterolateral margins are rounded. The pedicle beak is erect to slightly incurved, almost covering the more obscure brachial beak. The delthyrium is open and triangular with a small foramen located apically. No deltidial plates were observed. The point of maximum width is generally anterior to midlength. The pedicle valve bears a sulcus which originates at about midlength. The brachial valve bears a corresponding fold, considerably weaker than the sulcus, which becomes more prominent anteriorly, resulting in a uniplicate anterior commissure.

Ornamentation consists of about 15 simple plicae, narrowly U-shaped in cross section. There are three plicae situated in the sulcus and four on the low fold (table 4). The plicae are separated by U-shaped interspaces. On some specimens a simple, prominent growth line is present at or anterior to midlength.

PEDICLE VALVE INTERIOR: Pedicle valve interiors are few and poorly preserved. There are two small, narrow, pointed hinge teeth



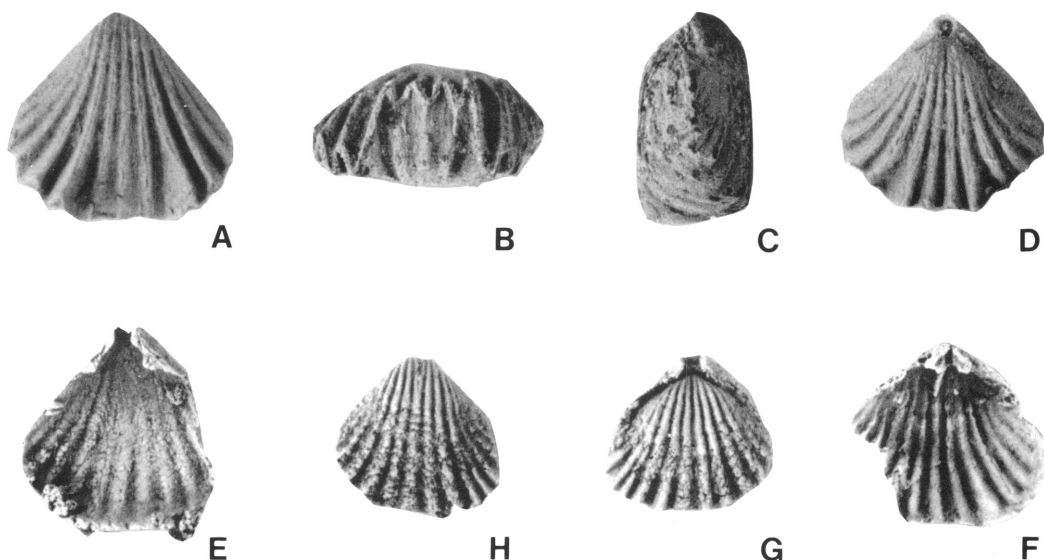


FIG. 30. *Cupularostrum* sp. A. A–D. AMNH Loc. 3135. Ventral, anterior, lateral and dorsal views, AMNH 39894,  $\times 5$ . E. AMNH Loc. 3138A. Pedicle valve interior, AMNH 39895,  $\times 5$ . F. AMNH Loc. 3138A. Brachial valve interior, AMNH 39896,  $\times 5$ . *Cupularostrum* sp. B. G, H. AMNH Loc. 3138A. Dorsal and ventral views, AMNH 39897,  $\times 5$ .

supported posteriorly by thin, bladelike dental plates which lie close to the walls of the shallow umbonal cavity. The valve floor is crenulated due to the impress of the plications.

**BRACHIAL VALVE INTERIOR:** The sockets are moderately shallow, widely divergent, and appear to be uncrenulated. The hinge plates are fairly wide and raised above a concave septalium which is supported by a short, low, median septum and lacking a transverse plate. No cardinal process is present. The valve floor is strongly crenulated due to the impress of the plications.

**COMPARISON:** The brachial valves of *Cupularostrum* sp. A from the Onondaga Limestone are transversely oval, moderately deeply convex, and possess four plicae on the low fold. The interiors have a concave septalium supported by a low median septum. In these respects the specimens are identical with the *Cupularostrum*? sp. from the Bois Blanc Formation (Boucot and Johnson, 1968, p. B11, pl. 3, figs. 21–29, Boucot and Johnson Loc. 4672-SD). Boucot, Gauri, and Southard (1970, p. 12, pl. 3, figs. 15–17) specimens from the Coeymans Limestone of the Green Pond Outlier assigned to *Cupularostrum*? sp.

A are similar to the Onondaga forms but do not possess a transverse plate extending across the septalium. *Cupularostrum macrocosta* (Boucot, 1973, p. 29, pl. 12, figs. 3–11) from the Moose River Synclinorium is larger (up to 3 cm in length) and has four to five plicae in the pedicle sulcus. The plications are finer in *C. macrocosta* than in the Onondaga and Coeymans species.

**COMMUNITY OCCURRENCE:** Feldman (1980) found this species in the *Atrypa-Coelospira-Nucleospira* and *Atrypa* communities.

**FIGURED SPECIMENS:** AMNH 39894, 39895, 39896.

*Cupularostrum* sp. B  
Figure 30G, H

**REMARKS:** These specimens are externally identical with those described above except for lack of a sulcus and fold (see table 4). Specimens of *Cupularostrum* sp. A at the same ontogenetic stage possess a noticeable sulcus and fold. No free valves were recovered so that the internal structures cannot be compared; consequently specific designation must be deferred.

**COMMUNITY OCCURRENCE:** Feldman (1980)



FIG. 31. *Atrypa* "reticularis" (Linnaeus, 1767). AMNH Loc. 3137. Dorsal view, AMNH 39889,  $\times 1.5$ .

found this species in the *Atrypa-Coelospira-Nucleospira* Community.

FIGURED SPECIMEN: AMNH 39897.

ORDER SPIRIFERIDA  
SUBORDER ATRYPOIDEA  
SUPERFAMILY ATRYPACEA GILL, 1871  
FAMILY ATRYPIDAE GILL, 1871  
SUBFAMILY ATRYPINAE GILL, 1871  
GENUS *ATRYPA* DALMAN, 1828

TYPE SPECIES: *Anomia reticularis* Linnaeus, 1758, p. 702.

*Atrypa* "reticularis" (Linnaeus, 1767)  
Figure 31

*Anomia reticularis* Linnaeus, 1758, p. 702.

*Atrypa* "reticularis" Boucot, 1959, p. 741, pl. 91, figs. 7-9; Boucot and Johnson, 1968, p. B12, pl. 3, figs. 30-49; Boucot, 1973, p. 36, pl. 15, figs. 1-6.

**EXTERIOR:** The shells are medium-sized to large and range from subcircular to elongate oval in outline. They are dorsibiconvex with the anterior end of some specimens becoming almost flat to concave at the margins. Maximum width occurs at about midlength on most individuals but tends to occur more toward the posterior than anterior to midlength. In lateral profile the great convexity of the brachial valve in many individuals gives a disproportionately inflated appearance. The pedicle beak is suberect; the brachial beak is erect. There is a low, narrow, triangular interarea with a small pedicle foramen on neanic specimens. These features atrophy with age and are absent in the ephebic and gerontic stages. No delthyrium was observed. There

is a variable pedicle sulcus and a broad brachial fold resulting in a slightly uniplicate anterior commissure. Young individuals are nonsulcate and rectimarginate.

The exterior is ornamented with well-rounded radial costellae which increase in size and number anteriorly. The costellae are separated by U-shaped interspaces. On the pedicle valve the costellae appear to increase by bifurcation while on the brachial valve they seem to increase by intercalation. Concentric growth lamellae cross the costellae becoming more distinct and frilly anteriorly. Toward the anterior commissure the lamellae become more closely spaced. Posteriorly, however, they become obscured.

**PEDICLE VALVE INTERIOR:** The large, stout hinge teeth are supported by short, narrow dental lamellae. The surface of the hinge teeth of less-worn specimens appear to be transversely corrugated in a manner similar to those of Boucot and Johnson (1968) which were grooved subparallel to the posterolateral margin of the valve and deeply crenulated to accept the median crenulated ridge within the sockets of the brachial valve. The muscle field is pyriform to subcircular, flabellate, and lies anterior to a broad, shallow, subtriangular delthyrial cavity. The adductor attachment site is represented by two raised areas near the base of the dental lamellae. The diductors attach to an anteriorly situated, longitudinally striated region often separated from the valve floor by a thick, raised, arcuate rim.

**BRACHIAL VALVE INTERIOR:** The sockets are from moderately to widely divergent and are bounded by the valve margin posterolaterally and by curved hinge plates anteromedially. Extending the length of each socket and medially situated, there is a transversely grooved ridge which accommodates the grooved hinge teeth. On the inner margins of the sockets, short, thin crural bases are attached; these project anteroventrally. No cardinal process is present. However, the posterior portion of the small notothyrial cavity is often longitudinally striated for diductor attachment. The adductor scars are subpyriform to suboval and are divided by either a single, thin, low myophragm or by a pair of myophragms. In both cases the posterior base of the myophragms is considerably thickened. When a

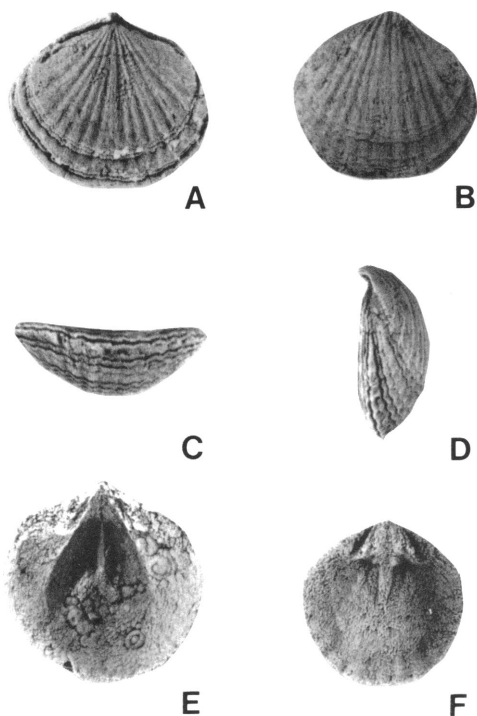


FIG. 32. *Coelospira camilla* Hall, 1867. A–D. AMNH Loc. 3135. Dorsal, ventral, anterior and lateral views, AMNH 39904,  $\times 3.5$ . E. AMNH Loc. 3138A. Pedicle valve interior, AMNH 39905,  $\times 3.5$ . F. AMNH Loc. 3135. Brachial valve interior, AMNH 39906,  $\times 3.5$ .

single myophragm is present the posterior base is pyramidal in cross section.

**DISCUSSION:** The shells described above fit the general description of the genus *Atrypa* (“*reticularis*” *sensu lato*) in ornamentation, outline, and internal structure. Specimens of similar morphology have been found in the Kanouse Sandstone (Boucot, 1959), Bois Blanc Formation (Boucot and Johnson, 1968), and Tomhegan Formation (Boucot, 1973). Hall (1867) described *A. reticularis* from the Onondaga (=Corniferous) Limestone (see Hall, 1867, pl. 51, figs. 11–13) of New York, Canada West, Ohio, Kentucky, Indiana, and Illinois. The occurrences of this species are so numerous that Hall (1867, p. 321) does not name them in detail but mentions that they are found in nearly every exposure of the Corniferous Limestone from Albany County to Black Rock, on the Niagara River.

**COMMUNITY OCCURRENCE:** Feldman (1980) found this species in the *Leptaena-Megakozlowskiella*, *Atrypa-Coelospira-Nucleospira*, *Atrypa*, *Atrypa-Megakozlowskiella*, *Levenea* Community I, *Pacificocoelia*, and “*Chonetes*” communities.

**FIGURED SPECIMEN:** AMNH 39889.

**SUPERFAMILY DAYTIACEA** WAAGEN, 1883

**FAMILY ANOPLOTHECIDAE**

SCHUCHERT, 1894

**SUBFAMILY COELOSPIRINAE** HALL AND

CLARKE, 1895

**GENUS COELOSPIRA** HALL, 1863

**TYPE SPECIES:** *Leptocoelia concava* Hall, 1857, p. 107.

*Coelospira camilla* Hall, 1867

Figure 32

*Leptocoelia concava* Hall, 1857, p. 107.

*Coelospira camilla* Hall, 1867, p. 329 (as *Coelospira concava*), pl. 52, figs. 13–19; Hall and Clarke, 1895, pl. 53, figs. 24–31; Boucot and Johnson, 1967, p. 1237, pl. 164, figs. 20–30; pl. 165, figs. 1–15; Boucot and Johnson, 1968, p. B13, pl. 4, figs. 1–25; Boucot, Gauri, and Southard, 1970, p. 17–18, pl. 5, figs. 17–19, 21–22.

**EXTERIOR:** The shells are small, concavo-convex to planoconvex, and subcircular to suboval in outline. The hinge line is rounded in adults but relatively straight in small specimens and diverging at an angle of approximately 65 degrees. There is a small but distinct pedicle foramen equally well developed in juveniles and adults. The pedicle beak is incurved and the pedicle valve strongly convex in most specimens. No interarea is evident. The maximum width (figs. 33, 34) is about one-third the valve length, occurring anterior to the pedicle foramen, in adults. In juveniles the maximum width is at mid-length. The anterior and anterolateral commissures are well rounded, whereas the posterolateral commissure is straighter. In some specimens the brachial valve has a broad sulcus which originates at the posterior extremity of the brachial valve and shallows out anteriorly.

The pedicle valve bears two medial plications (table 5) commonly at least as large as the remaining radial plications on the flanks

TABLE 5  
Measurements (in Millimeters) of Articulated  
Specimens of *Coelospira camilla* Hall, 1867

AMNH Locality	(L)	(W)	(T)	Number of Plications	
				Dor- sal	Ven- tral
3135	6.4	5.4	2.1	12	14
3135	5.1	5.2	1.6	13	14
3138A	3.8	3.8	1.5	—	15
3144A	5.3	5.2	1.4	11	13
3137	7.3	6.7	2.9	17	—
3137	3.5	3.4	1.1	—	—
3135	4.0	4.2	1.2	13	15
3135	7.4	6.7	2.6	10+	13
3137	6.6	6.1	2.4	14	12
3137	6.0	6.4	2.3	13	13
3137	5.0	5.0	1.7	11	15
3137	3.5	2.8	0.9	6	—
3135	2.9	3.2	0.9	10	11
3137	7.0	6.9	2.5	15	—
3135	6.0	6.9	1.5	—	—
3137	4.0	4.0	1.4	15	13
3137	4.4	4.5	1.5	17	14
3137	4.9	4.4	2.4	—	—
3135	6.5	7.0	2.4	17	14
3135	5.2	4.9	2.2	—	14
3135	3.1	3.2	1.0	12	12
3135	5.8	5.6	2.2	—	—
3138A	3.1	3.2	1.1	—	12
3138A	6.7	6.0	3.4	—	—
3138A	3.8	3.3	1.7	12	13
3138A	3.8	3.8	1.1	12	12
3138A	6.9	7.2	2.3	14	14
3138A	4.9	5.0	1.7	11	11
3138A	5.3	5.2	2.0	—	—
3138A	5.8	6.3	2.0	14	—
3138A	6.2	6.9	2.2	—	12
3138A	6.4	6.1	3.0	14	14

(numbering 11 on the average). The interspace between the two medial plications, in well-preserved specimens, bears two small ridges beginning at about midlength and extending to the anterior commissure. The interspaces between all plications on the flanks are U-shaped and are of approximately the same width as the plications, although the interspaces become broader than the plications as the lateral commissure is approached. There is some bifurcation on the lateral plications.

The brachial valve bears a medial plication which generally bifurcates at about one-third the valve length. The median interspace is either flat (most common condition) or bears a small median ridge. The plications become broader on the flanks and thinner toward the lateral commissure.

On many specimens, especially those in the ephebic to gerontic stage, several well-defined, concentric growth lines are concentrated toward the anterior commissure.

PEDICLE VALVE INTERIOR: The hinge teeth are small, slightly concave and thin, attaching ventrally to obscure dental lamellae. The hinge teeth diverge anterolaterally at an angle of approximately 80 degrees. There are small, distinct crural fossettes on the medial side of each hinge tooth. A low, blunt myophragm, rectangular to rounded in cross section, divides the ventral muscle field and ends almost at midlength. Elliptical to suboval diductor impressions are on either side of the myophragm. In some specimens the anterior boundary of the diductor impressions is well defined by a difference in elevation on the floor of the valve. In most cases, however, the muscle field grades into the valve floor without any noticeable change in elevation. No adductor scars were evident. The valve floor at the anterior periphery is crenulated due to the impress of the plications.

BRACHIAL VALVE INTERIOR: The sockets are deeply excavated and almost cylindrical in cross section, broadening slightly and shallowing-out anterolaterally. Medial, strongly incurved socket plates form one border of the sockets adjacent to the cardinal process. The distal border is represented by a small ridge along the posterior shell margin. The cardinal process ranges from a simple moundlike protuberance to a quadrilobed form. A short, pointed anteriorly tapering myophragm extends from the base of the cardinal process anteriorly and ends at about mid to three-quarters the length of the valve. In some specimens the plications are somewhat impressed upon the valve floor.

COMPARISON: Among the Devonian species of *Coelospira* the following comparisons may be made. These shells (fig. 35) are similar to *Coelospira* sp. of Boucot, Gauri, and Southard (1970) but differ in the degree of con-

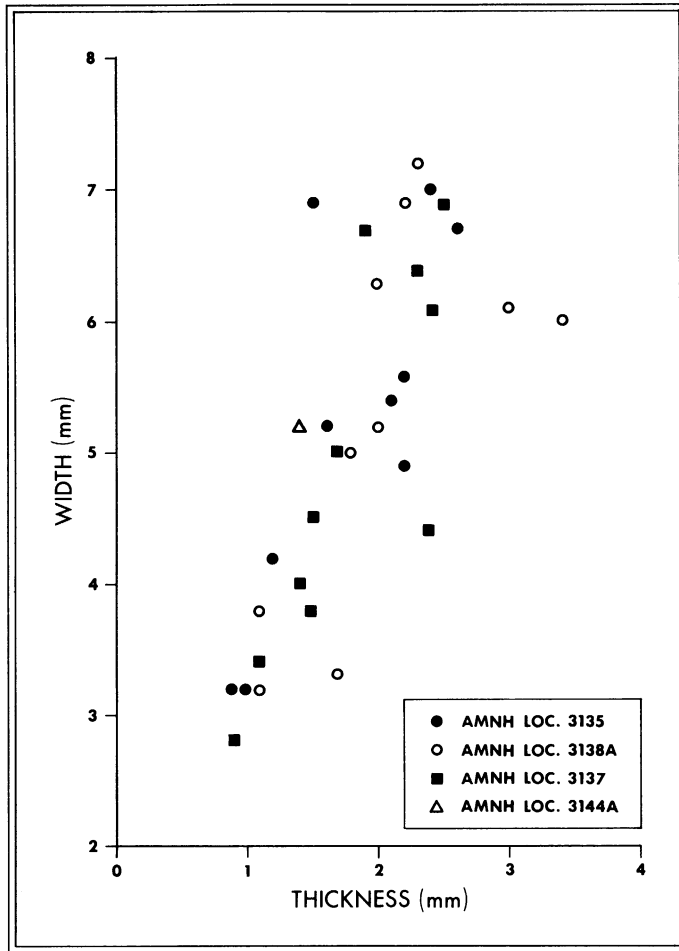


FIG. 33. Width/thickness scattergram of *Coelospira camilla* Hall, 1867.

vexity of the brachial valve, tending toward the concavoconvex condition rather than planoconvex (less than 1% of *C. camilla* are planoconvex).

*Coelospira concava* of Boucot and Johnson (1967) differs from this species in the greater number of costae (commonly 14 to 17 on a pedicle valve). Also, the degree of concavity of the brachial valve is more pronounced in *C. concava*. *Coelospira camilla* of Boucot and Johnson (1967) differs from these specimens only in the greater prominence of the two medial costae on the pedicle valve. *Coleospira dichotoma* is generally larger, has more radiating costae, and has peripherally obsolescent bifurcating costae in large specimens.

Boucot and Johnson (1967, p. 1235, pl. 163, figs. 1–7, 10, 15–27) describe and list occurrences of *C. camilla*. The reader is referred to p. 1235 (*op. cit.*) for a detailed locality list of the species' occurrence in the following states, Canada, and Mexico: New York, Quebec, New Brunswick, Oklahoma, Texas, and Nevada.

COMMUNITY OCCURRENCE: Feldman (1980) found this species in the *Leptaena-Megakozlowskiella*, *Atrypa-Coelospira-Nucleospira*, *Atrypa*, and *Atrypa-Megakozlowskiella* communities.

FIGURED SPECIMENS: AMNH 39904, 39905, 39906.

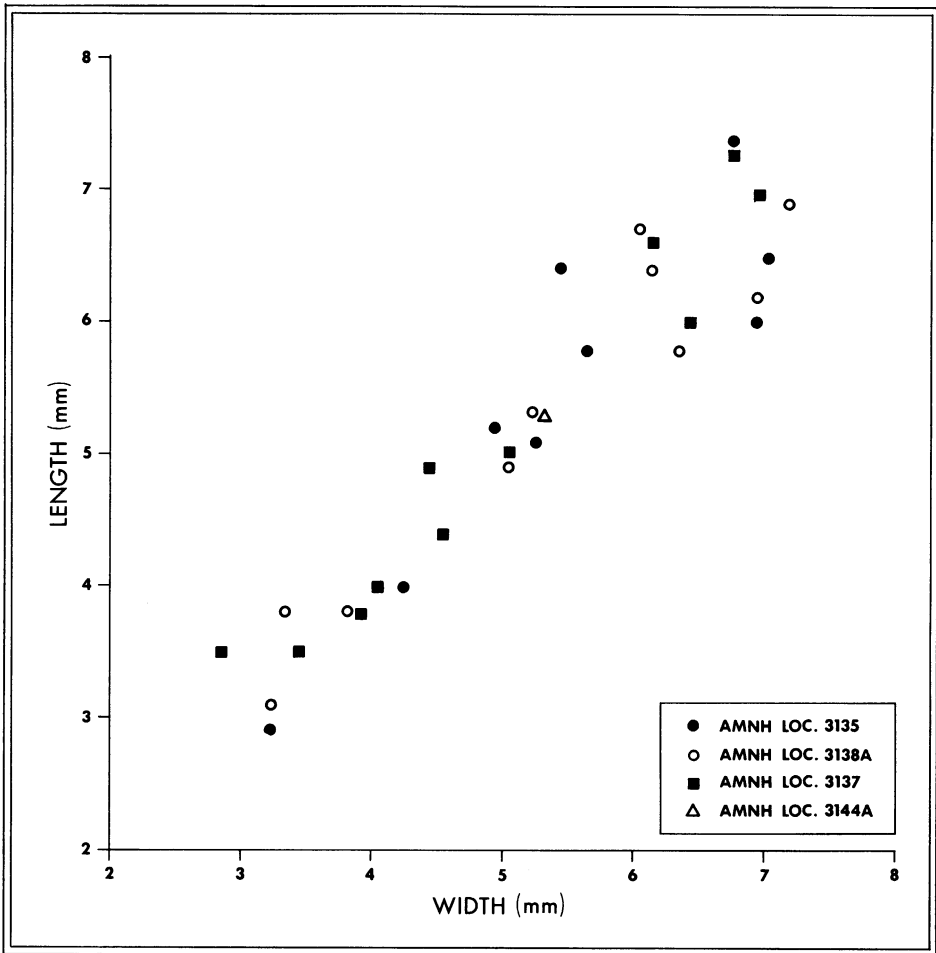


FIG. 34. Length/width scattergram of *Coelospira camilla* Hall, 1867.

FAMILY LEPTOCOELIIDAE BOUCOT

AND GILL, 1956

GENUS *PACIFICOCOELIA* BOUCOT, 1975

TYPE SPECIES: *Atrypa acutiplicata* Conrad, 1841, p. 54.

"*Pacificocoelia*" *acutiplicata* (Conrad, 1841)  
Figures 36, 37

*Anoplothea acutiplicata* Kindle, 1912, pl. 6, figs. 1-15.

*Leptocoelia acutiplicata* Hall, 1867, pl. 57, figs. 30-39.

*Pacificocoelia acutiplicata* Boucot, 1975, pp. 361-362; Boucot and Rehmer, 1977, p. 1130, pl. 1, figs. 1-26.

REMARKS: The bulk of material at hand is from the Nedrow Member which is quite shalley. The specimens are not silicified and preservation is generally poor. Rarely are the shells found loose. Most of the collection consists of impressions and fragments imbedded in the matrix with few internal structures preserved. Since all free articulated specimens are deformed or somewhat crushed the true convexity of the shells in lateral profile is unknown. However, it appears as though the brachial valve is gently convex and the pedicle valve slightly more so. The shells are subcircular in outline with the length almost equal to the width. A weak pedicle sulcus is sometimes noticeable on larger specimens.

No corresponding dorsal fold was observed. The hinge line is very short and becomes rounded anteriorly. No interareas were present. The entire apical region is poorly preserved. The anterior and lateral commissures are crenulate.

Ornamentation consists of 10 to 12 plications, more pronounced medially than on the flanks. In cross section they are U-shaped as are their interspaces. Compressed shells have V-shaped plications and interspaces. Distinct concentric growth lines (two or three per shell) occur on most large specimens.

COMPARISON: The author uses the name "*Pacificocoelia*" but notes that Koch (1981, and in prep., personal commun.) has assigned *acutiplicata* to a new genus which differs from *Pacificocoelia* and *Leptocoelia* in the absence of a cardinal process. The Onondaga shells have a gently convex brachial valve, strong plications, and indications of a weakly impressed pedicle valve muscle field. The closest pacificocoelid to this species would probably be *P. nunezi texana* with a weakly impressed pedicle valve muscle field and three or four lateral plications on the pedicle valve. Other related forms with deeply impressed pedicle valve muscle fields include *P. biconvexa*, *P. nunezi nunezi*, and *P. murphyi*.

COMMUNITY OCCURRENCE: Feldman (1980) found this species in the *Leptaena-Megakozlowskiella*, *Atrypa-Megakozlowskiella*, and *Pacificocoelia* communities.

FIGURED SPECIMENS: AMNH 39903, 42757.

#### SUBORDER ATHYRIDOIDEA

SUPERFAMILY ATHYRIDACEA M'COY, 1844

FAMILY ATHYRIDIDAE M'COY, 1844

GENUS *ATHYRIS* M'COY, 1844

*Athyris* sp. A

Figure 38A-J

EXTERIOR: The shells are small for the genus (about 9.9–13.2 mm wide) (table 6), transversely suboval in outline, and subequally biconvex with the pedicle valve slightly deeper than the brachial valve. The convexity is accentuated in the umbonal region. The ventral beak is suberect, terminating in a small round foramen. The brachial

beak is smaller and less noticeable. The pedicle valve bears a shallow sulcus with a corresponding low fold on the brachial valve, resulting in a weakly uniplicate anterior commissure. Some specimens are nonsulcate and rectimarginate.

Ornamentation consists of fine concentric growth lines on both valves, which are quite lamellose in some individuals.

PEDICLE VALVE INTERIOR: The hinge teeth are small, pointed, and dorsally directed. They are supported by weak dental plates diverging at an angle of approximately 45 degrees. The muscle scars are very faintly impressed and barely discernible. Possible adductor scars are just anterior to the base of the dental plates forming a vague, oval impression.

BRACHIAL VALVE INTERIOR: Since no free brachial valves were collected, a single articulated shell was dissected to provide the following description: The sockets are short, U-shaped, and appear to deepen anteriorly. There is a broad, concave cardinal plate which rises ventrally in the apical region forming a small lip. No muscle impressions were preserved.

COMPARISON: The specimens assigned to *Athyris* sp. A may be grouped as follows:

- (1) Rectimarginate, nonlamellose
- (2) Sulcate, nonlamellose
- (3) Sulcate, lamellose.

All three show affinities to *Athyris cora* Hall but are significantly smaller. Hall (1867, pp. 291–292, pl. 47, figs. 1–7) describes *A. cora* from the Hamilton at Delhi, New York, as well as a single specimen from the Chemung Group. *Athyris nuculoidea* from the St. Laurent Limestone (Cooper, 1945, p. 485, pl. 64, figs. 12–19) resembles *Athyris* sp. A in its lamellose ornamentation and small size. The Onondaga specimens are similar to *A. spiriferoides* (Eaton) only in the relatively divergent dental plates and muscle field; they differ significantly in size. Two specimens strongly resemble *A. lamellosa* (L'Eveille) with their narrow margins and strong concentric growth lamellae. However, their size and poor preservation preclude assignment to that species.

COMMUNITY OCCURRENCE: Feldman (1980) found this species in the *Leptaena-Megakozlowskiella*, *Atrypa-Coelospira-Nucleospira*,



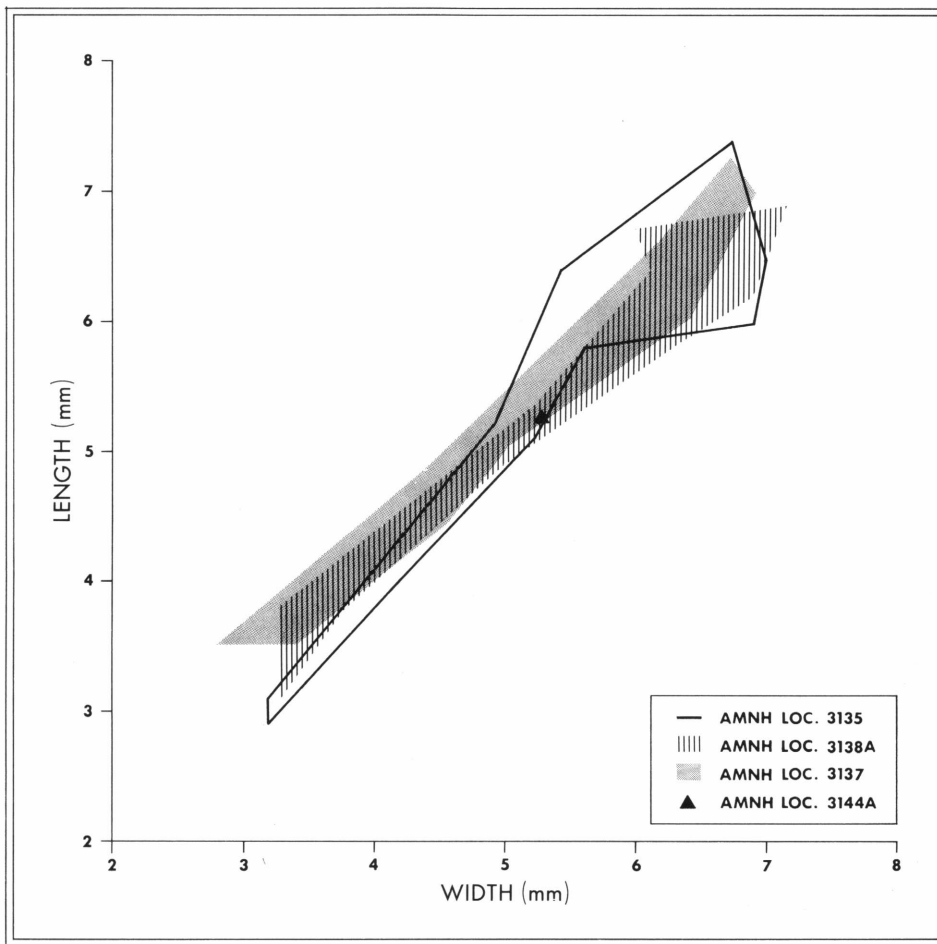


FIG. 35. Comparative-size polygons for *Coelospira camilla* Hall, 1867, fitted visually.

*Atrypa*, *Atrypa-Megakozlowskiella*, *Pacifico-coelia*, and “*Chonetes*” communities.

FIGURED SPECIMENS: AMNH 39901, 39907, 39908, 39909, 42765.

*Athyris* sp. B  
Figure 38K, L

REMARKS: Two pedicle valves are in the collection which may be differentiated from *Athyris* sp. A by their larger size (20.1 mm and 20.7 mm wide), subparallel dental plates, and narrow muscle field (see table 6).

COMMUNITY OCCURRENCE: Feldman (1980) found this species in the *Atrypa-Coelospira-Nucleospira* Community.

FIGURED SPECIMEN: AMNH 42766.

FAMILY MERISTELLIDAE WAAGEN, 1883  
SUBFAMILY MERISTELLINAE WAAGEN, 1883  
GENUS *MERISTINA* HALL, 1867

TYPE SPECIES: *Meristella maria* Hall, 1863, p. 212.

*Meristina* cf. *nasuta* (Conrad, 1842)  
Figure 39

*Atrypa nasuta* Conrad, 1842, p. 265.

*Meristella nasuta* Boucot and Johnson, 1968, pp. B13–B14, pl. 4, figs. 26–43.

REMARKS: Two specimens of this species are in the collection. One is a silicified pedicle (?) valve collected from AMNH Loc. 3137 with almost no internal structures preserved,

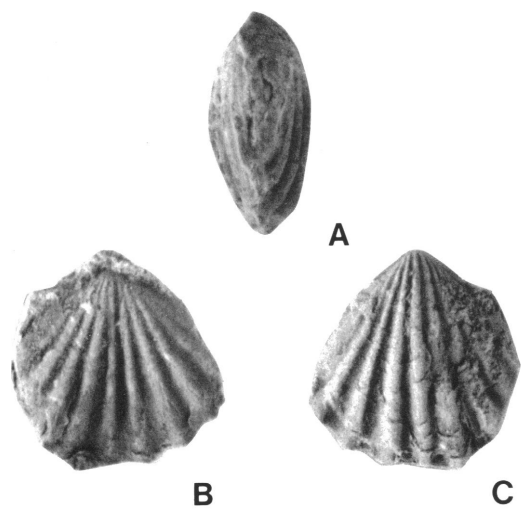


FIG. 36. “*Pacificocoelia*” *acutiplicata* (Conrad, 1841). AMNH Loc. 3128B. Lateral, dorsal and ventral views, AMNH 42757,  $\times 5$ .

and the other is a nonsilicified, quite weathered, and exfoliated pedicle valve collected from AMNH Loc. 31238. The shells are convex, elongate, and suboval in outline with no noticeable interarea. Concentric growth lamellae are evident along the internal margins of the nonsilicified shell (AMNH 39900). Based on similar outline and external morphology to *Meristina nasuta* from the underlying Bois Blanc Formation (Boucot and Johnson, 1968, p. B13, pl. 4, figs. 26–36) these shells are assigned to the same genus.

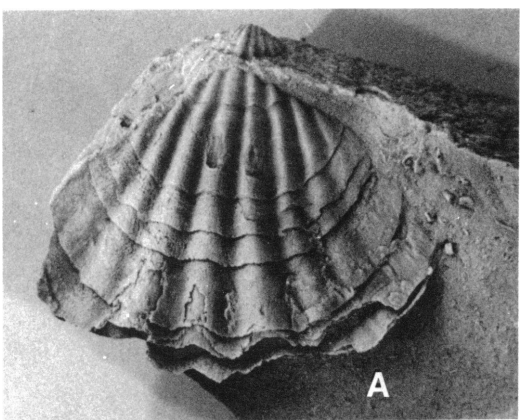


FIG. 37. “*Pacificocoelia*” *acutiplicata* (Conrad, 1841). AMNH Loc. 3128B. Ventral view, AMNH 39903,  $\times 3$ .

TABLE 6  
Measurements (in Millimeters) of *Athyris* sp. A and *Athyris* sp. B

Specimen	AMNH Locality	Articulated	p.v.	(L)	(W)	(T)
Sp. A <sup>a</sup>	3137	X	—	11.7	12.2 est.	6.2
Sp. A	3137	X	—	—	11.5	7.5
Sp. A	3137	X	—	7.6	7.8	4.5
Sp. A	3137	—	X	11.6	11.7	—
Sp. A	3137	—	X	12.3	—	—
Sp. A	3135	—	X	11.4	12.4	—
Sp. A def.	3123B	X	—	10.9	9.9	5.9
Sp. A	3138A	X	—	9.8	9.9	5.1
Sp. A	3138A	X	—	7.0	8.2	3.0
Sp. A	3144B	X	—	10.9	13.2	6.4
Sp. A	3136	X	—	8.3	9.4	5.5
Sp. B	3138A	—	X	16.4 est.	20.1	—
Sp. B	3138A	—	X	20.3	20.7	—

<sup>a</sup> Dissected to expose cardinalia. Note: there are no free brachial valves in the collection.

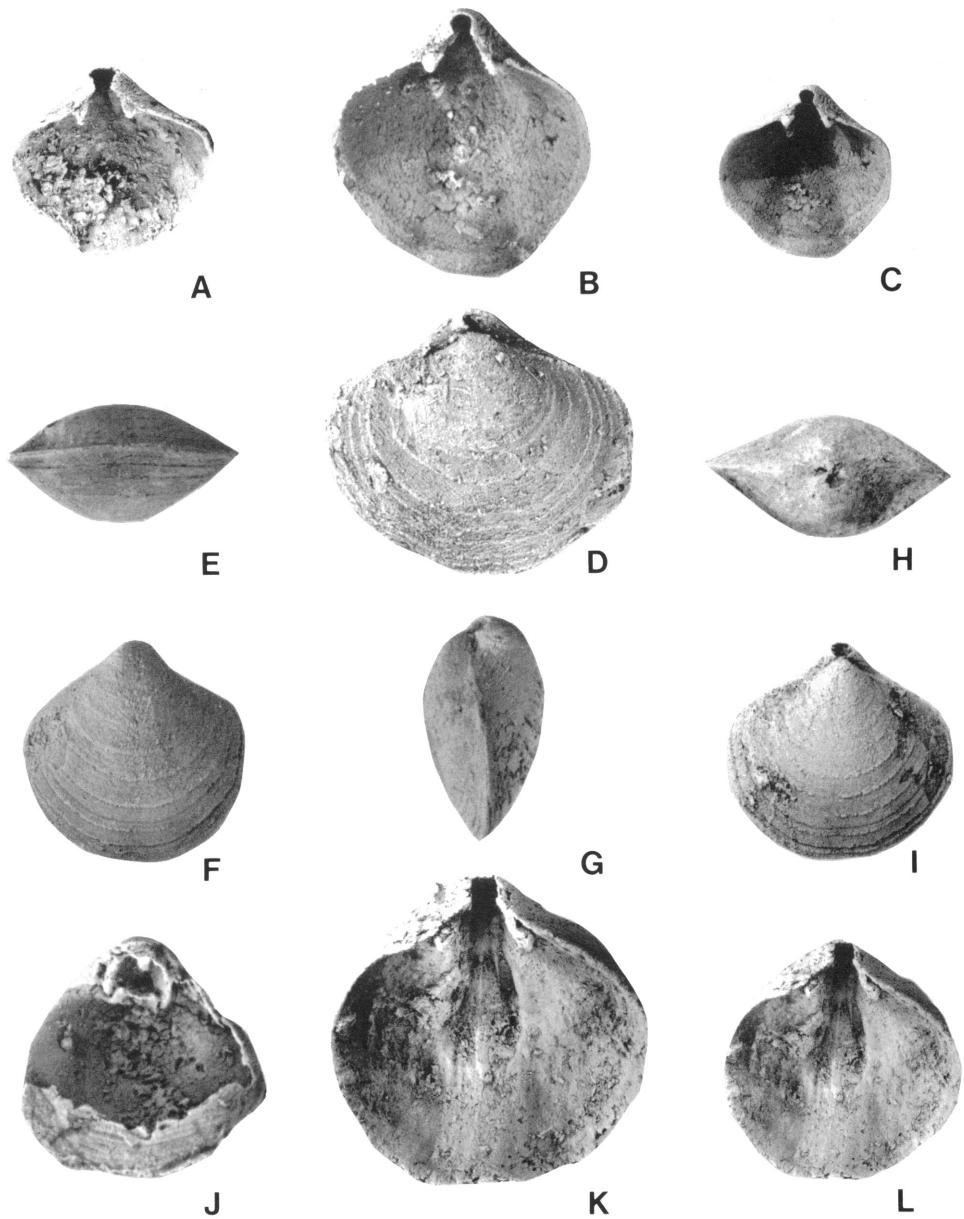


FIG. 38. *Athyris* sp. A. A. AMNH Loc. 3135. Pedicle valve interior, AMNH 42766,  $\times 2.5$ . B, C. AMNH Loc. 3137. Pedicle valve interior, AMNH 39908,  $\times 3$ ,  $\times 2$ . D. AMNH Loc. 3142. Dorsal view, AMNH 42765,  $\times 3.5$ . E-I. AMNH Loc. 3138A. Anterior, ventral, lateral, posterior and dorsal views, AMNH 39907,  $\times 3$ . J. AMNH Loc. 3137. Articulated specimen with pedicle valve dissected exposing interior of umbonal region. Note the broad, concave cardinal plate rising ventrally and adjacent articulating hinge teeth and sockets, AMNH 39909,  $\times 3$ . *Athyris* sp. B. K, L. AMNH Loc. 3138A. Pedicle valve interior, AMNH 39901,  $\times 1.5$ .

COMMUNITY OCCURRENCE: Feldman (1980) found this species in the *Leptaena-Megakoz-lowskiella* and *Atrypa-Coelospira-Nucleospira* communities.

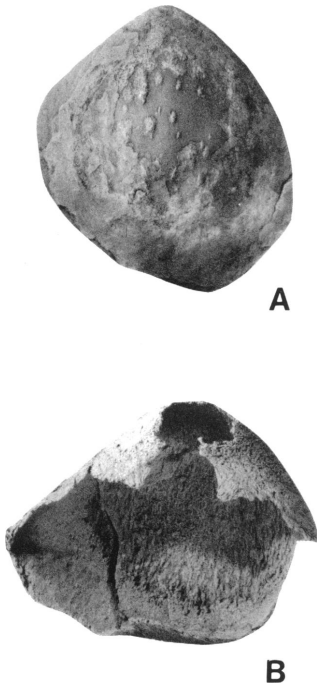


FIG. 39. *Meristina* cf. *nasuta* (Conrad, 1842). A. AMNH Loc. 3123B. Ventral view, AMNH 39900,  $\times 1$ . B. AMNH Loc. 3137. Pedicle valve interior, silicified and poorly preserved, AMNH 42730,  $\times 1$ .

FIGURED SPECIMENS: AMNH 39900, 42730.

GENUS *CHARIONOIDES* BOUCOT, JOHNSON, AND STATON, 1964

TYPE SPECIES: *Meristella doris* Hall, 1860, p. 84.

*Charionoides* aff. *doris* (Hall, 1860)  
Figure 40

*Meristella doris* Hall, 1860, p. 84.

*Charionoides doris* Boucot, 1973, p. 64, pl. 20, figs. 14–22.

REMARKS: A single, poorly preserved, convex pedicle valve was recovered with a fragment of the brachial valve attached at one lateral margin. The beak is relatively long and angular with a suggestion of a small pedicle foramen. The delthyrium was not preserved. The valve exterior is smooth with no indi-



FIG. 40. *Charionoides* aff. *doris* (Hall, 1860). AMNH Loc. 3123C. Ventral view, AMNH 39899,  $\times 2$ .

cation of a pedicle sulcus. Fine concentric growth lines, evident only at the lateral margins of the pedicle valve and the brachial fragment, are present.

Hall (1867, p. 303, pl. 50, figs. 1–12) describes *C. doris* (= *Meristella doris*) from the upper part of the Onondaga (=Corniferous) Limestone near Williamsville (Erie County) and from the Schoharie Grit (Schoharie County), New York.

COMMUNITY OCCURRENCE: Feldman (1980) found this species in the *Leptaena-Megakozlowskiella* Community.

FIGURED SPECIMEN: AMNH 39889.

GENUS *PENTAGONIA* COZZENS, 1846

TYPE SPECIES: *Atrypa unisulcata* Conrad, 1841, p. 56.

*Pentagonia unisulcata* (Conrad, 1841)  
Figure 41

*Atrypa unisulcata* Conrad, 1841, p. 56.

*Atrypa uniangularata* Hall, 1861, p. 101.

*Meristella? unisulcata* (Conrad), Hall, 1862, p. 158, pl. 2, figs. 17, 20–23 (not figs. 19, 24, 25).

*Meristella* (*Pentagonia*) *unisulcata* (Conrad) Hall, 1867, p. 309, pl. 50, figs. 18–29 (not figs. 30–35).

Non *Meristella unisulcata* (Conrad) Nettleroth, 1889, p. 99, pl. 15, figs. 9–16.

*Pentagonia unisulcata* (Conrad) Stauffer, 1915, p. 104, 245, (not pp. 160, 171, 175, 234); Dunbar, 1919, pp. 87, 89; Goldring, 1935, p. 148, figs. 53B–D; Butts, 1940, pp. 300, 301, 304, 305; 1941, pl. 115, figs. 17–21, 35; Cooper, 1944, p. 333, pl. 127, fig. 37; Oliver, 1954, pp. 633, 634, 638–640; 1956, pp. 1452, 1456, 1462.

Non *Pentagonia unisulcata* (Conrad) Savage, 1930, pp. 47, 50, 53, 62; 1931, p. 242, pl. 30, figs. 17, 18.

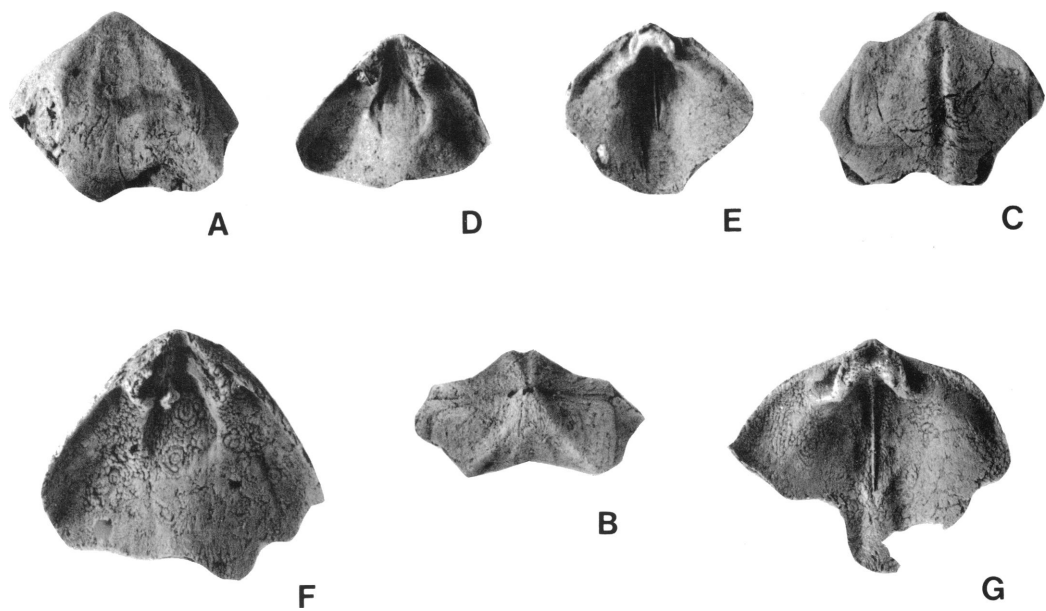


FIG. 41. *Pentagonia unisulcata* (Conrad, 1841). A–C. AMNH Loc. 3138A. Ventral, posterior and dorsal views, AMNH 42731,  $\times 1.5$ . D. AMNH Loc. 3138A. Pedicle valve interior, AMNH 42737a,  $\times 1.3$ . E. AMNH Loc. 3138A. Brachial valve interior (articulated with AMNH 42737a), AMNH 42737b,  $\times 1.3$ . F. AMNH Loc. 3138A. Pedicle valve interior, AMNH 39910a,  $\times 2$ . G. AMNH Loc. 3138A. Brachial valve interior (articulated with AMNH 39910a), AMNH 39910b,  $\times 2$ .

*Pentagonia unisulcata* (Conrad) Dutro, 1971, pp. 187–188.

**EXTERIOR:** The shells are medium-sized (table 7) nonstrophic, impunctate, pentagonal in outline in plan view, and when viewed posteriorly. The beak is suberect. The shells are dorsibiconvex with the greatest width attained between midlength and the anterior commissure, usually more toward the anterior margin. The brachial valve is cariniform due to the presence of a raised, rounded fold

bearing a narrow, median groove which begins at the dorsal umbo and widens slightly anteriorly in some specimens forming two parallel to subparallel ridges extending almost half the length of the valve. The flanks are concave, dropping steeply adaxially, away from the sulcate fold.

The pedicle valve bears a relatively broad, shallow sulcus which widens considerably anteriorly. Two distinct ridges, defining the sulcus laterally, extend from the umbo across the posterolateral margins of the flanks to the anterolateral commissure. The anterior commissure is uniplicate.

The only ornamentation evident is vague concentric growth lines on the anterior portions of the shell.

**PEDICLE VALVE INTERIOR:** The hinge teeth are short, blunt, and taper posteriorly. They are triangular in cross section with the apex rounded and are supported by strong dental lamellae which extend one-fourth the valve length. Secondary shell material is deposited at the base of the dental lamellae and extends posteriorly to partially fill the umbonal cavity. The muscle field is broad, striate, and

TABLE 7  
Measurements (in Millimeters) of Articulated Specimens of *Pentagonia unisulcata* (Conrad, 1841)

AMNH Locality	(L)	(W)	(T)
3138A	—	21.1	10.5
3138A <sup>a</sup>	—	14.6	—
3144A	—	17.1	8.5
3138A	—	18.8	9.7
3138A	—	20.9	10.3

<sup>a</sup> Badly damaged. Note: all specimens are incomplete to some extent.

flabelliform, extending about one-third the valve length. A readily apparent difference in elevation, in the form of a low circular ridge, separates the anterior extremity of the muscle field from the valve floor in many specimens. In others the muscle field is gradationally absorbed into the floor of the shell. In most individuals there is an indication of a small pedicle foramen, although it is doubtful whether the ephebic form possessed a functional pedicle.

**BRACHIAL VALVE INTERIOR:** The sockets are deep and cylindrical in cross section. A prominent cardinal process dominates the posterior section of the brachial interior. The cardinal process is A-shaped when viewed from above and bears a deep pit on the distal end. The anterior end drops off steeply to the valve floor. When viewed laterally, the cardinal process appears to have a step, corresponding to the posterior depression (pit), parallel to the hinge axis. When viewed posteriorly the cardinal process appears to be bilobed.

A low, well-defined, median septum originates on the anterior face of the cardinal process, drops to the floor of the valve, and bisects the dorsal muscle field. The median septum extends approximately one-half to one-third the valve length. Two subparallel to parallel ridges define the medial aspect of the adductor scars which appear to be elliptical to oval in outline. These ridges extend for approximately half the length of the median septum.

**COMPARISON:** *Pentagonia unisulcata* may be differentiated from the stratigraphically younger *P. peersi* only by its lesser dimensions. Juveniles of *P. peersi* are identical in form with adults of *P. unisulcata*. *Pentagonia lenta*, ancestral to *P. unisulcata*, is smaller and subovate in plan view. The interiors, however, are identical. Dutro (1971, p. 182) reports that *Pentagonia* is well represented by *P. unisulcata* in Onondaga age rocks from New York to Virginia but that species has not yet been reported from the western equivalents of the Onondaga in Ohio, Kentucky, Indiana, and Illinois. Boucot and Johnson (1968, p. B2) summarize the distribution of *Pentagonia* in rocks of Schoharie age. Conrad (1841) describes the genus (*Atrypa unisulcata*) from the Onondaga Limestone at Schoharie, New York.

**COMMUNITY OCCURRENCE:** Feldman (1980) found this species in the *Atrypa-Coelospira-Nucleospira*, *Atrypa*, and *Atrypa-Megakozlowskiella* communities.

**FIGURED SPECIMENS:** AMNH 39910a, b, 42731, 42737a, b.

FAMILY NUCLEOSPIRIDAE DAVIDSON, 1881  
GENUS *NUCLEOSPIRA* HALL, 1859

**TYPE SPECIES:** *Spirifer ventricosa* Hall, 1857, p. 57.

*Nucleospira* aff. *ventricosa* (Hall, 1857)

Figure 42

*Spirifer ventricosa* Hall, 1857, p. 57, not figs. 1 and 2.

*Nucleospira ventricosa* Hall, 1859, pp. 220–221, pl. 14, fig. 1a–h, pl. 28B, figs. 2–9; Hall and Clarke, 1894, pl. 48, figs. 2–6, 18; Weller, 1903, p. 290, p. 30, figs. 19–22; Schuchert, 1913, p. 430, pl. 73, figs. 10–12; Bowen, 1967, pp. 37–38, pl. 5, figs. 16–17.

*Nucleospira* sp. Boucot and Johnson, 1968, p. H14, pl. 5, figs. 1–11.

**EXTERIOR:** The shells are small (table 8), transversely suboval in outline, and biconvex in profile with the pedicle valve slightly deeper than the brachial valve. The hinge line is curved. The brachial beak fits into the anterior end of the delthyrium which is partially covered by a concave pseudodeltidium in some specimens. Both beaks are erect. There is no interarea evident. The shell surface lacks radial ornamentation and is without a fold or sulcus. However, in some specimens the pedicle has an indistinct median depression. Concentric growth lamellae are present and noticeably concentrated toward the anterior of the valves. The anterior commissure is rectimarginate.

**PEDICLE VALVE INTERIOR:** The hinge teeth are small, pointed, and hooked medially, and are supported by secondary shell material representing true dental lamellae, which are absent. Shallow sockets are located posterior to each tooth. The delthyrium is closed by a concave pseudodeltidium in some specimens; in others the pseudodeltidium is not preserved. In most individuals the delthyrium is open. A low, thin, median septum extends from the deep umbonal cavity to about seven-eighths the valve length. Often, the

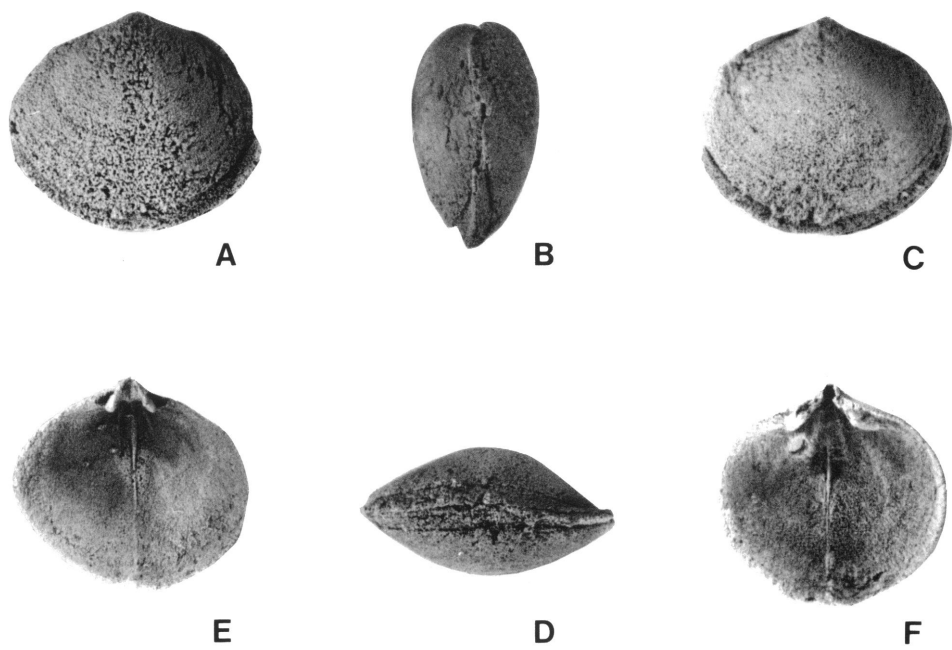


FIG. 42. *Nucleospira* aff. *ventricosa* (Hall, 1857). A–D. AMNH Loc. 3138A. Dorsal, lateral, ventral and anterior views, AMNH 39914, ×3. E. AMNH Loc. 3137. Brachial valve interior, AMNH 39913, ×3.5. F. AMNH Loc. 3138A. Pedicle valve interior, AMNH 39912, ×3.

TABLE 8  
Measurements (in Millimeters) of Articulated Specimens of *Nucleospira* aff. *ventricosa* (Hall, 1857)

AMNH Locality	(L)	(W)	(T)
3138A	3.0	3.4	1.7
3138A	6.6	8.5	3.4
3135	9.1	10.5	4.7
3135	7.3	7.5	4.4
3135	4.9	5.5	3.2
3138A	10.6	11.7	7.0
3138A	4.2	4.8	2.5
3138A	4.6	4.6	2.8
3138A	4.9	5.4	3.2
3138A	7.6	8.7	4.6
3138A	9.2	10.6	5.5
3137	5.1	5.8	2.8
3137	5.8	6.6	3.2
3137	6.5	7.4	3.9
3137	6.5	7.0	3.8
3137	6.9	7.5	4.2
3137	8.0	8.9	4.1
3137	7.5	8.6	4.4
3137	9.7	11.1	5.1
3137	9.7	11.6	5.2

median septum is obscured by secondary shell material in the umbonal cavity and appears to originate at about midlength. The muscle field is weakly impressed but appears to be flabellate (diductor scars) with two longitudinal, suboval scars (adductors) bisected by the myophragm. The muscle field extends to just past midlength.

BRACHIAL VALVE INTERIOR: The cardinal process is large and projects up from the valve floor such that when viewed from above the outline is triangular. The anterior edge is doubly concave—bisected by a ridge—giving the appearance of a lower case “m.” The ventral face of the cardinal process is scyphiform, whereas the apex is recurved posterodorsally. Well-developed, anterolateral diverging sockets are located at the base of the cardinal process. A low, bladelike median septum extends from the anterior vertical face, where it appears to be a longitudinal ridge, to just past midlength, tapering out anteriorly. Elongate, suboval adductor muscle impressions are bisected by the median septum. The diductors probably attached onto the vertical anterior face of the cardinal process since,



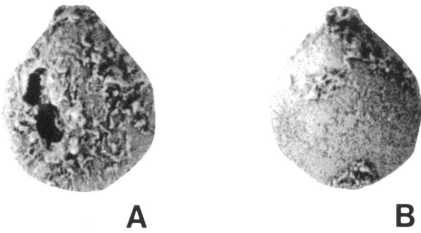


FIG. 43. Athyridacean indet. A, B. AMNH Loc. 3138A. Ventral and dorsal views, AMNH 39902,  $\times 4$ .

when the valves are articulated, there is a very narrow space between the ventral face of the cardinal process and the floor of the delthyrial cavity. The spires, partially preserved on only one specimen, are laterally directed, becoming increasingly smaller with six turns on the side preserved. Not enough of the jugum is preserved for analysis.

COMPARISON: *Nucleospira* aff. *ventricosa* differs from *Nucleospira* sp. (Boucot, 1973, p. 64, pl. 20, figs. 23–27) of the Moose River Synclinorium in its transversely suboval outline. The pedicle interiors of both forms are similar although the Moose River material is poorly preserved and precludes further comparison.

*Nucleospira ventricosa* from the Keyser Limestone (Bowen, 1967, p. 37, pl. 5, figs. 16–27) is similar in lateral profile but differs in the shape of the cardinal process (large and prominent in both forms). This difference may be due to intraspecific variation. Bowen (1967, p. 38) discusses variation in *Nucleospira* and concludes that most of the species have been based on variations in distinctness of the sulci, convexity of the valves, ratio of the length to width, presence of growth lines, and shell size; but the differences between species are nearly always vague. He places no species in synonymy because of the range in variation within *N. ventricosa*.

*Nucleospira ventricosa* from the New Scotland Formation and equivalents (Cooper, 1944, p. 331, pl. 127, figs. 8, 9) has a cardinal process which differs from the Keyser and Onondaga shells in its subovate outline. *Nucleospira concinna* (Cooper, 1944, p. 331, pl. 127, figs. 5–7) more closely approaches *N. aff. ventricosa* in size but interiors are not illustrated.



FIG. 44. *Trematospira*? sp. AMNH Loc. 3124B. Dorsal view of poorly preserved specimen, AMNH 39915,  $\times 1$ .

*Nucleospira* sp. from the Bois Blanc Formation (Boucot and Johnson, 1968, p. B14, pl. 5, figs. 1–11) most closely resembles *N. aff. ventricosa* in shell outline, size, and morphology of the cardinal process (see pl. 5, fig. 10). Since only fragmentary brachial valves are available no further comparisons can be made.

COMMUNITY OCCURRENCE: Feldman (1980) found this species in the *Atrypa-Coelospira-Nucleospira*, *Atrypa*, and *Atrypa-Megakozlowskiella* communities.

FIGURED SPECIMENS: AMNH 39912, 19913, 19914.

#### Athyridacean indet.

##### Figure 43

REMARKS: These shells were recovered from Upper Moorehouse strata in the southeastern part of New York State. The specimens probably belong to the superfamily Athyridacea, showing certain affinities to the Meristellidae. Due to the lack of material and absence of free valves with good internal morphology, these shells cannot be described or assigned at this time.

COMMUNITY OCCURRENCE: Feldman (1980) found this species in the *Atrypa-Coelospira-Nucleospira* Community.

FIGURED SPECIMEN: AMNH 39902.

#### SUBORDER RETZIOIDEA

#### SUPERFAMILY RETZIIACAE WAAGEN, 1883

#### FAMILY RETZIIDAE WAAGEN, 1883

#### GENUS *TREMATOSPIRA* HALL, 1859

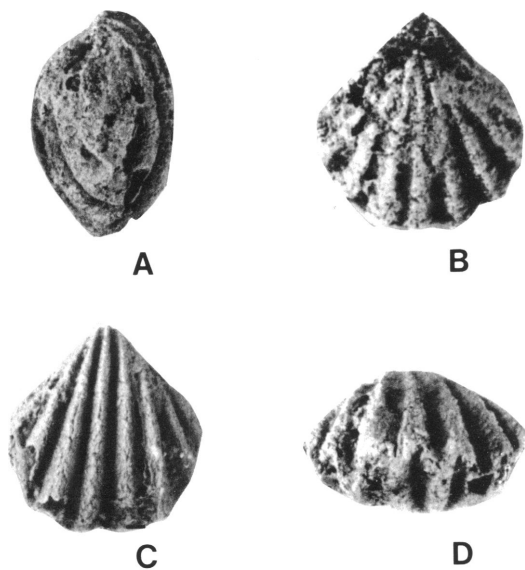


FIG. 45. *Rhynchospirina* sp. A–D. AMNH Loc. 3135. Lateral, dorsal, ventral and anterior views, AMNH 39918,  $\times 5$ .

*Trematospira?* sp.  
Figure 44

REMARKS: One specimen is available for study in the collection. The articulated shell is partly exposed at the ventral umbo, whereas approximately half of the dorsal valve is visible. The outline appears to be elongate, suboval, and moderately biconvex. The hinge line is curved and the interarea difficult to see, but appears to be extremely narrow. There are about 45 rounded, bifurcating costae on the dorsal exterior and about 19 on the ventral exterior. The peak is pointed and apically twisted.

COMMUNITY OCCURRENCE: Feldman (1980) found this species in the *Leptaena-Megakozlowskiella* Community.

FIGURED SPECIMEN: AMNH 39915.

TABLE 9  
Measurements (in Millimeters) of  
*Rhynchospirina* species

AMNH Locality	(L)	(W)	(T)
3137	6.0	5.8	3.9

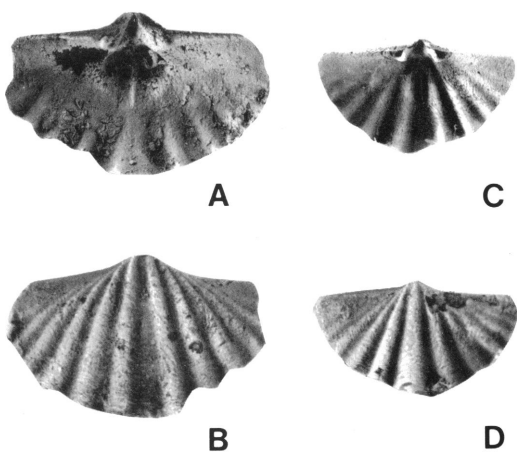


FIG. 46. *Acrospirifer duodenaria* (Hall, 1843). A, B. AMNH Loc. 3135. Pedicle valve interior and exterior, AMNH 39916,  $\times 2$ ,  $\times 1.5$ . C, D. AMNH Loc. 3137. Brachial valve interior and exterior, AMNH 39917,  $\times 2$ ,  $\times 2$ .

FAMILY RHYNCHOSPIRINIDAE  
SCHUCHERT AND LEVENE, 1929  
GENUS *RHYNCHOSPIRINA* SCHUCHERT AND  
LEVENE, 1929

*Rhynchospirina* sp.  
Figure 45

REMARKS: This genus is represented by only one specimen which is slightly damaged in the beak region. Since the beak region has been used to determine specific levels in rhynchospirinid taxonomy (Hall, 1857; Davidson, 1867; Schuchert, 1913; Kozlowski, 1929; Bowen, 1967), a specific assignment is not attempted here.

The shell is small (table 9), pyriform in outline, and biconvex (subglobose) in lateral profile with an inflated brachial valve. Maximum width is attained at midlength. The pedicle beak is erect but broken at the apex and possibly incurved. The small pedicle foramen appears to be permesothyridid. The brachial beak is chipped off. The postero-lateral margins are straight and diverge at an angle of about 90 degrees. The anterior margin is semicircular. The pedicle valve bears a weak sulcus but there is no corresponding fold visible on the brachial valve. The anterior commissure, however, is slightly uniplicate due to the influence of the sulcus. Ornamentation consists of eight subangular

plications on the brachial valve and nine on the pedicle valve with subangular interspaces between the plications. As the anterior margins are approached, the plications become more distinct and well defined.

DISCUSSION: Bowen (1967) describes two new species of *Rhynchospirina* from the Keyser Limestone of Pennsylvania and West Virginia. The genus has also been reported from the Decker Formation of New Jersey (Weller, 1903), the New Scotland Formation (New York), and the Oriskany Sandstone (Maryland) by Hall (1857).

COMMUNITY OCCURRENCE: Feldman (1980) found this species in the *Atrypa-Coelospira-Nucleospira* Community.

FIGURED SPECIMEN: AMNH 39918.

SUBORDER SPIRIFEROIDEA  
SUPERFAMILY DELTHYRIDACEA  
PHILLIPS, 1841

FAMILY DELTHYRIDIDAE PHILLIPS, 1841

SUBFAMILY DELTHYRINAE PHILLIPS, 1841

GENUS *ACROSPIRIFER* HELMBRECHT  
AND WEDEKIND, 1923

TYPE SPECIES: *Spirifer primaevus* Steininger, 1853, by subsequent designation of Wedekind, 1926, p. 202.

*Acrospirifer duodenaria* (Hall, 1843)

Figure 46

*Delthyris duodenaria* Hall, 1843, p. 171, fig. 5.

*Spirifer duodenaria* Hall, 1867, p. 189, pl. 27, 28; Landes, Ehlers, and Stanley, 1945, pl. 12, fig. 4.

*Hysterolite (Acrospirifer) worthenanus?* Amsden in Amsden and Ventress, 1963, p. 182, pl. 16, figs. 1–4, 6–8, 11–16, 5?, 9?, 10?.

*Acrospirifer duodenaria* Boucot and Johnson, 1968, pp. B14–B15, pl. 5, figs. 12–39.

EXTERIOR: The shells are biconvex with a slightly more convex pedicle valve, and are transversely subelliptical in outline. The width, greatest at the hinge line, is commonly twice that of the length in most specimens studied, although that relationship is variable. The hinge line is long and straight. The pedicle interarea is long, low, narrow, moderately curved, and apsacline. There is a medial open delthyrium with no preserved deltidial plates. The pedicle beak is incurved toward the brachial umbo. The brachial in-

terarea ranges from slightly orthocline to anacline (most common) and is exceedingly long and thin. The pedicle valve bears a narrow, triangular, moderately deep, noncostate sulcus originating in the umbonal region. The brachial valve bears a corresponding fold with a somewhat flattened crest.

On each pedicle flank there are five or six rounded plications becoming progressively narrower laterally. The interspaces are U-shaped, narrowing toward the bottom. The brachial flanks bear four or five plications also with U-shaped interspaces. In some of the better-preserved specimens there are indications of fine, numerous, concentric growth lines. The anterior commissure is uniplicate. Fine, radial ornamentation was not preserved.

PEDICLE VALVE INTERIOR: The hinge teeth are short, blunt, and somewhat subcircular in cross section. The dental plates are short and almost obscured by the deposition of secondary shell material in the posterior portion of the umbonal cavity and along the inner margins of the delthyrium. In some specimens this secondary shell material results in a raised platform-like mound located in the posterior region of the delthyrium. A low myophragm bisects the subcircular muscle field which consists of two suboval diductor impressions. There is no line of demarcation between the muscle field and the valve floor, which is crenulated anteriorly due to the impress of the plications.

BRACHIAL VALVE INTERIOR: The dental sockets are short, deeply excavated, laterally directed, and subtriangular in outline. Short, incurved, crural bases attach to the inner margins of the sockets and merge into the socket floors. The hinge line overhangs the sockets on the posterior margin. The notothyrial cavity is empty and uncovered by chilidial plates. A vague, striated region represents the site of diductor attachment at the apex of the notothyrial cavity. Two adductor scars are separated by a low myophragm extending to almost half the valve length. The muscle field is poorly impressed. The valve floor is crenulated due to the impress of the plications.

COMPARISON: *Acrospirifer purchisoni* from the Moose River Synclinorium (Boucot, 1973, p. 41, pl. 16, figs. 19–25) differs from *A. duo-*

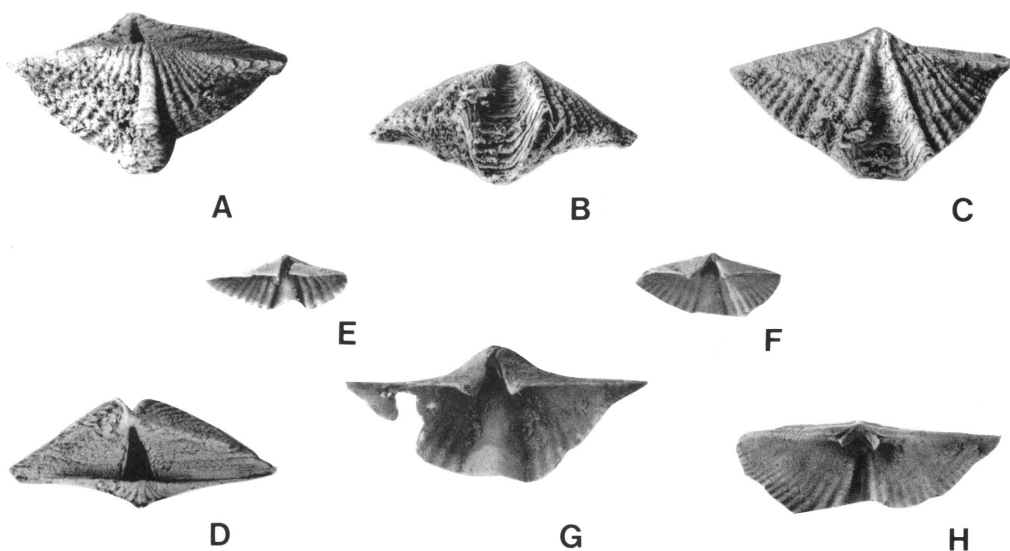


FIG. 47. *Mucrospirifer* cf. *macra* (Hall, 1857). A-D. AMNH Loc. 3138A. Dorsal, anterior, ventral and posterior views, AMNH 39919,  $\times 1.5$ . E. AMNH Loc. 3137. Pedicle valve interior, AMNH 42767,  $\times 1$ . F. AMNH Loc. 3137. Pedicle valve interior, AMNH 42763,  $\times 1$ . G. AMNH Loc. 3137. Pedicle valve interior, AMNH 42761,  $\times 1$ . H. AMNH Loc. 3137. Brachial valve interior, AMNH 42762,  $\times 1$ .

*denaria* in its larger size and wide pedicle interarea. *Acrospirifer atlanticus*, also from the Moose River Synclinorium, is considerably larger and more alate. Boucot, Gauri, and Southard (1970, p. 14, pl. 4, figs. 22-26) describe *Acrospirifer?* sp. from the Esopus Formation to the Green Pond Outlier which is a medium-sized shell considerably less transverse in outline than the Onondaga shells. *Acrospirifer* aff. *murchisoni* from the Great Basin (Johnson, 1970, p. 189, pl. 56, figs. 5-13; pl. 57, figs. 1-6) is less alate and more transversely suboval. Also, it generally has six plications on the pedicle valve flank. The Nevada shells usually have fewer plications (three to six on each pedicle valve flank).

In their discussion of *Acrospirifer duodenaria* from the Bois Blanc Formation, Boucot and Johnson (1968, p. B15) note that specimens of the species from the Kanouse Sandstone were assigned to *A. macrothyris* based on the belief that *A. duodenarius* represented the young of *A. macrothyris*. However, based upon their study of the Bois Blanc shells, Boucot and Johnson distinguish *A. macrothyris* by its much lower plications and narrow, shallow interspaces. The size difference between the two species is therefore real.

Hall (1867, pp. 189-190) in describing *A. duodenaria* from the Schoharie Grit and Onondaga Limestone mentions that the species is known throughout "all the extent of the formation within the state," and occurs in Canada West and Ohio.

COMMUNITY OCCURRENCE: Feldman (1980) found this species in the *Atrypa-Coelospira-Nucleospira* and *Atrypa-Megakozlowskiella* communities.

FIGURED SPECIMENS: AMNH 39916, 39917.

#### FAMILY MUCROSPIRIFERIDAE

PITRAT, 1965

#### SUBFAMILY MUCROSPIRIFERINAE

BOUCOT, 1959

#### GENUS MUCROSPIRIFER GRABAU, 1931

TYPE SPECIES: *Delthyris mucronatus* Conrad, 1841, p. 54.

#### *Mucrospirifer* cf. *macra* (Hall, 1857)

Figures 47-50

*Delthyris mucronatus* Conrad, 1841, p. 54.

"*Mucrospirifer*" cf. *macra* Boucot and Johnson, 1968, p. B15, pl. 6, figs. 1-6; Boucot, 1973, p. 60, pl. 18, figs. 21, 22.

EXTERIOR: The shells range from small to

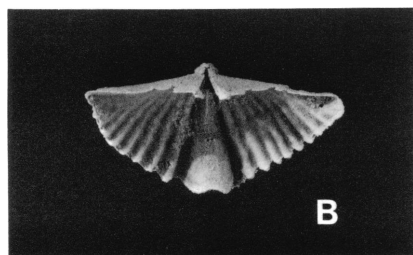
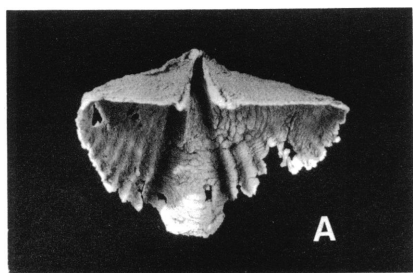


FIG. 48. *Mucrospirifer* cf. *macra* (Hall, 1857). A. AMNH Loc. 3137. Pedicle valve interior, AMNH 42754,  $\times 2$ . AMNH Loc. 3138A. Pedicle valve interior, AMNH 42753,  $\times 2$ .

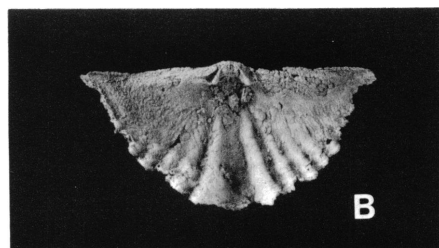
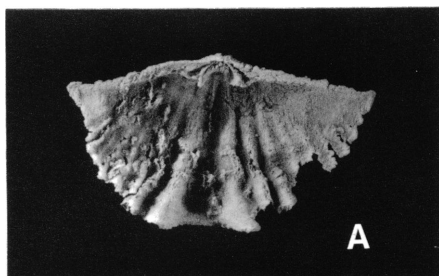


FIG. 49. *Mucrospirifer* cf. *macra* (Hall, 1857). A. AMNH Loc. 3138A. Brachial valve interior, AMNH 42750,  $\times 2$ . B. AMNH Loc. 3137. Brachial valve interior, AMNH 42751,  $\times 2$ .

large and are transversely subtrigonal to subsemicircular in outline and biconvex in lateral profile with the brachial valve a little flatter than the pedicle valve. The point of maximum width, commonly twice the length or more, is at the hinge line, which is straight. The relative widths on specimens studied is highly variable and is often dependent upon the degree of alation. The ventral interarea is moderately high, long, slightly curved, and apsacline. The ventral beak, posterior to the interarea, is short and stubby, and ranges from nearly straight to suberect. An open, triangular delthyrium, enclosing an angle of about 20 to 30 degrees, divides the interarea medially. No deltidial plates were observed. Faint, horizontal striations are present in the interarea of one specimen. The dorsal interarea is long, thin, ribbonlike, and apsacline. The brachial valve bears a high, medial fold flattened at the top and raised above the crests of the adjoining lateral plications. The pedicle valve bears a corresponding U-shaped sulcus. Both fold and sulcus originate in the umbonal region. The surface of the shells is covered by sharply defined plications (normally nine to 15 on each flank) which range

from U-shaped to subangular (almost chevron-like on some specimens) in cross section. Numerous, concentric, frilly growth lamellae are present, but no fine radial ornamentation was observed.

**PEDICLE VALVE INTERIOR:** The hinge teeth are small, pointed, dorsally directed and somewhat crescentic in some specimens. They are supported by thin, relatively straight,

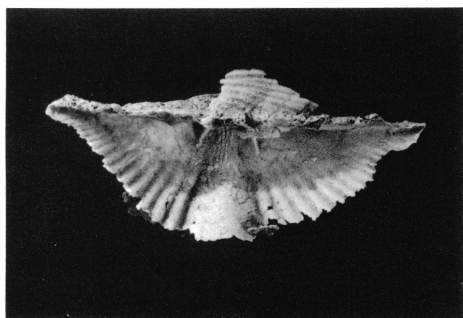


FIG. 50. *Mucrospirifer* cf. *macra* (Hall, 1857). AMNH Loc. 3137. Pedicle valve interior, AMNH 42752,  $\times 1.5$ .

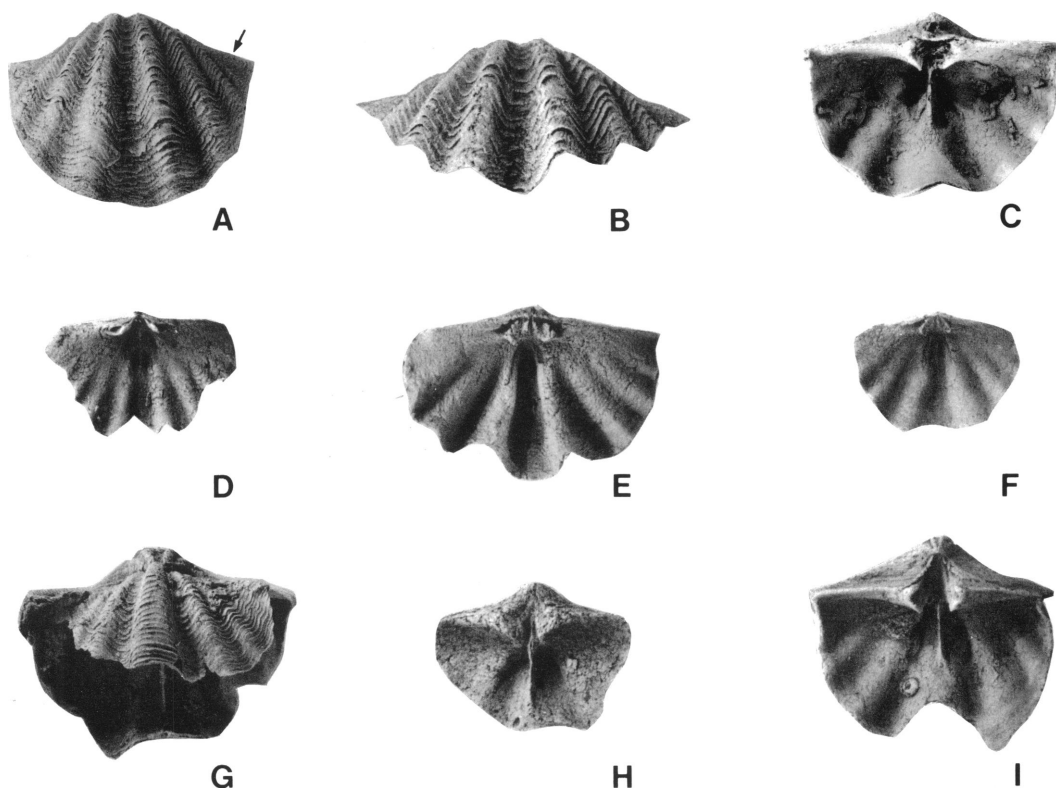


FIG. 51. *Megakozlowskiella raricosta* (Conrad, 1842). A–C. AMNH Loc. 3137. Pedicle valve exterior (note arrow on Fig. 46A denoting growth line along which an enlarged photograph was cropped in order to illustrate detail of external ornamentation), pedicle valve interior, AMNH 39920,  $\times 1.2$ ,  $\times 2$ ,  $\times 1.2$ . D. AMNH Loc. 3137. Brachial valve interior, AMNH 42735,  $\times 1.2$ . E. AMNH Loc. 3137. Brachial valve interior, AMNH 39922,  $\times 1.5$ . F. AMNH Loc. 3137. Brachial valve interior, AMNH 42736,  $\times 1.3$ . G. AMNH Loc. 3149. Dorsal view with anterior commissure dissected exposing well developed, high, thin median septum, AMNH 42759,  $\times 1$ . H. AMNH Loc. 3137. Severely weathered pedicle valve interior, AMNH 42734,  $\times 1.2$ . I. AMNH Loc. 3137. Pedicle valve interior, AMNH 42733,  $\times 1.3$ .

prominent dental plates which extend to the floor of the valve. The dental plates diverge at an angle equal to that which is enclosed by the delthyrium (20 to 30 degrees). Muscle scars are not impressed and a short, thin myophragm may or may not be present. The valve floor is crenulated anteriorly due to the impress of the plications. The crenulations disappear toward the umbonal cavity due to deposition of secondary shell material.

**BRACHIAL VALVE INTERIOR.** The sockets are long, thin, U-shaped, and are widely divergent anterolaterally. The inner margin of the interarea overhangs the lateral edges of the sockets. The crural bases attach to the inner edges of the sockets and are concave in ap-

pearance, although their form is highly variable. Although muscle scars are not impressed, there is a thin, beadlike myophragm present on some specimens which extends almost half the length of the valve. The only cardinal process observed is bilobed and rests apically on a thickened callus in the notothyrial cavity. Other specimens bear a thickened region, ventrally directed, in the notothyrial cavity which is longitudinally striated and represents the site of diductor attachment. The valve floor is crenulated due to the impress of the plications.

**COMPARISON:** The brachial interior of the Onondaga shells is almost identical in its morphology to that of Boucot and Johnson's

(1968, p. B15, pl. 6, fig. 4) "*Mucrospirifer*" cf. *macra* from the Bois Blanc Formation. Specimens from both the Onondaga and Bois Blanc have 15 rounded plications on each brachial flank (although there is some variation in Onondaga shells in which nine to 12 plications are sometimes present). Boucot (1973, p. 60, pl. 18, figs. 21, 22) describes "*M.*" cf. *macra* from the Moose River Synclinorium based upon a single, poorly preserved pedicle valve internal mold. Although no meaningful comparison can be made from this material it is noteworthy that the interarea is similar to that of some variants of "*M.*" cf. *macra* from the Onondaga Limestone.

Specimens of *Mucrospirifer* from the Middle Devonian Silica Formation (Kesling and Chilman, 1975) differ from *Mucrospirifer* cf. *macra* as follows: *M. prolificus* is larger, more alate, and has a wider interarea. *Mucrospirifer mucronatus* has a narrower pedicle interarea and *M. profundus* is more globose, less alate, and has a thicker shell. *Mucrospirifer grabaui* differs in the unusually long mucronate hinge extensions resulting in an extreme alate morphology. The Onondaga shells lack a shallow median groove on the dorsal fold.

COMMUNITY OCCURRENCE: Feldman (1980) found this species in the *Atrypa-Coelospira-Nucleospira* and *Atrypa-Megakozlowskiella* communities.

FIGURED SPECIMENS: AMNH 39919, 42751, 42752, 42753, 42754, 42761, 42762, 42763, 42764.

#### SUBFAMILY KOZLOWSKIELLININAE

BOUCOT, 1957

GENUS *KOZLOWSKIELLINA* BOUCOT, 1958

(=*KOZLOWSKIELLA* BOUCOT, 1957)

SUBGENUS *MEGAKOZLOWSKIELLA*

BOUCOT, 1957

TYPE SPECIES: *Spirifer perlamellosus* Hall, 1857, p. 57.

*Megakozlowskiella raricosta* (Conrad, 1842)

Figures 51, 52

*Spirifer perlamellosus* Hall, 1857, p. 57.

*Delthyris raricosta* Conrad, 1842, p. 262, pl. 14, fig. 18.

*Spirifer raricosta* Hall, 1867, p. 192, pl. 27, figs. 30–34; pl. 30, figs. 1–9.

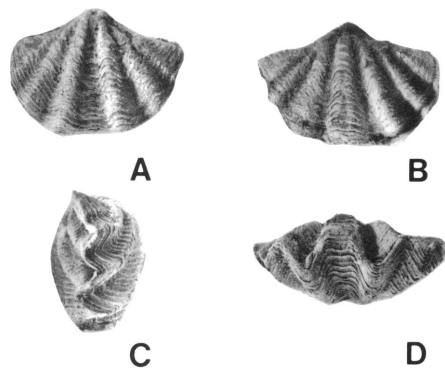


FIG. 52. *Megakozlowskiella raricosta* (Conrad, 1842). A–D. AMNH Loc. 3135. Ventral, dorsal, lateral, and anterior views, AMNH 39921,  $\times 1$ .

*Kozlowskiella* (*Megakozlowskiella*) *raricosta* Boucot, 1957, pl. 3, figs. 18, 19.

*Megakozlowskiella* cf. *raricosta* Johnson, 1970, p. 204, pl. 70, figs. 26–28.

*Megakozlowskiella raricosta* Boucot and Johnson, 1968, p. B16, pl. 6, figs. 7–15.

EXTERIOR: The shells are subtransverse in outline, strophic, medium to large (up to 24.5 mm long and 33.6 mm wide) and ventribi-convex with a lessening convexity in both valves anteriorly. The hinge line is straight with the maximum width usually at the hinge line but occasionally slightly anterior to it. The pedicle interarea is moderately narrow and apsacline, but in some gerontic specimens tends to be almost catacline. Striae are present in the pedicle interarea which parallel the hinge line and extend the entire length of the interarea, becoming less distinct as the delthyrium is approached. These striae appear to be extensions of the growth lines. The brachial interarea is extremely narrow and in articulated specimens is hidden by the ventral umbo.

There is a distinct, slightly flattened fold on the brachial valve and a corresponding deep, U-shaped sulcus on the pedicle valve. Both fold and sulcus originate deep in the umbonal region. There is usually a minimum of three plications on the flanks of both the pedicle and brachial valves. As the flanks are approached the plications become narrower and less prominent. Between the plications are deep U-shaped interspaces which, in rare cases, tend to be almost V-shaped.

TABLE 10  
Measurements (in Millimeters) of *Megakozłowskiella raricosta* (Conrad, 1842)

AMNH Locality	Valve Present	Length p.v.	Length b.v.	(W)	(T)	Number of Plications		Frills No./ 5 mm	Length p.v./Width Ratio	Length b.v./Width Ratio
						p.v.	b.v.			
3149	art.	24.5	20.7	33.6	22.5	6	7	8	0.729	0.616
3135	art.	14.6	13.7	21.6	10.0	6	5	9	0.676	0.634
3137 def.	art.	23.7	19.9	26.7	18.0	6	—	7	0.888	0.745
3137	art.	16.2	—	23.1	14.6	8	7	11	0.701	—
3137	art.	17.0	12.8	20.4	11.5	6+	5+	6	0.833	0.627
3138A	p.v.	17.0	—	24.7	—	6	—	7	—	—
3135	p.v.	15.0	—	17.0	—	6	—	—	—	—
3135	p.v.	10.9	—	—	—	6	—	7	—	—
3137	p.v.	20.5	—	22.5	—	8	—	7	—	—
3137	p.v.	22.9	—	25.5	—	8	—	7	—	—
3137	p.v.	19.7	—	—	—	8	—	—	—	—
3137	p.v.	16.5	—	21.9	—	8	—	—	—	—
3137	p.v.	10.8	—	14.9	—	8	—	—	—	—
3137	p.v.	7.8	—	11.0	—	6	—	—	—	—
3137	p.v.	6.9	—	9.5	—	6	—	—	—	—
3137	p.v.	8.2	—	11.9	—	6	—	—	—	—
3137	b.v.	—	18.4	21.8	—	—	7	9	—	—
3137	b.v.	—	16.9	23.3	—	—	7	8	—	—
3137	b.v.	—	15.5	22.0	—	—	7	7	—	—
3137	b.v.	—	17.7	20.1	—	—	7	9	—	—
3137	b.v.	—	16.0	—	—	—	7	—	—	—
3137	b.v.	—	13.2	18.2	—	—	5	8	—	—
3137	b.v.	—	13.0	20.8	—	—	9	—	—	—
3137	b.v.	—	10.1	13.8	—	—	7	—	—	—
3137	b.v.	—	9.4	—	—	—	7	—	—	—
3138	art.	18.8	16.7	—	12.7	6	—	7	—	—
3139	p.v.	15.3	—	16.5	—	6	—	9	—	—

Note: the number of plications on the brachial valve includes the fold.

The delthyrium includes an angle of approximately 60 degrees in most specimens. No deltidial plates were preserved although there are indications of narrow ridges on the sides of the delthyrium of some specimens indicating the probable presence of deltidial plates.

The anterior commissure is uniplicate with crenulations corresponding to the ends of the coarse plications on the flanks (two to five on each flank) (table 10). Strong, concentric growth lamellae possess anterior frills (numbering six to 11 per 5 mm) in unworn specimens. Radial ornamentation consists of extremely fine striae, or capillae, noticeably more prominent at the anterior ends of the growth lamellae. These appear to be the terminal ends of radial spines and are especially well developed in the pedicle sulcus where

there are approximately 25 at the anterior commissure.

PEDICLE VALVE INTERIOR: Small, pointed hinge teeth are attached to the dental lamellae along the margin of the hinge line. The dental lamellae are short, blunt, and directed medially at an angle of approximately 45 degrees. Two thin, posteriorly directed ridges extend from the base of the dental lamellae through the umbonal cavity toward the beak. In neanic and gerontic individuals a large amount of secondary shell material is deposited in the umbonal region. A high, thin, well-developed median septum extends from the anterior base of the umbonal cavity to a point approximately two-thirds to three-quarters of the valve length. The median septum never comes in contact with the base of the brachioophores but extends through the delthy-



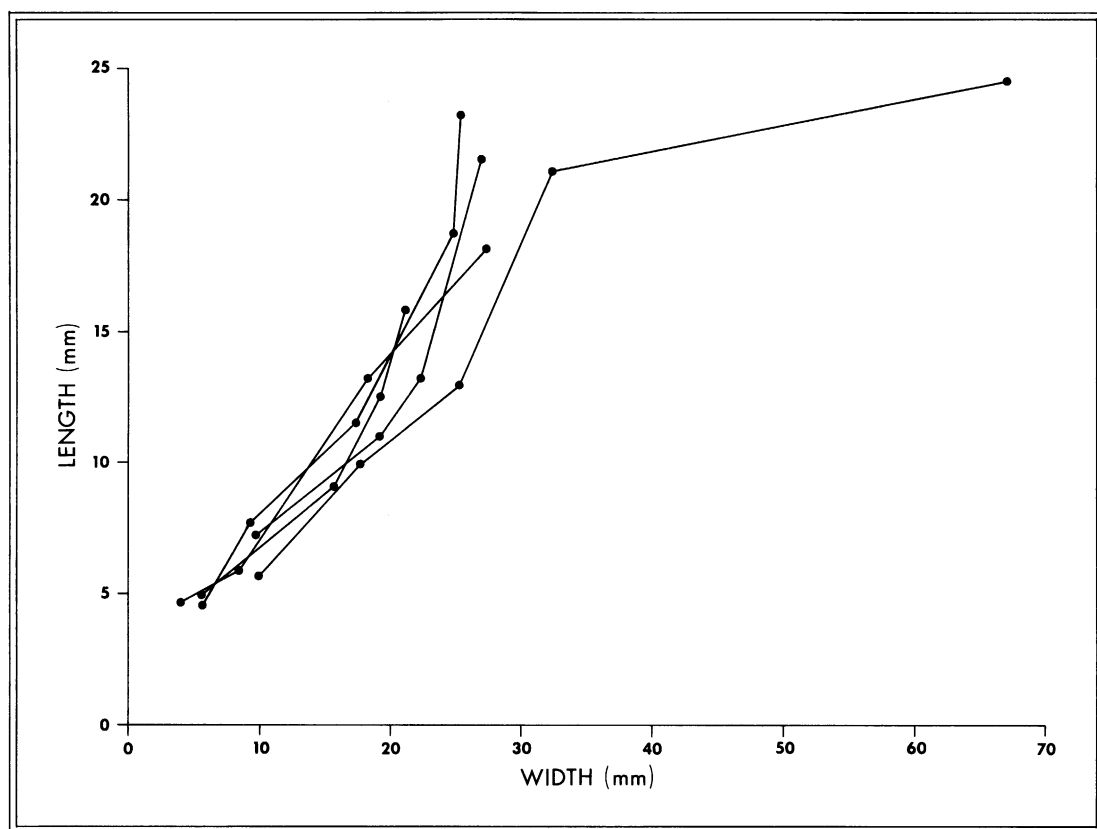


FIG. 53. Length/width ontogenies of five pedicle valves of *Megakozlowskiella raricosta* (Conrad, 1842).

rium to the beak. In older specimens the anterior limit of the median septum is marked by a sudden convexity in the valve floor such that the convexity of the valve appears to increase greatly at that point. In one specimen the median septum increases in height at about midlength to a maximum of more than 50 percent of the distance to the floor of the brachial valve, and then drops off quickly to the pedicle valve floor. In all other specimens the median septum is relatively low.

The muscle field is represented by two longitudinal pits (diductor impressions) adjacent to the median septum extending from the base of the dental lamellae to a point about one-third to one-half the valve length. Adductor and adjustor impressions are not discernible.

The crenulations of the external plicae are strong at the anterior periphery and extend

posteriorly along the valve floor becoming progressively weaker.

**BRACHIAL VALVE INTERIOR:** The dental sockets are U-shaped, constricted posteriorly, and widen and shallow out anteriorly. The outer socket ridges are smooth and diverge laterally at an angle of from 20 to 35 degrees from their origin at the brachial interarea. The crural plates, small, slightly concave, and somewhat triangular, extend anteroventrally a short distance from the notothyrial platform.

The cardinal process is deeply striated in an anteroposterior direction. There is an indication of a bilobed cardinal process in some specimens studied but due to erosion most display worn cardinalia. The cardinal processes are generally not well preserved. Anterior to the notothyrial cavity extends a low, medially situated, indistinct myophragm

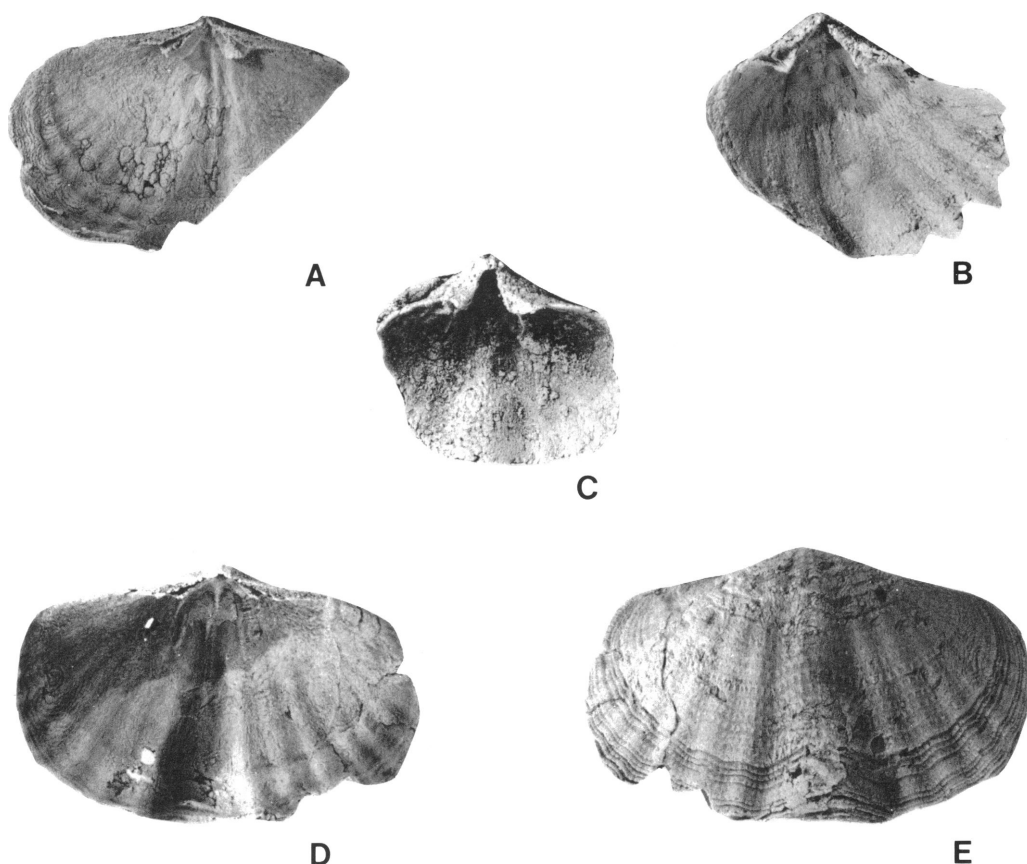


FIG. 54. *Elytha fimbriata* (Conrad, 1842). A. AMNH Loc. 3138A. Brachial valve interior, AMNH 42741,  $\times 2$ . B. AMNH Loc. 3138A. Brachial valve interior, AMNH 42742,  $\times 2.5$ . C. AMNH Loc. 3138A. Pedicle valve interior, AMNH 42743,  $\times 2.5$ . D, E. AMNH Loc. 3139. Brachial valve interior and exterior, AMNH 39923,  $\times 2$ .

which is worn in most specimens. The myophragm generally extends about one-third to one-quarter the valve length, becoming progressively lower and thinner anteriorly. The myophragm divides the dorsal muscle field in which the sites of the adductors are represented by two pits, shallowing-out anteriorly and disappearing before midlength. The dorsal muscle field is not well preserved. The interior of the valve reflects the external plications and is strongly corrugated, especially anteriorly. The anterior commissure is crenulated.

COMPARISON: *Megakozlowskiella* may be differentiated from *Kozlowskiella* by its greater size (length, width, and thickness), and more convex brachial valve (fig. 53). Inter-

nally there is little to distinguish the two genera. The cardinalia are almost identical.

*Kozlowskiella strawi* Boucot (1957) is easily distinguished by its flatter brachial valve, less prominent median septum, and more alate appearance.

*Kozlowskiella (M.) praenuntia* (Swartz, 1929) has a flatter pedicle interarea, less incurved beak, and is generally smaller in size.

*Pliocyrtina* sp. differs from *Megakozlowskiella* in its more developed spondylium, weaker growth lamellae, and median plication within the pedicle sulcus.

*Megakozlowskiella magnapleura* from the Great Basin, Nevada (Johnson, 1970, p. 202, pl. 71, figs. 1–19), has fewer plications and is more subquadrate in outline.

Hall (1867, p. 192, pl. 27, figs. 30–34; pl. 30, figs. 1–9) describes *M. raricosta* from the Schoharie Grit (Helderberg Mountains and Schoharie, New York), and from the Onondaga Limestone at Stafford, Caledonia, and Williamsville, all in western New York. Hall also reports occurrences in Columbus, Ohio, Falls of the Ohio, and Canada West.

COMMUNITY OCCURRENCE: Feldman (1980) found this species in the *Leptaena-Megakozlowskiella*, *Atrypa-Coelospira-Nucleospira*, *Atrypa*, *Atrypa-Megakozlowskiella*, “*Pacificocoelia*” and “*Chonetes*” communities.

FIGURED SPECIMENS: AMNH 39920, 39921, 39922, 423733, 423734, 423735, 423736, 423759.

FAMILY RETICULARIIDAE WAAGEN, 1883  
GENUS *ELYTHA* FREDERIKS, 1918

TYPE SPECIES: *Delthyris fimbriatus* Conrad, 1842, p. 263.

*Elytha fimbriata* (Conrad, 1842)  
Figure 54

- Delthyris fimbriatus* Conrad, 1842, p. 263.  
*Spirifer fimbriata* Hall, 1867, p. 214, pl. 33, figs. 1–21.  
*Elytha* sp. Boucot and Johnson, 1968, p. B18, pl. 7, figs. 1–5.  
*Elytha fimbriata* Goldring, 1943, p. 236, fig. 43J; Cooper, 1944, p. 327, pl. 126, figs. 1–3.

EXTERIOR: The shells are medium-sized (table 11), biconvex in lateral profile, and transversely oval in outline. Both valves are approximately equal in depth with the brachial valve a little less convex. Maximum width is attained anterior to the hinge line, at about midlength. The hinge line is relatively short, about half the maximum width. The beak is short and erect. The ventral interarea is low, and ranges from slightly catacline to apsacline. The dorsal interarea is extremely low and narrow, and appears to be apsacline. The pedicle valve bears a distinct, moderately shallow, triangular sulcus which originates at the beak. The brachial valve bears a corresponding low, rounded fold.

The lateral slopes are covered by faint plications, broadly U-shaped in cross section, which disappear as the lateral margins are approached. The plications are separated by

TABLE 11  
Measurements (in Millimeters) of Disarticulated  
Valves of *Elytha fimbriata* (Conrad, 1842)

AMNH Locality					No. of Plica- tions per Flank
	p.v.	b.v.	(L)	(W)	
3139	—	X	18.3	27.9	6
3139	—	X	15.2	—	7
3139	—	X	12.8	—	4
3137	X	—	7.9	9.5	3 est.
3137	X	—	11.2	15.0	5
3137	—	X	10.2	13.6	4 est.
3137	—	X	10.0	13.5 est.	5
3137	X	—	17.4	—	6
3137	X	—	11.2	12.3 est.	—
3137	X	—	11.5	13.4 est.	—

equally indistinct U-shaped interspaces. Crossing the plications are concentric growth lamellae, more numerous anteriorly, which terminate in short, attenuated spines (five per 1 mm in juveniles, but indistinct in larger specimens due to exfoliation). The rows of spines give the appearance of costellae when viewed without a lens. The anterior commissure is uniplicate.

PEDICLE VALVE INTERIOR: The hinge teeth are short, pointed, and somewhat laterally directed. They are supported by slightly divergent dental lamellae which extend to the floor of the valve and then anteriorly for several millimeters. There is an open delthyrium with no indication of deltidial plates or a pseudodeltidium. A long, low, narrow myophragm, extending from the apex of the delthyrial cavity through the faintly impressed muscle field, gradually merges with the ridge which represents the impress of the sulcus. The valve floor is faintly crenulated due to the impress of the plications.

BRACHIAL VALVE INTERIOR: The sockets diverge, broaden anterolaterally and are covered posteriorly by the overlapping hinge line. Broad crural plates, medially concave, partially adjoin the floor of the valve but do not unite into a septalium. In some specimens there is a moderate buildup of secondary shell material in the notothyrial cavity, but an insufficient amount to cause obsolescence of

the crural plates. A short, low myophragm is present in adult specimens but not in juveniles. The muscle field is obscure and too faintly impressed to determine the position of the scars. The valve floor is crenulated by the impress of the plications, especially anteriorly. On some specimens the concentric growth lamellae are also impressed upon the floor of the valve, anteriorly.

COMPARISON: *Elytha* sp. described by Boucot and Johnson (1968, p. B18, pl. 7, figs. 1–5) from the Bois Blanc Limestone is assigned here to *E. fimbriata* based upon its oval shape, short hinge line, length of the myophragm, and presence of dental lamellae. Although the material is fragmentary the shells appear remarkably like those found in the overlying Onondaga Limestone (compare fig. 51C).

Hall (1867) described *E. fimbriata* from the Oriskany Sandstone at Saugerties, New York, and at Knox in Albany County. He also found it in the Schoharie Grit in Albany and Schoharie counties and in the Onondaga Limestone at Cherry Valley, Westmoreland (Oneida County), Onondaga Hollow (Onondaga County), Stafford (Genesee County), Williamsville, Clarence (Erie County), and in Canada West and Columbus, Ohio.

COMMUNITY OCCURRENCE: Feldman (1980) found this species in the *Atrypa-Coelospira-Nucleospira*, *Atrypa*, *Atrypa-Megakozlow-skiella*, and *Levenea* Community I communities.

FIGURED SPECIMENS: AMNH 39923, 42741, 42742, 42743.

Eospiriferid? indet.

Figure 55

REMARKS: Because of paucity of material this shell cannot yet be assigned to a genus. However, the following observations can be made: The specimen is a single, medium-sized, convex pedicle valve, moderately transverse, plicate, and covered by fine radiating striae. There is a well-developed sulcus which originates in the beak region. Internally, the hinge teeth are supported by strongly arched dental plates which reach to the floor of the valve. The delthyrium is triangular with slightly corrugated edges indicating the possible presence of deltidial plates or a pseudodeltidium.

The general morphology fits Boucot's (1963) diagnosis of the superfamily Eospiriferinae. *Eospirifer* differs in its unplicated flanks, whereas *Striispirifer* is similar in its unplicated sulcus laterally bordered by numerous striae. The radial ornamentation on the Onondaga material is very poorly preserved.

Savage (1974, p. 34) notes that within the eospiriferids there are several intermediate stages of plication in addition to the unplicated flanks of *Eospirifer* at one extreme, and the broadly rounded plications immediately bordering the fold and sulcus of *Macropleura* on the other extreme. Shells of *E. parahentius* from the Maradana Shale in New South Wales possess weak lateral plications variably developed. In the Onondaga specimen the plications are stronger and less broad.

COMMUNITY OCCURRENCE: Feldman (1980) found this species in the *Atrypa-Coelospira-Nucleospira* Community.

FIGURED SPECIMEN: AMNH 39927.

FAMILY AMBOCOELIIDAE GEORGE, 1931  
SUBFAMILY AMBOCOELIINAE GEORGE, 1931  
GENUS *AMBOCOELIA* HALL, 1860

*Ambocoelia* sp.

Figure 56

EXTERIOR: The shells are small (the largest is 4.7 mm in length), ventribiconvex, and subcircular in outline. The pedicle valve is smooth and bears a weak sulcus which originates at the umbo and extends to the anterior commissure. The beak is incurved and the pedicle interarea apsacline. The hinge line is straight and the delthyrium open. The greatest width is attained anterior to the hinge line at about midlength. The brachial valve is slightly convex, with no ornamentation. The anterior commissure is rectimarginate to uniplicate to slightly intraplicate.

PEDICLE VALVE INTERIOR: Short hinge teeth are located at the anterior end of thin fossated tracks which form the inner boundaries of the delthyrium. No dental lamellae are present. A weak, low myophragm originates at the posterior end of the umbonal cavity and terminates at about midlength. Longitudinal muscle scars are weakly impressed on either side of the myophragm.



FIG. 55. Eospiriferid? AMNH Loc. 3135. Pedicle valve interior, AMNH 39927,  $\times 2.5$ .

**BRACHIAL VALVE INTERIOR:** No brachial interiors are in the collection.

**COMPARISON:** The shells are assigned to *Ambocoelia* sp. based upon the presence of a median pedicle valve furrow and lack of plications on the flanks. *Metaplasia* has a sulcus on the brachial valve and a fold on the pedicle valve. *Plicoplasia* has a biplicate fold (see Boucot, Gauri, and Southard, 1970, p. 15) and a strong plication on the brachial sulcus.

*Ambocoelia* sp. from the Bois Blanc Formation (Boucot and Johnson, 1968, p. B18, pl. 7, figs. 6–10) has a shorter delthyrium and a less incurved, stubbier beak.

**COMMUNITY OCCURRENCE:** Feldman (1980) found this species in the *Atrypa-Coelospira-Nucleospira* Community.

**FIGURED SPECIMEN:** AMNH 39924.

#### SUPERFAMILY CYRTINACEA

FREDERIKS, 1912

[*nom. transl.* Johnson, 1966,

ex. Cyrtininae Frederiks, 1912]

FAMILY CYRTINIDAE FREDERIKS, 1912

GENUS *CYRTINA* DAVIDSON, 1858

**TYPE SPECIES:** *Cyrtia hamiltonensis* Hall, 1857, p. 166.

*Cyrtina hamiltonensis* (Hall, 1857)

Figures 57A–D, F, 58

*Cyrtia hamiltonensis* Hall, 1857, p. 166.

*Cyrtina hamiltonensis* Hall, 1867, p. 268, pl. 27, figs. 1–4; pl. 44, figs. 26–33, 38–52.

**EXTERIOR:** The shells are small (table 12), hemipyramidal in outline, wider than long, with a straight hinge line anterior to which maximum width is usually attained. In some

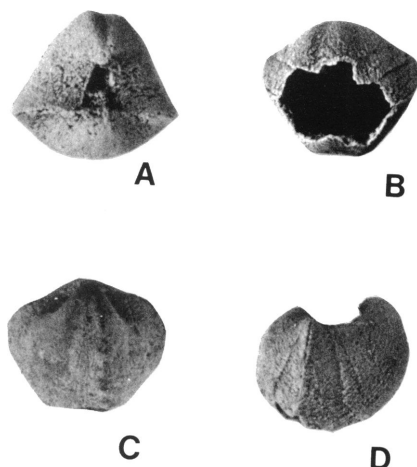


FIG. 56. *Ambocoelia* sp. A–D. AMNH Loc. 3135. Posterior, anterior, ventral and lateral views, AMNH 39924,  $\times 5$ .

specimens maximum width is at the hinge line. The ventral interarea is high, smooth, and catacline to slightly apsacline. The beak curves in at the apex of the pedicle valve forming a concavity in the ventral aspect of the interarea. The delthyrium encloses an angle of about 20 to 30 degrees, but is variable. A convex pseudodeltidium covers the triangular delthyrium in about half of the specimens studied. In the others the delthyrium is open, but longitudinal grooves are present along the margins of the delthyrial cavity representing the seat of attachment for the pseudodeltidium.

The pedicle valve bears a triangular, smooth sulcus, V-shaped in cross section, which originates at the apex of the umbo and extends and expands anteriorly until the anterior commissure is reached. Two to three rounded plications extend along the pedicle flanks. Concentric growth lamellae are present, mainly at the anterior portion of the valve. The anterior commissure is uniplicate.

The brachial valve bears a fold corresponding to the pedicle sulcus. Three to four lateral plications were observed on either side of the fold. The only ornamentation consists of concentric growth lamellae.

**PEDICLE VALVE INTERIOR:** The small, blunt, hinge teeth astride the hinge margin are anterodorsal extensions of the elongate den-

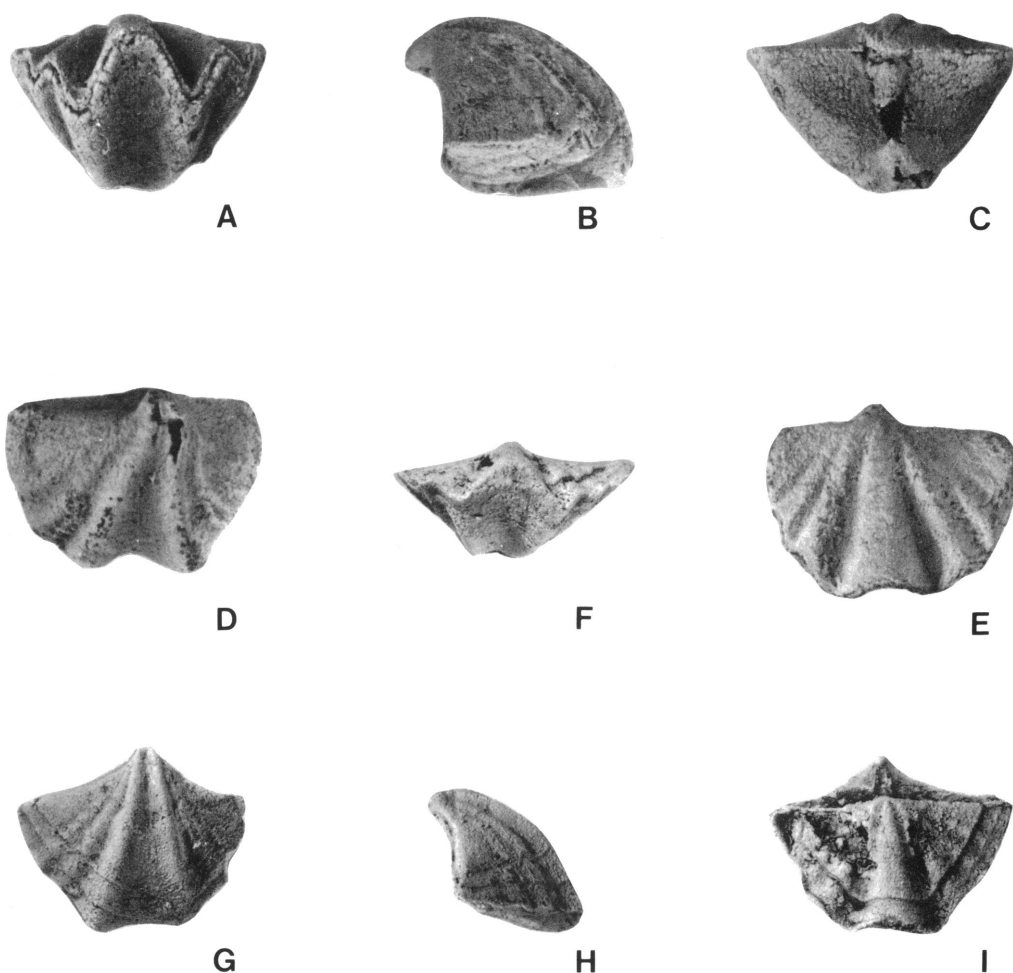


FIG. 57. *Cyrtina hamiltonensis* (Hall, 1857). A-E. AMNH Loc. 3138A. Anterior, lateral, posterior, ventral and dorsal views, AMNH 39925,  $\times 4$ . *Cyrtina* sp. A. F-I. AMNH Loc. 3135. Anterior, ventral, lateral and dorsal views, AMNH 39926,  $\times 2$ .

tal plates. The dental plates form a V-shaped spondylium bisected by a median septum running from the posterior extremity of the valve to the anterior end of the spondylium where it drops precipitously to the valve floor and continues for approximately three-fourths the length of the valve. The spondylium bears a small, suboval, tichorhinum formed by struts extending from the abaxial slopes of the dental plates to the median septum. The tichorhinum probably functioned as a housing for the pedicle roots. Two longitudinal troughs, probably diductor supports, extend the length of the spondylium dorsal to the tichorhinum. The adductors could have at-

tached to the keel-like median septum within the spondylium.

**BRACHIAL VALVE INTERIOR:** There is only one free brachial valve in the collection so that an adequate description of the brachial interior is somewhat limited, especially since the single specimen is slightly damaged.

The cardinal process is short, blunt, and transverse in outline. The posterior end is eroded but might have shown a triangular outline if present. Small, but well-excavated, anterolaterally diverging sockets lie on either side of the cardinal process. No muscle scars are evident. The interarea is narrow and apascline to orthocline. The external plications

TABLE 12  
Measurements (in Millimeters) of Articulated  
Specimens of *Cyrtina hamiltonensis* (Hall, 1857)

AMNH Locality	(L)	(W)	(T)	Number of Plications	
				Dor- sal <sup>a</sup>	Ven- tral
3141	4.5	6.7	6.3	6	6
3138A	6.4	6.6 est.	6.5	—	6
3138A	7.2	8.1	5.5	6	6
3138A	4.6	5.0	4.0	6	—
3138A	5.4	6.6	5.2	4	6
3138A	3.6	4.5	3.8	6	6 est.
3137	9.8	11.7	11.7	8	10 est.
3137	3.0	4.3	3.2	4	6
3137	4.4	—	4.7	—	6 est.
3137	4.9	5.3	4.4	6	8
3137	5.8	8.0	5.7	4	6
3135	3.1	4.7	3.6	2	4
3135	4.1	6.5	4.7	4	6
3135	4.2	6.5	5.5	6	8
3135	5.4	7.8	6.8	4	6
3135	6.8	8.7	6.6	4	6
3135	5.5	8.0	7.0	—	8

<sup>a</sup> Excluding fold.

are impressed upon the floor of the valve which is crenulated at the anterior commissure.

COMPARISON: *Cyrtina hamiltonensis* may be differentiated from the Middle Devonian *C. umbonata* (Cooper, 1944, p. 359, pl. 140,

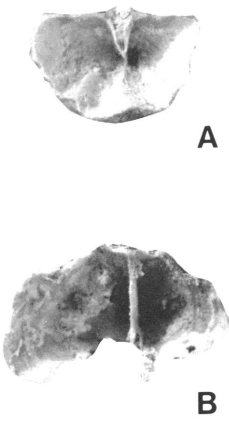


FIG. 58. *Cyrtina hamiltonensis* (Hall, 1857).  
A. AMNH Loc. 3137. Pedicle valve interior,  
AMNH 42775, ×4. B. AMNH Loc. 3137. Pedicle  
valve interior, AMNH 42776, ×4.



FIG. 59. *Amphigenia?* sp. AMNH Loc. 3126.  
Pedicle valve interior of poorly preserved speci-  
men from the basal sandy (note matrix) zone of  
the Edgecliff Member, Onondaga Limestone, near  
Nedrow, New York, AMNH 39928, ×2.

figs. 40–42) by its larger size and less incurved umbo. *Cyrtina* cf. *varia* (Johnson, 1970, pp. 219–220, pl. 73, figs. 1–14) has a shallower sulcus, more acute cardinal angles and is less circular when viewed dorsally. *Cyrtina alpenensis* from the Middle Devonian Traverse Group of Michigan is considerably larger than *C. hamiltonensis* while the Mississippian *C. acutirostris* is smaller and more rectangular in outline.

COMMUNITY OCCURRENCE: Feldman (1980) found this species in the *Atrypa-Coelospira-Nucleospira*, *Atrypa*, and *Atrypa-Megakozlowskiella* communities.

FIGURED SPECIMENS: AMNH 39925, 42775, 42776.

*Cyrtina* sp. A  
Figure 57E, G–I

REMARKS: Two articulated specimens of shells assigned to *Cyrtina* sp. A have been recovered. They are distinguished from *Cyrtina hamiltonensis* by their larger size and more robust appearance. More material is needed for specific designation.

COMMUNITY OCCURRENCE: Feldman (1980) found this species in the *Atrypa-Coelospira-Nucleospira* Community.

FIGURED SPECIMEN: AMNH 39926.

ORDER TEREBRATULIDA  
 SUBORDER TEREBRATULOIDEA  
 SUPERFAMILY TEREBRATULACEA GRAY  
 FAMILY CENTRONELLIDAE WAAGEN, 1882  
 SUBFAMILY AMPHIGENIINAE CLOUD, 1942  
 GENUS *AMPHIGENIA* HALL, 1867

*Amphigenia?* sp.

Figure 59

REMARKS: This species is represented by several spondylose fragments, suboval in outline and deeply convex, consistently found in the sandy basal Onondaga in the central

region. The species seems to fit Boucot and Johnson's (1968) description of the unequally biconvex forms geographically limited to New York and the northern Appalachians (*A. elongata* and *A. parva*) rather than the subequally biconvex *A. curta* (Meek and Worthen) and *A. chickasawensis*. The spondylium is morphologically similar to the rhomboidal spondylium of *A. elongata* (Boucot and Johnson, 1968, pl. 8, figs. 1, 3).

COMMUNITY OCCURRENCE: Feldman (1980) found this species in the *Amphigenia?* Community.

FIGURED SPECIMEN: AMNH 39928.

## APPENDIX 1

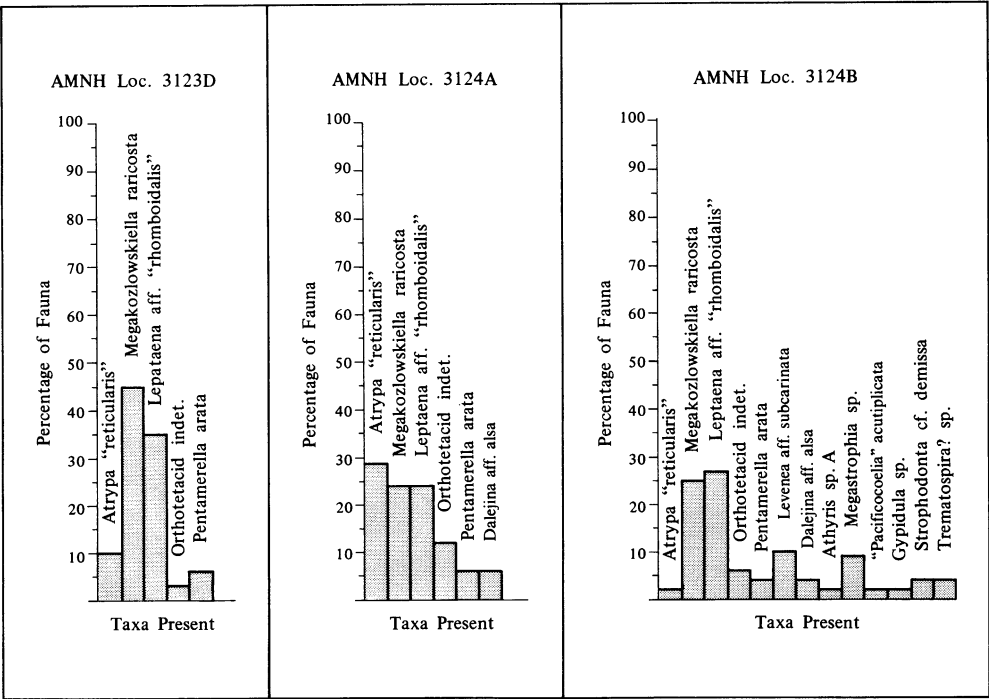
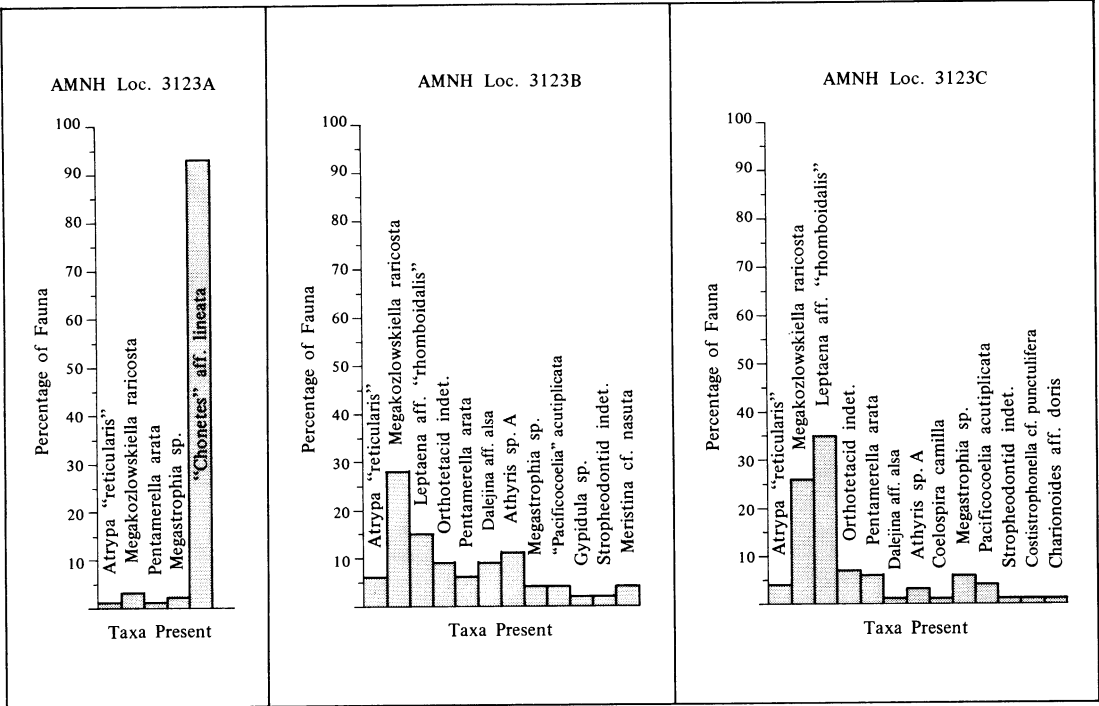
The brachiopod faunas collected at key AMNH localities along the west-southeast transect of the outcrop belt of the Onondaga Limestone in central and southeastern New York are presented here in the form of histograms. The taxa at a specific locality are listed horizontally, whereas the percentage each represents at the given locality is plotted vertically. Taxa representing less than 1 percent of the fauna are not plotted. The total number of specimens collected at each locality is listed in table 13. Based on the above data several distributional patterns are evident.

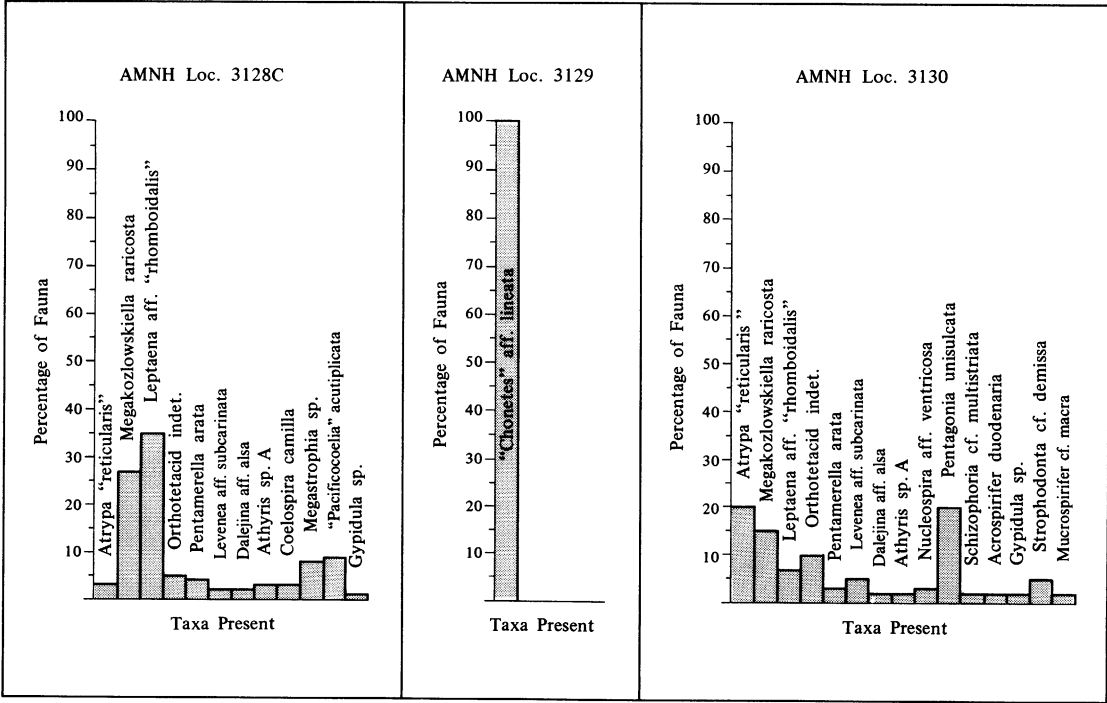
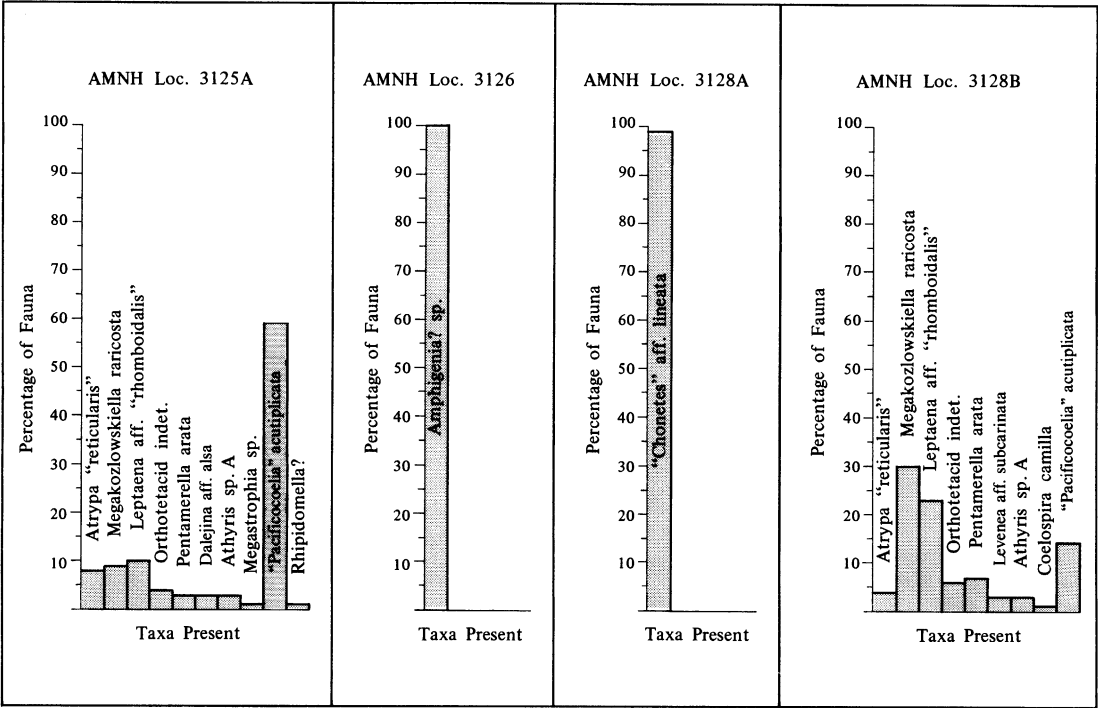
"*Chonetes*" aff. *lineata* appears explosively in the "*Chonetes*" Zone 10 ft. above the Tioga Bentonite, from Syracuse to Cherry Valley (AMNH Locs. 3123A, 3128A, 3129) and occurs in constant density across the outcrop belt as far as Cherry Valley. At one locality (AMNH Loc. 3131B) in Cherry Valley the species was recovered from upper Moorehouse rocks. The only record of its appearance in the east is in upper Moorehouse strata in the mid-Hudson Valley (AMNH Loc. 3137).

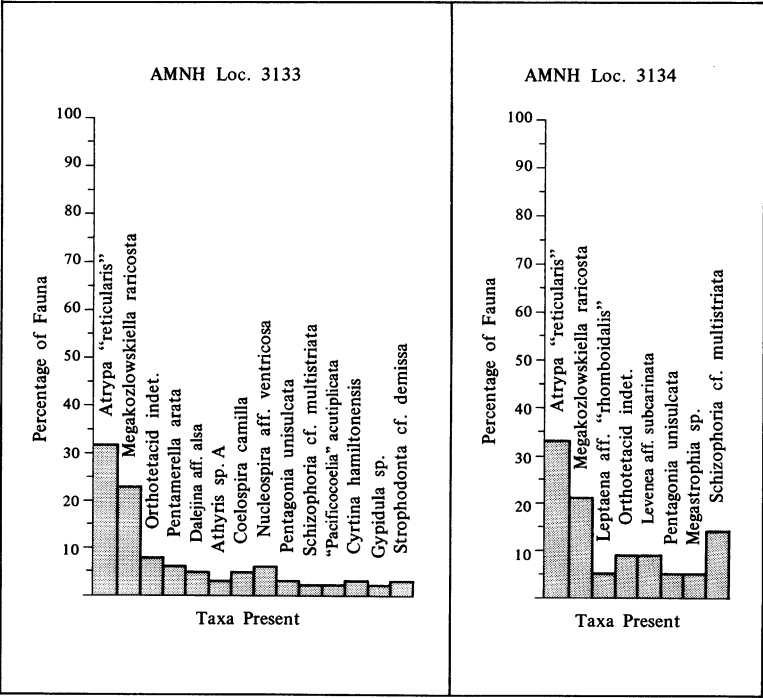
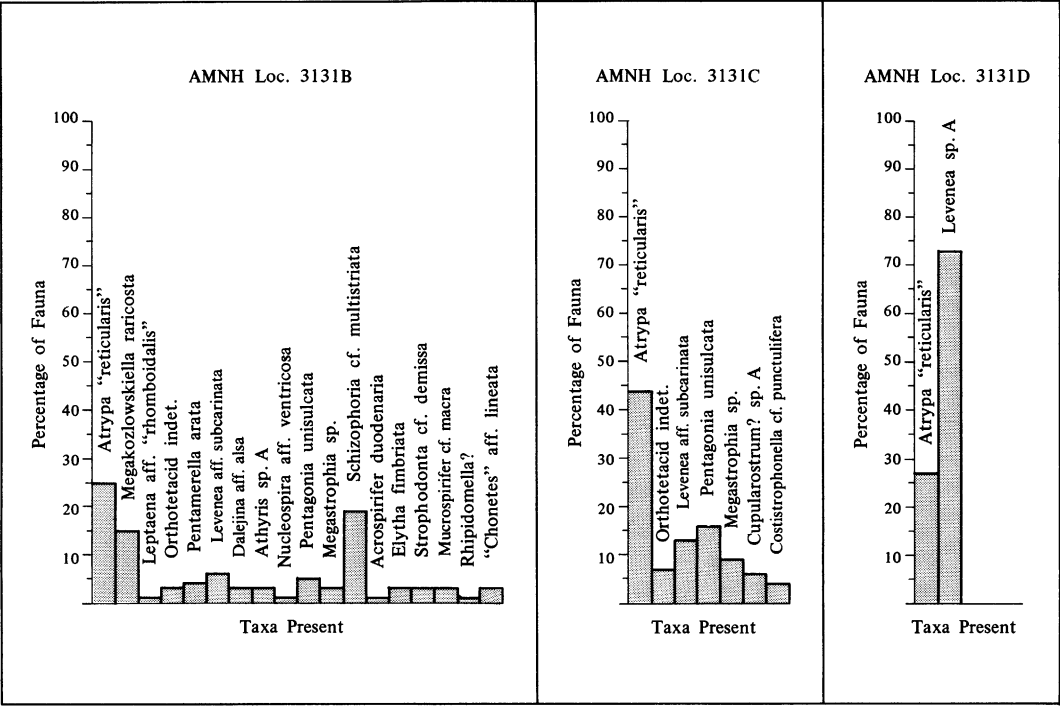
"*Pacificocoelia*" *acutiplicata* occurs mainly in the central part of New York, except for its appearance as a minor faunal constituent in Moorehouse rocks (AMNH Loc. 3133 at Thompson's Lake). The species is also present in upper Moorehouse rocks in the mid-Hudson Valley (AMNH Loc. 3137) but comprises less than 1 percent of the fauna. Toward the west abundance increases markedly, peaking at Nedrow, New York (AMNH Loc. 3125A) where it dominates the entire fauna (>60%).

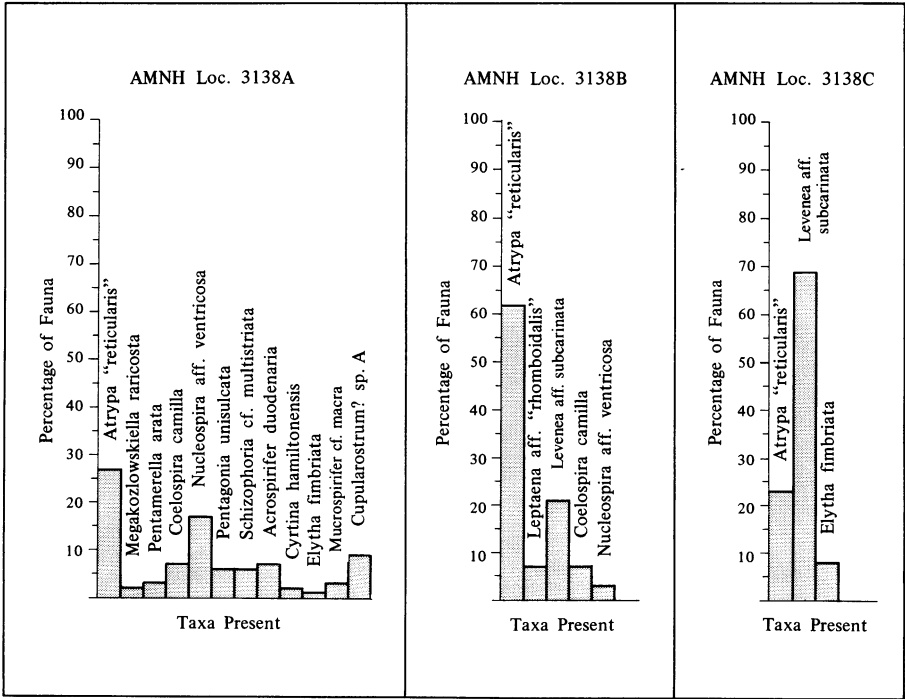
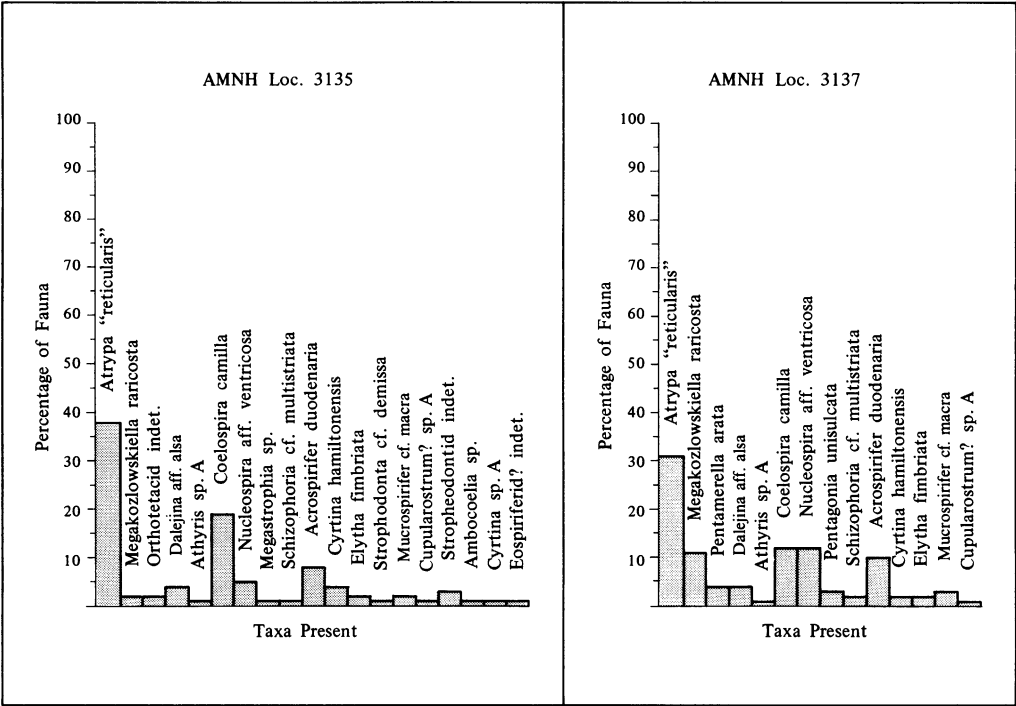
The fauna of the *Atrypa-Coelospira-Nucleospira* Community found in the mid-Hudson Valley (especially at AMNH Locs. 3135, 3137) shows the greatest density of all Onondaga faunas studied in this report. In general, the fauna is recognizable in upper Moorehouse rocks in the eastern part of the outcrop belt but as one progresses west certain faunal elements are no longer present. For example, in Cherry Valley (AMNH Loc. 3131B) the following species are no longer present (the term "no longer present" in this discussion includes those species which appear as less than 1 percent of the fauna and should be read as "no longer present in significant amounts"): *Coelospira camilla*, *Cyrtina hamiltonensis*, *Cupularostrum* sp. A, stropheodontid indet., *Ambocoelia* sp., and eospiriferid? indet. However, the following species not present in the east are present for the first time in Cherry Valley: *Leptaena* aff. "*rhomboidalis*," *Levenea* aff. *subcarinata*, "*Rhipidomella*?" and "*Chonetes*" aff. *lineata*. Whereas the eastern faunas are dominated by *Atrypa* "*reticularis*," *Coelospira camilla*, *Nucleospira* aff. *ventricosa*, *Levenea* aff. *subcarinata*, *Pentaconia unisulcata*, and *Acrospirifer duodenaria* the central faunas are generally dominated by *Leptaena* "*rhomboidalis*" and *Megakozłowskiella raricosta*.

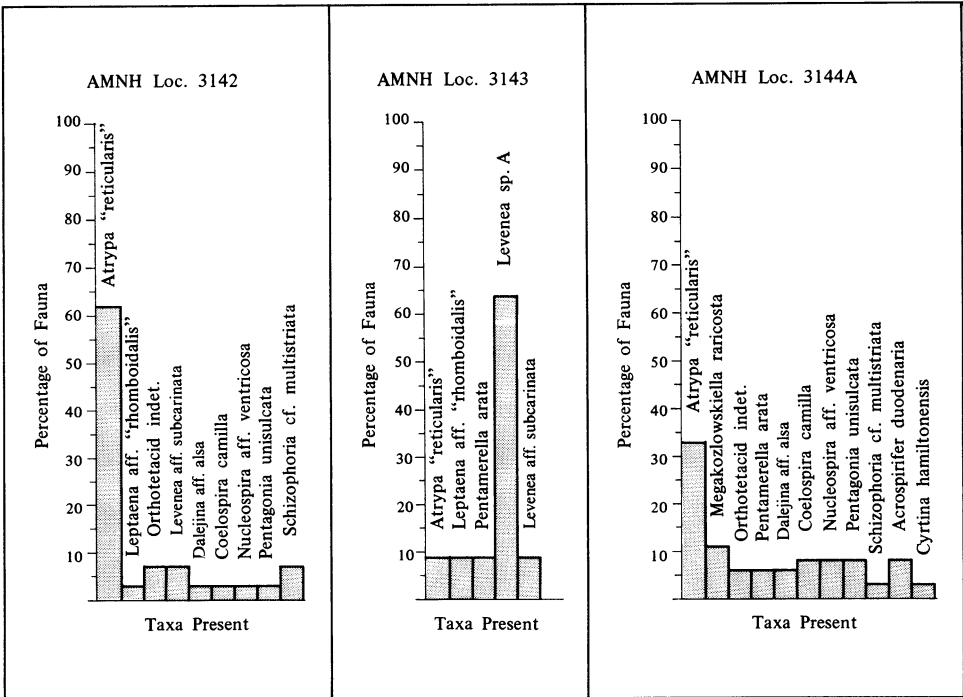
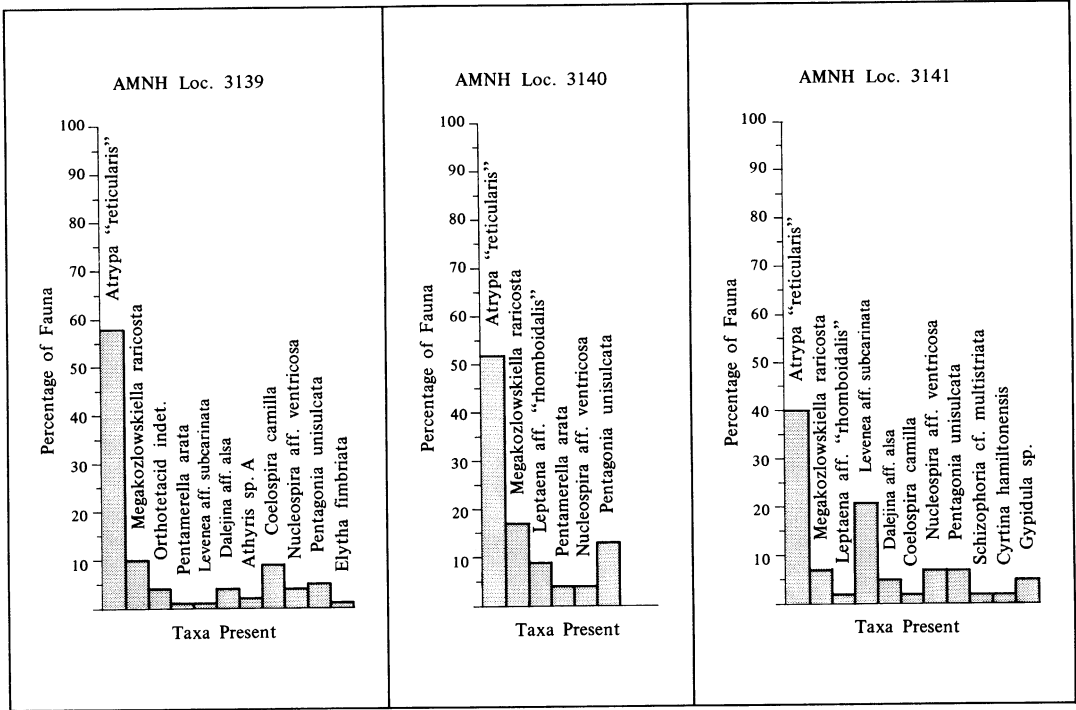


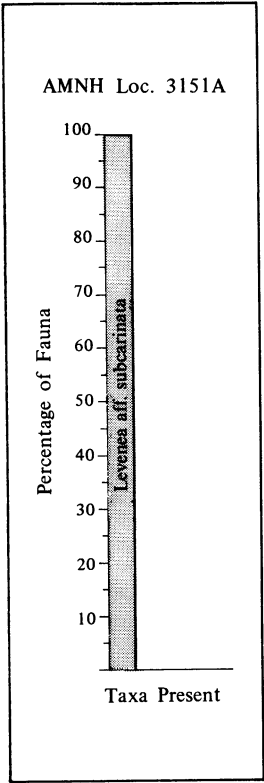












APPENDIX 2: LOCALITY REGISTER

AMNH Loc. 3122, near Onondaga Hill, New York: A small exposure (1.5 ft.) of the “*Chonetes*” zone, Seneca Member, on the south side of Route 173, just west of Howlitt Hill Road. The rock is a very fine-grained, light gray limestone with no chert. Collecting is moderately good to poor.

AMNH Loc. 3123A–D, Nedrow, New York: This section is exposed in the Onondaga Indian Reservation quarry just southwest of the junction of Route 11 and I-81. All four members of the Onondaga Formation are visible in outcrop at this locality excluding the lower half (approximate) of the Edgecliff and the upper part of the Seneca. This is the type section of the Nedrow Member (Oliver, 1954). The Edgecliff Member is best exposed on the quarry floor at the southwest end of the quarry where the upper few feet are visible and accessible. Characteristic of the Edgecliff, especially in the central part of New York State, are the large crinoid columnals, up to 1 inch in diameter, weathered out on the quarry floor. The Nedrow-Edgecliff contact is best seen at the southern face of the quarry wall where the rock becomes shaly with interbedded shaly beds. The Moorehouse-Nedrow contact is difficult to pinpoint but can be placed with a high degree of consistency (in the central area) at the end of the series of shaly beds and at the beginning of a fine-grained, uniformly medium-bedded (8 to 10 inches thick) rock with characteristically straight contacts (as opposed to wavy in the Nedrow) between bedding planes. The Tioga Bentonite forms a reentrant (Seneca-Moorehouse contact) on the face of the quarry wall which is difficult to locate without climbing up the cliff and digging out the heavily weathered debris under which a fresh, platy gray clayey layer (3 to 8 inches thick) is clearly visible. Although the top of the Seneca Member is eroded here, it is exposed across highway I-81 along the drainage ditch adjacent to the northbound lanes, where a small thrust fault cuts the top of the member along with the overlying Union Springs Black Shale, resulting in a zone of crumpling and jointing. Compare the description of the section below with those of Oliver (1954) and Chute and Brower (1964).

TABLE 13  
Distribution of Brachiopods in the Onondaga  
Limestone in Central and Southeastern New  
York

AMNH Locality	Total Number of Brachiopods Collected
3123A	151
3123B	47
3123C	68
3123D	31
3124A	17
3124B	51
3125A	186
3126	12
3128A	4008
3128B	64
3128C	161
3129	410
3130	59
3131B	79
3131C	68
3131D	11
3133	66
3134	66
3135	209
3137	532
3138A	359
3138B	29
3138C	13
3139	82
3140	23
3141	43
3142	29
3143	22
3144A	36
3151A	98
N = 7030	

ONONDAGA LIMESTONE  
Seneca Member (AMNH Loc. 3123A)

Unit	Unit Thickness (feet)	Interval Above Base (feet)
4. Limestone, fine grained, medium bedded, medium gray.	4	12-16
3. Limestone, fine grained, medium bedded, medium gray, Chonetes zone.	2	10-12
2. Limestone, fine grained, medium bedded, medium gray.	9.5	0.5-10
1. Tioga Bentonite: Deeply weathered reentrant from 3 to 8 inches thick.	0.5	0-0.5

Moorehouse Member (AMNH Loc. 3123B)

Unit	Unit Thickness (feet)	Interval Above Base (feet)
2. Limestone, fine grained, medium bedded, medium gray, with abundant chert seams. Eumophalacean gastropods (rare) in outcrop.	7	12-19
1. Limestone, fine grained, medium bedded, medium gray with little chert.	12	0-12

Nedrow Member (AMNH Loc. 3123C)

Unit

- |   |       |      |
|---|-------|------|
| 3. Limestone, shaly with interbedded shaly beds, medium to coarse grained, medium to thin bedded, medium to dark gray, crinoidal in places. Most limy beds are medium to coarse grained crinoidal limestone. The shaly beds are usually thin (1 to 4 inches thick). The uppermost shaly bed represents the Moorehouse-Nedrow contact. | 23    | 2-25 |
| 2. Limestone, shaly, coarse grained, medium to thin bedded, with a crinoidal matrix. Large crinoid columnals seen in cross section, some of which are comparable in size with the columnals of the Edgecliff Member. In cross section, some of the columnals act as competent units with the softer shale flowing around them.        | 0.5-1 | 1-2  |
| 1. Limestone, coarse grained, massive medium gray.  | 1     | 0-1  |

Edgecliff Member (AMNH Loc. 3132D)

Unit

- |  |   |     |
|--|---|-----|
| 1. Limestone, medium to coarse grained, crystalline, massive light gray. Most of the quarry floor represents the top of the Edgecliff Member. Brachiopods on uppermost bedding plane (quarry floor): <i>Megakozlow-skiella raricosta</i> , <i>Leptaena</i> aff. " <i>rhomboidalis</i> ." | 5 | 0-5 |
|--|---|-----|

AMNH Loc. 3124A-C, Nedrow, New York: This section extends along Route 11 at the junction of highway I-81 and Route 11 just south of Nedrow, New York. As one progresses south along the outcrop the following members of the Manlius Formation, stratigraphically below the Onondaga Formation, are encountered: Clark Reservation Member, Jamesville Member, and Pools Brook Member. The contact between the Manlius and the Onondaga formations is sharp and easily recognizable even though at this location the basal sandy zone of the Edgecliff Member is missing, resulting in a small disconformity. The exit ramp from the southbound lanes of I-81 cuts through the middle of the Nedrow Member in which shaly beds weather out to form talus piles with fairly good fossil material. On the southeast side of the exit ramp the Nedrow Member is jointed; the joints are inclined and are discontinuous. The Nedrow-Edgecliff contact is placed at the first shaly bed, deeply weathered, and quite noticeable. The Moorehouse-Nedrow contact is placed at the top of the last two shaly beds, approximately 7 inches apart. The remainder of the Moorehouse and Seneca members is concealed.

ONONDAGA LIMESTONE

Seneca Member (AMNH Loc. 3123A)

Unit	Unit Thickness (feet)	Interval Above Base (feet)
1. Limestone, medium to fine grained, medium bedded, medium gray with distinct chert seams. These chert seams appear to correlate closely with identical seams in the same stratigraphic position in the Jamesville Quarry (Lower Moorehouse).	11.5	0-11.5

Nedrow Member (AMNH Loc. 3124B)

Unit

- |  |     |         |
|--|-----|---------|
| 4. Limestone, shaly, medium grained, interbedded with shaly beds. Two distinct shaly beds approximately 7 inches apart above which no shaly beds appear. The uppermost bed represents the Moorehouse-Nedrow contact. | 2.5 | 10-12.5 |
| 3. Limestone, shaly, medium grained, interbedded shaly beds, medium gray, with wavy contacts between bedding planes.   | 3.5 | 6.5-10  |
| 2. Limestone, medium grained, massive, medium gray, at the top of which is a 2 inch thick shale bed.   | 2   | 2-4     |



- |  |   |     |
|--|---|-----|
| 1. Limestone, shaly, medium grained, interbedded with numerous shaly beds. Weathers to a fissile talus pile. There is a sharp contact with the underlying Edgecliff Member at the lowermost (approximately 1 ft. thick) deeply weathered shaly zone. | 2 | 0-2 |
|--|---|-----|

Edgecliff Member (AMNH Loc. 3124C)

Unit

- |  |    |      |
|--|----|------|
| 1. Limestone, medium to coarse grained, massive, light gray crystalline, biostromal with typical Edgecliff lithology. Joined in places forming massive blocks. A small disconformity is evidenced by the missing lowermost sandy zone. | 12 | 0-12 |
|--|----|------|

MANLIUS FORMATION

AMNH Loc. 3125A, B, Nedrow, New York: The Edgecliff and most of the Nedrow members are exposed in a large roadcut on highway I-81 just south of AMNH Loc. 3126 approximately one-half mile north of exit 16 (Nedrow), southbound lanes. The top few feet of the Nedrow Member are missing. At the base of the Edgecliff Member the basal sandy zone is accessible and well exposed. Fossil collecting is moderately good in the weathered shaly talus of the Nedrow and poor in the Edgecliff. However, this is not meant to imply that the Edgecliff is lacking in fossils; rather, that extraction from the dense, massive limestone is extremely difficult. Also, there are no silicified fossils in the area, so that collecting large blocks of limestone (with no exposed, weathered, bedding planes) would be relatively unproductive unless one is studying material that may be sectioned (e.g., corals).

ONONDAGA LIMESTONE

Nedrow Member (AMNH Loc. 3125A)

- | Unit  | Unit Thickness (feet) | Interval Above Base (feet) |
|---|-----------------------|----------------------------|
| 2. Limestone, shaly, medium to fine grained, medium to thin bedded, tan to gray interbedded with occasional chert nodules which are often weathered out. Distinct, wavy contacts between the bedding planes of fissile shaly beds. Weathered shale forms talus pile where fossil collecting is moderately good. | 7                     | 3.5-10.5                   |
| 1. Limestone shaly, medium grained, alternating light and dark bands of gray to tan beds. Poorly fossiliferous.   | 3.5                   | 0-3.5                      |

Edgecliff Member (AMNH Loc. 3125B)

Unit

- |  |      |        |
|--|------|--------|
| 2. Limestone, fine to medium grained, massive and jointed, light gray and dense. Typical Edgecliff lithology.                                  | 11.5 | 6-17.5 |
| 1. Sandstone, limy, coarse grained, massive, jointed and friable in places, brown with <i>Amphigenia?</i> sp. and scattered phosphate nodules. | 6    | 0-6    |

AMNH Loc. 3126, Nedrow, New York: Good exposures of the typical Edgecliff biostromal limestone and basal sandy zone with *Amphigenia?* sp. fragments on highway I-81, approximately 1.5 miles north of exit 16 (Nedrow), southbound lanes, east side of the road.

ONONDAGA LIMESTONE

Edgecliff Member (AMNH Loc. 3125A)

- | Unit   | Unit Thickness (feet) | Interval Above Base (feet) |
|--|-----------------------|----------------------------|
| 3. Limestone, medium to coarse grained, massive, light gray crystalline biostromal with a noticeable abundance of crinoidal debris. Large crinoidal columnals. | 10.5                  | 10.5-15.5                  |

2. Limestone, sandy, coarse grained, massive, brownish, gradational with overlying unit.	4	1-5
1. Sandstone, limey, coarse grained, friable and jointed in places. Dark brown with scattered phosphate nodules.	1	0-1

AMNH Loc. 3127, Clark Reservation State Park, Jamesville, New York: The Edgecliff Member outcrops at the lip of the abandoned waterfall, above a plunge basin, just west of Jamesville, New York. The rock is a water-worn, massive, light gray, crystalline limestone (approximately 14 ft. thick) with basal sandy zone directly overlying the Manlius Formation, which, although exposed on the cliff wall, is extremely difficult to reach. As one proceeds to higher ground additional Onondaga outcrops become apparent, but exact stratigraphic placement is difficult.

AMNH Loc. 3128-D, Jamesville, New York: This section is in the Jamesville Quarry (formerly Solvay Process Co.), #3 pit. This is the most complete section of the Onondaga Limestone in central New York. It was inaccessible when Oliver (1954) did his work on the stratigraphy of the Onondaga but has since come under new management and is now open to visitors for study. Quarrying is quite active resulting in few weathered surfaces. This is especially significant for the limy members (Edgecliff, Moorehouse, and to some degree, Seneca) since collecting in them is difficult unless specimens have had a chance to weather out. The Nedrow Member, with its shaly partings, provides talus piles of moderately weathered material from which some good specimens have been retrieved although internal structures of the brachiopods are not generally visible. However, based upon external morphology, generic identifications are often possible. Bedding is horizontal and heavily jointed in many places. All members are accessible since the walls of the quarry are terraced. The Onondaga Limestone, the uppermost formation in the quarry, is missing only the top of the Seneca Member.

ONONDAGA LIMESTONE

Edgecliff Member (AMNH Loc. 3128A)

Unit	Unit Thickness (feet)	Interval Above Base (feet)
4. Limestone, muddy, fine grained, medium to thick bedded with some chert nodules. Weathered surface earth color; fresh surface dark gray. Heavily jointed at quarry wall. Fauna on uppermost bedding plane: <i>Athyris</i> sp., indet. brachiopod fragments, bryozoans, numerous horn corals, trilobite fragments (cf. <i>Odontocephalus</i> ), euomphalacean gastropods.	2	12-14
3. Limestone, fine grained, fresh surface dark gray, wavy contacts between bedding planes. Stylolites present (characteristic of the Seneca Member). At the top of this unit occurs a 1 inch thick chert band. " <i>Chonetes</i> " Zone (=Zone J of Oliver, 1954).	2	10-12
2. Limestone, medium to fine grained, medium to thick bedded, light gray to muddy, horizontally jointed.	9.5	0.5-10
1. Tioga Bentonite: Soft, gray clayey platy unit at the base of the Seneca Member. The Tioga Bentonite represents the Seneca-Moorehouse contact. Deeply weathered iron bearing minerals oxidized to a limonitic coating.	0.5	0-0.5

Moorehouse Member (AMNH Loc. 3128B)

Unit		
3. Limestone, fine grained, medium bedded light gray with distinct and continuous chert bands. Limonitic in places.	5	20-25
2. Limestone, fine grained, medium to thick bedded, light gray, no chert.	12	8-10
1. Limestone, fine grained, medium bedded, medium to light gray with some distinct chert bands. Fresh surface dark throughout all three units.	8	0-8

Nedrow Member (AMNH Loc. 3128C)

2. Limestone, shaly, fine grained, medium to thin bedded, medium to dark gray with two distinct shaly beds 8 inches apart. The uppermost shaly bed represents the Moorehouse-Nedrow contact in the central New York area. On weathered surfaces the limestone is greenish and platy. Scattered chert nodules are present throughout the member but are of no stratigraphic value. Good fossil collecting from weathered surfaces only. Brachiopods: <i>Leptaena</i> and <i>Megakozłowskiella</i> common.	3.5	7–10.5
--	-----	--------

Edgecliff Member (AMNH Loc. 3128D)

Unit

3. Limestone, medium to coarse grained, massive crystalline, pinkish. Typical Edgecliff facies with large crinoid columnals up to 1 inch in diameter.	9.5	9.5–19
2. Limestone, sandy, coarse grained, massive, tan, with small scattered phosphate nodules.	1	8.5–9.5
1. Sandstone, limey, coarse grained, massive, dark brown with numerous large phosphate nodules.	8.5	0–8.5

AMNH Loc. 3129, Stockbridge Falls, New York: The section is located just west of Stockbridge Falls, New York, along Stockbridge Falls Road and Oneida Creek. Much of the outcrop is covered by debris but about 10–15 ft. of the Seneca Member is exposed. The Union Springs Black Shale outcrops just up the road and around the bend. The contact between the Seneca and the Union Springs is exposed on the hill at some small, isolated outcrops. The limestone is fine grained, medium to thin bedded, heavily weathered and muddy on weathered surfaces but dark gray on fresh surfaces. The rock is jointed and blocky. The “*Chonetes*” zone is exposed and collecting is moderately good. The Tioga Bentonite was not seen by the writer but is present (personal commun., W. A. Oliver, Jr.). The Moorehouse Member is exposed in the creek (5 ft.+).

AMNH Loc. 3130, Cherry Valley, New York: This section is 2.8 miles west of AMNH Loc. 3131 along the north side of Route 20. About 9 ft. of the Moorehouse Member is exposed. The limestone is medium grained, medium to dark gray, and medium bedded with light chert. The fauna and lithology indicate stratigraphic placement within the (Upper?) Moorehouse: *Atrypa* “*reticularis*,” orthotetacid fragments, spiny platyceratids (correlates with Upper Moorehouse sections in the eastern part of the state), *Pentagonia unisulcata* (common), *Leptaena* “*rhomboidalis*,” *Stropheodonta* cf. *demissa*, bryozoan fragments.

AMNH Loc. 3131A–D, Cherry Valley, New York: This large outcrop extends for approximately 250 yards along Route 20 on the west side of Cherry Valley. The section is almost complete, missing only the top of the Moorehouse and bottom of the Seneca members which are actually concealed but assumed to be present. The Tioga Bentonite was too deeply buried by talus debris to be seen by this writer but its presence was verified by W. A. Oliver, Jr. and L. V. Richard (personal commun.). Both the lower contact (Carlisle Center Formation) and upper contact (Union Springs Black Shale) were observed.

ONONDAGA LIMESTONE

Edgecliff Member (AMNH Loc. 3131A)

Unit	Unit Thickness (feet)	Interval Above Base (feet)
1. Limestone, shaly, very muddy, fine grained, irregularly bedded dark gray to brownish (mottled) in places. This appears to be equivalent to Zone K of Oliver (1954). The rock becomes darker and muddier toward the top. Only rare fossil fragments were present and they were too fragmentary for identification. The overlying Union Springs Black Shale contact is evident.	5.5	0–5.5

## Moorehouse Member (AMNH Loc. 3131B)

## Unit

- |   |    |       |
|---|----|-------|
| 2. Limestone, medium to fine grained, medium bedded, light gray with numerous chert seams and very dense. | 10 | 25-35 |
| 1. Limestone, medium to fine grained, medium bedded, light gray, dense, without chert.                    | 25 | 0-25  |

## Nedrow Member (AMNH Loc. 3131C)

## Unit

- |  |     |          |
|--|-----|----------|
| 2. Limestone, bracketed by two shaly beds approximately 1 ft. apart. The uppermost shaly bed represents the contact with the overlying Moorehouse Member. The intervening limestone is medium grained and medium gray.   | 1   | 9.5-10.5 |
| 1. Limestone, shaly, medium grained, medium to thin bedded, medium gray with no chert. Interbedded shaly beds as in Jamesville Quarry and Nedrow, New York. Wavy contacts between the bedding planes. Typical Nedrow weathering (recessed). Fauna includes small, non-spiny platyceratids, <i>Levenea</i> sp., and <i>Pentagonia</i> sp. | 9.5 | 0-9.5    |

AMNH Loc. 3132, Thompson's Lake, New York: A small outcrop (20 ft. thick) of the Edgecliff Member is exposed on an east-west road just east of Route 157, north of Thompson's Lake. The limestone is massive and medium to dark gray, coarsely crystalline and biostromal (upper 12 ft). The lower 8 ft. consists of thin bedded, medium to coarse grained, medium gray, fossiliferous limestone. The entire outcrop was packed with corals but the only brachiopod observed was *Atrypa* "*reticularis*."

AMNH Loc. 3133, Thompson's Lake, New York: Approximately 21 ft. of the Moorehouse Member is exposed on the south shore of Thompson's Lake on the property of the Thompson's Lake Hotel. Since the Marcellus Formation outcrops in a nearby stream bed (personal commun., W. A. Oliver, Jr.), and based on faunal similarities, this section is placed in the upper Moorehouse. The limestone is dense, fine grained, medium to thin bedded, medium to light gray, and cherty. The chert has weathered out giving the rock a pitted texture. The chert that is still present is dark weathering. The fauna includes: *Atrypa* "*reticularis*," *Megakozłowskiella raricosta* (very common), orthotetradid fragments, *Pentamerella* sp., *S. demissa*, "*Pacificocoelia*" sp. ?, gypidulinids?, *Coelospira camilla*, spiny platyceratids (common 5 ft. from base of unit), and crinoids (abundant in some beds in the middle of the unit).

AMNH Loc. 3134, Clarksville, New York: The section outcrops along Route 32, about 2 miles southeast of Clarksville, New York. The limestone is 22 ft. thick and medium grained, medium bedded, light to medium gray, and coarsely crinoidal in places. There is some blue gray chert with dark weathering chert common in the upper 5 ft. of the unit (seams). The fauna is typically Upper Moorehouse: *Atrypa* "*reticularis*," *Megakozłowskiella raricosta* (common), *Leptaena* "*rhomboidalis*," *Megastrophia*?, *Schizophoria* sp., *Levenea* sp., orthotetradid fragments, spiny platyceratids, and bryozoan fragments.

AMNH Loc. 3135, Leeds, New York: An extensive bedding plane near the top of the Onondaga Formation is exposed at the rear of Samantha's Inn, on Route 23B, in Leeds, New York. The outcrop runs parallel to Catskill Creek (east bank) and consists of more than 500 ft. of medium gray, medium-grained, somewhat cherty limestone dipping at a shallow angle to the west. On the surface of the rock there are numerous platyceratid gastropods (spiny) and clusters of *Atrypa* "*reticularis*" along with many other silicified fossils typical of the Upper Moorehouse.

AMNH Loc. 3136, southwest of Catskill, New York: This roadcut is located along the New York State Thruway at the junction of the Thruway and Route 23A. A total of about 40+ ft. of the Edgecliff Member is exposed overlying the Schoharie Formation. The contact is gradational but is recognizable at the first buff layer toward the base of the Edgecliff. Slickensides are present and faulting has occurred within the Edgecliff to some degree. Thus, the exact thickness of the units, especially unit 2, is questionable. Lithologies correlate well with the strata at AMNH Localities 3138C, 3147, 3149.

ONONDAGA LIMESTONE

Edgecliff Member (AMNH Loc. 3128A)

Unit	Unit Thickness (feet)	Interval Above Base (feet)
2. Limestone, medium grained, thick bedded to massive, light gray with numerous light gray weathering chert seams. Crinoid columnals up to 1 inch in diameter.	35?	5-40
1. Limestone, medium grained, thick bedded to massive, light gray with very little chert. The contact with the underlying Schoharie Formation is somewhat gradational but is placed at the first buff weathering unit.	5	0-5

AMNH Loc. 3137, Quatawichna-ach, on the Kaaterskill Stream, near Timmerman Hill, New York: This anticlinal exposure takes its name from the Indian "place where water all goes in a hole" (Chadwick, 1944) referring to the chert seams and massive joints which take the water underground as it passes through the limestone. The location is approximately four and one-half miles southwest of Catskill, New York, just east of Timmerman Hill, in the streambed. The stratigraphic position of the outcrop is placed at the top of the Moorehouse Member since the Bakoven Shale, which directly overlies the Onondaga Formation in this area, outcrops just downstream. In addition, shale debris is evident in the outcrop area although there is no indication of any shale exposures in the immediate vicinity. The Bakoven Shale is extremely soft and erodes easily, forming a line of weakness—the Bakoven Valley. The fauna at this locality is well silicified, for the most part. The silicification is not surficial but permeates the limestone.

ONONDAGA LIMESTONE

Moorehouse Member (AMNH Loc. 3137)

Unit	Unit Thickness (feet)	Interval Above Base (feet)
6. Limestone, medium grained, medium bedded (4 to 8 inches thick) dense with discontinuous dark weathering chert bands and sharp contacts between the bedding planes.	15	13-28
5. Limestone, medium grained, massive light gray, extremely dense with thin chert bands often forming nodules. Variable fractured with silicified fossils weathering out of the rock surface.	3	10-13
4. Dark chert band traceable as a marker throughout most of the outcrop.	0.5	9.5-10
3. Limestone, massive, light gray fractured in places with discontinuous chert nodules and thin dark chert bands. Silicified fossil fragments observed in cross section.	2.5	7-9.5
2. Dark chert band traceable as a marker throughout most of the outcrop.	0.5	6.5-7
1. Limestone, medium grained, medium gray dense with numerous chert bands stringing out into dark nodules. Several extensive bedding planes are exposed upon which silicified fossil fragments partially weather out of the matrix. These consist mainly of corals, brachiopods, and trilobite fragments. <i>Atrypa "reticularis"</i> and spiny platyceratid gastropods are common.	6.5	0-6.5

AMNH Loc. 3138A-C, Saugerties, New York: On the New York State Thruway at the Saugerties interchange. The most complete section of the Onondaga Formation in eastern New York is exposed in the roadcut made by the New York State Thruway. Although this area was tectonically active, resulting in numerous folds and faults, no evidence of significant faulting was found in the section measured. Slickensides in the strata bordering the southbound lanes, about 50 ft. south of the measured section, tend to indicate small scale reverse faulting. An identical fauna occurs at 75 to 85 ft. above the Nedrow-Moorehouse contact at two separate areas of this outcrop and at the few feet exposed at Leeds, New York (AMNH Loc. 3135). This fauna is also found at AMNH Loc. 3137 and at the Onondaga-Bakoven

contact, thus providing strong evidence for the stratigraphic correlation of the various Moorehouse units in eastern New York.

ONONDAGA LIMESTONE  
Moorehouse Member (AMNH Loc. 3138A)

Unit	Unit Thickness (feet)	Interval Above Base (feet)
1. Limestone, medium grained, medium to thick bedded, irregularly bedded in places probably due to blasting the roadcut, medium to dark gray, dense in silicified zones. Dark weathering chert seams throughout the entire unit which are characteristic of the Moorehouse Member in the east. Silicified faunas interspersed throughout but consistently found at 75–85 ft. above the Nedrow-Moorehouse contact.	92+	0–92+

Nedrow Member (AMNH Loc. 3138B)

Unit	Unit Thickness (feet)	Interval Above Base (feet)
1. Limestone, medium grained, massive, light gray with light gray weathering chert seams. The rock is very dense and the chert is sparse. The Moorehouse-Nedrow contact is placed at the first dark weathering chert seam. Some large crinoid columnals evident.	23	0–23

Edgecliff Member (AMNH Loc. 3138C)

Unit	Unit Thickness (feet)	Interval Above Base (feet)
2. Limestone, medium grained, massive, light gray with numerous light gray weathering chert seams. The lithology here is identical with that at Forsyth Park (see below).	40.5	7.5–48
1. Limestone, medium grained, massive, light gray with very little chert. The little chert that is present is light gray. The Edgecliff-Schoharie contact is placed at the first buff colored band of gritty limestone.	7.5	0–7.5

SCHOHARIE FORMATION

AMNH Loc. 3139, Saugerties, New York: This is a continuation of the large outcrop at AMNH Loc. 3138A on the New York State Thruway, near the Saugerties interchange. The stratigraphic position is middle to upper Moorehouse based upon lithology, fauna, and structure. The section is as follows:

ONONDAGA LIMESTONE  
Moorehouse Member (AMNH Loc. 3128A)

Unit	Unit Thickness (feet)	Interval Above Base (feet)
2. Dark chert band, discontinuous in places, varying in thickness from 6 to 12 inches but averaging about 10 inches.	0.5	8.85
1. Limestone, medium grained, medium bedded, light gray, dense, horizontally jointed with small (1 to 3 inches) dark chert bands. Contacts between the bedding planes vary from sharp to wavy.	6.5	0–1.5

AMNH Loc. 3140, Kingston, New York: The section outcrops at the junction of Hooker and Lincoln roads, on the east side of the street. Two-thirds of the exposed strata are Lower Moorehouse directly overlying the Nedrow Member, which consists of about 3.5 ft. of massive, light gray, dense limestone with no discernible fossils in the outcrop and no silicified fauna within the matrix. Above lies 7 ft. of

dense, medium grained, medium gray, Moorehouse Limestone with no noticeable chert, although it appears that the chert was incorporated into the matrix as darker bands within the limestone. Bedding is both massive and irregular. The section seems to be conformable with the Schoharie Formation which outcrops due east at the bottom of the hill.

AMNH Loc. 3141, Kingston, New York: The outcrop is a few hundred feet south of AMNH Loc. 3139 on the west side of the road. Stratigraphically, the section appears to be Middle Moorehouse. There are dark weathering chert seams in a medium to dark gray, dense medium-grained limestone which contains silicified fossils about 6 ft. up on a ledge. Due to the dip of the strata the exact thickness of the outcrop is difficult to determine, but it approximates 10 ft.

AMNH Loc. 3142, rear of hospital in Kingston, New York: This section outcrops along the railroad tracks and is about 75+ ft. thick. The exposure represents Middle to Upper Moorehouse and is laced with typically dark weathering chert seams. The limestone is medium grained, medium gray, dense and correlates with the Middle to Upper Moorehouse rocks at AMNH Loc. 3138A. No upper contact was observed at the outcrop although the top of the Onondaga Formation must have been close to the easternmost end of the section.

AMNH Loc. 3143, Forsyth Park and Zoo, Kingston, New York: Scattered outcrops of the Edgecliff Member occur throughout the park. The limestone is typical of the extremely cherty Edgecliff with numerous seams of light weathering chert in a medium to dark gray matrix. The rock is medium grained and up to about 20 ft. thick (cumulative thickness, estimated) throughout the park.

AMNH Loc. 3144A, B, Ulster County Highway Department Quarry, Kingston, New York: The quarry is located on the west side of Kingston, and just west of Forsyth Park and Zoo. The strata here overlie the units at Forsyth Park (Edgecliff):

Moorehouse Member (AMNH Loc. 3128A)

Unit	Unit Thickness (feet)	Interval Above Base (feet)
2. Limestone, medium to fine grained, medium bedded, medium to dark gray with dark chert seams.	22	8-30
1. Limestone, medium grained, medium bedded, light to medium gray with no chert.	8	0-8

Nedrow Member (AMNH Loc. 3144B)

Unit	Unit Thickness (feet)	Interval Above Base (feet)
1. Limestone, medium grained, medium bedded, medium to light gray, with light gray chert.	8	0-8

AMNH Loc. 3145, Kingston, New York: The Edgecliff Member of the Onondaga Limestone is exposed in a syncline about 100 yards north of the intersection of the Penn Central Railroad and West O'Reilly Street, in Kingston. The Saugerties (30 ft.), Aquetuck (44 ft.) and Carlisle Center (143 ft.) members of the Schoharie Formation directly underlie the Edgecliff Member of the Onondaga Limestone, which is approximately 26 ft. thick at this locality. The contact between the Onondaga and Schoharie is gradational here and is difficult to place. However, based upon lithologic criteria I am placing the contact at the first dark band below the extensive light, cherty, limestone which typifies the Edgecliff Member in southeastern New York.

ONONDAGA LIMESTONE

Moorehouse Member (AMNH Loc. 3128A)

Unit	Unit Thickness (feet)	Interval Above Base (feet)
2. Limestone, medium grained, massive, medium gray with numerous light weathering chert seams throughout.	12	14-26
1. Limestone, medium grained, massive, medium to dark gray with no chert. Contact gradational with underlying Schoharie Formation.	14	0-14

SCHOHARIE FORMATION

Saugerties Member

Unit

- |  |    |         |
|--|----|---------|
| 1. Sandstone, limy, brownish yellow to light gray, banded, medium grained. | 30 | 187–217 |
|--|----|---------|

Aquetuck Member

Unit

- |   |    |         |
|---|----|---------|
| 1. Sandstone, almost calcareous mudstone, brownish yellow to yellowish gray, with interbedded layers of nodular limestone and muddy lenses. | 44 | 143–187 |
|---|----|---------|

Carlisle Center Member

Unit

- |   |     |       |
|---|-----|-------|
| 1. Mudstone, brownish yellow to light gray calcareous gritty matrix with an increasing limy content toward the top of the member. | 143 | 0–143 |
|---|-----|-------|

AMNH Loc. 3146, near Kingston, New York: The section outcrops along the New York State Thruway 0.9 miles south of the Kingston interchange. The strata exposed represent the Nedrow (upper?) and correlate lithologically with the rocks at AMNH Loc. 3148 and 3138B. The total thickness here is 21 ft. The limestone is fine grained, massive, light gray and jointed (probably due to the blasting when the thruway was constructed) with some light weathering chert.

AMNH Loc. 3147, near Kingston, New York: This section outcrops along the New York State Thruway approximately 1.25 miles south of the Kingston interchange, along the northbound lanes. Stratigraphically the rocks are Edgecliff. The limestone is fine to medium grained with coarse crinoidal debris alternating with chert seams. Many of the chert seams have weathered out but there are still numerous seams and nodules in the matrix so that the lithology closely resembles that in Forsyth Park. Five ft. from the base of the unit there is a prominent lens of crinoidal material. Large crinoid columnals up to 1 inch thick are present along with *Atrypa “reticularis.”* The total thickness is 22 ft.

AMNH Loc. 3148, near Hurley, New York: The outcrop is small, approximately 2.5 miles southwest of Kingston, along Route 209, on the northwest side of the road. Based upon structural relationships and lithology this section is placed in the Nedrow Member.

AMNH Loc. 3149, one-fourth of a mile southwest of AMNH Loc. 3148 on the southeast side of the road. The lithology is identical with that at AMNH Loc. 3147 (crinoidal with numerous light weathering chert seams). This section is stratigraphically lower than the units at AMNH Loc. 3148. (fig. 60).

ONONDAGA LIMESTONE

Nedrow Member (AMNH Loc. 3128A)

Unit	Unit Thickness (feet)	Interval Above Base (feet)
2. Limestone, fine grained, light gray, dense, massive, and crinoidal. Two distinct light weathering chert bands, discontinuous to nodular, are separated by about 2 ft. (fig. 61). The fauna appears to be partly silicified with <i>Atrypa “reticularis”</i> fairly common.	4	9–13
1. Limestone, same lithology, massive, no chert, dense. The fresh surface is medium to dark gray.	9	0–9

AMNH Loc. 3150, near Accord, New York: The outcrop appears to be rather small in breadth when viewed from the road at approximately 3.3 miles northeast of Accord, New York, along Route 209, on the southeast side of the road. The exposure is about 15 ft. thick, massive, cherty, medium-grained, medium gray limestone, with crinoid columnals up to 1 inch in diameter. The front of the outcrop, along Route 209, is 6 ft. thick and the only fossils noticeable on the exposed bedding planes are crinoid columnals. The rear of the outcrop is exfoliated. The chert is incorporated into the matrix and does not weather out to form nodules. There is no silicified fauna. Stratigraphically the section is either Edgecliff



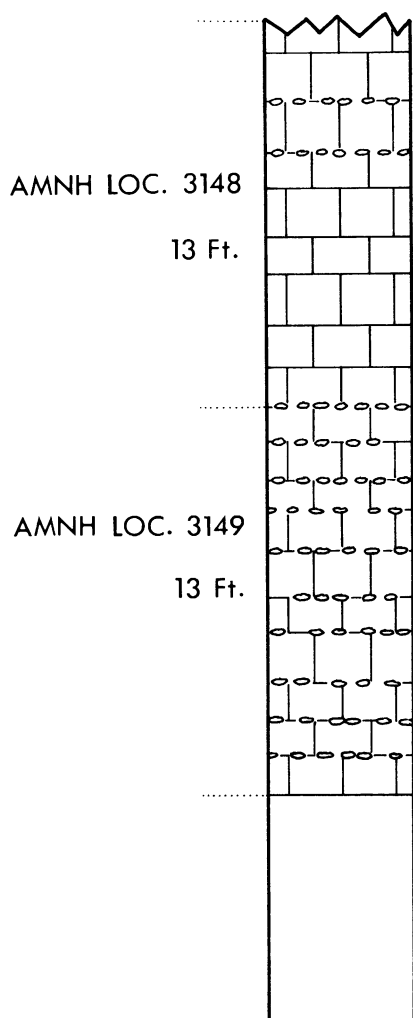


FIG. 60. Composite stratigraphic section: AMNH Loc. 3148 and AMNH Loc. 3149. Note the even distribution of chert throughout the outcrop at AMNH Loc. 3149 compared with the relatively sparse amount of chert at AMNH Loc. 3148.

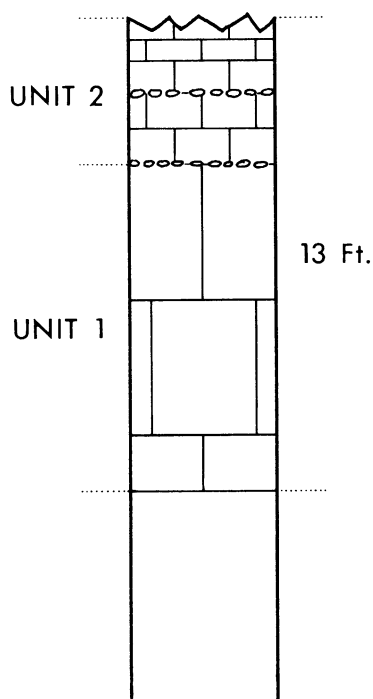


FIG. 61. Detailed stratigraphic section of AMNH Loc. 3148 illustrating two distinct light weathering chert bands, the base of which represents the contact between units one and two at this outcrop. Silicification of the faunas seems to be more complete in unit two. There also appears to be a positive correlation between amount of chert present and silicification of fossils in the area of Kingston, New York. (See Feldman, 1980, p. 28, for index map delineating a silicified region.)

or Nedrow but most likely Edgecliff, as the Nedrow cannot be lithologically differentiated this far southeast. Also, in Wawarsing, farther along Route 209, the Nedrow is no longer present.

AMNH Loc. 3151A, B, Wawarsing, New York: The Edgecliff and part of the Moorehouse members are exposed in an abandoned quarry approximately 100 ft. north of Route 209, about 0.5 miles northeast of Vernooy Kill. The measurements are approximate due to the inaccessibility of the rocks and covered strata.

## ONONDAGA LIMESTONE

## Moorehouse Member (AMNH Loc. 3151A)

Unit	Unit Thickness (feet)	Interval Above Base (feet)
3. Limestone, very fine grained, massive, medium gray with small amounts of chert (discontinuous seams) with a maximum thickness of 1 inch. The chert seems to be incorporated into the matrix in a manner similar to AMNH Loc. 3150 resulting in a "banded" appearance. The upper half of the unit is medium gray while the lower half is light gray. Common here are trilobite fragments and <i>Levenea</i> sp. No silicified fauna is present.	17	34-51
2. Limestone, medium bedded, light gray. Beds are 4 to 10 inches thick. In the lower half of the unit the beds are up to 2 ft. thick.	9	25-34
1. Limestone, massive, light gray. Some medium bedded subunits are 5 to 8 inches thick. Cherty in spots.	25	0-25

## Edgecliff Member (AMNH Loc. 3151B)

## Unit

- |  |    |      |
|--|----|------|
| 2. Limestone, medium grained, medium bedded to massive, medium to dark gray, transitional with the Lower Moorehouse. The contact is defined on the basis of a darker color (Edgecliff) and the presence of large crinoid columnals. There does not appear to be any significant difference in the color of the Moorehouse from the Nedrow and Edgecliff members. | 25 | 2-27 |
| 1. Siliceous, limy grit transitional to the Schoharie Formation.   | 2  | 0-2  |

## SCHOHARIE FORMATION

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