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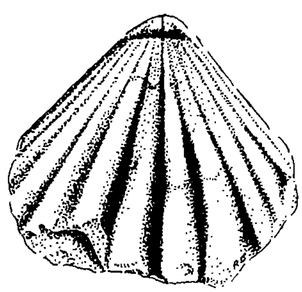
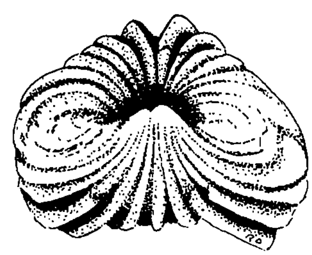
ARTICULATE BRACHIOPODS OF THE QUARRY MOUNTAIN FORMATION (SILURIAN), EASTERN OKLAHOMA

THOMAS W. AMSDEN





The University of Oklahoma
Norman
1978

Title Page Illustration

Ink drawing by Roy D. Davis of dorsal and posterior views of holotype of *Ancillotoechia conspicuua* Amsden, n. sp. This specimen, also illustrated on plate 9 (figs. 1c, 1d), was collected from the Marble City Member of the Quarry Mountain Formation at locality S9.

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ARTICULATE BRACHIOPODS OF THE QUARRY MOUNTAIN FORMATION (SILURIAN), EASTERN OKLAHOMA

THOMAS W. AMSDEN[1]

Abstract—The brachiopods described in this report are from the Marble City Member and the upper part of the Barber Member of the Quarry Mountain Formation of Silurian age. These beds are well exposed in a small area near Marble City in eastern Oklahoma. The strata from which the brachiopods were collected are predominantly organo-detrital limestones, locally heavily dolomitized. The megafauna is dominated by pelmatozoans and bryozoans, with brachiopods making up a small but persistent part of the total biota. Twenty-five brachiopod species are described, of which 6 are new; 1 new subfamily, Lepidocyclinae, 2 new genera, *Stegerhynchops* and *Arctomeristina*, and 1 new subgenus, *Eospirifer (Acutilineolus)*, are described. Included in the systematic descriptions is a discussion on the biostratigraphy of the strophomenacids and rhynchonellacids in the central United States. The Quarry Mountain strata supplying these brachiopods are assigned a Wenlockian age and are correlated with the Fitzhugh Member of the Clarita Formation in the Arbuckle Mountains-Criner Hills area of south-central Oklahoma and with the St. Clair Limestone of north-central Arkansas.

INTRODUCTION

The brachiopods described in this report are from the upper part of the Quarry Mountain Formation of Silurian age, which crops out in eastern Oklahoma in parts of Adair, Cherokee, and northern Sequoyah Counties (text-figs. 1–3). This region is of special interest because it occupies a geographic position midway between the outcrop area of the Clarita Formation in south-central Oklahoma and the St. Clair Limestone of north-central Arkansas, making it possible to combine the results of the present investigation with those of earlier studies (Amsden, 1960; Amsden and Rowland, 1965; Amsden, 1968; Amsden, 1975a) to give a reasonably complete biostratigraphic and lithostratigraphic view of Wenlockian-age strata in a broad belt extending from the Anadarko basin in western Oklahoma to the Batesville district of north-central Arkansas. The present report is confined largely to a description of the brachiopod fauna and a discussion of the biostratigraphic and biofacies relationships in eastern Oklahoma. In a subsequent paper I will discuss the regional relationships of Wenlockian-age strata in Oklahoma and adjacent areas.

Brachiopod Collections

Brachiopods can be collected from the Marble City Member at many of the exposures in the vicinity of Marble City and also at the small outcrops in western Sequoyah County (S21) and Adair County (Ad1). The following 15 localities yield brachiopods: S1, S2, S3, S4, S5, S9, S12, S15, S16, S17, S18, S19, S20, S21, Ad1 (described in Amsden, 1961, Appendix, p. 89–111; Amsden and Rowland, 1965, Appendix IA, p. 90–101; located in text-figs. 2, 3). The Barber Member has supplied brachiopods from the upper 20 feet of the member at only one locality (S18), reflecting in part the poor exposures, in part the destructive effect of extreme dolomitiza-

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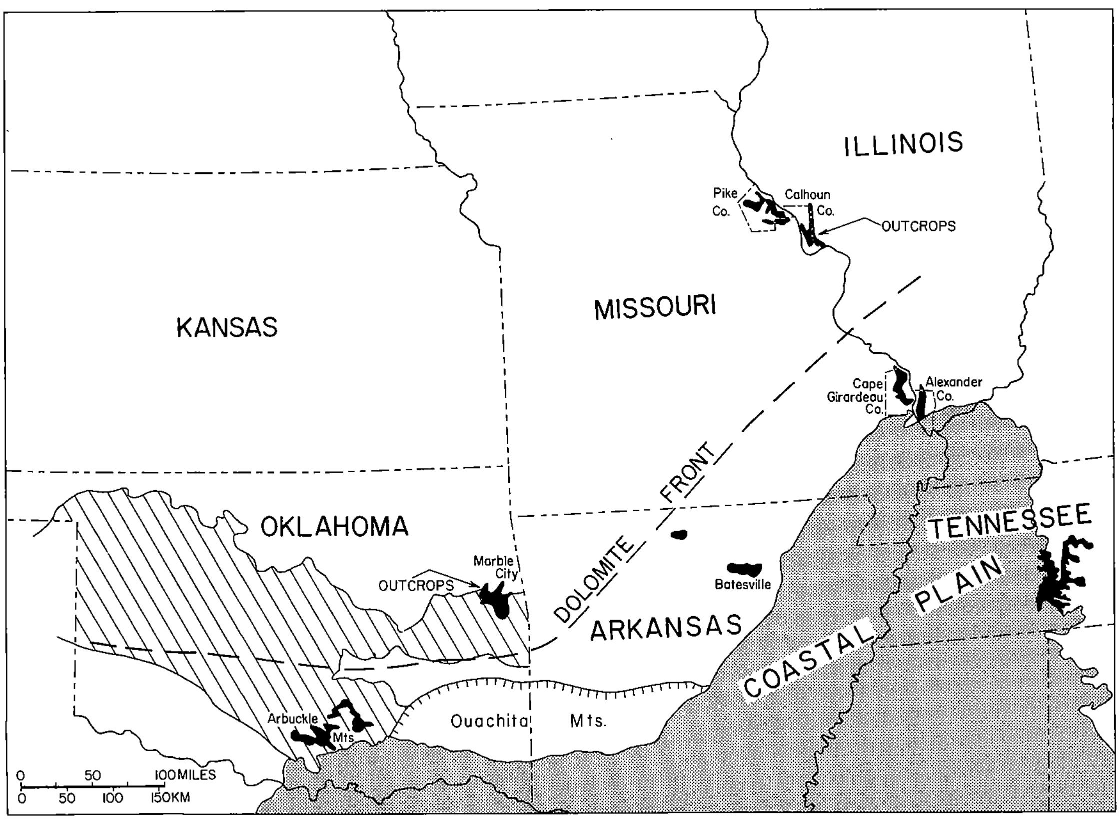
tion on fossil preservation, and possibly also the effect on the faunas of an increase in the magnesium content of the sea water.

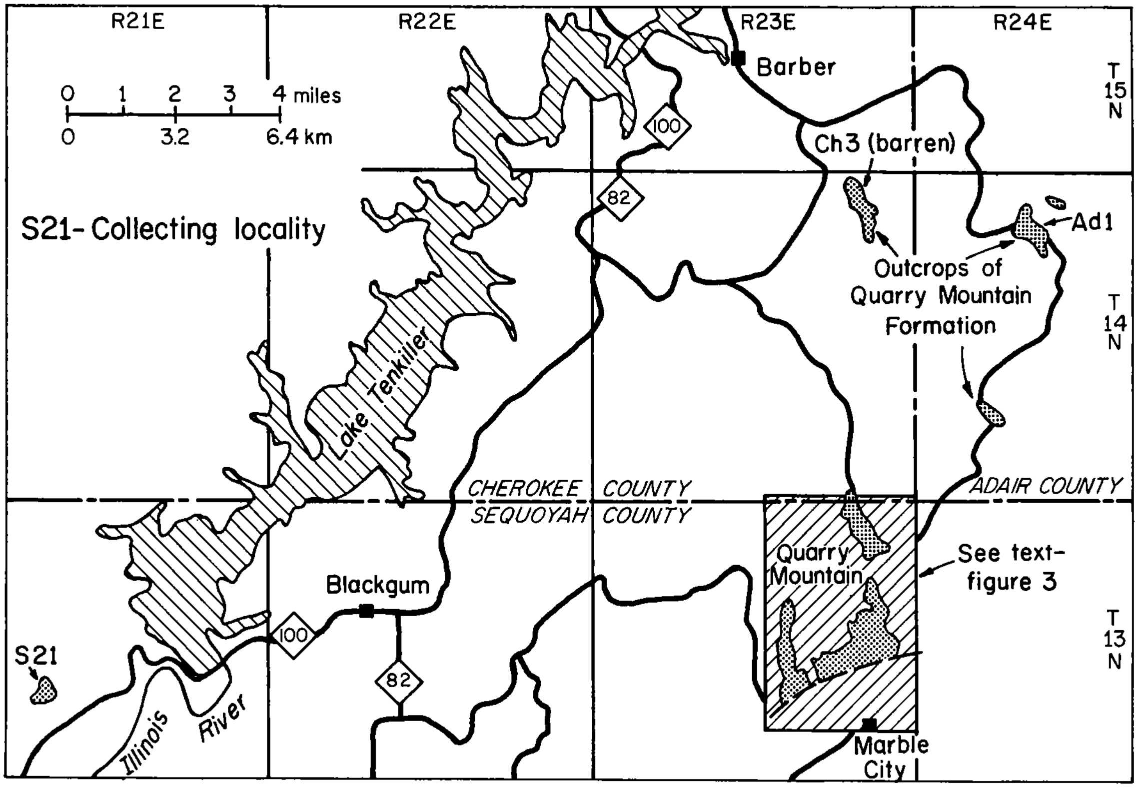
Collections from both members were made exclusively by breaking the fossils out of the matrix. For the most part, the fossils are cemented with spar and in many beds will break free of the matrix. Some well-preserved shells including frills and delicate fila have been obtained, but on the whole this collecting method produces extensive breakage and exfoliation. It will be noted that of the 23 species described in this report only 8 are assigned specific identification without question, reflecting the fragmentary character of many of the shells collected.

Acknowledgments

I wish to express my appreciation to the following individuals who read the manuscript and made helpful suggestions: Dr. A. J. Boucot, Oregon State University; Dr. J. T. Dutro, Jr., U.S. Geological Survey; Dr. C. W. Harper, Jr., The University of Oklahoma; Dr. J. G. Johnson, Oregon State University; and Dr. Gilbert Klapper, The University of Iowa. I wish to acknowledge also the use of the H. E. Christian eastern Oklahoma brachiopod collections in the present study, and I thank T. L. Rowland and T. H. Warren, who helped me collect Quarry Mountain fossils. Dr. G. Arthur Cooper of the U.S.



Text-figure 1. Regional map showing outcrop areas of Clarita Formation, Quarry Mountain Formation, and St. Clair Limestone. Ruled area shows inferred subsurface distribution of Wenlockian-age strata in Oklahoma (not shown in other states). Enlarged maps of Quarry Mountain outcrop area shown in text-figures 2 and 3.



Text-figure 2. Map of Lake Tenkiller area in eastern Oklahoma showing Quarry Mountain outcrops and stratigraphic localities furnishing brachiopods described in this report. After Amsden and Rowland (1965, pl. B).

National Museum and Dr. R. L. Batten of the American Museum of Natural History very kindly lent specimens from these institutions. Dr. David Holloway, University of Edinburgh, provided useful information on the Quarry Mountain, Clarita, and St. Clair trilobites.

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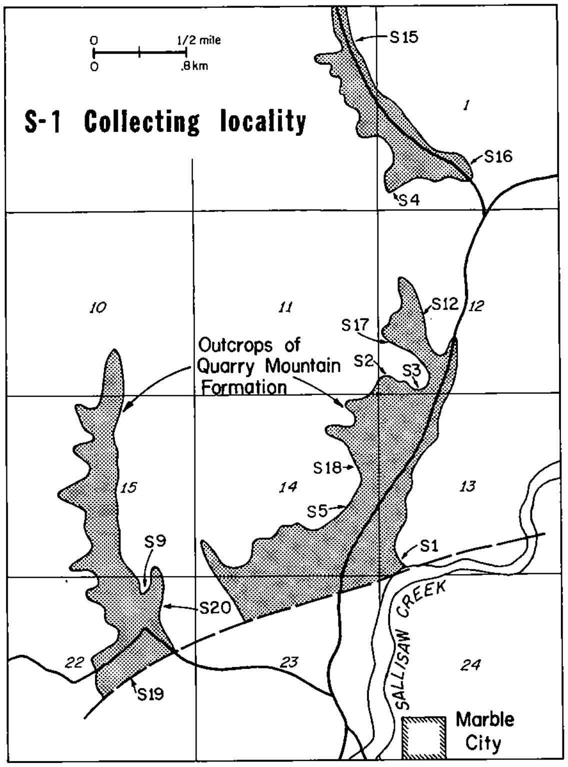
LITHOSTRATIGRAPHY

Quarry Mountain Formation

This formation is made up of a sequence of limestones and dolomites, all with a low HCl-insoluble-residue content. The most extensive and most complete exposures are in the Marble City area of north-central Sequoyah County (text-figs. 1, 2, 3), where the formation has been quarried extensively for high-calcium limestone. A detailed description of the stratigraphy, texture, chemical composition, and stratigraphic relations is given in an earlier bulletin (Amsden and Rowland, 1965), and the present paper includes only a brief summary of the physical characteristics of the formation. The stratigraphic sections and collecting localities (e.g., S1) are described in Amsden (1961, Appendix, p. 89–111) and Amsden and Rowland (1965, Appendix IA, p. 90–101).

The Quarry Mountain Formation was proposed by Amsden and Rowland (1965, p. 42–52), with the type locality in the St. Clair Lime Quarry, Marble City area (S18). These are the strata to which earlier authors referred the St. Clair Limestone, a formation



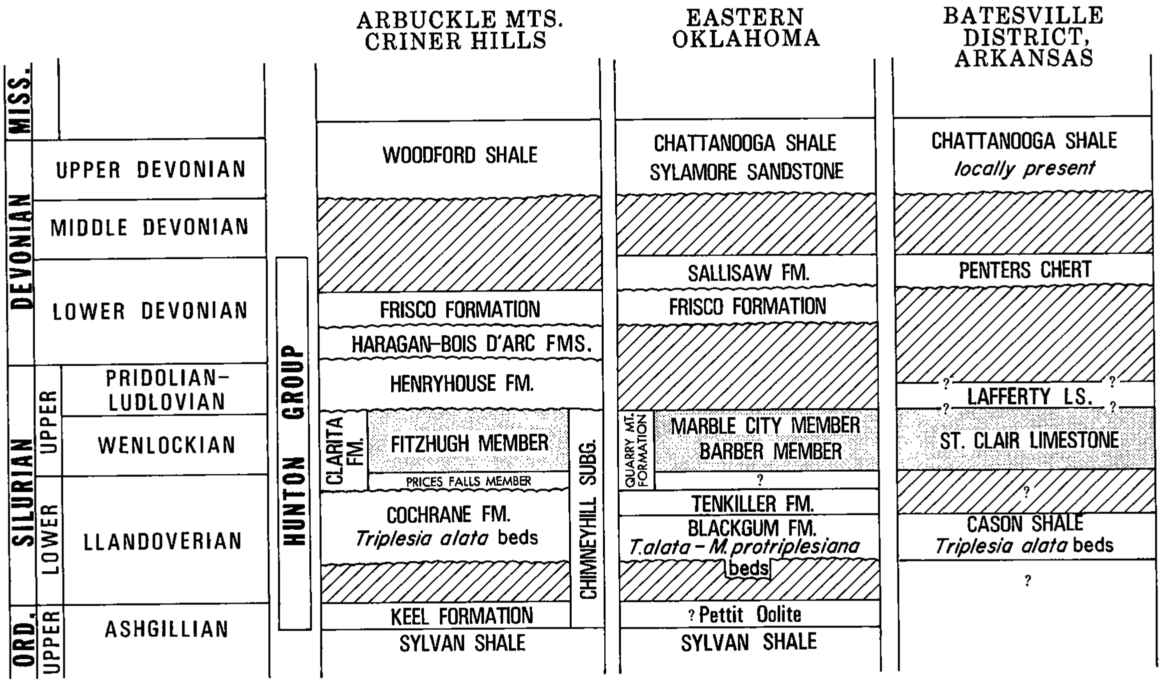
Text-figure 3. Map of Marble City area showing Quarry Mountain outcrops and stratigraphic localities furnishing brachiopods described in this report. After Amsden and Rowland (1965, pl. A).

whose type locality is near Batesville in north-central Arkansas. The Quarry Mountain Formation is divided into an upper Marble City Member, predominantly limestone, and a lower Barber Member, mostly dolomitic limestone and dolomite. At the type locality the Quarry Mountain Formation is 154 feet thick, the maximum thickness in the outcrop area. In the vicinity of the type section it is unconformably overlain by the Lower Devonian (Siegenian) Frisco Formation and underlain by the Tenkiller Formation; in other areas it is overlain by the Lower Devonian (Emsian) Sallisaw Formation or the Late Devonian Sylamore Sandstone (text-fig. 4). I have not observed any diagnostic fossils in the Tenkiller Formation, but Dr. Gilbert Klapper (letter, March 23, 1976) reports *celloni*-zone conodonts about 15 feet above the base of the Tenkiller Formation, indicating a late Llandoverian (C5) age; this zone is present in the uppermost beds of the Cochrane Formation in the Arbuckle Mountains and is older than the Prices Falls Member of the Clarita Formation (Barrick and Klapper, 1976, p. 66).

The upper Marble City Member is well exposed in numerous quarries and prospect pits in the Marble City area (text-figs. 2, 3), and it also crops out in a small area in Adair County (locality Ad1) and in western Sequoyah County (locality S21). The Barber Member, on the other hand, can be seen in only one small area in the Marble City district (S18) and in one small exposure in Cherokee County (locality Ch3), both in the upper 20 feet of the member. The Barber Member is, however, well known from extensive core drilling.

Marble City Member.—This is predominantly a light-gray to pinkish-gray organodetrital limestone, almost completely cemented with spar (text-fig. 5; pls. 12, 13). The fossil clasts are predominantly pelmatozoan plates and bryozoans, although most beds include some brachiopods, trilobites, and other groups (see section on Biofacies). The HCl-insoluble-residue content is very low, averaging about 0.3 percent with a maximum of about 1.5 percent (Amsden and Rowland, 1965, p. 49); the insolubles are almost entirely silt-size, subangular quartz detritus. Much of the Marble City is high-calcium limestone with an average $MgCO_3$ content of about 3 percent and a mode of about 1 percent; beds of dolomitic limestone are common locally, however, and some of these grade into crystalline limestone with as much as 36 percent $MgCO_3$ (Amsden and Rowland, 1965, p. 44).

I have observed no reefs or boundstone in either the surface exposures or the cores, and this member appears in large part to represent sheets of organic debris spread out on the sea floor. The fossils show relatively little breakage or evidence of size sorting by current and (or) wave action. In fact, relatively large bryozoan fronds are intact, many of the brachiopods are articulated (pl. 12, fig. 2; pl. 13, figs. 5, 6), and some of the brachiopods have delicate shell structures, such as frills, preserved (pl. 9, figs. 3a, 3b), suggesting that the organic debris was not shifted far after death. In all proba-



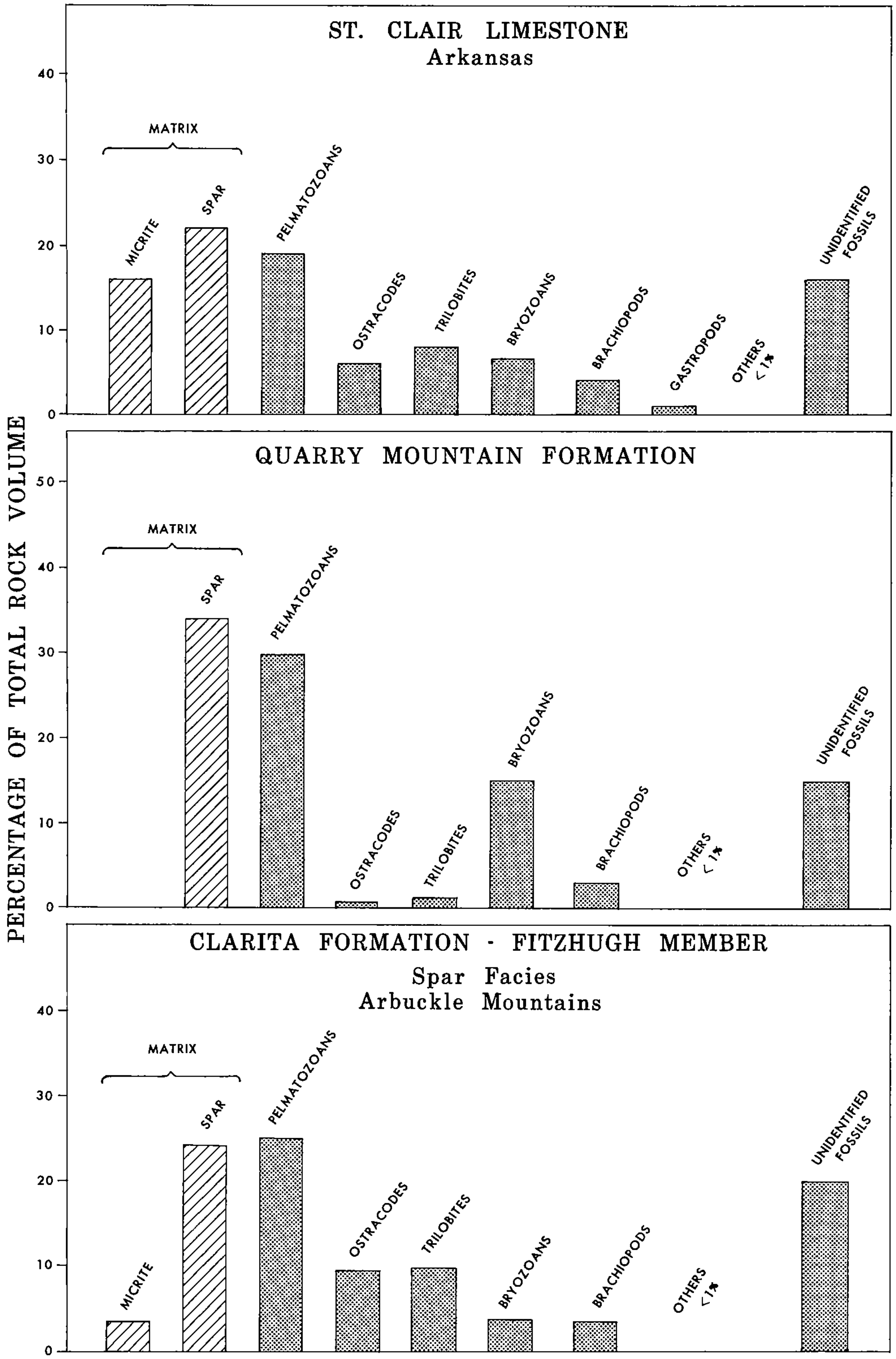
Text-figure 4. Chart showing inferred age and correlation of brachiopod-bearing strata (stippled) in Clarita and Quarry Mountain Formations of Oklahoma and in St. Clair Limestone of Arkansas (all Late Ordovician, Silurian, and Early Devonian age relations are based on my brachiopod studies). Chart not to scale in terms of stratigraphic thickness or time.

bility, the faunal assemblage is essentially a "life assemblage" or fossil community, as defined by Fagerstrom (1964, p. 1199).

The Marble City Member was exposed to at least three periods of erosion prior to Late Devonian time: (1) pre-Frisco, (2) pre-Sallisaw, and (3) pre-Sylamore-Chattanooga (Amsden, 1961, p. 37–42, 55–58, 61–65). These periods of uplift also produced considerable solution, and many of the cavities and crevices were later filled with sediment introduced during deposition of the overlying strata (Amsden, 1961, p. 38, 62–64; Amsden and Rowland, 1965, p. 50–51). There are also sediment-filled cavities in the Marble City Member and the Tenkiller Formation, some of which appear to represent penecontemporaneous cavities that were developed and filled during deposition (Amsden and Rowland, 1965, p. 36–37, pls. 8, 9). In addition, there are numerous cavities associated with fossils, most of which appear to represent unfilled or incompletely filled shells such as brachiopods and cephalopods. Some of these are empty, whereas others are partly filled with spar (pl. 13, figs. 1, 2), indicating incomplete cementation of the original fabric. On the whole, the Quarry Mountain Formation in the outcrop area developed a fair amount of porosity, and some of the cavities are known to be filled with hydrocarbons (Christian, 1953, p. 18).

The Marble City Member is unconformably overlain by either the Frisco Formation, the Sallisaw Formation, or the Late Devonian Sylamore Sandstone. It is underlain with apparent conformity by the Barber Member. The thickness of the Marble City Member in the outcrop area ranges from 60 to 70 feet.

Barber Member.—This member is typically dolomitic limestone, with an average $MgCO_3$ content of about 18 percent. In places these strata grade into crystalline dolomite with as much as 36 percent $MgCO_3$ and, less commonly, into low-magnesium lime-



Text-figure 5. Graphs comparing distribution of major invertebrate fossil groups in Quarry Mountain Formation with those in St. Clair Limestone near Batesville, Arkansas, and Clarita Formation, Fitzhugh Member, Arbuckle Mountains (latter is from spar facies in northeastern part of mountains, the beds that produced almost all brachiopod collections; see Amsden, 1968, text-figs. 9, 11). Data are based on point counts of thin sections and are shown as percentages of total rock volume. Data for each formation represent an average based on a number of point counts of thin sections prepared from specimens taken from different geographic localities and stratigraphic levels. Insoluble detritus is low in all strata represented here, averaging less than 2 percent.

stones. Typically, the texture is that of an organo-detrital limestone with euhedral crystals of dolomite invading the matrix and, as the magnesium content increases, impinging against and corroding the fossil clasts. I interpret this as, in large part, a primary dolomite introduced at or near the time of deposition (Amsden and Rowland, 1965, p. 51–56; Amsden, 1975b, p. 51–56). The HCl-insoluble-residue content is mostly very low with a mode of about 2 percent; this is mainly silt-size, subangular quartz detritus.

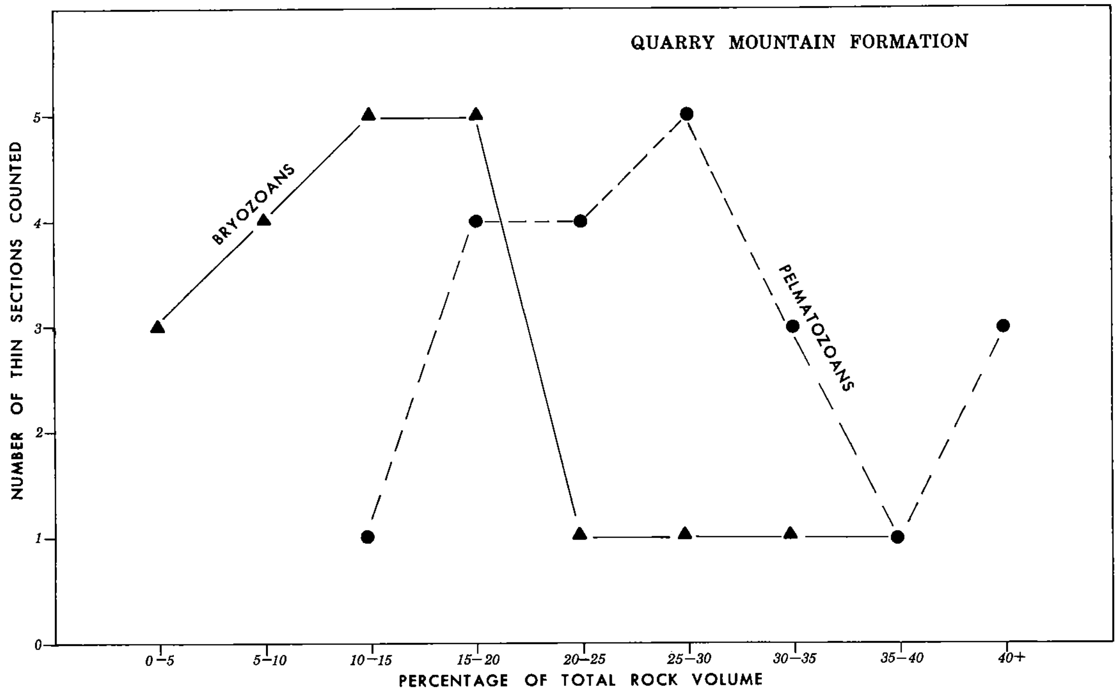
The Barber Member is underlain by the Tenkiller Formation and overlain by the Marble City Member except in those areas where post-Marble City erosion has removed the Marble City. All lithostratigraphic and biostratigraphic evidence suggests that the Barber Member is closely related to, and gradational into, the basal Marble City beds, the distinction between the two being based on the fairly abrupt change in $MgCO_3$ content at this boundary. In the outcrop area the Barber Member ranges from 50 to 80 feet in thickness.

BIOFACIES

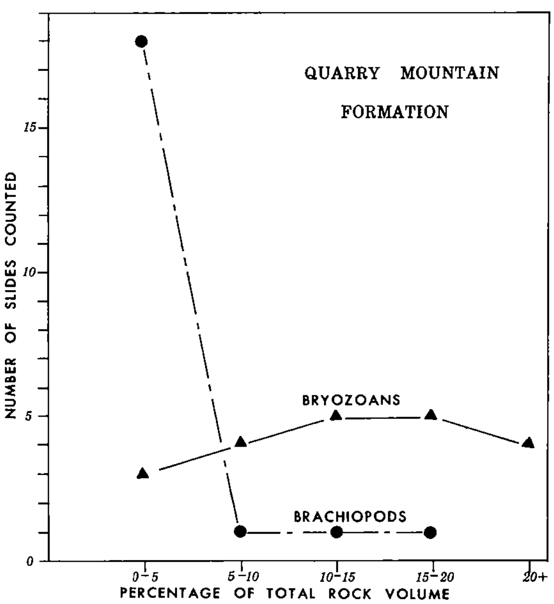
I am presently making a paleoecologic study of Wenlockian facies in the belt extending from the Texas Panhandle across Oklahoma into north-central Arkansas (Amsden, 1975a, p. 974–975). This investigation is based on surface and subsurface information and will consider the lithofacies as well as the biofacies, the latter being based on fossil collections supplemented by point counts of thin sections. The point counts are especially useful, because they (1) furnish information on stratigraphic horizons and geographic localities from which it is difficult to collect megafossils, and (2) provide some quantitative information on community structure at major taxonomic levels. This study is still in progress, but enough work has been done to provide some significant biofacies information, and as this helps toward a better understanding of the brachiopods, especially in appraising their relationship to other Wenlockian faunas, a brief summary follows. (Detailed information on the method used in point counting, as well as tabulation of individual counts, will be given in the report covering the entire study.)

The Quarry Mountain Formation has a varied megafauna that includes pelmatozoans, bryozoans, brachiopods, ostracodes, trilobites, cephalopods, snails, and rare corals (no calcareous algae have been recognized). Excluding the present study, no systematic description of any considerable part of the Quarry Mountain megafauna has been published. A number of faunal lists have been prepared, however, the most extensive being those of Taff (1905, p. 2; identified by E. O. Ulrich), Powell (1951), and Christian (1953). All these lists indicate a strong preponderance of brachiopods, at least in terms of species (Christian listed 16 brachiopod species and only 5 species of all other groups), and Amsden and Rowland (1965, p. 52) stated that the Marble City fauna (exclusive of pelmatozoans) is dominated by brachiopods and trilobites. On the basis of present information, it is not possible to determine the relative abundance of species representing the different phyla, although the point counts of thin sections clearly show that, in terms of biomass, the pelmatozoans and bryozoans strongly dominate the Marble City and upper Barber Members (i.e., that portion of the Quarry Mountain Formation supplying the brachiopods studied in the present report). Some 75 thin sections have been prepared from the upper Barber and Marble City Members, and these were taken from samples representing almost all geographic localities and stratigraphic levels, including all beds supplying brachiopods for the present study. As shown in text-figure 5, the pelmatozoans are the dominant element, comprising almost 30 percent of the rock volume. Next in abundance are the bryozoans, which contribute about 15 percent, and the brachiopods are a distant third with slightly over 3 percent. A comparison of bryozoans to pelmatozoans is shown in text-figure 6, and the greater abundance of bryozoans compared to brachiopods is shown in text-figure 7. It should be emphasized that the dominance of bryozoans over brachiopods is apparent even in those thin sections prepared from beds supplying the brachiopods described in this report.

Trilobites and ostracodes are present and locally constitute as much as 6 percent of the rock volume. A few beds include



Text-figure 6. Frequency diagram showing concentration of bryozoan material and pelmatozoan plates in Quarry Mountain Formation, eastern Oklahoma. Data are based on point counts of 21 thin sections expressed as percentages of total rock volume.



Text-figure 7. Frequency diagram showing concentration of bryozoan and brachiopod material in Quarry Mountain Formation, eastern Oklahoma. Data are based on point counts of 21 thin sections expressed as percentages of total rock volume.

gastropods and cephalopods, but other groups are poorly represented. Corals are rare, no stromatolites or any type of laminated head have been observed, and the evidence for calcareous algae is meager.

Many of the bryozoans are of the fenestellid type, but other colonial forms are also represented. Few, if any, appear to be in growth position, although the presence of long, well-preserved, delicate fronds (pl. 12, fig. 1, pl. 13, fig. 4) suggests that the water energy level was low, a conclusion also supported by the presence of articulated brachiopod shells, some with well-developed frills (pl. 9, figs. 3a, 3b, pl. 8, fig. 4; see also discussion of Marble City Member in section on Lithostratigraphy). This would certainly appear to be essentially a "life assemblage," or fossil community (Fagerstrom, 1964, p. 1199), there being no evidence that the skeletal material was moved any great distance or that it was selectively sorted by wave action. Thus the Marble City region appears to have been the site of a crinoid-bryozoan community (thicket community) of impressive dimensions. The water must have been clear, as both lime muds and terrigenous detritus are extremely scarce; the undolomitized portions of these strata are limestones of exceptional purity, with analyses commonly showing 99 percent or more $CaCO_3$. The substrate was mostly calcareous sands made up of organic debris. Brachiopods lived among the crinoids and bryozoans, probably attaching to the bryozoans in places. Ostracodes and trilobites made up most of the vagrant benthos. The depth of water is difficult to ascertain, beyond the fact that it must have been removed from the zone of active wave and (or) current action. The scarcity of corals and calcareous algae here as well as elsewhere in this belt of Wenlockian strata is puzzling. Possibly depth of water was a factor, and shading by the presumably dense crinoid-bryozoan thickets may have played a part; whatever the cause, crinoids and bryozoans completely dominate the sessile benthos in the Quarry Mountain community.

The Quarry Mountain biofacies is different from that of the Fitzhugh Member of the Clarita Formation in the Arbuckle Mountains of south-central Oklahoma (text-figs. 1, 4). The sparite facies of the Fitzhugh, which is largely confined to the northeastern part of the Arbuckle Mountain region, furnished almost all the brachiopods described in my 1968 paper (Amsden, 1968, p. 13–18). The biofacies of these strata, as determined by point counts, is illustrated in text-figure 5. It will be noted that arthropods are the second most abundant element in the fauna, completely overshadowing the bryozoans (a condition even more pronounced in the micritic facies of the Fitzhugh). The community structure of the St. Clair Limestone of Arkansas (text-fig. 5) is basically like that of the Fitzhugh, with arthropods next in abundance to pelmatozoans; bryozoans, however, are somewhat more abundant in the St. Clair than in the Fitzhugh. Wenlockian-age strata in all three areas are similar in having very low coral-algae counts. I will defer an evaluation of the ecological conditions that produced these differences in community structure until a later time when all data are available. It is, however, certainly noteworthy that the Fitzhugh and St. Clair strata, which have similar general community structures, have similar brachiopod faunas, whereas the brachiopods from the Quarry Mountain Formation, with its conspicuous pelmatozoan-bryozoan dominated community, differ from the brachiopod faunas of the other two formations in a number of respects. The problems concerned with brachiopod correlations within this region are discussed in the chapter on Correlation and Age, and here I will note only that these taxonomic differences in the brachiopods may be related at least in part, perhaps entirely, to paleoecological differences.

Calef and Hancock (1974) studied the brachiopod communities in Wenlock- and Ludlow-age rocks of Wales and the Welsh Borderland. Their investigation is based exclusively on brachiopods, which they estimate make up about 90 percent of the total biota, and it includes almost no information on the character of the enclosing sediments. These authors recognize five essentially depth-controlled communities, which they believe to be completely intergrading in composition. Recently, Lawson (1975) reexamined the faunal relations in the Silurian strata of this region and criticized the approach used by these authors as well as their conclusions. Among other things, Lawson objected to the reliance of Calef and Hancock on the brachiopods to the exclusion of all other biota and to their failure to give any real consideration to the lithology. Lawson concluded that there are four rather than five communities and that "the picture drawn by Calef and Hancock is an oversimplification resulting, perhaps, from an attempt to impose a relatively straight forward Llandovery pattern on the more complex Ludlow rocks." I will not discuss the relative merits of either interpretation, because the biota and the lithofacies of the Welsh strata are so different from those of the Quarry Mountain as to make any comparison ineffective. However, I concur with Lawson's conclusions that those community (biofacies) studies that are based exclusively on brachiopods, and that virtually ignore lithofacies, represent an oversimplification of what is really a very complex problem. This is not to negate the use of brachiopods in paleoecological studies, but their relationship to other faunal elements, and to the enclosing sediments, should be considered.

Many paleontologists working on Silurian benthic communities (concentrating largely if not entirely on brachiopods) have interpreted them as essentially depth controlled (Ziegler and others, 1968; Berry and Boucot, 1970; Calef and Hancock, 1974; Boucot, 1975). Lawson (1975, p. 521) indicated the need for caution in such an interpretation, and, indeed, investigators studying recent benthic communities stress the character of the bottom sediments, currents, and other factors not directly related to depth. This is well shown in a recent monograph by Parker, who gives the results of a study in the Woods Hole area as well as an excellent summary of previous work done on recent benthic communities (Parker, 1975, p. 210-233). My study of Wenlockian communities in the Midcontinent area, of which the present investigation is a part (Amsden, 1975a), suggests that bottom sediment, turbidity, and currents play an important role in community structure.

	MARBLE CITY MEMBER														Barber Member	Clarita Formation	St. Clair Limestone
	S1	S2	S3	S4	S5	S9	S12	S15	S16	S17	S19	S20	S21	Ad1	S18		
Resserella sp.					X			X		X	X			X	X		
Coolinia sp.*				X	X					X			X		X		
Dalejina? sp.					X												
Strophondonta (Brachyprion) sp. A*					X			X		X		X	X	X	X		
Strophodonta (Brachyprion) sp. B															X		
Amphistrophia (A.) sequoyensis Amsden, n. sp.*					X			X	X		X		X		X	X	
Lissostrophia sp.				X				X	X	X					X		
Leptostrophia sp.					X												
Leptaena sp.		X						X							X		
Ancillotoechia conspicuua Amsden, n. sp.*				X	X	X	X	X		X	X	X	X		X		
Rhynchotreta cf. *R. cuneata* (Dalman)								X	X					X	X		
Stegerhynchops marblensis Amsden, n. sp.																	
Sieberella sp.*	X						X	X		X		X	X	X	X		
Boucotides barrandei Amsden*		X			X			X	X				X				X
Eospirifer (Acutolineolus) inferatus Amsden, n. sp.								X	X				X				
Eospirifer (Eospirifer) radiatus? (Sowerby)*		X			X	X		X	X	X	X	X	X		X		
Arctomeristina compressa Amsden, n. gn. & n. sp.*		X					X	X	X	X	X	X		X	X		
Meristina? sp.								X				X		X			
Delthyris? sp.												X					
Howellella cf. *H. splendens* (Thomas)												X				X	X
Atrypa petrotella Amsden, n. sp.*	X	X		X		X	X	X	X	X		X		X			
Plectatrypa arctoimbricata Amsden*		X						X		X	X		X	X			X
Homoeospirella? sp.																	

*Represented by 30 or more specimens

Text-figure 8. Brachiopods from Marble City Member of Quarry Mountain Formation. Collecting localities described in Amsden (1961, Appendix) and Amsden and Rowland (1965, Appendix 1A). Localities shown in text-figures 2 and 3 of this report.

BRACHIOPOD BIOSTRATIGRAPHY

The Quarry Mountain brachiopods were collected throughout the Marble City Member and down into the upper 20 feet of the Barber Member. In the Marble City area, which has the best and most complete exposures of the formation, brachiopods have been obtained throughout the upper 95 feet of the Quarry Mountain Formation, with only the lower 60 feet supplying no diagnostic specimens. This upper portion is mainly limestone with some dolomitic limestone, whereas the lower 60 feet is principally calcareous dolomite and dolomite; thus the brachiopods studied in this report are predominantly from low-magnesium limestones. It should, however, be kept in mind that the lower 60 feet of the Barber Member is poorly exposed and is known mainly from core drilling (Amsden and Rowland, 1965, p. 9, 10).

The Marble City collection of brachiopods contains 23 species, 8 of which can be identified without question (text-fig. 8). Twelve of the Marble City species are also present in the Barber Member, a substantial percentage, considering the somewhat fragmentary nature of the material plus the stratigraphic concentration of the collections in the upper part of the formation.

The Barber brachiopod collection contains 14 species, 12 of which are also present in the Marble City Member (text-fig. 9). This is an impressive number of common species, considering that all the Quarry Mountain shells came from a single locality in the upper 20 feet of the member and that many of the species herein described are represented by only a few specimens. On the basis of these data, which are the only biostratigraphic information available to me, I see no solid evidence of any brachiopod zonation, and, at least for the purpose of biostratigraphic correlation, I will treat the Quarry Mountain brachiopods as a single faunal entity.

	Barber Member S18	Marble City Member	Clarita Formation	St. Clair Limestone
Resserella sp.	X	X		
Dicoelosia sp.	X			
Coolinia sp.*	X	X		
Strophodonta (Brachyprion) sp. A*	X	X		
S. (B.) sp. B	X	X		
Amphistrophia (A.) sequoyensis Amsden, n. sp.*	X	X	X	
Lissostrophia sp.	X	X		
Leptaena sp.	X	X		
Leangella (Opikella) dissiticostella? Amsden	X		X	X
Ancillotoechia conspicuua Amsden, n. sp.*	X	X		
Rhynchotreta cf. *R. cuneata* (Dalman)	X	X		
Sieberella sp.	X	X		
Eospirifer (Eospirifer) radiatus? (Sowerby)*	X	X		
Arctomeristina compressa Amsden, n. gn. and n. sp.*	X	X		

*Represented by 30 or more specimens

Text-figure 9. Brachiopods from Barber Member of Quarry Mountain Formation. Collecting localities described in Amsden (1961, Appendix) and Amsden and Rowland (1965, Appendix 1A). Localities shown in text-figures 2 and 3 of this report.

AGE AND CORRELATION

For many years the relative age of the Quarry Mountain Formation has been in question. In 1905 Ulrich (*in* Taff, 1905, p. 2) correlated the St. Clair fauna of Oklahoma (these fossils were from strata here referred to the Quarry Mountain Formation) with that of the St. Clair Limestone of Arkansas and assigned both to the Niagaran Series. However, in later papers Ulrich (1911, p. 559; 1927, p. 32) stated that the St. Clair of the Marble City areas was younger than the type St. Clair, correlating the latter with the pink crinoidal beds (=Clarita Formation, Fitzhugh Member) of Oklahoma. In a Silurian correlation chart (Swartz and others, 1942, chart 3), the St. Clair of Oklahoma (=Quarry Mountain Formation) was correlated with the St. Clair of Arkansas and was assigned a late Llandoverian age. These formations were considered to be younger than the Chimneyhill Formation and older than the Henryhouse Formation of the Arbuckle Mountain region. In the present report the brachiopod-bearing strata of the Quarry Mountain Formation (essentially equivalent to the Oklahoma St. Clair of earlier authors) are assigned a Wenlockian age (text-fig. 4).

In 1976 a small collection of Marble City trilobites was sent to Dr. K. S. W. Campbell, Australian National University, and Dr. David Holloway, University of Edinburgh, who was visiting Australia at that time. Later, my entire collection of Clarita, Quarry Mountain, and St. Clair trilobites was sent to Dr. Holloway at the U.S. National Museum for study. Dr. Holloway identified 20 species of trilobites in the Clarita material, of which 12, possibly 13, were also present in the St. Clair of Arkansas. The Quarry Mountain collection is smaller and less well preserved than the Clarita collection. Eleven species were identified provisionally, of which one, *Dalmanites,* cf. *D. bassleri,* is similar to a St. Clair species. Dr. Holloway noted that the Quarry Mountain material did not allow for precise comparisons but was consistent with a Wenlock age (written communication, June 15, 1976). It thus appears that the trilobites, like the brachiopods, show a much greater similarity between the Clarita and the St. Clair than between the Quarry Mountain and either of the other two, with all three indicating a Wenlockian age. This is the only Quarry Mountain faunal data other than brachiopods known to me.

The Quarry Mountain brachiopod collection contains a large and diverse Silurian brachiopod fauna, although many of the species cannot be identified unequivocally because of an insufficient number of specimens and (or) poor preservation. There are no genera in the assemblage that restrict the fauna definitely to a particular Silurian series. The weight of evidence, however, favors a post-Llandoverian age, and an analysis of the different taxa provides fairly convincing evidence for a Wenlockian age. This can best be understood by considering each of the better represented taxa.

Resserella sp.: The Quarry Mountain collections are not adequate to justify a specific identification, but the closest similarity appears to be with *Resserella canalis* (J. de C. Sowerby) from the Slite Marlstone (Wenlockian), Gotland.

Strophodontidae: *Strophodonta (Brachyprion)* sp. A: In general size, shape, ventral interior, and denticulations, the species is similar to *Megastrophia (Protomegastrophia) semiglobosa* (Davidson) from the Wenlock of Great Britain and Gotland; the chilidium and denticulations are similar to those present on *Strophodonta (Brachyprion)*? *newsomensis* Foerste from the Waldron Shale (Wenlockian), Indiana. The Quarry Mountain shells are similar in all respects to those from the Fitzhugh Member of the Clarita Formation (Wenlockian), Oklahoma (see discussion under section on Biostratigraphic Distribution of Strophomenacid Brachiopods, which follows description of *Amphistrophia sequoyensis* in section on Systematic Paleontology).

Leangella (Opikella) dissiticostella? Amsden, 1968: Only a single Quarry Mountain specimen has been found, but this specimen resembles shells from the St. Clair Limestone (Wenlockian), Arkansas, and the Fitzhugh Member, Clarita Formation (Wenlockian), Oklahoma.

Ancillotoechia conspicuua Amsden, n. sp.: This species has some resemblance to the Waldron Shale (Wenlockian) representatives of *Ancillotoechia neglecta* (Hall).

Rhynchotreta, cf. *R. cuneata* (Dalman): The Gotland representatives are similar to the Quarry Mountain specimens. On Gotland the species is reported to range from the Upper Visby Marlstone (Late Llandoverian) into the Eke Marlstone (Early Ludlovian).

Boucotides barrandei Amsden, 1968: The Quarry Mountain shells are conspecific with Fitzhugh Member, Clarita (Wenlockian), representatives, Oklahoma.

Eospirifer (Acutilineolus) inferatus Amsden, n. subgen. and sp.: This subgenus is presently known only from the Quarry Mountain Formation, St. Clair Limestone (Wenlockian), Arkansas, and Fitzhugh Member, Clarita Formation (Wenlockian), Oklahoma.

Eospirifer (Eospirifer) radiatus? (J. de C. Sowerby): The Quarry Mountain specimens are similar to, if not conspecific with, representatives from the Wenlock of Great Britain.

Arctomeristina compressa Amsden, new gen. and sp.: All presently known representatives of this genus are believed to be from Wenlockian-age strata in North America.

Howellella, cf. *H. splendens* (Thomas, 1926): Only a single specimen is known from the Quarry Mountain Formation, and it is comparable to the St. Clair (Wenlockian) and Fitzhugh Members, Clarita Formation (Wenlockian) representatives.

Plectatrypa arctoimbricata Amsden,

1968: The Quarry Mountain specimens are conspecific with the St. Clair (Wenlockian) shells.

No single item in the taxa discussed is in itself conclusive, but the sum total seems to offer reasonably convincing evidence for a Wenlockian age. There are a number of similarities between the Quarry Mountain fauna and that of the St. Clair Limestone, Arkansas, and the Fitzhugh Member, Clarita Formation, Oklahoma, to both of which I assign a Wenlockian age (Amsden, 1968, p. 20–23; based on conodonts, Barrick and Klapper, 1976, p. 66, assign almost all the Fitzhugh Member to the Wenlockian). In addition to the specific similarities just cited, there is a generic correlation, with 13 of the 22 Quarry Mountain genera present also in the St. Clair–Clarita fauna. This correlation is further emphasized in the generic range chart (text-fig. 10), which shows the relationship of the Quarry Mountain brachiopods to the known distribution of Late Ordovician to Early Devonian brachiopods in this region. There are also differences between the St. Clair–Clarita brachiopod faunas and that of the Quarry Mountain, with perhaps the most distinctive contrast being the complete absence of triplesiids in the Quarry Mountain.

Triplesiids, however, are not a conspicuous element in most Wenlockian faunas, and the St. Clair and Clarita faunas, especially the former, are noteworthy because of the abundance of these forms. These and other differences *may* be in part, or entirely, the result of paleoecologic variations (see section on Biofacies), and, weighing all the evidence, I interpret the Quarry Mountain brachiopod-bearing strata as being essentially correlative with those of the St. Clair and Clarita.

Correlations with other North American faunas are difficult, partly because of the lack of a modern systematic treatment of the brachiopods. This is discussed in my monograph on the St. Clair–Clarita brachiopods (Amsden, 1968, p. 20–23).

There is a general similarity between the brachiopods of the type Wenlock in the Welsh Borderland and those in the Quarry Mountain Formation, with 14 of the genera in the latter represented in the Wenlock (Shergold and Bassett, 1970, p. 137). The sections of Bassett's descriptions of Wenlock articulate brachiopods published through 1974 (Bassett, 1970, 1972, 1974) are most helpful, and when completed this study will give a modern, monographic treatment of the type-Wenlock brachiopods. (Bassett's 1977 monograph describing Wenlockian Strophomenacea and Pentameracea appeared after the present paper was in press, and the results of his latest study are not included.) At the time the present report was being prepared, Bassett's investigation covered only the Orthacea, Enteletacea, and Triplesiacea, superfamilies with only meager representation in the Quarry Mountain brachiopods. (The Quarry Mountain generic suite is similar to that recorded from the type Wenlockian by Bassett and others, 1975, p. 8, 11.) A general discussion of European Wenlockian brachiopod faunas and a comparison with the St. Clair–Clarita brachiopods are given in my 1968 paper (Amsden, 1968, p. 20–23).

SYSTEMATIC PALEONTOLOGY

The articulate brachiopods from the Quarry Mountain Formation of eastern Oklahoma are described and illustrated in the following pages and on plates 1–11. Each of the fossil collections studied in this report has been given a letter-number designation (e.g., S18), and these localities are described in Amsden (1961, Appendix, p. 89–111) or in Amsden and Rowland (1965, Appendix IA, p. 90–101). The repositories of type specimens are abbreviated as follows: OU, The University of Oklahoma; AMNH, American Museum of Natural History; USNM, United States National Museum.

Order ORTHIDA
Superfamily DALMANELLACEA Schuchert 1913
Family DALMANELLIDAE Schuchert, 1913
Subfamily DALMANELLINAE Walmsley and Boucot, 1971
Genus **Resserella** Bancroft, 1928

Resserella sp.

Pl. 4, figs. 5a–k

Description.—This species is represented by a few reasonably well-preserved ventral valves and one small but complete dorsal valve. It has a slightly elongate ventral valve with fairly uniform costellae spaced 6 to 7 per 2 mm at the front margin of mature shells; the ventral valve bears a well-marked, narrow median panel composed of slightly depressed, narrow costellae (pl. 4, figs. 5c, 5e). The dorsal valve is almost flat, with a slight concavity toward the front (pl. 4, fig. 5i).

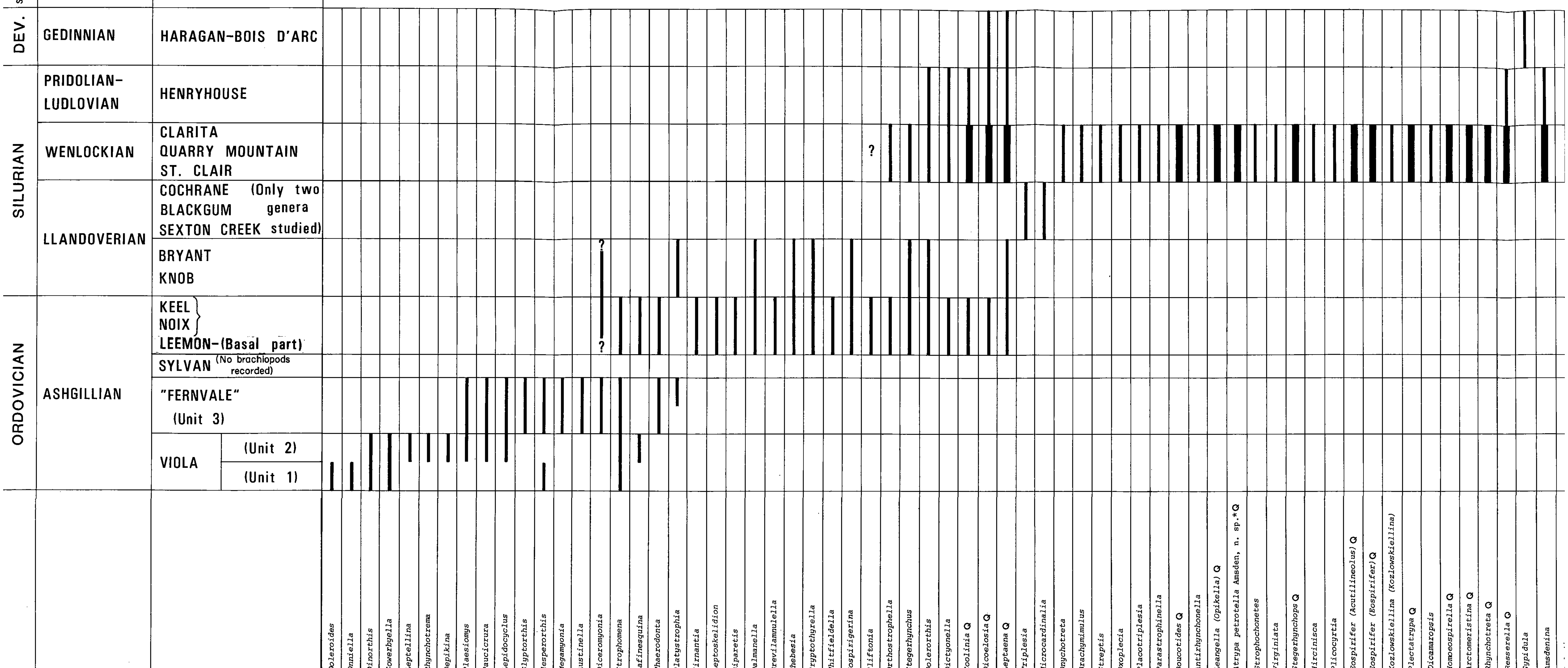
No information is available on the internal structure of this species.

The largest ventral valve in the collection is slightly over 11 mm long. Measurements of 7 complete ventral valves are given:

Length (mm)	Width (mm)	Length/width ratio	Costellae per 2 mm at anterior margin
3.7	3.5	1.06	10
5.5	5.1	1.08	10
8.2	7.8	1.05	6
9.1	8.7	1.05	6
7.5	7.5	1.00	6
10.7	11.3	0.95	7
11.4	11.0	1.04	6

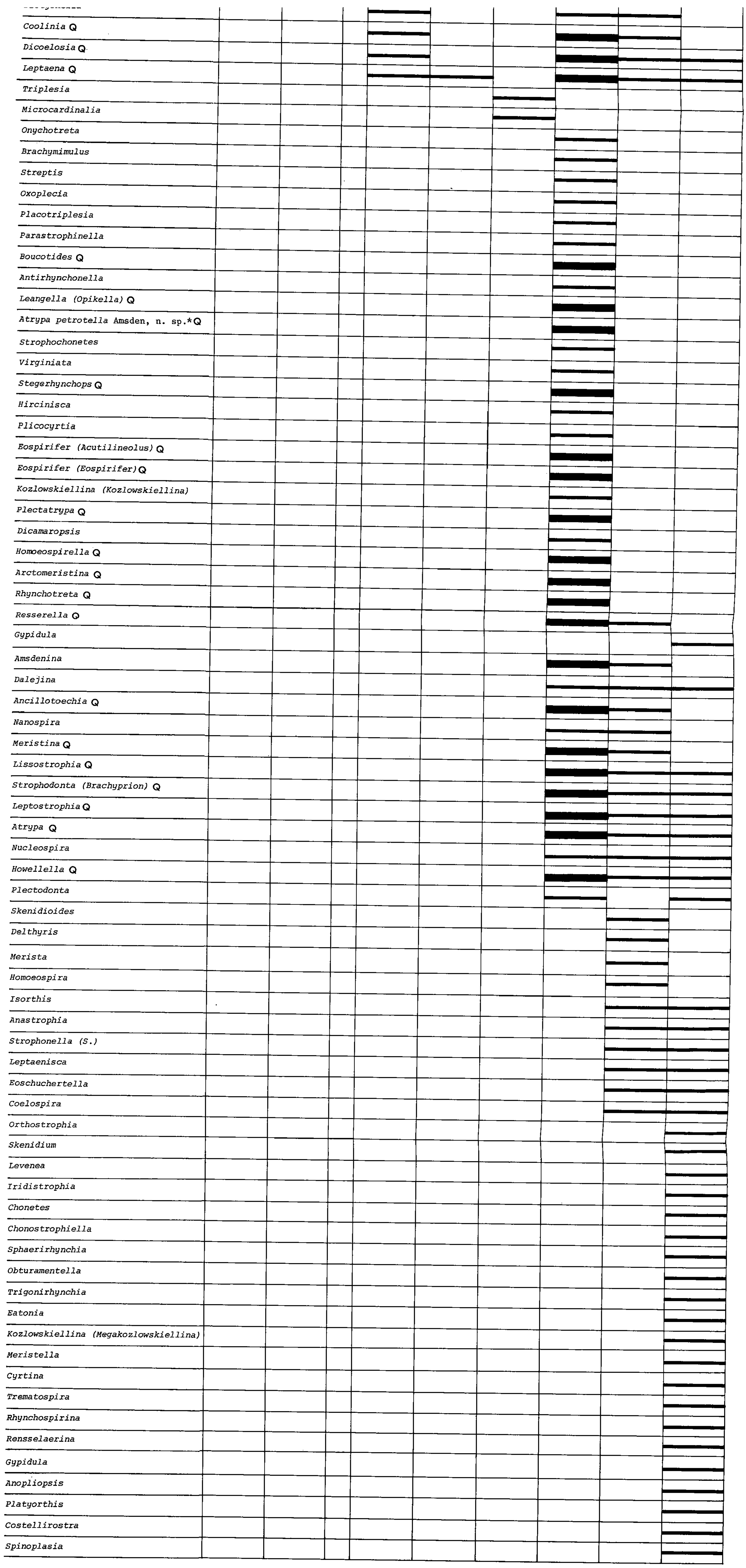
Discussion.—It is not possible on the basis of the present collection to make a precise species identification. Two other examples of *Resserella* are recognized in the Silurian strata of this region: *Resserella* sp. from the St. Clair Formation (Wenlockian) of Arkansas, a specimen too fragmentary to identify specifically, and *R. brownsportensis,* a well-represented species in the Henryhouse Formation (Ludlovian) of Oklahoma and the Brownsport Formation (Ludlovian) of western Tennessee. A recent examination of large collections from the Henryhouse and the Brownsport indicates substantial morphologic variation in these specimens of *Resserella,* especially with respect to ornamentation. In 1949, I described *Parmorthis brownsportensis* (Amsden, 1949, p. 42–43, pl. 1, figs. 1–6; =*Resserella brownsportensis*) from the Brownsport Formation without reference to a previously described species, *Parmorthis crassicostata* Schuchert and Cooper (1932, p. 129, pl. 21, figs. 4, 5; =*Resserella crassicostata*) from the same formation. In 1951, I (Amsden, 1951, p. 74, pl. 16, figs. 17–23) referred the Henryhouse species to *Parmorthis brownsportensis* (= *Resserella brownsportensis*), and in 1956 I (Amsden, 1956, p. 78–81) presented a table of measurements on Henryhouse and Brownsport specimens to show the degree of variation in dimensions and rib spacing, a matter that was discussed further in 1968 (Amsden, 1968, p. 29). Walmsley and Boucot (1971, p. 487–531, pls. 91–102), in their study of the Resserellinae, recognized *R. brownsportensis* (Amsden) and *R. crassicostata* (Schuchert and Cooper), from the Henryhouse and Brownsport Formations, and a new species, *Resserella amsdeni* Walmsley and Boucot, from the Henryhouse Formation. According to these authors, *R. brownsportensis* is characterized by an elongate shield-shaped to subcircular outline and broad, rounded costellae; *R. crassicostata* is characterized by a shield-shaped to subcircular outline with relatively few coarse, subangular costellae; *R. amsdeni* is characterized by a transversely shield-shaped outline and a raised median area in the dorsal sulcus and corresponding sulcus in the ventral valve, and it is fascicostellate. Based on my recent examination of Brownsport and Henryhouse collections, I can make the following observations: (1) From a typological point of view, there is no doubt that at least three end members can be readily distinguished in this group of shells: *R. brownsportensis,* with reasonably uniform, close spaced costellae; *R. crassicostata,* with coarser, subangular costellae; and *R. amsdeni,* with bundled costellae and a ventral sulcus. (2) A study of the entire collection shows that: *R. brownsportensis* exhibits considerable variation in coarseness and angularity of costellae; *R. crassicostata* shows variation in both angularity and size of costellae and a distinct tendency to develop bundling of the ribs; *R. amsdeni* shows differences in the strength of the median ventral depression and in rib spacing and degree of fasciculation. (3) All three types range throughout the Henryhouse Formation, very commonly occurring together in collections from the same locality and level, and there can be little doubt that all three lived together in close association in the Henryhouse seas. Whether these should be treated as a single variable species or as separate subspecies or species is probably to a considerable degree a subjective decision, although certainly no zonation should be attempted on the basis of this speciation. As far as a comparison of the Quarry Mountain species with Henryhouse *Resserella* species is concerned, the

GENERIC RANGE CHART



xt-figure 10. Chart showing range of articulate brachiopod genera in following Late Ordovi-
ın-Silurian-Early Devonian strata: Arbuckle Mountains-Criner Hills, Oklahoma (Keel, Cochrane,
ərita, Henryhouse, and Haragan Formations); eastern Oklahoma (Blackgum and Quarry
ountain Formations); Batesville district, Arkansas (St. Clair Limestone); Mississippi River,
stern Missouri and southwestern Illinois (Sexton Creek Formation; Edgewood Group—Noix,
emon, and Bryant Knob Formations). Brachiopod genera present in Quarry Mountain
rmation indicated with heavy line and Q. This chart records only known range in formations
ted above, and many of these genera are known to have a more extended time range
ewhere. Based on data from Amsden (1951, 1958, 1966, 1968, 1971, 1974).

GENERIC RANGE CHART



Q Genera present in Quarry Mountain Formation "typical" representatives of *R. crassicostata* and *R. amsdeni* can be easily distinguished from *Resserella* sp. on the basis of costellation. The Quarry Mountain shells are most similar to "typical" representatives of *R. brownsportensis*, although *brownsportensis* does have finer costellation if the substantial variation displayed is incorporated into the species concept of the Henryhouse shells. With similarities in outline, profile, and ornamentation, the Quarry Mountain shells are probably most like specimens of *R. canalis* (J. de C. Sowerby) from the Slite Marlstone of Gotland (Walmsley and Boucot, 1971, p. 497–499, pl. 97, figs. 1, 4–7, pl. 98, figs. 1, 2, pl. 100, fig. 4; I have fairly large collections of *R. canalis* from the Slite Marlstone).

Distribution.—About 18 free ventral valves and one dorsal valve from the Marble City and Barber Members were recovered at the following localities: Ad1, S5, S15A, S15C, S17, S18, S19.

Family Dicoelosiidae Cloud, 1948
Genus **Dicoelosia** King, 1850
Dicoelosia sp.

Pl. 4, figs. 6a, 6b

Discussion.—Only the two ventral valves illustrated on plate 4 have been found in the Quarry Mountain Formation. This meager representation, especially the absence of any dorsal valves, makes any species comparison ineffective.

Distribution.—Two ventral valves from the Barber Member; locality S18.

Superfamily Davidsoniacea King, 1850
Family Chilidiopsidae Boucot, 1959
Genus **Coolinia** Bancroft, 1949
Coolinia sp.

Pl. 5, figs. 2a–n; text-fig. 11

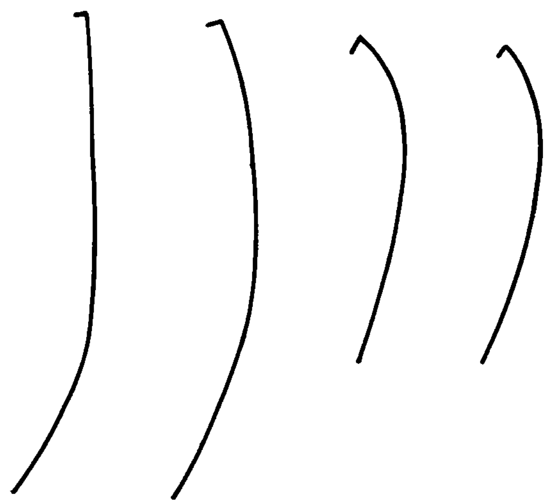
Description.—This is a common species in the Quarry Mountain Formation, although all specimens are disarticulated valves, many of which are incomplete and at least partly exfoliated. The outline is transverse, the length/width ratio ranging from 0.6 to 0.8; most specimens have the cardinal extremities broken, but well-preserved shells suggest that the hinge line represents the point of maximum shell width and in all probability this species has a more strongly transverse shell than the measurements cited below indicate. The dorsal valve is gently and uniformly convex from front to back, whereas the ventral valve is convex around the umbo, becoming flattened toward the front (text-fig. 11). The surface is costellate, with rounded costellae that are separated by flat interspaces crossed by delicate fila (pl. 5, figs. 2g, 2k); 12 to 18 costellae occupy a space of 5 mm, counted 10 mm in front of the beaks.

The ventral valve has well-developed dental plates and a poorly defined muscle area (pl. 5, figs. 2c, 2d). The socket plates in the dorsal valve unite to make a cardinal process (pl. 5, figs. 2a, 2b); the development of the chilidium and the delthyrium is poorly known.

One of the largest complete valves is 29 mm long; measurements of 12 valves are given:

Valve	Length (mm)	Width (mm)	Length/width ratio	Costellae per 5 mm 10 mm in front of beak
Dorsal	10.5	15.0	0.70	12
Dorsal	14.0	17.9	0.78	15
Dorsal	14.5	20.6	0.70	13
Dorsal	14.2	20.5	0.69	—
Dorsal	14.3	22.2	0.64	15
Dorsal	15.0	22.0	0.68	—
Dorsal	15.1	21.2	0.71	15
Dorsal	18.6	29.0	0.64	12
Ventral	10.5	15.0	0.70	13
Ventral	6.0	9.0	0.67	15
Ventral	11.0	18.0	0.61	13

Discussion.—In an earlier paper (Amsden, 1974, p. 58–59) I discussed *Coolinia* and pointed out that representatives of this genus appear to show a progressive enlargement of the chilidium during the Silurian. Unfortunately, the Quarry Mountain material is not well enough preserved to give a clear indication of the development of this structure, nor are the specimens complete enough to permit a precise species comparison. *Coolinia* sp. has a smaller shell and finer costellation than the Henryhouse (Ludlovian) species *Coolinia reedsi* (Amsden, 1951, p. 84, pl. 17, figs. 1–8). The Quarry Mountain shells are about the same size as those of *C. propinquua* (Meek and Worthen;



Text-figure 11. Longitudinal profiles of *Coolinia* sp. (×2) from Marble City Member of Quarry Mountain Formation, locality S5. Two outlines on left are dorsal valves; those on right are ventral valves.

Amsden, 1974, p. 59–60, pl. 2, figs. 3a–e, pl. 3, figs. 1–5, pl. 4, fig. 1a) from the Late Ordovician Edgewood Group of Missouri-Illinois and the Keel Formation of south-central Oklahoma. The ribbing has about the same spacing, and the ventral dental plates show a similar amount of divergence in the two species; the chilidium of the Quarry Mountain species, however, is not well enough preserved to permit a comparison of this important shell feature. *Coolinia subplana* (Conrad) from the Waldron Shale (Wenlockian) of Indiana and Tennessee has a shell of comparable size to that of *Coolinia* sp., but again a definitive comparison cannot be made until better Quarry Mountain material is available.

Distribution.—About 60 valves, mostly from the Marble City Member at locality S5. Also present in the Marble City Member at localities S4-A, S21, and S17. A single valve from the Barber Member, S18.

Superfamily ENTELETACEA

Family RHIPIDOMELLIDAE Schuchert, 1913

Subfamily RHIPIDOMELLINAE Schuchert and Cooper, 1931

Genus **Dalejina** Havlíček, 1953

Dalejina? sp.

Pl. 5, figs. 1a–c

Discussion.—Only two specimens, an articulated shell and a dorsal valve, are assigned to this genus. No interiors have been observed, and the affinities of this species will be uncertain until better material is available.

Distribution.—Two shells from the Marble City Member; locality S5.

Order STROPHOMENIDA Öpik, 1934

Superfamily STROPHOMENACEA King, 1846

Family STROPHEODONTIDAE Caster, 1939

Subfamily STROPHEODONTINAE Caster, 1939

Subgenus **Strophodonta (Brachyprion)** Shaler, 1865

Strophodonta (Brachyprion) sp. A

Pl. 5, figs. 3a–c; pl. 6, figs. 1a–n; text-fig. 12

Description.—Some shells of this species attain a large size, with the largest in the collections having a length of approximately 55 mm (pl. 6, fig. 1f). It is difficult to determine the outline with any degree of accuracy, because many shells are broken, especially near the cardinal margin; however, probably it consistently has a transverse shell with a length/width ratio of about 0.70 to 0.80 (the large specimen illustrated on pl. 6, figs. 1f–h, appears elongate, but both lateral margins are broken). The longitudinal profile is variable, with some shells having consistent strong curvature from front to back, whereas others are flattened somewhat around the ventral umbo, the convexity developing mainly near the front margin. Moreover, some small shells develop a strong curvature so that as here defined this species shows a wide range in profile (text-fig. 12). There are no articulated shells in the collections and only one dorsal valve, but the concave curvature of the latter indicates that this valve parallels the ventral closely, producing a shallow living chamber.

The surface is costellate, with 9 to 12 costellae occupying a space of 2 mm. The costellae tend to alternate in size, with 3 or 4 small ribs occupying the space between the large ones (pl. 6, figs. 1c, 1l). This is a variable feature, however, and even on the same valve the minor ribs may be absent or poorly developed near the back and lateral margins, developing the alternating rib character only near the front.

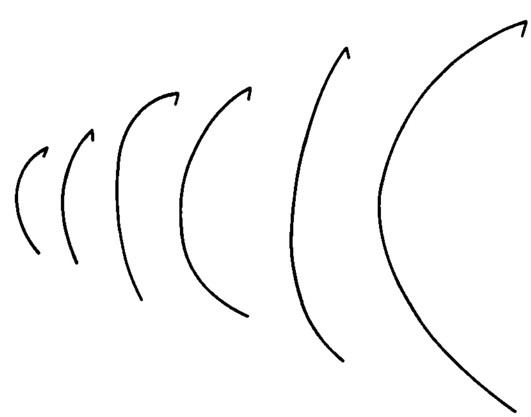
The ventral valve has a fan-shaped to subrounded, weakly impressed muscle area with no dental plates or bounding ridges. The teeth have been replaced by two small, denticulate plates located one on each side of the delthyrium; about a dozen denticles are present on each plate (pl. 6, figs. 1d, 1n). The delthyrium is closed at the apical end by a small pseudodeltidium. The dorsal valve has a well-developed chilidium (pl. 6, fig. 1j); the internal features of the dorsal valve are unknown.

Discussion.—This species is referred to *Strophodonta (Brachyprion),* a subgenus characterized by the absence of dental plates and bounding ridges and by a "degenerate" chilidium (Muir-Wood and Williams, 1965, p. H395). The ventral internal structure of *Strophodonta (Brachyprion)* sp. A agrees with this diagnosis, although its chilidium is well developed (see discussion, following). No information is available on the dorsal interior of the Quarry Mountain specimens.

In their large size and deep convexity, the Quarry Mountain shells resemble *Leptaena profunda* Hall (1852, p. 61, pl. 21, figs. 4a, 4b), a species based on specimens from the Clinton Group, Lockport, Niagara County, New York. *L. profunda* species was later made the type of *Megastrophia (Protomegastrophia)* Caster, 1939 (Muir-Wood and Williams, 1965, p. H395), a subgenus whose ventral interior, according to Muir-Wood and Williams, is characterized by a "transversely suboval muscle field with well developed bounding ridges." However, according to Dr. Charles Harper (The University of Oklahoma, personal communication, March 1, 1976), *M. (Protomegastrophia)* is characterized by a muscle field that is commonly elongate rather than transverse, with bounding ridges usually absent and developed only rarely in a few large adult specimens. It should, however, be noted that this diagnosis is based on specimens from the Racine Formation, Racine, Wisconsin (Williams, 1953, pl. 9, figs. 1–3; Muir-Wood and Williams, 1965, fig. 256, 4a, 4b), rather than on topotypes from Niagara County, New York. I have examined Hall's type specimen of *Leptaena profunda* from the Clinton Group, Rochester, New York. The American Museum of Natural History collections include only the one specimen (AMNH 1522/1) illustrated by Hall (1852, pl. 21, figs. 4a, 4b), which is an exfoliated ventral valve showing no critical internal features, and until better topotype material can be studied the internal structure of this subgenus will remain in doubt.

The chilidium and denticulations of *Strophodonta (Brachyprion)* sp. A are similar in their development to those present on *S. (B.) newsomensis* Foerste from the Waldron Shale (cf. pl. 6, figs. 1d, 1j, 1n, to pl. 7, fig. 1a). I have not examined the ventral musculature of *newsomensis,* and its reference to *Strophodonta (Brachyprion)* has not been verified by me.

The Quarry Mountain species is similar in size, outline, profile, and ventral interior to *Megastrophia (Protomegastrophia) semi-*



Text-figure 12. Longitudinal profiles of ventral valves of *Strophodonta* (*Brachyprion*) sp. A, showing variation in curvature (×1).

globosa (Davidson) from the Wenlock of Great Britain and the Upper Visby and Högklint beds of Gotland (redescribed and reillustrated by Bassett, 1977, p. 141–142, pl. 37, figs. 1–5). The poor preservation of the Quarry Mountain material makes for unsatisfactory comparisons, but *S. (B.)* sp. A appears to differ from *M. (P.) semiglobosa* and the other Wenlock species, *M. (P.) quetra* Bassett (1977, p. 142–143, pl. 37, figs. 6–9; figs. 1, 2), in having more closely spaced major costellae with fewer intervening minor costellae. Of particular note is the similarity between the denticulate hinge plate in the Quarry Mountain species and the Wenlock species.

Strophodonta (Brachyprion) sp. A shows a wide range in degree of curvature from back to front. In fact, almost every specimen in the collections differs from the others, and it is clear that the sequence of shells illustrated in text-figure 12 cannot represent a simple growth progression, because the curvature on most of the smaller specimens is too sharp to develop into the larger ones. Assuming that these represent a single species, and the alternative would be to recognize a truly formidable number of species, the degree of curvature is a highly variable shell feature. Presumably these shells began growth attached by a small peduncle that atrophied early in life, allowing the shell to come to rest with the ventral valve down. From this point on, the pattern of shell growth may have been governed largely by local bottom conditions in the immediate vicinity of the individual. A somewhat similar growth pattern is evident in at least some species of *Leptaena* (Amsden, 1951, p. 85).

Distribution.—About 30 specimens, many fragmentary, from the Marble City and Barber Members at the following localities: Ad1, S5, S15-A, S17, S18, S20, S21.

Strophodonta (Brachyprion) sp. B

Pl. 7, figs. 2a, 2b

Description.—Only two small ventral valves are referred to this species. These are sharply convex, transverse shells with well-developed alternating costellation. The major costellae, which are located on ridges that give the shell a plicated appearance, are separated from one another by 6 to 8 minor ones; 12 to 17 costellae occupy a space of 2 mm. The ventral valve illustrated on plate 7, figure 2a, is a partial steinkern showing weakly impressed muscle scars with no bounding ridges.

Discussion.—The ventral interior of these shells is similar to that of *Strophodonta (Brachyprion)* sp. A, and they may be only a variation of that species. They do, however, have a distinctive ornamentation, suggesting a distinct species or subspecies.

Distribution.—Two specimens, one from the Barber Member at locality S18, and the other from the Marble City Member, abandoned quarry, NE$\frac{1}{4}$NW$\frac{1}{4}$ sec. 13, T. 13 N., R. 23 E.

Subfamily DOUVILLININAE Caster, 1939

Genus **Amphistrophia** Hall and Clarke 1892

Amphistrophia (Amphistrophia) sequoyensis Amsden, n. sp.

Pl. 7, figs. 5a–j; text-fig. 13

Amphistrophia sp. AMSDEN, 1968, p. 53–54, pl. 19, figs. 4a–j, text-fig. 36.

Holotype.—Marble City Member, locality S15-C; pl. 7, fig. 5b; OU 8542.

Text-figure 13. Longitudinal profile of pedicle valve of *Amphistrophia (Amphistrophia) sequoyensis* Amsden, n. sp. (×2). This is valve illustrated on plate 7, figure 5h.

Description.—This species has a transverse shell with the hinge line probably consistently the point of greatest shell width, although this part is commonly broken, making it difficult to get a precise length/width shell ratio. The pedicle valve is gently convex around the umbo, but toward the front the curvature is reversed and the shell becomes weakly resupinate; the dorsal valve parallels the ventral closely to produce a shallow living chamber. The surface bears costellae of two ranks, with 5 to 9 of the major costellae occupying a space of 2 mm; the major costellae are separated by 2 to 5 smaller ones (pl. 7, figs. 5a, 5e).

The ventral muscle field is bounded by well-developed ridges for most of its length, and there is a low median septum that abuts against the pseudodeltidium (pl. 7, figs. 5f, 5g). The ventral cardinal area is narrow and apsacline, and a few small denticles are located on plates on each side of the delthyrium (Amsden, 1968, pl. 19, figs. 4a–d, 4g). In the dorsal valve the socket ridges unite to produce a cardinal process that is partly hooded by the chilidium (pl. 7, figs. 5i, 5j).

Measurements of 4 reasonably complete valves follow:

Length (mm)	Width (mm)
17.8	22.5
15.5	21.0
17.0	19.5
10.8	15.0

Discussion.—The Quarry Mountain shells appear similar in all respects to specimens from the Clarita Formation which I (Amsden, 1968, p. 53–54, pl. 19, figs. 4a–j) referred to *Amphistrophia* sp., and both are here assigned to a new species, *A. (A.) sequoyensis.* This species has the well-developed ridges bounding the ventral muscle area, which Muir-Wood and Williams (1965, p. H398) considered to be diagnostic of the douvillinids, and the resupinate profile and well-developed chilidium that characterize the genus *Amphistrophia* (Muir-Wood and Williams, 1965, p. H400). Bassett (1971, p. 319–327) recently proposed to divide the amphistrophids into two subgenera: *Amphistrophia (Amphistrophia),* characterized by the absence of dental plates, and *Amphistrophia (Pembrostrophia),* characterized by well-developed dental plates. The Quarry Mountain shells clearly belong in the *Amphistrophia (Amphistrophia)* group. The Wenlock species *A. (A.) whittardi* Cocks and *A. (A.) funiculata* (McCoy; Bassett, 1971, p. 319–323, pl. 58, figs. 2–4, 5–16) have a more strongly developed curvature, and the denticular plates extend farther along the hinge than in *A. (A.) sequoyensis* (see discussion that follows).

Distribution.—About 30 specimens of *A. sequoyensis* from the Marble City and Barber Members; localities S5, S15-C, S16, S18, S19, S21.

Biostratigraphic distribution of middle Paleozoic strophomenacid brachiopods in central United States

A number of reasonably well-defined strophomenid and stropheodontid brachiopods are presently known from Late Ordovician to Early Devonian strata in the central United States. These brachiopods, which have considerable regional as well as local value in biostratigraphic correlations, are listed in table 1 along with additional details on their morphology and phylogeny.

Strophomena satterfieldi Amsden, which is found in the basal Edgewood beds (basal Leemon Formation) of eastern Missouri, has a resupinate shell with well-developed teeth and sockets that are striated. *Rafinesquina*? *stropheodontoides* (Savage), from the same level, has a normal curvature and well-developed teeth and sockets that are striated (this species may be a representative of *Eostropheodonta*). These are the oldest species cited in table 1 and the only ones with teeth and sockets; all later species have the teeth replaced by a partly to completely denticulate hinge.

No Lower Silurian (Llandoverian) species are listed above. Several stropheodontid species have been reported from Brassfield and correlative strata, but as far as I am aware none have been sufficiently well defined morphologically to be useful in biostratigraphic or phylogenetic studies.

In *Amphistrophia (A.) sequoyensis* Amsden, which is present in both the Marble City Member and the Clarita Formation, the teeth are replaced by small plates bearing

TABLE 1.—MIDDLE PALEOZOIC STROPHOMENACID BRACHIOPODS IN CENTRAL UNITED STATES

Series	Stage	Unit	
Lower Devonian	Emsian	Sallisaw Formation	*Protoleptostrophia blainvillei* (Billings) (Amsden, 1963, p. 164–166, pl. 19, figs. 1–6).
	Siegenian	Frisco Formation	*Leptostrophia magnifica* (Hall) (Amsden and Ventress, 1963, p. 70–71, pl. 2, figs. 1–5). *Strophodonta* sp. (Amsden, 1963, p. 74–75, pl. 2, figs. 6, 7). *Pholidostrophia*? sp. (Amsden, 1963, p. 72–74, pl. 11, figs. 21, 23).
	Gedinnian	Haragan-Bois d'Arc Formations	*Strophonella* (*Strophonella*) *bransoni* Amsden (1958, p. 70–72, pl. 4, figs. 15–21; this report, pl. 10, figs. 2a–c). *Strophodonta* (*Brachyprion*) *gibbera* Amsden (1958, p. 73–74, pl. 4, figs. 6–14; this report, pl. 10, fig. 6a). *S.* (*B.*) *arata* Hall (Amsden, 1958, p. 75–76, pl. 4, figs. 1–5, pl. 5, fig. 16, pl. 10, figs. 4a, 4b). *Leptostrophia beckii tennesseensis* Dunbar (Amsden, 1958, p. 78–80, pl. 3, figs. 15–20, pl. 6, fig. 1, pl. 11, figs. 27, 28). *Lissostrophia lindenensis* (Dunbar) (Amsden, 1958, p. 77–78, pl. 7, figs. 1–4, pl. 12E).
Upper Silurian	Ludlovian	Henryhouse Formation, Brownsport Formation	*Strophonella* (*Strophonella*) *prolongata* Foerste (Amsden, 1951, p. 79–80, pl. 18, figs. 52–57; this report, pl. 8, figs. 5a–d). *Strophonella* (*Strophonella*) *alterniradiata* Amsden (1951, p. 80–81, pl. 18, figs. 45–51). *Strophonella* (*Strophonella*) *loeblichi* Amsden (1951, p. 81–82, pl. 20, figs. 36–41; this report, pl. 8, figs. 7a–c, pl. 10, fig. 1a). *Strophonella* (*S.*)? *laxiplicata* (Foerste) (Amsden, 1951, pl. 20, figs. 1–6). *Strophodonta* (*Brachyprion*) *attenuata* Amsden (1951, p. 82, pl. 20, figs. 13–20; this report, pl. 8, figs. 8a–e). *Lissostrophia cooperi* Amsden (1951, p. 83–84, pl. 20, figs. 21–29; this report, pl. 10, figs. 3a, 3b). *Strophonella* (*Strophonella*) *dixoni* Foerste (Amsden, 1949, p. 51–52, pl. 5, figs. 6, 7). *Strophonella* (*Strophonella*) *prolongata* Foerste (Amsden, 1949, p. 51, pl. 5, figs. 8–10). *Strophonella* (*Strophonella*) *semifasciata brownsportensis* Foerste (1090, p. 87, pl. 2, fig. 26).
	Wenlockian	Waldron Shale	*Strophonella* (*Strophonella*) *semifasciata* (Hall) (Williams, 1953, p. 48, pl. 13, figs. 7–14). *Strophodonta* (*Brachyprion*) *newsomensis* Foerste (1909, p. 87, pl. 4, fig. 67; this report, pl. 7, fig. 1a).
		Clarita Formation, St. Clair Limestone, Quarry Mountain Formation	*Amphistrophia* sp. (=*A. sequoyensis* Amsden) (Amsden, 1968, p. 53–54, pl. 19, figs. 4a–j). *Lissostrophia*? sp. (Amsden, 1968, p. 53, pl. 13, figs. 4a, 4b). *Strophodonta* (*Brachyprion*) sp. A (this report, pl. 5, figs. 3a–c, pl. figs. 1a–n). *Strophodonta* (*Brachyprion*) sp. B (this report, pl. 7, figs. 2a, 2b). *Amphistrophia* (*A.*) *sequoyensis* Amsden, n. sp. (this report, pl. 7, figs. 5a–j). *Lissostrophia* sp. (this report, pl. 7, figs. 4a–c). *Leptostrophia* sp. (this report, pl. 7, figs. 3a–e).
Upper Ordovician	Hirnantian	Edgewood Group	*Strophomena satterfieldi* Amsden (1974, p. 51, pl. 23, figs. 2a–g). *Rafinesquina*? *stropheodontoides* (Savage) (Amsden, 1974, p. 52–54, pl. 12, figs. 2a–o, 3a, 4a–d, pl. 13, fig. 1a). *Rafinesquina*? *latisculptilis* (Savage) (Amsden, 1974, p. 54, pl. 13, figs. 2a–d).

a few denticles, the chilidium is well developed, and ridges bound the ventral muscle area. The Marble City Member also contains two species of *Strophodonta (Brachyprion).* In these strophodontids the teeth and bounding ventral ridges are lost, but they have a well-formed chilidium and small denticulate plates very much like those found in *Amphistrophia (A.) sequoyensis.* Representatives of *Lissostrophia* and *Leptostrophia* are tentatively identified from Marble City strata, but their internal structure is poorly known.

Strophodonta (Brachyprion) newsomensis Foerste, a Waldron species tentatively assigned to *Brachyprion,* is similar to the Marble City representatives of *S. (B.)* sp. A in its well-formed chilidium and in having the hinge denticles confined to a small area on each side of the delthyrium.

In 1951 I assigned four Henryhouse species to *Strophonella: S. prolongata* Foerste, *S. alterniradiata* Amsden, *S. laxiplicata* Foerste, and *S. loeblichi* Amsden (Amsden, 1951). A restudy of these species shows that *S. prolongata* (this report, pl. 8, figs. 5a–d) and *S. alterniradiata* lack dental plates and thus belong in the subgenus *Strophonella (Strophonella)* as presently defined. The generic relationship of *S. loeblichi* presents more of a problem because the ventral muscle area appears to have bounding ridges, at least near the posterior end (pl. 8, fig. 7a). However, the ventral interior illustrated in my earlier paper (Amsden, 1951, pl. 20, fig. 38), refigured on plate 8, figure 7c, and plate 10, figure 1a, of this report, shows that this ridge extends forward, merging with a raised calosity toward the front of the muscle area, and thus does not differ in any essential way from the structure of *S. (S.) prolongata* and *S. (S.) alterniradiata.* It should be noted that the denticles in *S. (S.) loeblichi* are restricted to a small area on each side of the delthyrium, whereas in the other two species they occupy from one-third to one-half the length of the hinge (pl. 8, figs. 5c, 7c). The generic position of *S. (S.)? laxiplicata* is uncertain, as no satisfactory ventral interiors have been observed. All four species have well-developed pseudodeltidia and chilidia (pl. 8, figs. 5b, 5d, 6a, 7b).

The Henryhouse species *Strophodonta (Brachyprion) attenuata* Amsden is without dental plates or bounding ridges, and in this respect it is a characteristic representive of this subgenus. The denticulations, like those of the Early Devonian species *S. (B.) gibbera* and *S. (B.) arata,* extend throughout most of the hinge (pl. 10, figs. 4a, 4b, 6a). The Henryhouse species is unusual in that the delthyrium appears to have been closed by a flat plate that cannot be distinguished from the rest of the cardinal area. *S. (B.) attenuata* has a small shell, and any delthyrial structure would be minute and difficult to distinguish; nevertheless, an examination of several reasonably well-preserved articulated shells shows no recognizable pseudodeltidium or chilidium (pl. 8, figs. 8a–e, this report). Free ventral valves (no free dorsal valves were observed) have an open delthyrium, and presumably the delthyrial opening during life was closed by a small, delicate flat plate that was easily broken by disarticulation. This structure is unlike that present on the Quarry Mountain or Haragan-Bois d'Arc species and suggests that *attenuata* is not in the direct brachyprionid lineage.

Lissostrophia cooperi Amsden from the Henryhouse Formation has a completely denticulate hinge and a delthyrium closed by a flat plate that is indistinguishable from the cardinal area bordering the delthyrium (pl. 10, figs. 3a, 3b); the chilidium appears to be completely absent, and the cardinal process lobes approach the disjunct 2 stage (Williams, 1953, p. 12). Shells with the external form of *Lissostrophia* are present in the Quarry Mountain Formation, the St. Clair Limestone, and the Waldron Shale, and also in the Lower Devonian Haragan Formation and in the Birdsong Shale of western Tennessee. I have no information on the internal structure of these species, and the phylogeny of *Lissostrophia* is unknown to me.

Two brachyprionid species, *S. (B.) gibbera* and *S. (B.) arata* (pl. 10, figs. 4a, 4b, 6a), are present in the Lower Devonian Haragan-Bois d'Arc Formations. In these species the pseudodeltidium and chilidium are smaller in size than those of the Quarry Mountain and Waldron species (cf. pl. 7, fig. 1a, pl. 6, figs. 1a–n, and pl. 10, figs. 4a, 4b, 6a), and the hinge is nearly completely denticulate. In contrast, the denticulations on *Strophonella bransoni* extend for only one-third the hinge line (large shells), as in the Henryhouse species of *Strophonella*; the pseudodeltidium and chilidium of the Haragan species are considerably smaller, however, than those of the Henryhouse species (cf. pl. 10, figs. 2a–c, to pl. 8, figs. 5b–7b), and *S. bransoni* has a cardinal process and chilidium of the type Williams (1953, p. 12) termed disjunct.

Leptostrophia beckii tennesseensis Dunbar from the Haragan-Bois d'Arc Formations (and the Birdsong Shale of Tennessee) has denticulations extending for one-half to two-thirds the length of the hinge. The internal structure of the Quarry Mountain shells referred to *Leptostrophia* is too poorly understood to be compared with the Lower Devonian species. No well-preserved shells showing the hinge line of *Leptostrophia magnifica* (Hall) from the Lower Devonian (Deerparkian) Frisco Formation have been observed, but specimens from the Oriskany Sandstone have a completely denticulate hinge.

The preceding brief discussion of Silurian-Early Devonian stropheodontacid stocks from the central United States indicates certain phylogenetic changes. Among other things, these involve: (1) loss of teeth and development of denticulations, (2) spread of denticulations along the hinge line, and (3) reduction in the chilidium and associated changes in the cardinal process. Williams (1953, p. 9–10), who discussed these various elements, believed that the spread of denticulations along the hinge was governed by factors other than phylogenetic development, but in the brachyprionids herein studied a progressive increase appears to have taken place throughout Silurian and Early Devonian time. This change, coupled with the reduction in the chilidium, provides a useful guide for local and regional biostratigraphic investigations. On the other hand, the resupinate strophonellids do not appear to involve much change in the denticulation from the Late Silurian into the Early Devonian, although there is a reduction in the chilidium during this time. *Amphistrophia (Amphistrophia)* is a resupinate douvillinid whose phylogenetic history is not well understood. The morphology of the leptostrophids and lissostrophids here studied is not well enough known to assess phylogenetic trends.

Subfamily Pholidostrophiinae Stainbrook 1943

Genus **Lissostrophia** Amsden, 1949

Lissostrophia sp.

Pl. 7, figs. 4a–c

Description.—This species is known from only a few ventral valves, all of which are strongly convex. The cardinal extremities are broken, but they appear to have extended originally into fairly well marked "ears." Even lacking the cardinal extremities, most are transverse shells, although two valves have the length nearly equal to the width. The surface is smooth and is marked only by concentric growth lines. Nothing is known about the internal structure.

Measurements of six ventral valves are given:

Length (mm)	Width (mm)	Length/width ratio
4.6	9.5	0.48
5.1	7.2	0.71
4.1	5.4	0.76
5.6	5.7	0.98
4.6	6.6	0.70
5.2	5.7	0.91

Discussion.—It is not possible to make a precise species comparison on the basis of the small Quarry Mountain collections. *L. cooperi* Amsden (1951, p. 83–84, pl. 20, figs. 21–29) from the Henryhouse Formation (Ludlovian) has a more elongate shell, and *L. glabella* (Amsden, 1949, p. 52–53, pl. 5, figs. 1–5) from the Brownsport Formation (Ludlovian) of western Tennessee has a distinctly triangular outline. *L. lindenensis* (Dunbar, 1920, p. 126, pl. 2, figs. 15, 16) from the Birdsong Shale (Lower Devonian) of Tennessee has a transverse shell. There is also an unidentified species, *Lissostrophia*? sp., present in the St. Clair Limestone of Arkansas (Amsden, 1968, p. 53, pl. 13, figs. 4a, 4b). Of the aforementioned brachiopods, only the type, *L. cooperi*, is well understood, this species being represented by numerous well-preserved dorsal and ventral valves showing the external and internal features. The internal morphology of the others is unknown to me, and their provisional reference to *Lissostrophia* is based entirely on external features.

Williams described *Lissostrophia (Mesolithostrophia) minuta* from the Waldron Shale, Newsom, Tennessee (illustrated in Williams, 1953, pl. 8, figs. 8, 9). He assigned this to *Lissostrophia (Mesolithostrophia),* a subgenus based on *L. (M.) pellucida* Williams (1953, p. 38, pl. 8, figs. 8, 9) from the Silurian of Gotland.

Distribution.—Nine specimens from the Marble City and Barber Members; localities S4-A, S15-C, S16, S17, S18.

Subfamily LEPTOSTROPHIINAE Caster, 1939

Genus **Leptostrophia** Hall and Clarke 1892

Leptostrophia sp.

Pl. 7, figs. 3a–e

Description.—This species is represented in the Quarry Mountain collections by two moderate-sized ventral valves and a small, presumably immature, ventral valve. The ventral valve has a gentle arch extending from the umbo to the front, with a relatively flat slope from this arch to the lateral margins. The surface bears low, rounded costellae separated by narrow interspaces; 12 to 15 ribs occupy a space of 2 mm (pl. 7, figs. 3b, 3d).

The internal structure of the dorsal and ventral valves is unknown.

Discussion.—The internal structure of this species is unknown, and the species is referred to the genus *Leptostrophia* on the basis of its outline and relatively flat ventral valve. In Oklahoma the genus *Leptostrophia* is represented by two Lower Devonian species, *L. magnifica* (Hall; Amsden, 1963, p. 70–72, pl. 2, figs. 1–5) from the Frisco Formation (Siegenian) and *L. beckii tennesseensis* Dunbar (Amsden, 1958, p. 78–80, pl. 3, figs. 15–20, pl. 6, fig. 1, pl. 11, figs. 27, 28) from the Haragan-Bois d'Arc Formations (Gedinnian). These Lower Devonian species have larger, flatter shells than the Quarry Mountain species.

Distribution.—Three ventral valves from the Marble City Member; locality S5.

Family LEPTAENIDAE Hall and Clarke, 1894

Genus **Leptaena** Dalman, 1828

Leptaena sp.

Pl. 8, figs. 1a–c

Discussion.—This species is represented by only a few indifferently preserved specimens, which cannot be specifically identified and which have little biostratigraphic value. One ventral valve is interesting because the trail is considerably longer than the visceral disc, but whether this is typical of the Quarry Mountain leptaenids cannot be determined from the collections now available.

Distribution.—About 15 specimens from the Marble City and Barber Members; localities S2, S18, S15-C.

Order STROPHOMENIDA Öpik, 1934

Superfamily PLECTAMBONITACEA Jones, 1928

Family LEPTESTINIDAE Ulrich and Cooper 1936

Subfamily LEPTESTIINAE Havlíček, 1961

Genus **Leangella** Öpik, 1933

Subgenus **Leangella (Opikella)** Amsden 1968

Leangella (Opikella) dissiticostella? Amsden, 1968

Pl. 8, fig. 3a

Leangella (Opikella) dissiticostella AMSDEN, 1968, p. 48–50, pl. 5, figs. 1a–q, pl. 16, figs. 1a–e, pl. 19, figs. 2a, 2b, text-figs. 33, 34, table 11.

Description.—This species is represented in the Quarry Mountain collections only by the small shell illustrated on plate 8. Its outline, profile, and ornamentation are similar to specimens of *L. (O.) dissiticostella* from the St. Clair Limestone and the Clarita Formation, and it is provisionally assigned to that species. No interiors have been observed.

Discussion.—This species is well represented in the St. Clair Limestone of Arkansas and is moderately common in the Clarita Formation of south-central Oklahoma.

Distribution.—One ventral valve from the Barber Member; locality S18.

Order Rhynchonellida Kuhn, 1949
Superfamily Rhynchonellacea Gray, 1848
Family Trigonirhynchiidae McLaren, 1965
Genus **Ancillotoechia** Havlíček, 1959
Ancillotoechia conspicuua Amsden, n. sp.
Pl. 9, figs. 1a-l; text-fig. 14

Holotype.—Quarry Mountain Formation, Marble City Member (upper 20 feet), locality S9; pl. 9, figs. 1a-d; OU8571.

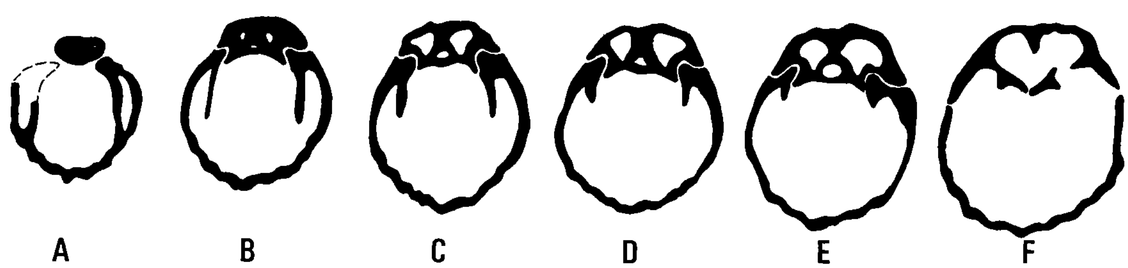
Description.—This species has a subtriangular shell with a length/width ratio ranging from 0.80 to 0.93. Its profile is variable, but most specimens are unequally biconvex, with the dorsal valve considerably deeper than the ventral; the length/thickness ratio ranges from 1.09 to 1.98 (pl. 9, figs. 1a, 1e, 1i). The ventral beak is erect, although the exact nature of the delthyrium is not clear; a few well-preserved specimens suggest, however, that it was partially closed by deltidial plates. A ventral sulcus and dorsal fold begin near the beaks, becoming deep and well defined toward the front. The surface bears strong, subangular costae, 3 or 4 occupying a space of 3 mm (counted 5 mm in front of the beaks).

The ventral shell wall is thin throughout, including the posterior portion, and the dental plates are well developed (text-fig. 14). In the dorsal valve there is a stout median septum supporting the septalium (cruralium), which is roofed over throughout its length (text-fig. 14); the septum extends forward only a few millimeters.

Most shells in the collections are less than 10 mm long, but one dorsal valve is slightly over 13 mm long. Measurements of 8 nearly complete specimens are given:

Length (mm)	Width (mm)	Thickness (mm)	Costellae per 3 mm at 5 mm	Length/width ratio	Length/thickness ratio
5.7	5.9	3.7	4	0.97	1.54
6.6	7.2	5.5	4	0.93	1.20
7.1	8.7	6.5	4	0.82	1.09
7.6	8.3	4.8	3	0.92	1.58
7.9	9.9	4.0	4	0.80	1.98
7.9	8.7	4.6	3	0.90	1.72
9.2	9.9	6.2	3	0.93	1.48
13.2	14.6 (dorsal)	—	4	0.90	—

Discussion.—Havlíček (1959; 1961a, p. 58) proposed the genus *Ancillotoechia,* basing his discription on *Rhynchonella ancillans* Barrande (Havlíček, 1961a, p. 59-60, pl. 6, figs. 8-11, text-fig. 15) from the Kopanina beds (Ludlovian) of Bohemia. This author included two other Bohemian species, *A. minerva* (Barrande; Havlíček, 1961a, p. 60-62, pl. 8, figs. 4-8, text-figs. 16-18) from the Liten (?Llandoverian-Wenlockian) and *A. radvani* Havlíček (1961a, p. 62-63, pl. 6, figs. 3, 4, text-figs. 19-22) from the Kopanina beds (Ludlovian). In 1968, I assigned *Camarotoechia marginata* Thomas (Amsden, 1968, p. 55-56, pl. 5, figs. 4a-l, text-figs. 37-40) from the St. Clair Limestone of Arkansas to *Ancillotoechia,* and according to Bassett and Cocks (1974, p. 27),



Text-figure 14. Transverse serial sections of *Ancillotoechia conspicuua* Amsden, n. sp. ($\times 3\frac{1}{2}$) from Marble City Member of Quarry Mountain Formation, locality S17. Distance (mm) from posterior to tip of ventral beak: *A,* 0.3; *B,* 0.4; *C,* 0.7; *D,* 0.9; *E,* 1.1; *F,* 1.3. Parlodion peels, OU.

Terebratula bidentata Hisinger from the Mulde Marlstone (Wenlockian) of Gotland may be a representative. Bowen (1967, p. 55–56, pl. 7, figs. 25, 26) assigned *Rhynchonella litchfieldensis* Schuchert from the Keyser Limestone (Pridolian?) of Maryland to *Ancillotoechia,* although he stated that the distinction between Sartenaer's genus *Cupularostrum* and *Ancillotoechia* is not clear. According to Schmidt and McLaren (1965, p. H561), *Ancillotoechia* differs from *Cupularostrum* internally in having the septalium entirely roofed over and externally by its narrower shell with smaller apical angle. In 1970 Sartenaer (p. 27–29) proposed to make *Rhynchonella litchfieldensis* Schuchert the type of a new genus, *Microsphaeridiorhynchus.* According to Sartenaer, the new genus is distinguished from *Cupularostrum* by its smaller size, and more elongate shape, with smaller apical angle; *Ancillotoechia* differs from *Microsphaeridiorhynchus* in its more delineated ventral beak, in having the posterior part of the ventral valve less incurved, and in having a fold and sulcus that are narrower at their inception, widening abruptly toward the front and with the sulcus bordered by more projecting costae. In its completely roofed-over cruralium, shell outline, and costation, *A. conspicuua* appears to be allied with *Ancillotoechia ancillans.* At the present time, the genus *Ancillotoechia* appears to be well represented in Upper Silurian strata (Wenlockian-Ludlovian, possibly extending down into the Llandoverian and up into the Pridolian), although it should be emphasized that the morphology of many previously described Silurian and Early Devonian rhynchonellids is poorly understood.

A. conspicuua differs from the previously mentioned Bohemian species in having stronger, more angular ribs and a better developed fold and sulcus. The Gotland species *A. bidentata* has a smaller shell with low, rounded costellae that are unlike the costellae of *A. conspicuua.* The Quarry Mountain species is similar to the St. Clair species *A. marginata,* from which it differs in its stronger, more angular costellae and better developed fold and sulcus.

A. conspicuua is similar to the Waldron Shale shells commonly referred to *Atrypa neglecta* Hall (1852, p. 70, pl. 23, figs. 4a–d). This species was based on specimens from the Clinton Group, Niagara County, New York, but it has been widely reported from other Silurian strata, including the Waldron Shale (Beecher and Clarke, 1889, p. 37–38, pl. 4, figs. 3, 6–8). Two Waldron Shale specimens presumed to be typical representatives of *neglecta* have been serially sectioned, and these have the typical internal structure of *Ancillotoechia,* including dental plates and a roofed-over septalium (the covering plate is arched rather than flat). The Waldron Shale specimens are like those from the Quarry Mountain Formation, although the Waldon shells are considerably smaller and appear to have more sharply angular ribs. I have not examined shells from the Clinton of New York, and their conspecific relationship to Waldron specimens requires verification. As noted above, the internal structure of many Silurian rhynchonellid species is unknown, and until these have been studied no meaningful comparisons can be attempted.

A. conspicuua has some resemblance to the Henryhouse species *"Camarotoechia" altisulcata* Amsden (1951, p. 86, pl. 18, figs. 6–13), but the latter has a more transverse shell with sharper costae and a more extravagantly developed fold and sulcus. *"C." altisulcata*, as well as all the Henryhouse species (Amsden, 1951, p. 85–87) for which the internal structure is known, has an open septalium (cruralium). The Brownsport species *"Camaraotoechia" perryvillensis* Amsden, *"C." shannonensis* Amsden, *"C." eccentrica* Amsden, *"C." acutiplicata* Amsden (=*"C." carmelensis* Amsden), and *"C." cedarensis* (=*"C." hollandi*) described by me (Amsden, 1949, p. 56–57, pl. 6, figs. 1–25, pl. 7, figs. 1–10), also have an open septalium.

In the central United States *Ancillotoechia* is known at present only from the Quarry Mountain Formation of eastern Oklahoma, the Waldron Shale of Indiana and Tennessee, and the St. Clair Limestone of Arkansas; it seems reasonable, however, to suppose that some of the described Silurian rhynchonellids now referred to other genera on further study will be found to belong to this genus.

Distribution.—About 60 specimens, many incomplete, from the Marble City and Barber Members at the following localities: S4-A, S5, S9, S12, S15-A, S15-C, S17, S18, S19, S20, S21.

Family OLIGORHYNCHIIDAE Cooper, 1956
Genus **Rhynchotreta** Hall, 1879
Rhynchotreta, cf. **R. cuneata** (Dalman)
Pl. 9, figs. 2a–d

Description.—Elongate, sharply triangular shells with an erect ventral beak. Both valves are shallow with abruptly deflected lateral margins that are nearly flat. Near the posterior end the ventral valve bears a low fold, but in a short distance this fold is reversed and develops into a very shallow sulcus. The dorsal umbo has a shallow sulcus; this sulcus is also reversed and forms a low fold near the front. Both valves bear strong, rounded plications and interspaces that are crossed by closely spaced, concentric fila (pl. 9, figs. 2a, 2b). The most complete specimen in the collection (pl. 9, fig. 2d) is 8.1 mm long and 7.5 mm wide; the incomplete shell illustrated on plate 9, figures 2a, 2b, has an estimated length of 9.5 mm and an estimated width of 8.5 mm.

The ventral and dorsal interiors are unknown.

Discussion.—Externally, this species is similar to *Rhynchotreta cuneata* (Dalman) from the Klinteberg Beds on Gotland, and it has a similar B angle of about 75° (Chiang, 1972, p. 22, text-fig. 22). According to Bassett and Cocks (1974, p. 25–26) the Gotland species as presently defined ranges from the Upper Visby Marlstone into the Eke Beds (late Llandoverian, Wenlockian, and early Ludlovian), although these authors think it is possible that more than one species is represented in this suite. *Rhynchotreta* sp. is also similar to *Rhynchotreta americana* (Hall) from the Waldron Shale (Wenlockian) of Indiana and Tennessee. The fold and sulcus are not as well developed as on the Waldron species, and in this respect the Quarry Mountain specimens are more like the Gotland shell illustrated by Bassett and Cocks (1974, pl. 8, figs. 1a–d). Unfortunately, the internal structure of the Oklahoma shells is unknown, precluding any comparison in this respect.

A number of Silurian species have been referred to this genus, although at least some of these assignments are known to be incorrect. Savage (1913, p. 125–127, pl. 6, figs. 19–22, pl. 7, figs. 9, 10) assigned three species from the Silurian of Illinois to *Rhynchotreta* (*Rhynchotreta parva* Savage, *Rhynchotreta thebesensis* Foerste, and *Rhynchotreta thebesensis multistriata* Savage), but I (Amsden, 1974, p. 69–70) assign these to a new genus, *Thebesia*. The range of the genus *Rhynchotreta* is uncertain at present, although it is well represented in Wenlockian-age strata, almost certainly ranging into strata at least as old as late Llandoverian and as young as early Ludlovian.

Distribution.—This is a rare species in the Quarry Mountain Formation, represented by only six specimens, most of which are poorly preserved. It is present in both the Marble City and Barber Members at localities Ad1, S15-A, S16, and S18 (85 feet below the top of the Quarry Mountain).

Order RHYNCHONELLIDA Kuhn, 1949
Superfamily RHYNCHONELLACEA Gray, 1948
Family RHYNCHOTREMATIDAE Schuchert, 1913
Subfamily LEPIDOCYCLINAE Amsden, new subfamily

Type genus.—*Lepidocyclus* Wang, 1949.

Diagnosis.—Rhynchotrematids with a thick posterior ventral shell wall and impressed muscle scars; dental plates obscure and teeth supported largely by the thickened shell wall. Includes the following genera: *Lepidocyclus* Wang, 1949; *Hypsiptycha* Wang, 1949; *Latonotoechia* Havlíček, 1960; *Australirhynchia* Savage, 1968; *Stegerhynchops* Amsden, n. gen.; ?*Pleurocornu* Havlíček, 1961; ?*Sicorhyncha* Havlíček, 1961. Range, Middle Ordovician to Lower Devonian.

Discussion.—In the *Treatise on Invertebrate Paleontology* (Schmidt and McLaren, 1965, p. H554–559), the family Rhynchotrematidae is divided into two subfamilies, the Rhynchotrematinae Schuchert, 1913, and the Orthorhynchulinae Cooper, 1956. According to Schmidt and McLaren, the Rhynchotrematinae is diagnosed to include rhynchotrematids with umbonal cavities, dental plates, and a notothyrial cavity formed by welding the hinge plate with a median septum or callosity. As thus diagnosed, this subfamily includes shells having two distinctly different types of ventral interiors. The first type includes genera like *Rhynchotrema,* in which the ventral shell wall is thin, the muscle scars shallow, and the teeth supported on dental plates. The second type, which is typified by *Lepidocyclus*, has a thick posterior ventral shell wall, impressed muscle scars, and teeth largely supported by the thickened wall, the dental plates being rudimentary or absent. On the basis of these differences, I propose the following taxonomic revisions in the family Rhynchotrematidae:

Family Rhynchotrematidae Schuchert, 1913: Sulcus and fold well developed; costae strong, angular to subangular, beginning at apex. Hinge plate concave, bearing a septiform cardinal process. Range, Middle Ordovician to Lower Devonian.

Subfamily Rhynchotrematinae Schuchert, 1913, emend. Amsden: Rhynchotrematids with a thin posterior ventral shell wall, shallow muscle scars, and dental plates. The subfamily includes *Rhynchotrema* Hall, 1860 (Cooper, 1956, p. 629, pl. 138, figs. A 1–7; describes and illustrates the lectotype, *Atrypa increbescens* Hall, 1847). In 1974 I borrowed the type specimens of this species, including the lectotype selected by Wang (1949, p. 11), from the American Museum of Natural History. This lot is made up of three specimens, two of which have lost most of the outer shell, showing clearly that this species has a very thin shell wall with well-developed dental plates. One specimen that is only partly exfoliated shows no trace of lamellae. This subfamily also includes the following genera: *Stegerhynchus* Foerste, 1909; *Stegerhynchonella* Rzonsnitskaya, 1959; *Ferganella* Nikiforova, 1937; *Thliborhynchia* Lenz, 1967; and *Franklinella* Lenz, 1973. Range, Middle Ordovician to Lower Devonian.

Subfamily Lepidocyclinae Amsden, new subfamily: Rhynchotrematids with a thick posterior ventral shell wall and impressed muscle scars; dental plates obscure and teeth supported largely by the thickened shell wall. Includes the following genera: *Lepidocyclus* Wang, 1949; *Hypsiptycha* Wang, 1949; *Latonotoechia* Havlíček; *Australirhynchia* Savage, 1968; *Stegerhynchops* Amsden, n. gen.; ?*Pleurocornu* Havlíček, 1961; and ?*Sicorhyncha* Havlíček, 1961. Range, Middle Ordovician to Lower Devonian.

Schmidt and McLaren (1965, p. H556–H558) changed the rank of the family Orthorhynchulidae Cooper (1956, p. 669) to subfamily and included it in the Rhynchotrematidae, but I believe that Cooper was justified in recognizing it as a separate family, based on its distinctive interarea. Schmidt and McLaren included *Callipleura* Cooper, 1942, *Machaeraria* Cooper, 1955, and *Zlichorhynchus* Havlíček, 1963, in the subfamily Orthorhynchulinae, but none of these possesses a well-defined interarea, and they should be removed from this family. Their taxonomic status requires further study.

Genus **Stegerhynchops** Amsden, n. gen.

Type species.—Stegerhynchops marblensis Amsden, n. sp.

Diagnosis.—Strongly costate, nonlamellose rhynchotrematids with the ventral muscle scars deeply impressed into the thickened shell wall; dental plates absent. Dorsal hinge plate thick, flattened, and bearing a blade-like cardinal process; supporting septum thick, short.

Discussion.—The dorsal interior of this genus is characterized by a thick hinge plate with a high, septiform cardinal process, supported by an abbreviated median septum. The ventral valve has a thick posterior shell wall into which the muscle attachment was deeply impressed; the teeth are stout and are supported by the thickened shell wall with no clearly defined dental plates. Recently Howe (1965, p. 1128), in a review of *Rhynchotremata, Hypsiptycha*, and *Lepidocyclus*, questioned the value of dental plates in generic diagnoses, noting that species assigned to these genera show much variation in the development of these plates. I agree that dental plates *per se* are not a diagnostic character. However, there does appear to be a significant morphologic difference between (1) those rhynchotrematids in which the posterior part of the ventral shell wall is thin, the muscle scars not deeply impressed, and the teeth supported on more or less well formed dental plates, and (2) rhynchotrematids with a thick ventral shell wall, deeply impressed muscle scars, and teeth resting primarily on the thick shell wall with little or no development of dental plates. As noted above, this is the basis for establishing the Lepidocyclinae, a subfamily with which *Stegerhynchops* is clearly allied.

The ventral muscle scars of *Stegerhynchops marblensis* are similar to those of *Lepidocyclus* Wang (1949, p. 13–17, pls. 4, 5, 6; see also Alberstadt, 1973, pls. 6, 7) and *Hypsiptycha* Wang (1949, p. 10); the dorsal interiors are also similar except for the abbreviated median septum in the Quarry Mountain species. Externally, *S. marblensis* lacks the concentric lamellae that are so well developed on *Lepidocyclus* and *Hypsiptycha. Latonotoechia* Havlíček (1961a, p. 24–28, fig. 1) has the dorsal umbonal cavity largely filled with shell material, and this is probably true also of *Sicorhynchus* Havlíček (1961a, p. 28–29). *Australirhynchia* Savage (1968, p. 731–735, pl. 141) has stout costae resembling *Stegerhynchops,* but it lacks a dorsal septum.

Stegerhynchops is distinguished from rhynchotrematids such as *Rhynchotrema* and *Stegerhynchus* by its impressed muscle area and by its lack of dental plates.

The genus *Stegerhynchus* Foerste (1909, p. 98) has been the subject of some discussion in regard both to its type species and its internal characters. I will not review its nomenclatorial history, as this is discussed in earlier papers (Amsden, 1968, p. 62; Amsden, 1974, p. 67), except to note that the type species is *Rhynchonella (Stegerhynchus) whitii-praecursor* Foerste, 1909 (p. 98–99, pl. 3, figs. 47A–C), from the Clinton beds near Clifton, Tennessee. Foerste described two species from the Clinton beds at this locality, *Rhynchonella (Stegerhynchus) whitii-praecursor* and *Rhynchonella (Stegerhynchus) neglecta-cliftonensis* (Foerste, 1909, p. 99–100, pl. 3, figs. 48A–C). According to Foerste, the internal characters of these two species are similar, the distinction between them being based solely on the costellation, with *S. neglecta-cliftonensis* having 4 plications in the fold and 3 in the sulcus, and *S. whitii-praecursor* having 2 in the fold and 1 in the sulcus. Recently I borrowed a topotype collection of some 30 specimens from the U.S. National Museum; these are preserved as internal and external molds and show the internal characters clearly. These specimens are labeled *Stegerhynchus praecursor*, but most shells have three costae in the sulcus (pl. 11, fig. 7a) and thus appear to be conspecific with *S. neglecta-cliftonensis,* at least as that species was diagnosed by the author. Specimens in this collection exhibit some variation, with at least one shell having only two costae in the sulcus (pl. 11, fig. 9b), suggesting a morphologic gradation between *whitii-praecursor* and *neglecta-cliftonensis;* this can be verified, however, only by a study of larger collections, including Foerste's types. Unfortunately, the type specimens of *whitii-praecursor* have been mislaid, and it is not possible at this time to compare the two species. The Clinton specimens examined by me do show the internal structure in some detail; the teeth are supported on well-developed dental plates (pl. 11, figs. 3d, 4a, 5a), and the cruralium, which is supported on a low, rounded median septum, bears a linear cardinal process (pl. 11, figs. 1a, 2a, 3d, 8a). Externally the costae are crossed by well-developed fila (pl. 11, figs. 7a, 9a, 9b). Assuming that the specimens studied are congeneric with *S. whitii-praecursor*, as seems likely, then *Stegerhynchus* is certainly a representative of the subfamily Rhynchotrematinae as herein diagnosed. The distinction between *Stegerhynchus* Foerste, 1909, *Ferganella* Nikiforova, 1937, and *Stegerhynchella* Rzhonsnitskaya, 1959, requires further study. The type specimens of *Rhynchotrema increbescens* (Hall) examined by me do not have fila.

The only species presently referred to *Stegerhynchops* is the type, although it should be noted that there are many Silurian rhynchonellid species whose internal characters are unknown.

Stegerhynchops marblensis Amsden n. sp.

Pl. 9, figs. 4a–h; text-fig. 15

Holotype.—Pl. 9, figs. 4c–h, Quarry Mountain Formation, Marble City Member, north of St. Clair Lime Quarry, NE$\frac{1}{4}$SE$\frac{1}{4}$NE$\frac{1}{4}$ sec. 14, T. 13 N., R. 23 E., Sequoyah County, Oklahoma; OU 8578.

Description.—Slightly elongate shells with a length/width ratio of approximately 0.9. The lateral profile is stoutly biconvex with a length/thickness ratio of about 1.1; the dorsal valve is considerably deeper than the ventral, and the ventral beak is hooked over the dorsal umbo. A ventral fold and dorsal sulcus begin near the beaks, becoming deep and well defined toward the front. The surface bears stout, rounded costae and interspaces; no lamellae or fila are present.

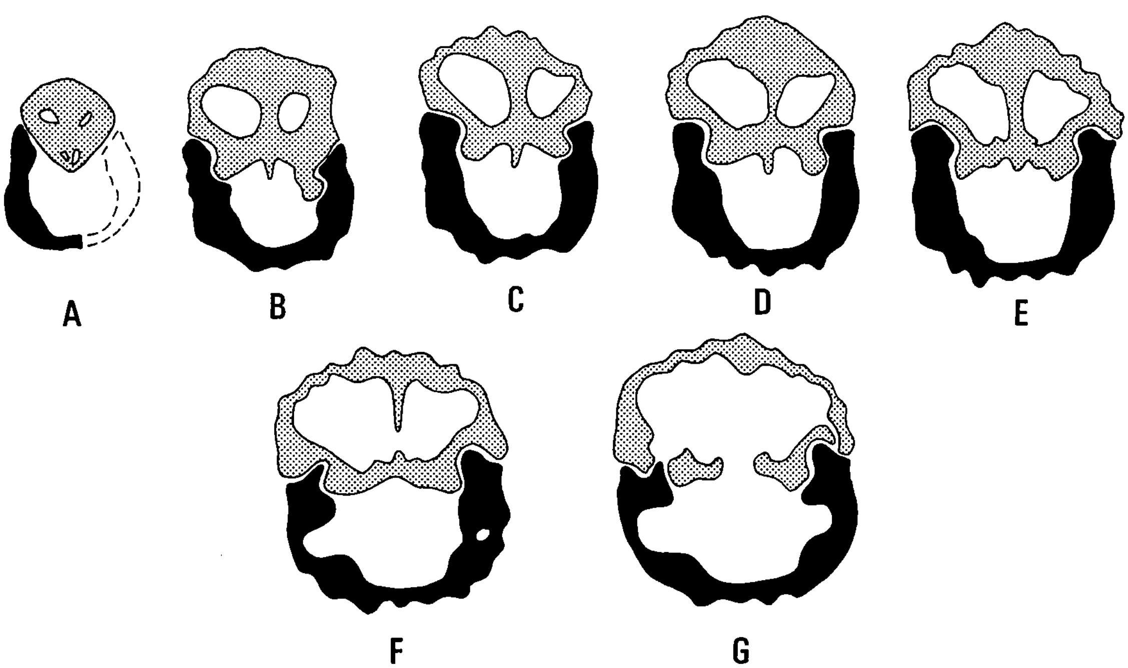
The wall of the ventral valve is thick at the posterior end of the shell, and the muscle scars are impressed into this thickened portion; the strong teeth are supported by the thickened walls, and there are no clearly-defined dental plates (text-fig. 15). The dorsal hinge plate, which is thick and nearly flat, bears a large, plate-like cardinal process; the hinge plate is supported by a thick median septum that extends forward less than 1 mm (text-fig. 15).

Measurements of the two illustrated specimens are given:

Length (mm)	Width (mm)	Thickness (mm)	Length/ width ratio	Length/ thickness ratio
11.1	12.5	9.9	0.89	1.12
9.6	10.1	8.8	0.95	1.09

Discussion.—Externally *S. marblensis* differs from *Ancillotoechia conspicuua* in having deeper biconvexity, a more incurved pedicle beak, and stouter, more rounded costae. The Marble City species cannot be compared effectively with many of the described Silurian rhynchonellid species, because their internal structure is unknown.

Distribution.—About a half dozen specimens from the Marble City Member, north

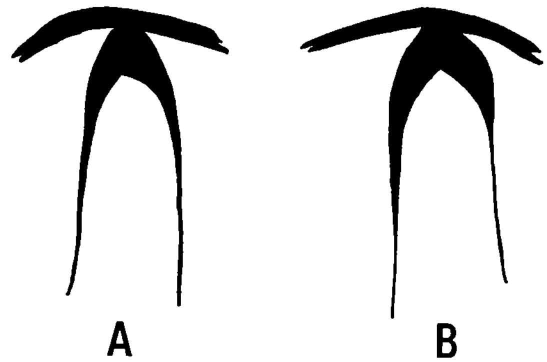


Text-figure 15. Transverse serial sections (×6) of *Stegerhynchops marblensis* Amsden, n. gen. and n. sp., from Quarry Mountain Formation, locality S9. Dorsal valve stippled, ventral valve solid. Distance (mm) from posterior tip of ventral valve: *A*, 0.2; *B*, 0.5; *C*, 0.6; *D*, 0.7; *E*, 0.9; *F*, 1.1; *G*, 1.2. Parlodion peels, OU.

of the St. Clair Lime Quarry, NE$\frac{1}{4}$SE$\frac{1}{4}$NE$\frac{1}{4}$ sec. 14, T. 13 N., R. 23 E., Sequoyah County, Oklahoma (north of S18).

Suborder PENTAMERIDINA Schuchert and Cooper, 1931
Superfamily PENTAMERACEA M'Coy, 1844
Family GYPIDULIDAE Schuchert and LeVene 1929
Subfamily GYPIDULINAE Schuchert and LeVene, 1929
Genus **Amsdenina** Boucot, 1975
Amsdenina sp.

Pl. 4, figs. 1a-g; text-fig. 16



Text-figure 16. Transverse serial sections showing brachial cruralium of *Amsdenina* sp. (×7). Marble City Member of Quarry Mountain Formation, locality S21. Distance (mm) from posterior tip of dorsal valve: *A*, 2.7; *B*, 2.8. Parlodion peels, OU.

Description.—*Amsdenina* is well represented in the Marble City collections under study, but most specimens are fragmentary free ventral valves, commonly at least partly exfoliated. Only one articulated shell has been found, and it is incomplete. On the basis of this material it is not possible to make a reasonable species comparison, especially since representatives of this genus exhibit considerable intraspecific variation (Amsden, 1951, p. 79).

Most of the Quarry Mountain specimens appear to be smooth, although a few ventral valves developed rounded plications and interspaces near the anterior margins (pl. 4, figs. 1c, 1g). The brachial plates unite just before reaching the valve floor to produce a well-developed cruralium (text-fig. 16); this structure is long, extending forward about 5 mm in a valve that is approximately 12 mm long. The articulated shell illustrated on plate 4 has only a slight suggestion of a ventral fold and dorsal sulcus; it has an estimated length of 17 mm, an estimated width of 13 mm, and a thickness of 12.5 mm. The largest ventral valve in the collections is 19 mm long and 21.5 mm wide.

Discussion.—Boucot (1975, p. 357-358) proposed the new genus *Amsdenina,* based on *Sieberella roemeri* Hall and Clarke, 1892, from the Brownsport Formation of western Tennessee and the Henryhouse Formation of Oklahoma (Amsden, 1949, p. 49-50, pl. 2, figs. 1-4; 1951, p. 79, pl. 16, figs. 35-40). This genus is distinguished from *Sieberella* by its rounded costae and interspaces and apparently includes the Silurian species formerly referred to *Sieberella. Gypidula multicostata* Dunbar (1920, p. 131-132, pl. 3, figs. 12, 13) from the Birdsong Shale (Gedinnian) of western Tennessee and *G. multicostata*? Dunbar (Amsden, 1958, p. 69, pl. 2, fig. 17) from the Haragan Formation (Gedinnian) of Oklahoma have numerous, narrow, angular costae and interspaces. Present information indicates that *Amsdenina* is present in beds of Wenlockian, Ludlovian, and Pridolian age.

Distribution.—About 50 specimens, mostly free ventral valves, from the Marble City Member (a few specimens from a bed 55 feet below the top of the Quarry Mountain Formation; loc. S20). From the following localities: Ad1, S1A, S12, S15A, S17, S18, S20, S21.

Genus **Boucotides** Amsden, 1968
Boucotides barrandei Amsden, 1968

Pl. 4, figs. 2a-k; text-fig. 17

Boucotides barrandei AMSDEN, 1968, p. 44-45, pl. 4, figs. 2a-g, text-figs. 28, 29.

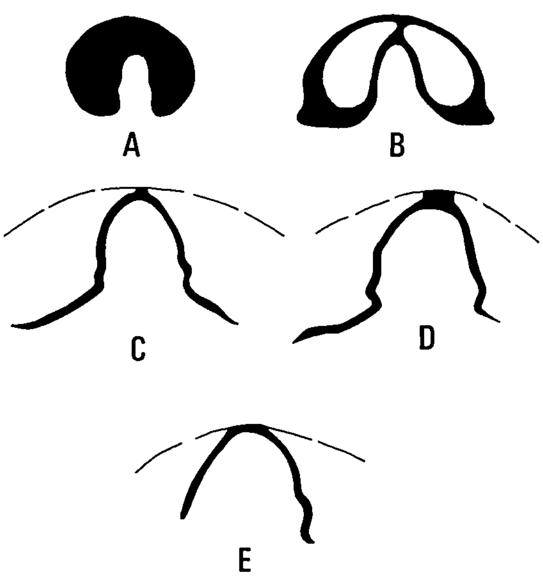
Discussion.—The Quarry Mountain collections include several free valves and two articulated shells that appear identical to the St. Clair representatives. The ventral valve has a narrow, V-shaped sulcus that becomes fairly deep at the front, and the dorsal valve has a corresponding sharp fold. The dimensions of the Oklahoma specimens are similar to those from Arkansas; the two articulated shells measure:

Length (mm)	Width (mm)	Thickness (mm)	Length/width ratio
10.6	12.3	7.8	0.86
13.9	18.2 est.	10.9	0.76

The brachial plates unite to make a cruralium that is supported on a low septum for part of its length. The outer plates are long, extending forward 5 mm on a valve that is 13 mm long. The inner plates abut smoothly against the brachial processes with no trace of carinae.

Recently Johnson and Ludvigsen (1972, p. 125–126) proposed to revise the definition of the Gypidulinae and Clorindinae, distinguishing between the two subfamilies on the basis of length of outer plates rather than the presence or absence of carinae as previously defined (Amsden, 1965, p. H548, H551; 1974, p. 64). The merits of these two definitions will not be discussed here, as the two Quarry Mountain gypidulinids, *Boucotides* and *Sieberella*, have a long, non-carinate brachial apparatus and would thus qualify for the subfamily Gypidulinae according to either classification.

Distribution.—About 30 specimens, including two articulated shells, from the upper 10 feet of the Marble City Member at the following localities: S2, S5, S15C, S16, S21. Common in the St. Clair Limestone of Arkansas.



Text-figure 17. Transverse serial sections (×5) of dorsal valve of *Boucotides barrandei* Amsden. Marble City Member of Quarry Mountain Formation, locality S16. Distance (mm) from posterior tip of brachial valve: *A*, 0.4; *B*, 0.8; *C*, 1.4; *D*, 1.9; *E*, 2.3. Parlodion peels, OU.

Suborder Spiriferidina Waagen, 1883
Superfamily Cyrtiacea Frederiks 1919 (1924)
Family Cyrtiidae Frederiks, 1919 (1924)
Subfamily Eospiriferinae Schuchert and LeVene, 1929
Genus **Eospirifer** Schuchert, 1913

Subgenus **Eospirifer (Acutilineolus)** Amsden, n. subgen.

Type species.—*Eospirifer acutolineatus acutolineatus* Amsden, 1968 (p. 64–69, pl. 1, figs. 1a–w, text-figs. 49–53); St. Clair Formation (Wenlockian), Batesville district, Arkansas.

Diagnosis.—Eospiriferids with very narrow capillae and interspaces and no concentric lirae.

Discussion.—This subgenus is similar to *Eospirifer (Eospirifer)* in its external form, including a moderate fold and sulcus. In both subgenera the shell is essentially smooth, although a few specimens show weak plications (Amsden, 1968, pl. 1, figs. 1p, 2c, 2f, 2r; this report, pl. 3, figs. 1p–r). The new subgenus is distinguished from *Eospirifer (Eospirifer)* by its delicate capillae, the latter subgenus having relatively stout capillae separated by U-shaped interspaces crossed by concentric fila (pl. 3, figs. 1d, 2e), whereas the interspaces in *Eospirifer (Acutilineolus)* are reduced to fine grooves that lack any concentric ornamentation (pl. 2, fig. 4f; Amsden, 1968, pl. 1, figs. 1u, 2s, 2t). *Havlicekia* appears to have fine ornamentation, judging by Boucot's illustrations (1963, pl. 103, figs. 12–17), but this genus is plicate in the early stages, becoming smooth at maturity and developing a high tongue at the anterior margin of the ventral valve.

Three species are presently referred to this subgenus: *Eospirifer (Acutilineolus) acutolineatus* Amsden and *Eospirifer (Acutilineolus) pentagonus* Amsden (1968, p. 69–70, pl. 1, figs. 2a–v, pl. 14, figs. 1a–o, text-figs. 49–53), from the St. Clair Limestone of Arkansas and the Clarita Formation of Oklahoma (Wenlockian), and *Eospirifer (Acutilineolus) inferatus* Amsden, n. sp., from the Quarry Mountain Formation (Wenlockian).

Eospirifer (Acutilineolus) inferatus

Amsden, n. sp.

Pl. 2, figs. 4a–m

Holotype.—Marble City Member, Quarry Mountain Formation, locality S15A; pl. 2, figs. 4a–f; OU 8485.

Description.—This species has a slightly transverse shell, the length/width ratio of three complete specimens ranging from 0.79 to 0.93. The hinge line is shorter than the greatest shell width (pl. 2, figs. 4c, 4g), and from the cardinal extremities forward the outline is uniformly rounded (pl. 2, figs. 4d, 4h, 4i, 4l, 4m). The lateral profile of the shell is subequally biconvex, with the ventral valve slightly deeper than the dorsal (pl. 2, figs. 4a, 4j). The ventral interarea (Amsden, 1974, p. 63) is apsacline, and the delthyrium is bordered by deltidial plates similar to those on *Eospirifer (Eospirifer) radiatus* (pl. 3, figs. 1j, 2f; text-fig. 18). A ventral sulcus is present near the posterior end (pl. 2, figs. 4c, 4g), becoming broad and shallow toward the front; on some specimens it is obscure (pl. 2, figs. 4b, 4c). The dorsal fold is reasonably well defined throughout its length, although at the front end it is only slightly elevated above the general level of the valve (pl. 2, figs. 4b, 4c, 4e, 4i, 4k, 4l). The surface bears fine capillae, 24 to 30 occupying a space of 2 mm, counted about 5 mm in front of the beaks (pl. 2, fig. 4f). The capillae are packed close together and are separated by extremely narrow interspaces. These have been observed only on the posterior portion of the valves, and probably they become obsolete toward the front although their apparent absence may be in part or completely the result of exfoliation.

The ventral teeth are supported on long, high dental plates that extend upward to make the deltidial plates bordering the delthyrium. The crural plates in the dorsal valve are long; jugum not observed.

The measurements of three complete shells are given:

Length (mm)	Width (mm)	Thickness (mm)	Length/ width ratio	Length/ thickness ratio
13.7	14.7	9.0	0.93	1.52
15.5	19.5	9.7	0.79	1.60
16.0	18.9	10.3	0.85	1.55

Discussion.—This species most closely resembles *E. (A.) pentagonus* (Amsden, 1968, p. 69–70, pl. 1, figs. 2a–v, pl. 14, figs. 1a–o; text-figs. 49–53) from the St. Clair Limestone of Arkansas and the Clarita Formation of south-central Oklahoma. *E. (A.) pentagonus* is distinguished from the Quarry Mountain species by its pentagonal outline, more strongly apsacline ventral interarea, and better developed fold and sulcus.

Distribution.—This is an uncommon species that has been found only in the Marble City Member. Eight specimens from localities S15A, S16, S21.

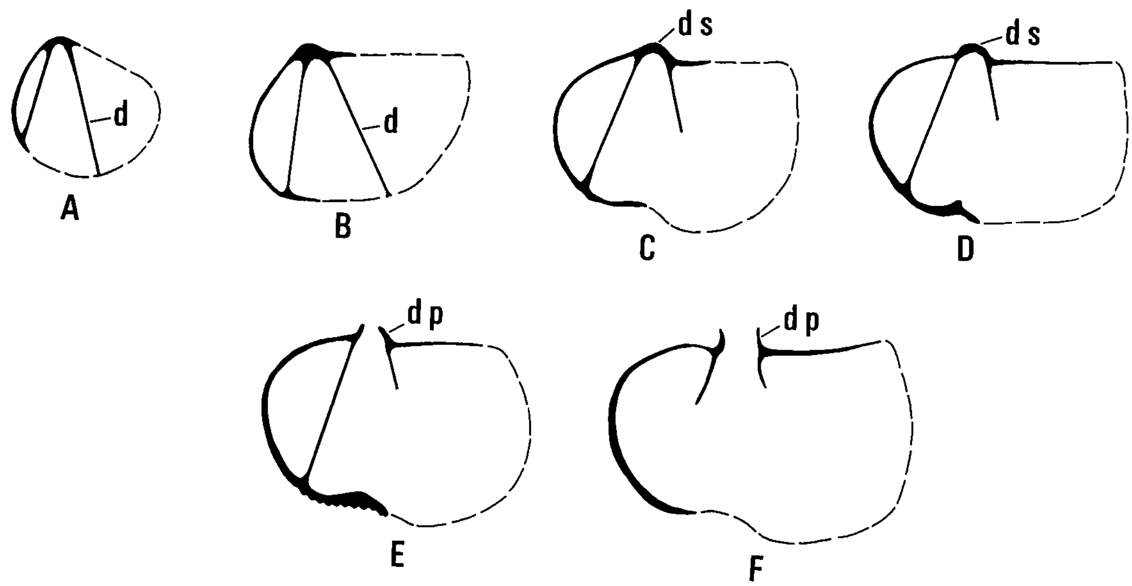
Eospirifer (Eospirifer) radiatus?

(J. de C. Sowerby, 1835)

Pl. 3, figs. 1a–u; text-fig. 18

Spirifer radiatus (linneatus) J. DE C. SOWERBY, 1835, p. 245.

Discussion.—The Quarry Mountain Formation includes a number of coarsely capillate specimens, many incomplete, that are provisionally referred to *Eospirifer (E.) radiatus*. This name has been widely applied to almost any smooth to moderately plicate eospiriferid, and as thus defined it has been reported from many parts of the world. A direct comparison of the Quarry Mountain shells with Wenlock Limestone specimens from my collections near Dudley, England, shows many similarities (pl. 3, figs. 2a–f; see also Amsden, 1968, pl. 1, fig. 1a). In general, the Oklahoma shells are similar to the English specimens in outline, profile, and development of fold and sulcus. Both have relatively coarse capillae separated by



Text-figure 18. Transverse serial sections (×5) of ventral valve of *Eospirifer (Eospirifer) radiatus?* (J. de C. Sowerby) from Quarry Mountain Formation. *d,* dental plates; *dp,* deltidial plates; *ds,* deltidial plates coalesced. Distance (mm) from posterior tip of pedicle beak: *A,* 0.9; *B,* 3.1; *C,* 3.4; *D,* 3.9; *E,* 4.7. Parlodion peels, OU.

U-shaped interspaces and crossed by fila (Amsden, 1968, p. 68). It should, however, be noted that the Quarry Mountain shells exhibit considerable variation, especially in lateral profile, and this is difficult to evaluate because of the fragmentary and disarticulated nature of much of the material. For the present, these shells are treated as a single taxonomic unit and are provisionally assigned to *E. (E.) radiatus*, a species with which they are certainly related, if not conspecific.

St. Joseph (1935, p. 320) noted that *E. (E.) radiatus* from the Wenlock Limestone commonly shows incipient rounded plications, with a tendency toward the type of ornamentation characteristic of *Eospirifer plicatellus* (Linnaeus) (=*Striispirifer plicatellus*), an observation fully supported by my own Wenlock collections. The Quarry Mountain shells show a similar tendency, and the individual illustrated on plate 3, figures 1p–t, has fairly well-developed plications along the front. In fact, a preliminary examination of *Eospirifer (Eospirifer)* suggests that weak plications along the front margin are fairly common.

In the central United States the genus *Eospirifer* is fairly common in beds presently assigned a Wenlockian age. It is well represented in the Clarita and Quarry Mountain Formations of Oklahoma, the St. Clair Limestone of Arkansas, and the Waldron Shale of Indiana and Tennessee. *Eospirifer* is relatively rare in Ludlovian-age strata; in fact, Boucot (1963, p. 688) cited only a few Ludlovian occurrences in all of North America.

Distribution.—About 70 specimens, many incomplete, from the Marble City and Barber Members; localities Ad1, S2, S5, S9, S15A, S16, S17, S18, S19, S20, S21.

Suborder ATHYRIDIDINA Boucot, Johnson, and Staton, 1964

Superfamily ATHRIDACEA M'Coy, 1844

Family MERISTELLIDAE Waagen, 1883

Subfamily MERISTELLINAE Waagen, 1883

Genus **Arctomeristina** Amsden, n. gen.

Type species.—*Arctomeristina compressa* Amsden, n. sp.

Diagnosis.—Internally similar to *Meristina,* but with mature specimens laterally compressed to develop a cylindrical shell, in larger specimens becoming elliptical in transverse section.

Discussion.—Internally this species has the deeply impressed ventral muscle scar, strong dental plates, and high dorsal median septum that characterize *Meristina.* However, representatives of *Meristina,* and, in fact, most if not all Silurian meristellids, have a transverse shell that is distinctly wider than it is deep, whereas submature to mature specimens of *A. compressa* have a somewhat circular outline, becoming distinctly elliptical in larger individuals. The new genus differs from *Cryptothyrella* in its high, long, blade-like dorsal median septum. In addition to the type species, *Arctomeristina* includes *Atrypa cylindrica* Hall (1852, p. 76, pl. 24, figs. 2a–g; this report, pl. 2, figs. 1a–h) from the Clinton Group (Irondequoit Limestone), Lockport, New York, and probably also *Whitfieldella cylindrica* (Hall; Hall and Clarke, 1894, p. 60, pl. 40, figs. 16–22) from the "Niagaran Group," Hillsboro, Ohio, and *Whitfieldella cylindrica* (Hall) Foerste (1919, p. 382–383, pl. 16, figs. 6A–C) from the Bisher Member, West Union Formation, near Hillsboro and Danville, Ohio. The Quarry Mountain species, as well as those from New York and Ohio, are believed to be of Wenlockian age.

Arctomeristina compressa Amsden, n. sp.

Pl. 1, figs. 1–39; text-figs. 19–22; table 2

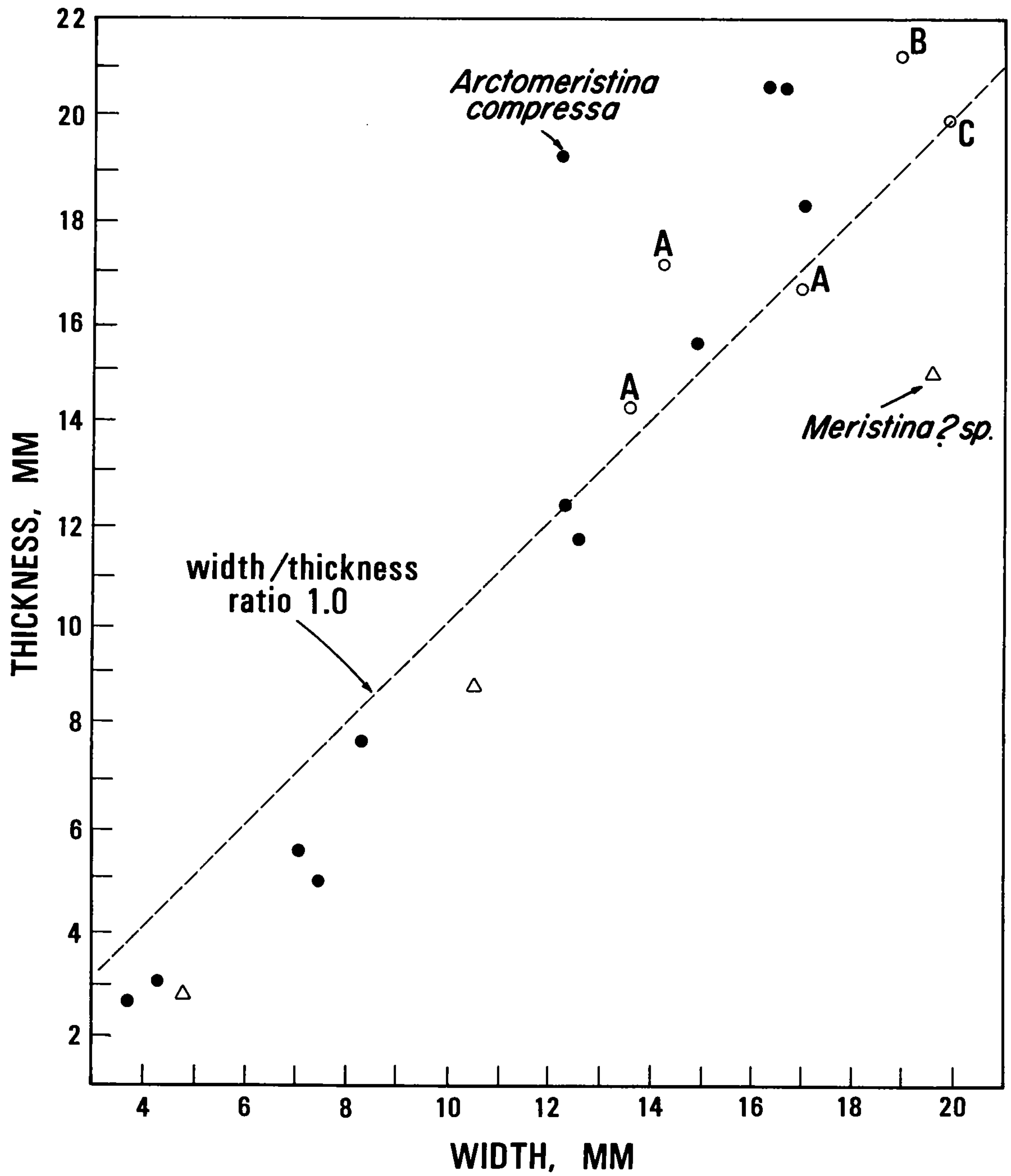
Holotype.—Quarry Mountain Formation, Marble City Member, locality S18; pl. 1, figs. 12–15; OU 8505.

Description.—Elongate shells with a length/width ratio in small individuals of about 1.1, increasing in mature shells to 1.8, and in one exceptionally narrow shell to 2.3 (pl. 1, fig. 15; text-fig. 20; table 2). In smaller shells the width is greater than the thickness (width/thickness ratio 1.3 to 1.5), but with increased size the thickness increases greater proportionally than the width, so that mature individuals are thicker than wide as is shown in text-figures 19 and 20. The ventral beak is hooked over the dorsal, and in all but the smallest shells it is pressed against the dorsal umbo; the ventral beak was probably closed at maturity. There is no well-defined fold and sulcus, although on larger shells the anterior part of the pedicle valve is flattened (pl. 1, fig. 11). On mature specimens the lateral margins of both valves tend to be compressed, to give a circular to elliptical outline (text-fig. 20). The surfaces of both valves are essentially smooth, but well-preserved shells do have a faint ribbing along the lateral and anterior margins, as is common in many so-called smooth-shelled species (pl. 1, figs. 4, 5).

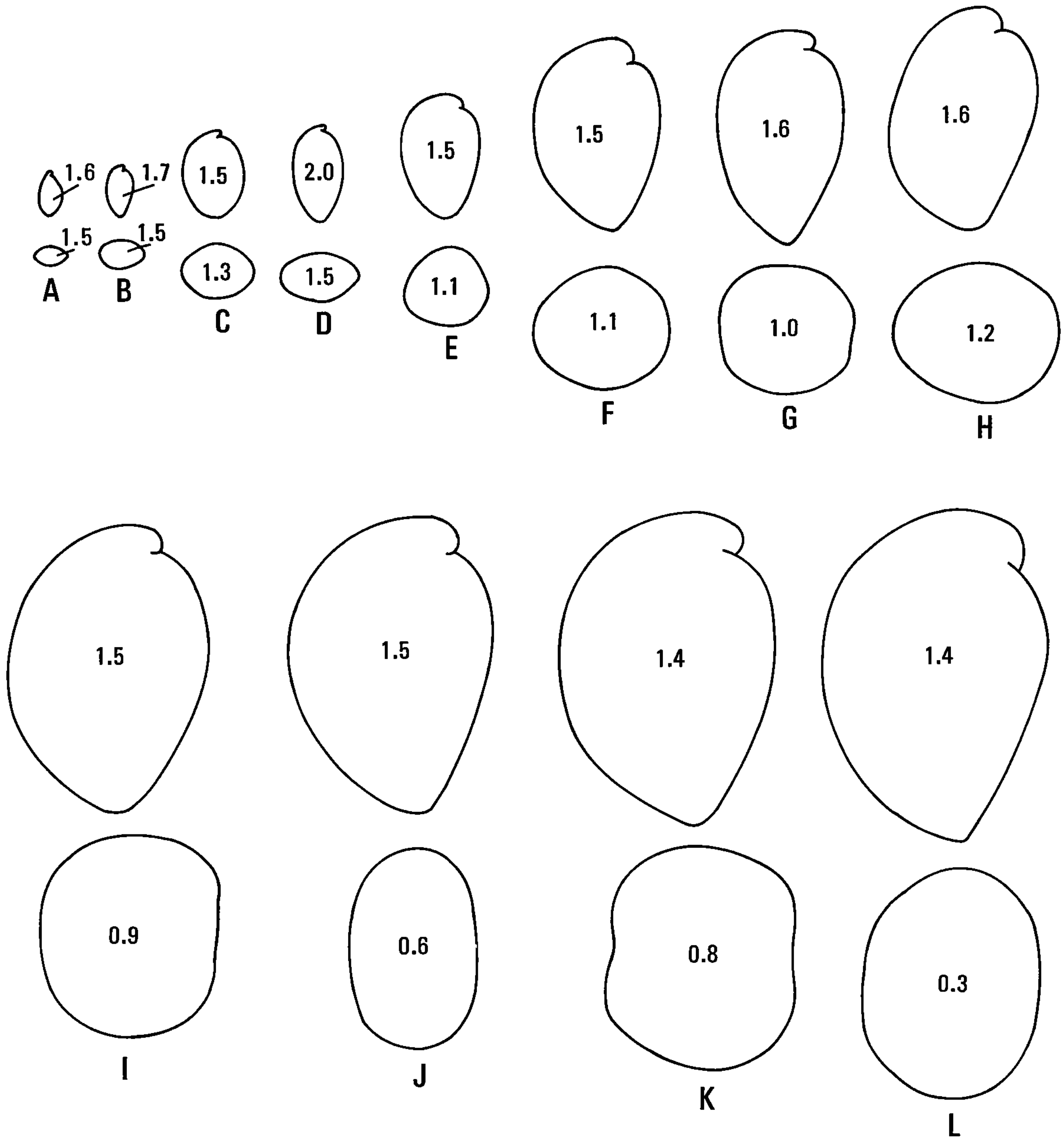
The posterior end of the ventral shell wall is much thickened, and the muscle scars are deeply impressed into this part of the shell (pl. 1, figs. 32, 39); vascular markings are well defined (pl. 1, fig. 32). The dental plates are well developed and extend forward for 10 mm or so on mature individuals (text-figs. 21, 22). The dorsal valve has a high, blade-like septum that extends forward for approximately one-half the valve length on mature shells; at the posterior end this septum supports a V-shaped hinge plate or cruralium that is probably open for most of its length (text-figs. 21, 22). The spiralium consists of 8 to 10 volutions with their apices directed laterally. The jugum is directed posteriorly, but none of the specimens showing this structure is well enough preserved to show the nature of its termination.

The largest specimen in the collections is about 30 mm long. Measurements for complete shells are given in table 2.

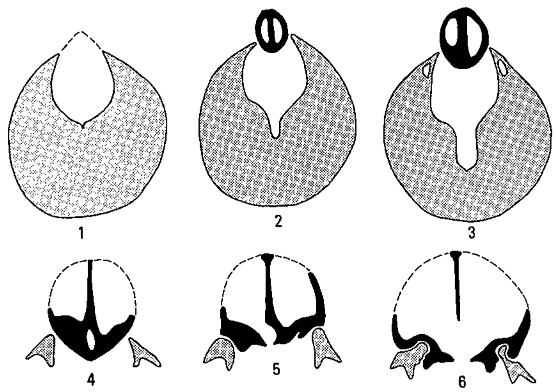
Discussion.—Small specimens of this species have transverse shells that are distinctly wider than long (width/thickness ratio about 1.5), but at about 10 mm in length they become cylindrical, with the width and thickness approximately equal, and with increased size they develop into laterally compressed shells (text-fig. 20). This species is most similar to *Atrypa cylindrica* Hall (1852, p. 76, pl. 24, figs. 2a–g), from which it is distinguished by its more laterally compressed shell. I borrowed Hall's type specimens from the Irondequoit Limestone, Lockport, New York, and four of these are illustrated on plate 2, figures 1a–i. The deeply impressed ventral muscle scar (pl. 2, fig. 1i), the high, median dorsal septum, and the cylindrical shape indicate that Hall's species should be referred to *Arctomeristina* rather than to *Whitfieldella.* A few years



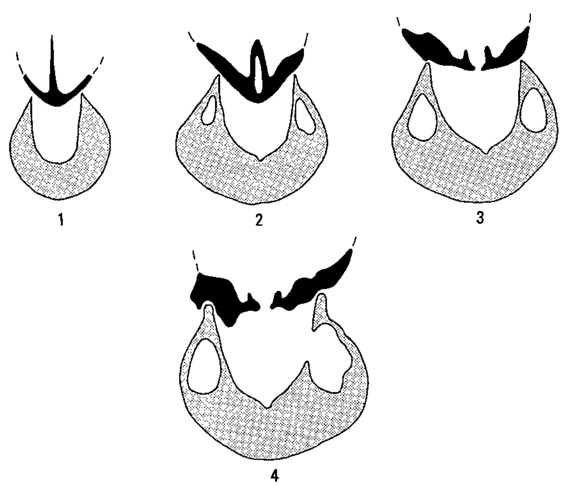
Text-figure 19. Scatter diagram showing width/thickness relationship of *Arctomeristina compressa*, n. sp., *A. cylindrica* (Hall), and *Meristina?* sp. Solid circles are specimens of *A. compressa*, Quarry Mountain Formation, Oklahoma; open circles (*A*) are Hall's type specimens of *A. cylindrica* from Clinton Group, New York; open circle (*B*) is Foerste's figured specimen of *A. cylindrica*, Bisher Formation, Danville, Ohio; open circle (*C*) is Hall's figured specimen of *A. cylindrica*, near Hillsboro, Ohio (measurements from Hall, 1894, pl. 40, figs. 16, 17); open triangles are *Meristina?* sp., Quarry Mountain Formation, Oklahoma.



Text-figure 20. *Arctomeristina compressa* Amsden, n. sp. Longitudinal (above) and transverse (below) outlines of 12 specimens ranging in size from smallest recognized in collections to largest complete individual (×1.5). Numbers in longitudinal outline are length/thickness ratios, and in transverse outline they are width/thickness ratios. *A,* Quarry Mountain Formation, Marble City Member, locality S12 (pl. 1, fig. 23); *B,* Quarry Mountain Formation, locality S18 (pl. 1, figs. 26–29); *C,* Quarry Mountain Formation, locality S18; *D,* Quarry Mountain Formation, Marble City Member, locality Ad1 (pl. 1, figs. 33–36); *E,* Quarry Mountain Formation, locality S15A (pl. 1, fig. 31); *F,* Quarry Mountain Formation, locality S18 (pl. 1, figs. 6, 7); *G,* Quarry Mountain Formation, Barber Member, locality S18 (pl. 1, figs. 16–18); *H,* Quarry Mountain Formation, locality S18 (pl. 1, figs. 3–5); *I,* Quarry Mountain Formation, locality S18; *J,* Quarry Mountain Formation, locality S18 (pl. 1, figs. 12–15); *K,* Quarry Mountain Formation, Barber Member, locality S18 (pl. 1, figs. 19–22); *L,* Quarry Mountain Formation, Marble City Member, locality Ad1 (pl. 1, figs. 8–11).



Text-figure 21. Transverse serial sections of *Arctomeristina compressa* Amsden, n. sp., Marble City Member, Quarry Mountain Formation, locality Ad1, ×1½. Dorsal valve solid, ventral valve stippled (only small part of ventral valve shown in sections 4–6). Distance (mm) from posterior tip of ventral beak: *1*, 4.0; *2*, 4.44; *3*, 4.9; *4*, 6.4; *5*, 6.7; *6*, 7.6. Parlodion peels, OU.



Text-figure 22. Transverse serial sections of *Arctomeristina compressa* Amsden, n. sp., Quarry Mountain Formation, locality S18, ×1½. Ventral valve stippled, dorsal valve solid (only part of dorsal valve shown). Distance (mm) from posterior tip of ventral valve: *1*, 4.4; *2*, 6.7; *3*, 6.1; *4*, 8.0 (thin section). Parlodion peels and thin section, OU.

after Hall described *A. cylindrica*, Hall and Clarke (1894, pl. 40, figs. 16–22) illustrated specimens identified as *Whitfieldella cylindrica* (Hall) from Silurian rocks near Hillsboro, Ohio. Boucot, Johnson, and Staton (1965, p. H655, fig. 533, 5c–e) reproduced Hall and Clarke's original illustration of the Hillsboro specimens, but, as is noted below, these shells are probably conspecific with the Irondequoit specimens and thus represent *Arctomeristina*. Foerste (1919, p. 382–383, pl. 16, figs. 6A–C) described and illustrated specimens from the Bisher Member, West Union Formation, near Hillsboro and Danville, Ohio, which he believed to be conspecific with Hall's specimens from the Irondequoit Limestone of New York and with Hall and Clarke's Ohio specimens. Foerste noted that specimens from the West Union Formation are similar to those from the Irondequoit Limestone of the same size, although few of the larger Ohio shells are elliptical in transverse section, most being cylindrical, a variation he interpreted as intraspecific. I have examined Foerste's type specimen (here refigured on pl. 2, figs. 2a–e), but Hall and Clarke's Ohio specimens are not at the American Museum of Natural History and their location is unknown. Foerste did not describe the internal structure, and his figured shell does not provide any information on this vital point. Hall and Clarke do provide illustrations of steinkerns, but these do not give data on the height of the dorsal septum. The external shape of the Ohio shells suggests strongly that they are related to the Irondequoit representatives of *A. cylindrica*, and in all probability Foerste was correct in interpreting the Ohio and New York shells as comprising a single, variable species. It should be emphasized that the type suite of specimens from Lockport includes shells that clearly show a deeply impressed ventral muscle scar and a high dorsal median septum, characters that, combined with the external shape, place them in the new genus *Arctomeristina;* none of these, however, shows the degree of lateral compression that is common on Quarry Mountain specimens of comparable size. Possibly the Oklahoma, Ohio, and New York specimens are all part of a single, variable species, but it seems best to treat the Quarry Mountain shells as a distinct species until such time as *A. cylindrica* has

TABLE 2.—BIOMETRICS OF *Arctomeristina compressa* AND *A. cylindrica*

Length (mm)	Width (mm)	Thickness (mm)	Length/ width ratio	Width/ thickness ratio	Length/ thickness ratio
Arctomeristina compressa, new gen. and sp. Quarry Mountain Formation					
5.1	4.3	2.9	1.19	1.48	1.76
4.1	3.7	2.5	1.11	1.48	1.64
8.5	7.1	5.5	1.20	1.29	1.55
9.6	7.5	4.9	1.28	1.53	1.96
11.4	8.3	7.6	1.37	1.09	1.50
17.4	12.6	11.6	1.38	1.09	1.50
20.1	12.3	12.2	1.63	1.01	1.65
23.2	14.9	15.5	1.55	0.94	1.45
28.1	12.2	19.0	2.30	0.64	1.48
29.0	16.6	20.5	1.75	0.81	1.41
29.6	16.4	20.5	1.80	0.80	1.44
Arctomeristina cylindrica (Hall) Type specimens, AMNH 1530, Clinton Group, Lockport, New York					
21.6	13.7	14.2	1.58	0.96	1.52
	14.4	17.1		0.84	
26.0 est.	17.1	16.6	1.52	1.03	1.57
Arctomeristina cylindrica (Hall) Foerste's figured specimen, USNM 97075, Bisher Formation, Danville, Ohio					
32.8	19.2	21.1	1.71	0.91	1.55

been more clearly defined by larger, more definitive specimens.

Hall's New York specimens are from the Irondequoit Limestone (Foerste, 1919, p. 382), and the Ohio shells described by Foerste and Hall and Clarke are from the Bisher Formation, strata that are assigned a late Llandoverian-early Wenlockian age by Berry and Boucot (1970, p. 122).

Atrypa crassirostra Hall (1852, p. 269–270, pl. 55, figs. 4a, b, c) from the "Niagaran Shale" at Lockport, New York, has been suppressed by some authors as a synonym of *Atrypa cylindrica* Hall; I have examined Hall's figured specimen, however, and it has a much better defined fold and sulcus than does *A. cylindrica*. Nothing is known about the internal structure of *A. crassirostra*, and until better material is available the taxonomic position of this species cannot be determined definitely.

Distribution.—The collections contain approximately 150 specimens, including a number of complete, articulated shells. These were collected from the upper 95 feet of the Quarry Mountain Formation, most coming from the Marble City Member, but several well-preserved shells were obtained from the upper 20 feet of the Barber Member; several collections were made *in situ* from the upper 2 to 3 feet of the Marble City Member. Most specimens are from Quarry Mountain, Walking Stick Hollow, and Payne Hollow (Amsden and Rowland, 1965, pl. A); one collection is from the Marble City Member in Malloy Hollow (Amsden and

Rowland, 1965, pl. B). Collections are from the following localities: Ad1, S2, S12, S15A, S15C, S16, S17, S18, S19, S20.

Genus **Meristina** Hall, 1867
Meristina? sp.
Pl. 2, figs. 3a–h; text-fig. 19

Description.—The collections under study include three specimens of a smooth brachiopod with a typical meristelloid shape and a moderately well-defined ventral fold and dorsal sulcus. These differ from *Arctomeristina compressa* in having transverse shells with the width greater than the thickness at all observed growth stages (text-fig. 19). I have no information on the internal structure of this species, and its provisional reference to *Meristina* is based on external form.

Measurements of the three specimens referred to this species are given:

Length (mm)	Width (mm)	Thickness (mm)
5.3	4.8	2.7
12.9	10.5	8.7
19.0	19.6	14.9

Distribution.—Three articulated specimens from the Marble City Member at localities Ad1, S15A, S20.

Suborder SPIRIFERIDINA Waagen, 1883
Superfamily SPIRIFERACEA King, 1846
Family DELTHYRIDIDAE Waagen, 1883
Subfamily DELTHYRININAE Phillips, 1841
Genus **Delthyris** Dalman, 1828
Delthyris? sp.
Pl. 4, figs. 3a–c

Discussion.—This species is represented by only two specimens, one an articulated shell and the other an isolated ventral valve. Both specimens are very small, and they may represent immature shells. Nothing is known about the internal structure, but the external ornamentation, consisting of subdued growth lamellae bearing capillae, is suggestive of *Delthyris*.

The genus *Delthyris* is reported to range from the Wenlockian into the Early Devonian. In Oklahoma *Delthyris kozlowskii* Amsden (1951, p. 91–92, pl. 18, figs. 32–38) is moderately common in the Henryhouse Formation (Ludlovian), but it has not been recognized in the Clarita Formation (Wenlockian) or older Silurian strata.

Distribution.—Two specimens from the Marble City Member at locality S20 (55 feet below the top).

Subfamily ACROSPIRIFERINAE Termier and Termier, 1949
Genus **Howellella** Kozlowski, 1946
Howellella?, cf. **H. splendens** (Thomas 1926)
Pl. 4, figs. 4a–c

Discussion.—This species is represented by a single small articulated shell. The specimen has some resemblance to immature shells of *Howellella splendens* (Thomas; Amsden, 1968, p. 70–72, pl. 2, figs. 2a–s, pl. 13, figs. 9a, 9b, pl. 16, fig. 6a) from the St. Clair Formation of Arkansas and the Clarita Formation of Oklahoma. Nothing is known about the internal structure or the external micro-ornamentation of the Quarry Mountain shell, and its reference to *Howellella* is provisional.

Howellella henryhousensis Amsden (1951, p. 92–93, pl. 18, figs. 39–44) is sparingly represented in the Henryhouse Formation (Ludlovian) of south-central Oklahoma.

Distribution.—A single small articulated shell from the Marble City Member (55 feet below the top) at locality S20.

Superfamily ATRYPACEA Gill, 1871
Family ATRYPIDAE Gill, 1871
Genus **Atrypa** Dalman, 1828
Atrypa petrotella Amsden, n. sp.
Pl. 8, figs. 4a, 4b; pl. 9, figs. 3a, 3b

Holotype.—Marble City Member, Quarry Mountain Formation, locality S15-A, OU 8577.

Description.—The Quarry Mountain collections include a number of specimens of this species, although many are broken and exfoliated. They are dorsibiconvex, with the front portion of most reasonably complete shells pinched into a moderate ventral fold and dorsal sulcus. The costellae, which are relatively stout, with 3 or 4 ribs occupying a space of 2 mm (counted 5 mm in front of the beaks), are crossed by concentric fila; the costellae near the margins are extended into spines that are connected by a well-developed frill or skirt that also has concentric fila (pl. 8, fig. 4b, pl. 9, figs. 3a, 3b).

No interiors have been observed.

Discussion.—Copper (1973, p. 496) proposed *Eospinatrypa* for Silurian spinose atrypids. *Atrypa petrotella* has spines at the anterior end that serve as struts for the frills, but at the present time this type of shell does not appear to be well-enough understood to justify the use of a new generic name.

A. petrotella is not particularly well represented in the collections, and it is given a new name primarily to identify clearly a species that is remarkable for its well-developed frill. These frills make a skirt that on at least one specimen is as large as the shell itself (pl. 9, fig. 3a). Atrypid species from formations that are noted for fine preservation rarely provide frills, and it is especially remarkable to find such excellent specimens in the Quarry Mountain, a formation that on the whole does not produce well-preserved brachiopods. This suggests that the skirt was present on all mature specimens of *A. petrotella*.

The presence of these delicate frills is significant because it suggests strongly that the Quarry Mountain sediments represented a low-energy deposit (see discussion under section on Biofacies).

Distribution.—About 60 specimens, many incomplete, from the Marble City Member at the following localities: Ad1, S1-A, S2, S4-A, S9, S12, S15-A, S15-C, S16, S17, S20, S21.

Genus **Plectatrypa** Schuchert and Cooper 1930

Plectatrypa arctoimbricata Amsden, 1968

Pl. 10, figs. 7a–i

Plectatrypa arctoimbricata Amsden, 1968, p. 75–76, pl. 10, figs. 3a–l, text-figs. 60, 61, table 19.

Description.—The Quarry Mountain shells have a subcircular outline, with the width about equal to the length; the length/width ratio ranges from 0.9 to 1.1. The lateral profile is subequally biconvex, and the ventral beak is erect to slightly hooked over the dorsal. A ventral sulcus begins near the beak, developing into a moderately deep, rounded trough near the front; a fairly well-defined dorsal sulcus is present at the front. The surface bears low, rounded costellae, 3 to 4 occupying a space of 2 mm (5 mm in front of the beak); costellae are crossed by delicate, closely spaced fila.

The internal characters are unknown.

The largest shell in the collections has an estimated length of about 14 mm; measurements of three specimens are given:

Length (mm)	Width (mm)	Thickness (mm)
11.2	10.5	7.2
12.8	11.2	8.2
12.0	13.5	—

Discussion.—Externally the Quarry Mountain shells resemble closely those from the St. Clair Limestone (Wenlockian), Arkansas, with the shells similar in size, outline, lateral profile, and ornamentation. No comparison of the internal structures can be made because of lack of information on the Oklahoma shells, but the external similarities suggest that they are similar internally and the specimens from the two areas are considered to be conspecific. The problems concerned with this generic assignment are discussed in Amsden (1968, p. 75–76; 1974, p. 74–76).

Distribution.—About 30 specimens, many incomplete, from the Marble City Member at the following localities: Ad1, S2, S15-C, S17, S19, S21.

Suborder Retziidina Boucot, Johnson, and Staton, 1964

Superfamily Retziacea Waagen, 1883

Family Rhynchospirinidae Schuchert and LeVene, 1929

Genus **Homoeospirella** Amsden, 1968

Homoeospirella? sp.

Pl. 10, figs. 5a–d

Discussion.—The collections under study include a single specimen of a small, costate, punctate shell. The costae are crossed by fila, and there is a faint, very weakly developed sulcus in the ventral valve. In its small size and costae with fila this shell resembles *Homoeospirella pygmaea* Amsden (1968, p. 94–95, pl. 7, figs. 6a–p) from the St. Clair Limestone (Wenlockian) of Arkansas, but the Quarry Mountain species lacks the ventral and dorsal split center ribs that characterize the St. Clair shells.

I have no information on the internal characters of this species, and its reference to *Homoeospirella* is uncertain.

Distribution.—A single shell from the Quarry Mountain Formation (probably Marble City Member), Marble City area, Sequoyah County, Oklahoma. (Christian collection.)

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PLATES

Plate 1

ARCTOMERISTINA

1, 2, dorsal (×2) and lateral (×1) views. Loc. S18 (Christian collection, loc. 1); OU 8491.

3-5, anterior (×1), lateral (×2), and enlarged surface (×5) views of slightly deformed specimen, showing faint costellae near margins. Quarry Mountain Formation (85 feet below top, *in situ*), Barber Member, loc. S18; OU 8498.

6, 7, lateral (×2) and dorsal-oblique-posterior (×3) views, showing relationship of ventral beak to dorsal umbo. Same level and locality as figures 3-5; OU 8489.

8-11, posterior, dorsal, lateral, and anterior views (×1) of one of largest shells in collections. Marble City Member, loc. Ad1; OU 8503.

12-15, posterior, lateral, ventral, and dorsal views (×1) of holotype. Marble City Member, loc. S18; OU 8505.

16-18, lateral (×1), anterior (×1), and dorsal (×2) views (text-fig. 20J). Same level and locality as figures 3-5; OU 8500.

19-22, dorsal, anterior, posterior, and lateral views (×1) of large shell (text-fig. 20K). Same level and locality as figures 3-5; OU 8502.

23, dorsal view (×3) of one of smallest shells in collections (text-fig. 20A). Marble City Member, loc. S12; OU 8497.

24, anterior view (×2). Marble City Member, loc. S18; OU 8493.

25, dorsal-oblique posterior view (×2). Loc. S18 (Christian collection, loc. 1); OU 8490.

26-29, lateral, dorsal, posterior, and anterior views (×3) of small shell (text-fig. 20B). Same level and locality as figures 3-5; OU 8499.

30, anterior view (×1). Same level and locality as figures 3-5; OU 8496.

31, dorsal-oblique-posterior view (×3; text-fig. 20E). Same level and locality as figures 3-5; OU 8495.

32, ventral steinkern (×2), showing deeply impressed muscle scars. Marble City Member, loc. Ad1; OU 8494.

33-36, dorsal, anterior, lateral, and posterior views (×3) of immature shell (text-fig. 20D). Marble City Member, loc. Ad1; OU 8501.

37-38, anterior and dorsal views (×1) of mature shell (text-fig. 20K). Same level and locality as figures 3-5; OU 8504.

39, ventral steinkern (×2), showing deeply impressed muscle scar. Loose block, loc. S18; OU 8492.


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Plate 2

ARCTOMERISTINA, MERISTINA, EOSPIRIFER

Page

Figures 1a–h.—*Arctomeristina cylindrica* (Hall); type specimens (AMNH 1530). Clinton Group (Irondequoit Limestone), Lockport, New York. 35

1a–e, posterior (×2), ventral (×1), lateral (×1), dorsal (×1), and anterior (×2) views of specimen figured by Hall (1852, pl. 24, figs. 2d–h).

1f, lateral view (×1); this specimen is split longitudinally and shows dorsal median septum on reverse side.

1g, 1h, dorsal and posterior views (×1) of specimen here designated lectotype; probably shell figured by Hall (1852, pl. 24, figs. 2a–c).

1i, ventral view (×2) of steinkern.

Figures 2a–e.—*Arctomeristina cylindrica* (Hall); specimen figured by Foerste (1919, pl. 16, figs. 6A–C). Bisher Formation, Sanderson Farm, north of Danville, Ohio; posterior, ventral, lateral, dorsal, and anterior views (×1); USNM 97075. 35

Figures 3a–3h.—*Meristina*? sp. Quarry Mountain Formation, eastern Oklahoma. 39

3a–c, ventral, dorsal, and anterior views (×2) of immature shell. Marble City Member, loc. S20; OU 8564.

3d, 3e, posterior and ventral views (×1) of large shell. Marble City Member, loc. S15A; OU 8565.

3f–h, anterior (×3), dorsal (×3), and lateral (×4) views of very small shell. Marble City Member, loc. Ad1; OU 8566.

Figures 4a–m.—*Eospirifer (Acutilineolus) inferatus* Amsden, n. sp. Quarry Mountain Formation, eastern Oklahoma. 32

4a–f, lateral, anterior, posterior, ventral, dorsal (×2), and enlarged surface (×5) views of holotype. Marble City Member, loc. S15A; OU 8485.

4g–i, anterior, ventral, and dorsal views (×2). Same level and locality as figures 4a–f; OU 8659.

4j–m, lateral, anterior, dorsal, and ventral views (×2); during life this individual received some damage, possibly through crowding, which was partially healed; OU 8484.

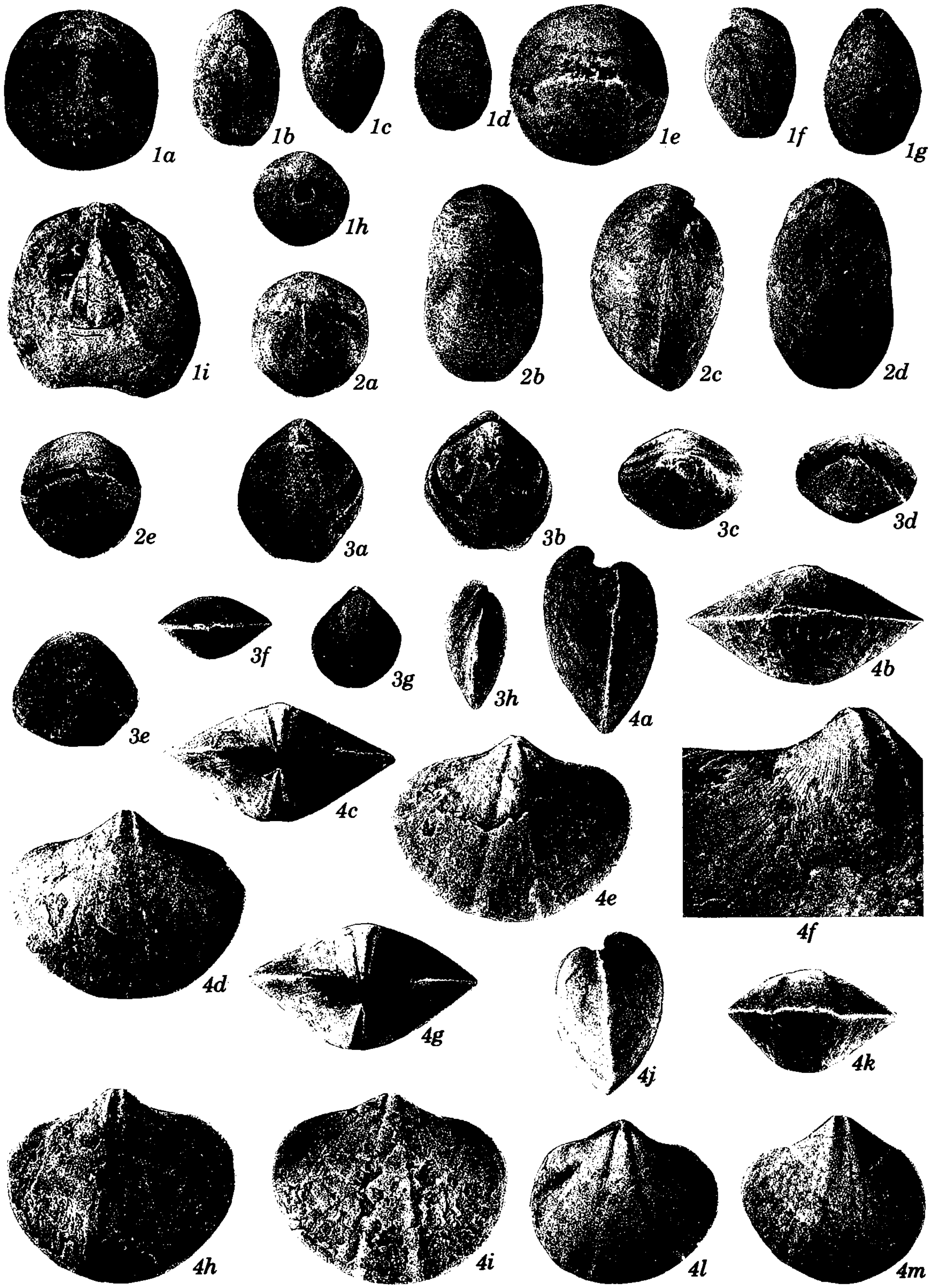
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Plate 3

EOSPIRIFER

Page

Figures 1a-u.—*Eospirifer (Eospirifer) radiatus*? (J. de C. Sowerby). Quarry Mountain Formation, eastern Oklahoma. 32

1a–c, dorsal, anterior, and posterior views (×3) of small shell. Marble City Member, loc. S15A; OU 8513.

1d, 1e, enlarged surface (×5) and dorsal (×1) views of free valve. Barber Member, loc. S18; OU 8512.

1f, dorsal view (×1) of large valve. Marble City Member, loc. S5; OU 8514.

1g, 1h, ventral and anterior views (×3) of small shell. S18; OU 8506.

1i, ventral view (×2) of a free valve; Quarry Mountain Formation, Barber Member, loc. S18; OU 8510.

1j–l, enlarged oblique view of cardinal area, showing deltidial plate (×5) and posterior and ventral views (×2). Marble City area (Christian collection); OU 8509.

1m–o, lateral, anterior, and dorsal views (×2). Marble City area (Christian collection); OU 8508.

1p–t, dorsal, ventral, anterior, lateral, and posterior views (×2) of shell with well-developed plications on anterior third of shell. Marble City Member, loc. S21; OU 8511.

1u, dorsal view (×4) of small free valve. Marble City Member, loc. S18; OU 8507.

Figures 2a-f.—*Eospirifer (Eospirifer) radiatus* (J. de C. Sowerby). Wenlock Limestone, west side of Wren's Nest, North Dudley, England (935920 #130 Kidderminster). 32

2a, b, dorsal and anterior views (×2) of incomplete shell; enlarged surface view (×5) of this shell illustrated in Amsden (1968, pl. 1, fig. 3a); OU 6418.

2c–f, dorsal (×2), ventral (×2), enlarged surface (×5), and oblique-posterior (×3) views; oblique posterior view shows deltidial plates coalescing at posterior tip of delthyrium; OU 8516.

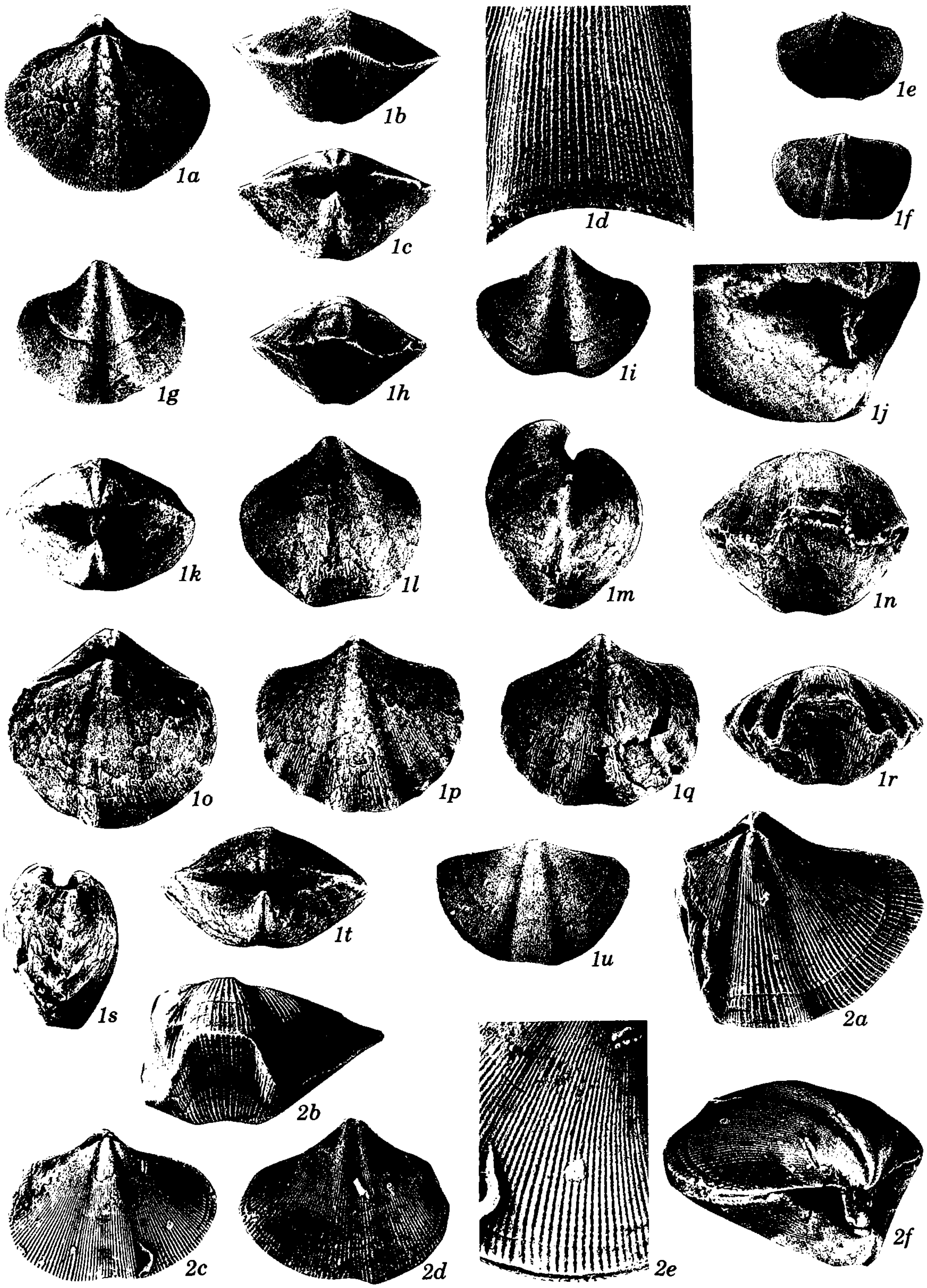
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Plate 4

BOUCOTIDES, AMSDENINA, DELTHYRIS?, HOWELLELLA?, RESSERELLA, DICOELOSIA

Page

Figures 1a–g.—*Amsdenina* sp. Quarry Mountain Formation, eastern Oklahoma. 30

1a–1b, lateral and posterior views (×2) of incomplete articulated shell. Marble City area (Christian collection, loc. 7); OU 8582.

1c, ventral view (×1) of free valve, showing anterior plications. Marble City area (Christian collection, loc. 7); OU 8583.

1d, ventral view (×1) of free valve. Marble City Member, loc. S17; OU 8584.

1e, 1g, lateral and ventral views (×1) of free valve. Marble City area (Christian collection, loc. 7); OU 8580.

1f, ventral view (×1) of free valve with weak anterior plications. Marble City Member, loc. S12; OU 8581.

Figures 2a–k.—*Boucotides barrandei* Amsden. Quarry Mountain Formation, eastern Oklahoma. 30

2a–e, dorsal, posterior, ventral, lateral, and anterior views (×2) of nearly complete shell. Marble City Member, loc. S2; OU 8486.

2f–j, posterior, dorsal, ventral, lateral, and anterior views (×2) of incomplete specimen. Marble City area (Christian collection, loc. 7); OU 8488.

2k, ventral view (×2) of free valve. Marble City Member, loc. S15-C; OU 8487.

Figures 3a–c.—*Delthyris*? sp. Dorsal, ventral, and posterior views (×5) of small shell. Quarry Mountain Formation, loc. S20; OU 8658. 39

Figures 4a–c.—*Howellella*?, cf. *H. splendens* (Thomas). Posterior, dorsal, and ventral views (×5) of small shell. Quarry Mountain Formation, Marble City Member, loc. S9; OU 8607. 39

Figures 5a–k.—*Resserella* sp. Quarry Mountain Formation, eastern Oklahoma. 13

5a, ventral view (×3) of free valve. Marble City Member, loc. S18; OU 8595.

5b, ventral view (×3) of free valve. Marble City Member, loc. S15A; OU 8596.

5c, 5d, enlarged surface (×5) and ventral (×2) views, showing median ornamentation. Abandoned quarry, NE¼NW¼ sec. 13, T. 13 N., R. 23 E.; OU 8597.

5e–g, enlarged surface (×5), ventral (×2), and posterior (×3) views of free valve. Barber Member, loc. S18; OU 8598.

5h, 5k, posterior and ventral views (×5) of small ventral valve. Barber Member, loc. S18; OU 8599.

5i, dorsal view (×4) of only brachial valve in collections. Marble City Member, loc. S15C; OU 8600.

5j, ventral view (×4) of free valve. Marble City Member, NW¼SE¼ sec. 15, T. 13 N., R. 23 E.; OU 8601.

Figures 6a, 6b.—*Dicoelosia* sp. 15

6a, ventral view (×5). Barber Member, loc. S18; OU 8603.

6b, ventral view (×5). Same level and locality as above; OU 8602.

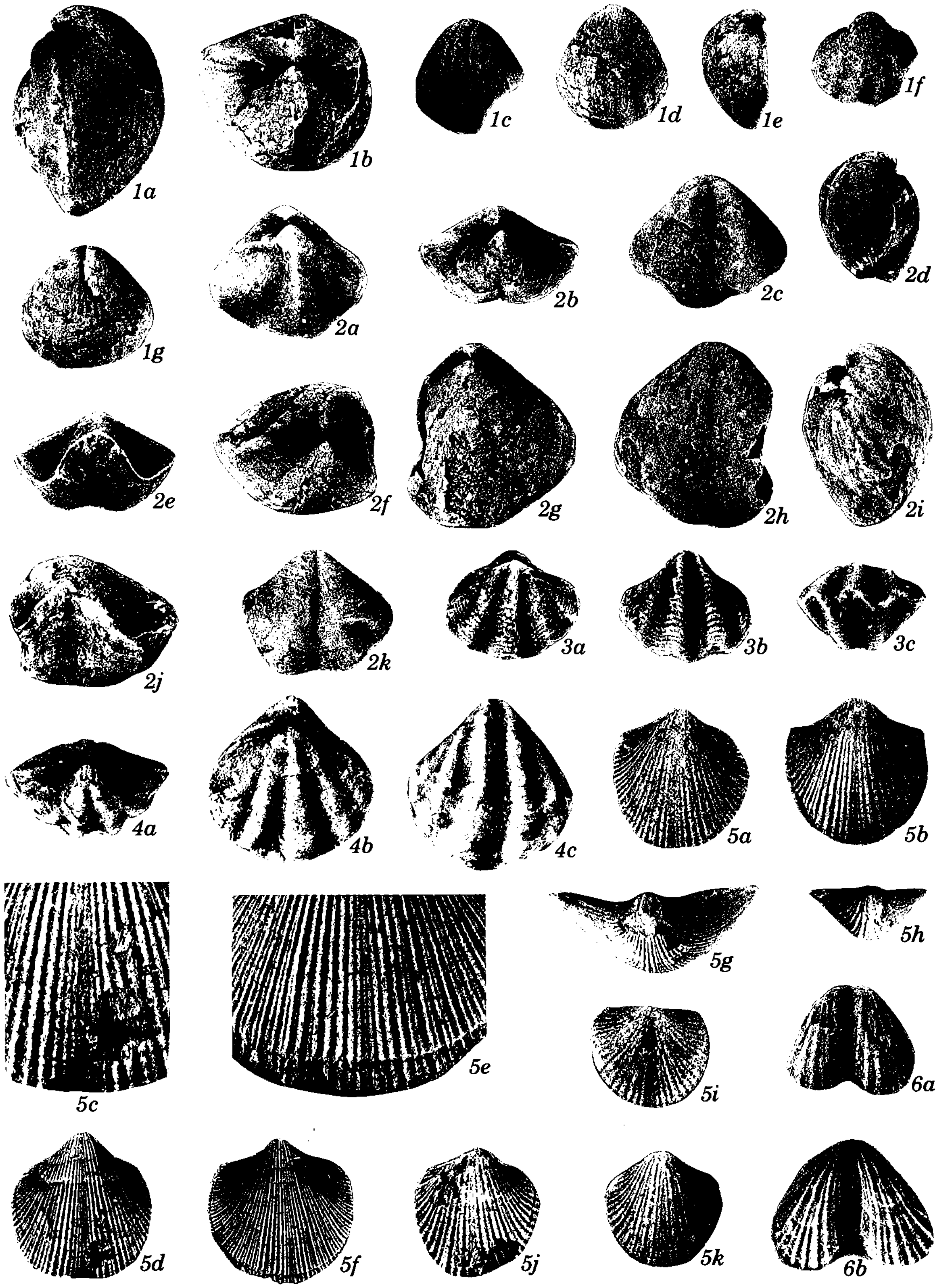
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Plate 5

Dalejina?, Coolinia, Strophodonta (Brachyprion)

Page

Figures 1a–c.—*Dalejina*? sp. Quarry Mountain Formation, eastern Oklahoma. 16

1a, dorsal view of a small valve (×5); Marble City Member, Quarry Mountain Formation, loc. 5; OU 8604.

1b, 1c, dorsal and posterior views (×3) of articulated shell. Christian collection, Marble City Member, Marble City area; OU 8605.

Figures 2a–n.—*Coolinia* sp. Quarry Mountain Formation, eastern Oklahoma. 15

2a, 2b, rubber cast and dorsal steinkern (×2). Loose block, loc. S18; OU 8546.

2c, 2d, rubber cast and ventral steinkern (×2). Marble City Member, loc. S5; OU 8545.

2e, dorsal valve (×1). Loose block, loc. S18; OU 8551.

2f, 2g, dorsal valve (×1) and enlarged surface view (×5). Marble City Member, loc. S5; OU 8550.

2h, small ventral valve (×1). Same level and locality as figures 2f, 2g; OU 8552.

2i, incomplete ventral valve (×2). Barber Member, loc. S18; OU 8553.

2j, 2k, dorsal valve (×1) and enlarged surface view (×5). Same level and locality as figures 2f, 2g; OU 8548.

2l, 2m, dorsal and ventral valves (×1) and enlarged view (×3) of ventral valve. Same level and locality as figures 2f, 2g; OU 8549.

2n, three brachial valves (×2). Same level and locality as figures 2f, 2g; OU 8547.

Figures 3a–c.—*Strophodonta (Brachyprion)* sp. A. Quarry Mountain Formation, Marble City Member, loc. S18; OU 8481. 16

3a, 3c, enlarged surface views (×5) of ventral valve shown in figure 3b; note alternating type of ribs in figure 3a and absence of minor costellae in figure 3c.

3b, incomplete ventral valve.

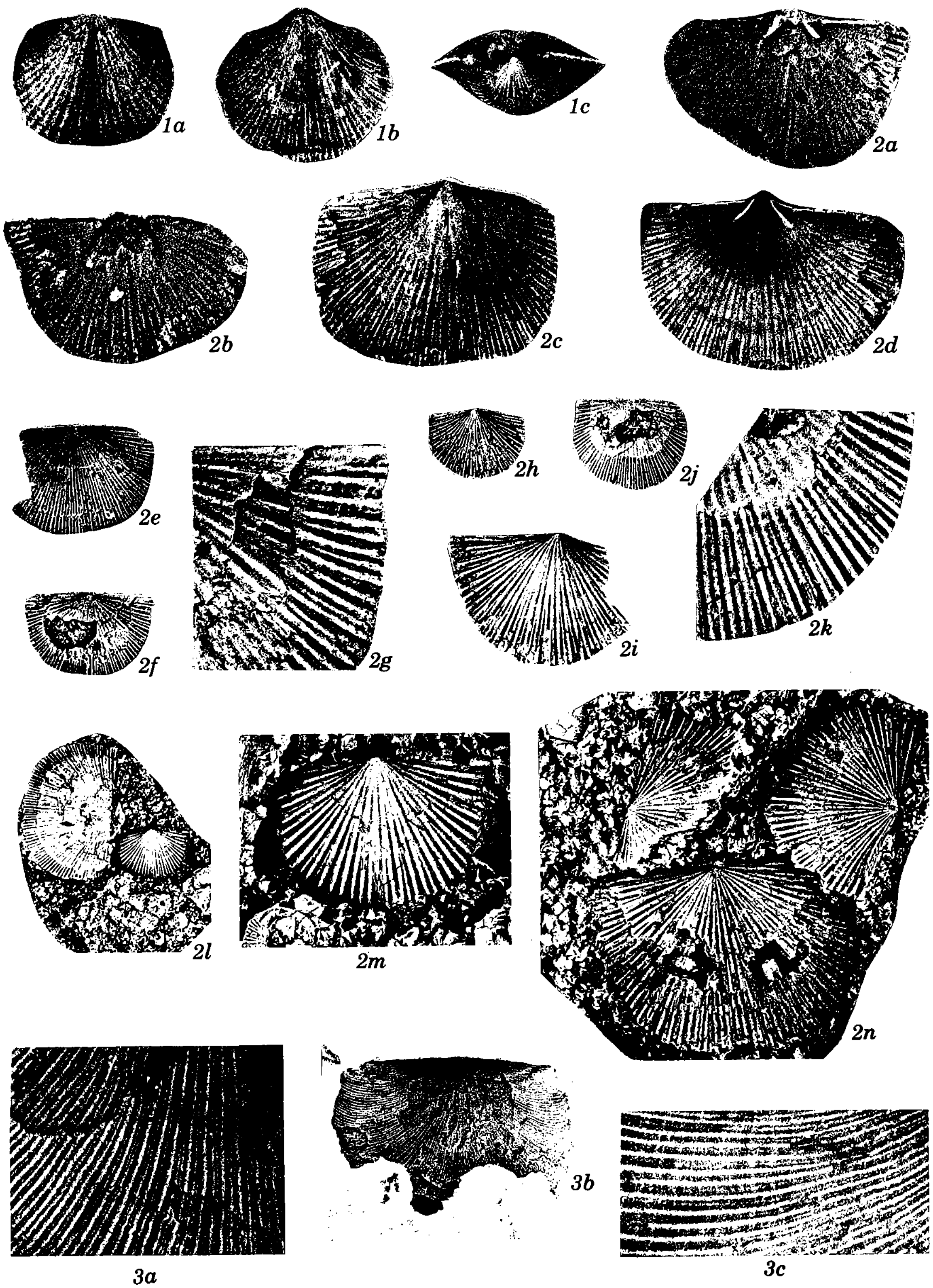
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Plate 6

STROPHODONTA (BRACHYPRION)

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Figures 1a–n. *Strophodonta (Brachyprion)* sp. A. Quarry Mountain Formation, eastern Oklahoma.	16

1a, 1d, 1e, ventral steinkern (×1) and enlarged views (×3) of rubber cast and steinkern, showing muscle area, delthyrium, pseudodeltidium, and denticulation. Loose block, loc. S18; OU 8480.

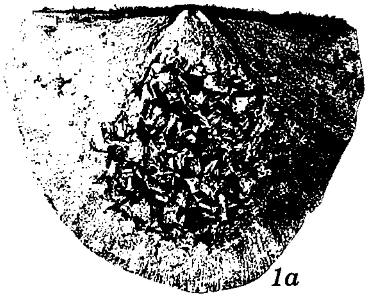
1b, 1c, ventral valve (×1) and enlarged surface view (×5). Christian collection, Marble City Member, Marble City area; OU 8477.

1f–h, ventral, posterior, and lateral views (×1) of large ventral valve. Marble City Member, loc. S3; OU 8476.

1i, 1j, dorsal view (×1) and enlarged view (×5) of chilidium of free dorsal valve. Loose block, loc. S18; OU 8478.

1k, l, ventral (×1) and enlarged surface (×5) views of free ventral valve. Marble City Member, loc. S20; OU 8482.

1m, 1n, ventral steinkern (×2) and enlarged delthyrial view (×5) of small ventral valve. Barber Member, loc. S18; OU 8479. Other views of the species shown on plate 5.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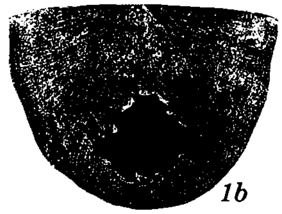
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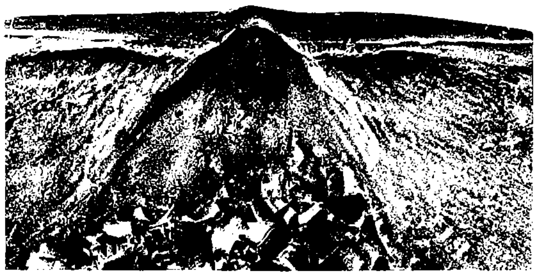
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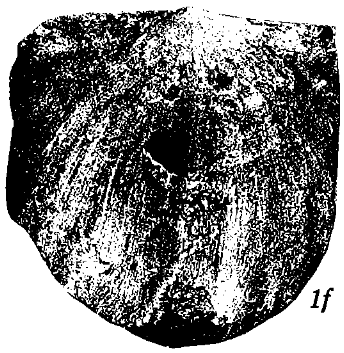
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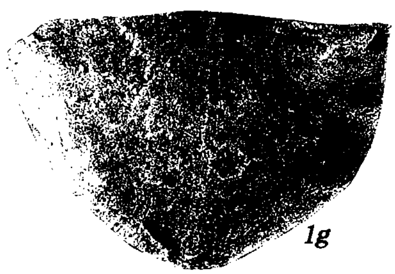
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Plate 7

STROPHODONTA (BRACHYPRION), LEPTOSTROPHIA, LISSOSTROPHIA, AMPHISTROPHIA (AMPHISTROPHIA)

Page

Figure 1a.—*Strophodonta (Brachyprion) newsomensis* Foerste. Posterior view (×6) of cardinal area, showing pseudodeltidium, chilidium, and denticulations. Waldron Shale, Newsom Station, Davidson County, Tennessee; OU 8536.

Figures 2a, 2b.—*Strophodonta (Brachyprion)* sp. B. Quarry Mountain Formation, eastern Oklahoma. 18

2a, ventral view (×3) of partially exfoliated valve. Barber Member, loc. S18; OU 8555.

2b, ventral view (×3) of incomplete valve. Loc S3; OU 8556.

Figures 3a–e.—*Leptostrophia* sp. Quarry Mountain Formation, eastern Oklahoma. 23

3a, 3b, ventral (×2) and enlarged surface (×5) views of partly exfoliated shell. Marble City Member, NE1/4SE1/4NE1/4 sec. 14, T. 13 N., R. 23 E., Sequoyah County, Oklahoma; OU 8557.

3c, 3d, ventral (×2) and enlarged surface (×5) views of partly exfoliated valve. Marble City Member, loc. S5; OU 8558.

3e, ventral view (×4) of small valve provisionally referred to this species. Marble City Member, same locality as figures 3a, 3b; OU 8559.

Figures 4a–c.—*Lissostrophia* sp. Quarry Mountain Formation, eastern Oklahoma. 22

4a, ventral view (×5). Marble City Member, loc. S16; OU 8568.

4b, ventral view (×5). Barber Member, loc. S18; OU 8569.

4c, ventral view (×5). Same level and locality as figure 4b; OU 8567.

Figures 5a–j.—*Amphistrophia (Amphistrophia) sequoyensis* Amsden, n. sp. Quarry Mountain Formation, eastern Oklahoma. 18

5a, enlarged surface view (×5) of incomplete ventral valve, showing alternating costellae. Marble City Member, loc. S5; OU 8541.

5b, ventral view (×1) of holotype. Marble City Member, loc. S15-C; OU 8542.

5c, dorsal valve (×1). Marble City Member, loc. S18; OU 8544.

5d, 5e, ventral valve (×1) and enlarged surface view (×5) showing alternating rib pattern. Marble City Member, loc. S18; OU 8543.

5f, 5g, rubber cast and ventral steinkern (×3). Marble City Member, loc. S18; OU 8538.

5h, ventral valve (×2). Marble City Member, loc. S16; OU 8540.

5i, 5j, rubber cast and dorsal steinkern (×3). Same level and locality as figures 5f, 5g; OU 8539.

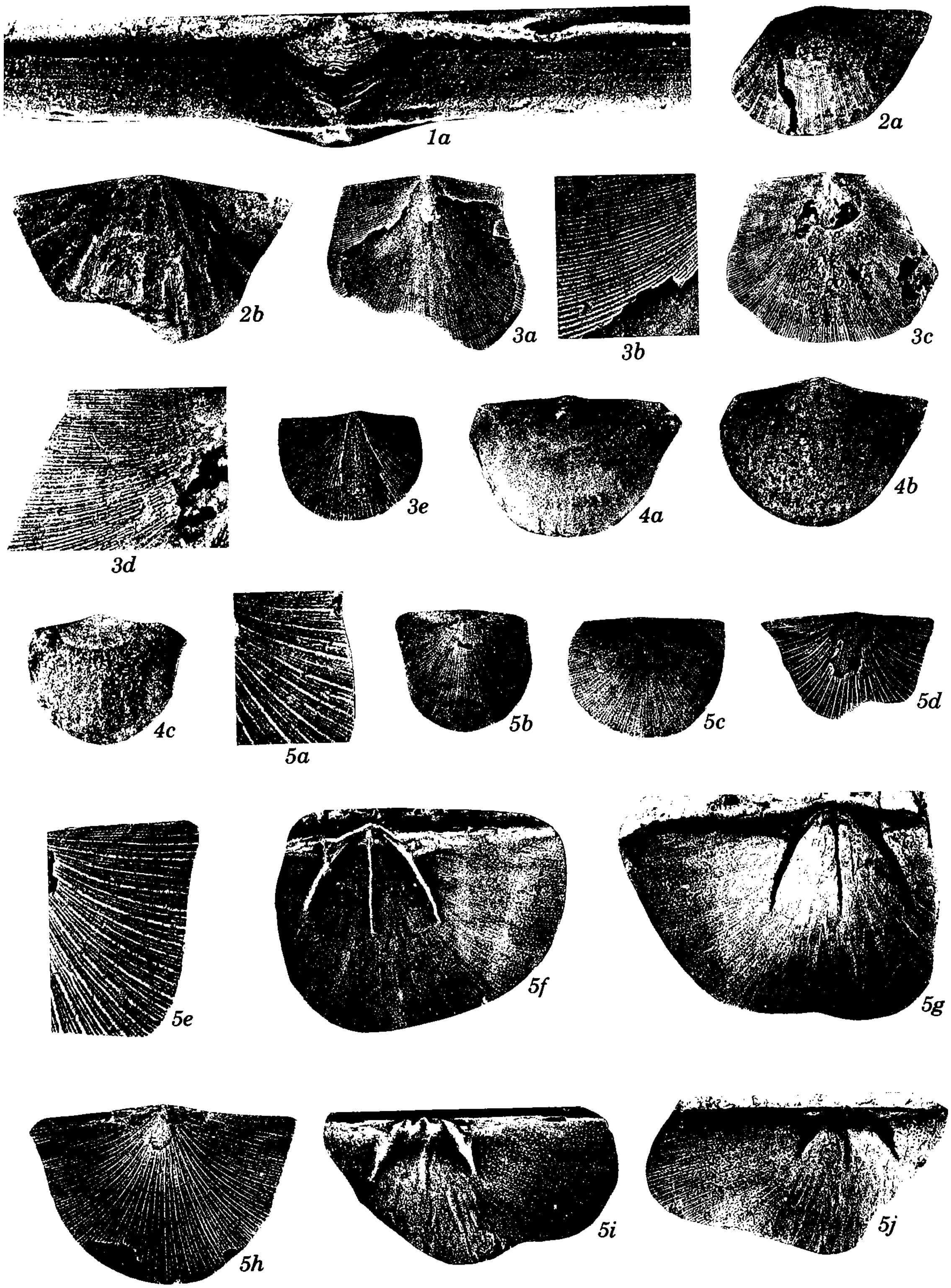
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Plate 8

LEPTAENA, LEPTOSTROPHIA, ATRYPA, LEANCELLA (OPIKELLA), STROPHONELLA
AMPHISTROPHIA, STROPHODONTA (BRACHYPRION)

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Figures 1a–c.—*Leptaena* sp. Quarry Mountain Formation, eastern Oklahoma. 23
1a, 1b, ventral views (×2, ×1). Loc. S18; OU 8561.
1c, ventral view (×1). Barber Member, loc. S18; OU 8560.

Figures 2a, 2b.—*Leptostrophia* sp. Quarry Mountain Formation, eastern Oklahoma. Ventral steinkern and rubber cast (×2). Same specimen illustrated on plate 7, figures 3a, 3b, with shell removed to show ventral muscle area; OU 8557. 23

Figure 3a.—*Leangella (Opikella) dissiticostella*? Amsden. Ventral view (×5). Quarry Mountain Formation, Barber Member, eastern Oklahoma, loc. S18; OU 8554. 23

Figures 4a, 4b.—*Atrypa petrotella* Amsden, n. sp. Quarry Mountain Formation, eastern Oklahoma. Other views of this species on plate 9, figures 3a, 3b. 39
4a, dorsal view (×1) of partly exfoliated shell. Marble City Member, loc. Ad1; OU 8576.
4b, ventral view (×3) of specimen with costellae extending into conspicuous frills. Barber Member, loc. S18; OU 8575.

Figures 5a–5d.—*Strophonella (Strophonella) prolongata* Foerste. Henryhouse Formation (Ludlovian), Arbuckle Mountain region, Oklahoma. 20
5a, 5b, dorsal interior and posterior views (×6) of same specimen, showing chilidium. Loc. P6 (Amsden, 1960, p. 276); OU 8527.
5c, ventral interior (×4) on incomplete valve. Loc. P18, NE¼SW¼ sec. 10, T. 2 N., R. 6 E.; OU 8519.
5d, posterior view (×6) of cardinal area, showing chilidium (above) and pseudodeltidium. Same locality as figure 5c; OU 8533.

Figure 6a.—*Strophonella (Strophonella)? laxiplicata* (Foerste). Posterior view (×6), showing chilidium (above) and pseudodeltidium. Loc. P1-K (Amsden, 1960, p. 266); OU 8534. 20

Figures 7a–c.—*Strophonella (Strophonella) loeblichi* Amsden. Henryhouse Formation (Ludlovian), Arbuckle Mountain region, Oklahoma. 20
7a, part of incomplete ventral interior (×3), showing muscle area, bounding ridge, and abbreviated denticulations. Loc. P1-Q (Amsden, 1960, p. 265); OU 8528.
7b, posterior view (×6), showing chilidium (above) and pseudodeltidium. Same locality as figure 5c.
7c, ventral interior (×2), showing well-defined muscle area. Cf. figure 5c. Henryhouse Formation, 114 to 159 feet above base, NE¼SW¼ sec. 10, T. 2 N., R. 6 E., Pontotoc County, Oklahoma (Amsden, 1951, pl. 20, fig. 38); USNM 115387.

Figures 8a–e.—*Strophodonta (Brachyprion) attenuata* Amsden. Henryhouse Formation, Arbuckle Mountain region, Oklahoma. 20
8a, posterior view (×6) of articulated shell, showing cardinal area extending across delthyrial region. Loc. P6 (Amsden, 1960, p. 276); OU 8531.
8b, oblique interior of ventral valve (×4), showing small median ridge, muscle area, and lack of bounding ridges. Same locality as figure 8a; OU 8530.
8c, ventral interior (×4), showing nearly completely denticulate hinge. Note absence of pseudodeltidium. Loc. P1-M (Amsden, 1960, p. 266); OU 8535.
8d, posterior view (×6) of articulated shell, showing cardinal area extending across delthyrial region with no evidence of pseudodeltidium. Same locality as figure 8a; OU 8537.
8e, posterior view (×6) of articulated shell. Same locality as figure 8a; OU 8657.

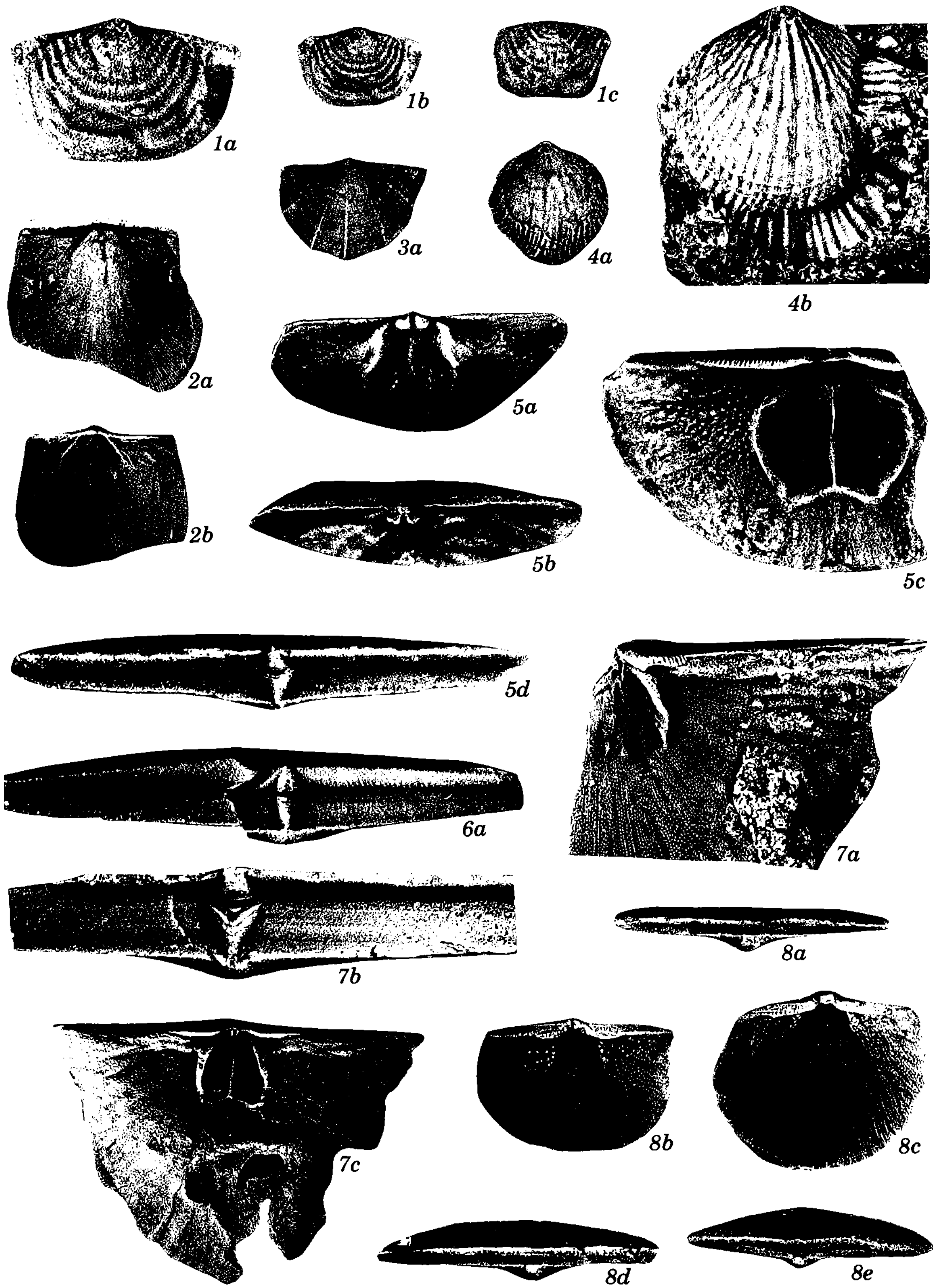
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Plate 9

ANCILLOTOECHIA, RHYNCHOTRETA, ATRYPA, STEGERHYNCHOPS

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Figures 1a–l.—*Ancillotoechia conspicuua* Amsden, n. sp. Quarry Mountain Formation, eastern Oklahoma. 24

1a–1d, lateral, ventral, dorsal, and posterior views (×3) of holotype. Marble City Member, loc. S9; OU 8571.

1e, 1f, lateral and dorsal views (×3) of shell with relatively shallow biconvexity. Marble City Member, loc. S15-C; OU 8573.

1g–k, posterior, dorsal, lateral, anterior, and ventral views (×3). Marble City Member, loc. S9; OU 8572.

1l, anterior view (×3). Marble City Member, loc. S5; OU 8574.

Figures 2a–d.—*Rhynchotreta,* cf. *R. cuneata* (Dalman). Quarry Mountain Formation, eastern Oklahoma. 26

2a–c, dorsal, ventral, and lateral views (×4) of incomplete shell. Barber Member (85 feet below top of Quarry Mountain Formation), loc. S18; OU 8589.

2d, dorsal view (×4) of specimen, showing concentric lirae. Same level and locality as figures 2a–c; OU 8588.

Figures 3a, 3b.—*Atrypa petrotella* Amsden, n. sp. Quarry Mountain Formation, eastern Oklahoma. . . . 39

3a, ventral view (×4) of holotype, showing well-developed frill. Marble City Member, loc. S15-A; OU 8577.

3b, ventral view (×4) of small specimen, showing incipient frill. Marble City Member, loc. S15-A; OU 8578. Other views of this species on plate 8, figures 4a, 4b.

Figures 4a–h.—*Stegerhynchops marblensis* Amsden, n. gen. and n. sp. Quarry Mountain Formation, eastern Oklahoma. 28

4a–d, posterior, dorsal, ventral, and lateral views (×3). Marble City Member (upper 30 feet), north of St. Clair Lime Quarry, NE¼SE¼NE¼ sec. 14, T. 13 N., R. 23 E., Sequoyah County, Oklahoma; OU 8587.

4e–h, posterior, dorsal, lateral, and anterior views (×3) of holotype. Same level and locality as figures 4a–d; OU 8586.

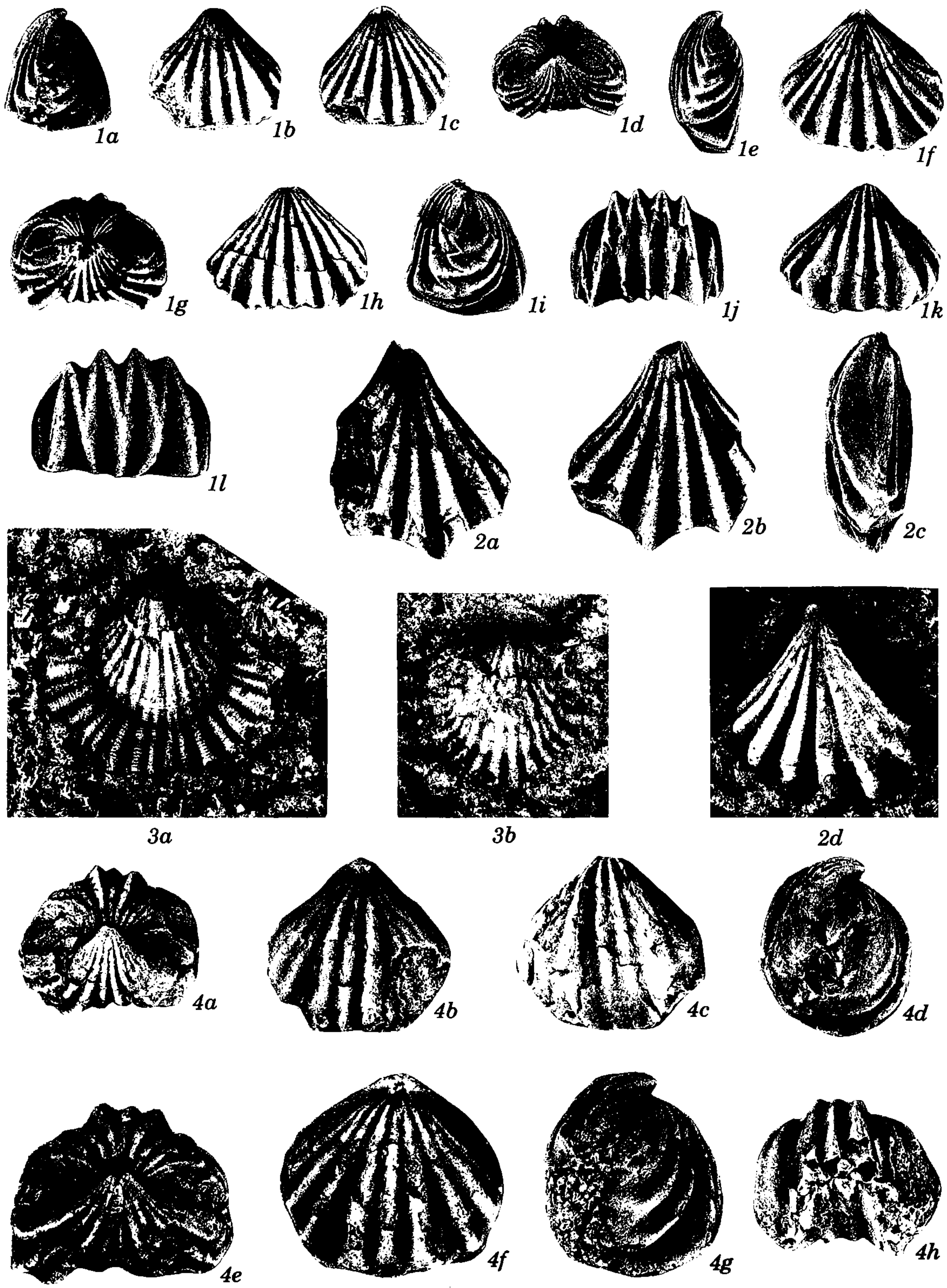
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Plate 10

STROPHONELLA, STROPHODONTA, LISSOSTROPHIA, HOMOEOSPIRA, PLECTATRYPA

Page

Figure 1a.—*Strophonella (Strophonella) loeblichi* Amsden. Oblique view (×4) of ventral interior, showing denticulation and pseudodeltidium. Henryhouse Formation (Ludlovian), 114 to 159 feet above base, NE¼SW¼ sec. 10, T. 2 N., R. 6 E., Pontotoc County, Oklahoma (Amsden, 1951, pl. 20, fig. 38; see also pl. 8, fig. 7c, this report); USNM 115387. 20

Figures 2a–c.—*Strophonella (Strophonella) bransoni* Amsden. Haragan Formation, Arbuckle Mountain region, Oklahoma. 20

2a, oblique view (×6) of dorsal interior, showing chilidium and denticulations. Old Hunton townsite, locality C1-K (Amsden, 1960, p. 182; figured in Amsden, 1958, pl. 4, fig. 19); OU 939.

2b, 2c, posterior views (×6) of two articulated shells, showing cardinal area, pseudodeltidium, chilidium, and denticulations. East of White Mound, loc. M2 (Amsden, 1960, p. 235); OU 8525 and 8526.

Figures 3a, 3b.—*Lissostrophia cooperi* Amsden. Henryhouse Formation, Arbuckle Mountain region, Oklahoma. 20

3a, dorsal view (×6) of articulated shell, showing cardinal area. Note absence of pseudodeltidium and chilidium. Loc. P5 (Amsden, 1960, p. 276); OU 8524.

3b, oblique dorsal view (×6) showing denticulate hinge. Note absence of any obvious pseudodeltidium. Same locality as figure 3a; OU 8523.

Figures 4a, 4b.—*Strophodonta (Brachyprion) arata* Hall. Haragan Formation, Arbuckle Mountain region, Oklahoma. 20

4a, posterior view (×6), showing cardinal area, chilidium, and denticulations. Loc. C1-J (Amsden, 1960, p. 182); OU 8521.

4b, posterior view (×6), showing chilidium. Loc. M2-M (Amsden, 1960, p. 235); OU 8520.

Figures 5a–d.—*Homoeospirella*? sp. Dorsal, lateral, anterior, and posterior views (×4). Quarry Mountain Formation, Marble City area (Christian collection); OU 8585. 40

Figure 6a.—*Strophodonta (Brachyprion) gibbera* Amsden. Posterior view (×6), showing pseudodeltidium, chilidium, and denticulations. Haragan Formation, loc. C1-K (Amsden, 1960, p. 182); OU 8522.

Figures 7a–i.—*Plectatrypa arctoimbricata* Amsden. Quarry Mountain Formation, eastern Oklahoma. . . 40

7a, 7b, dorsal and anterior views (×2). Marble City Member, loc. S1 (Christian collection); OU 8594.

7c, ventral view (×3), showing concentric lamellae. Marble City Member, loc. S15-C; OU 8591.

7d–f, anterior, lateral, and dorsal views (×2). Marble City Member, loc. S1 (Christian collection); OU 8590.

7g, ventral view (×3), showing concentric lamellae. Marble City Member, loc. S15-C; OU 8593.

7h, 7i, lateral and dorsal views (×2) of relatively large shell. Marble City Member, loc. S1 (Christian collection): OU 8592.

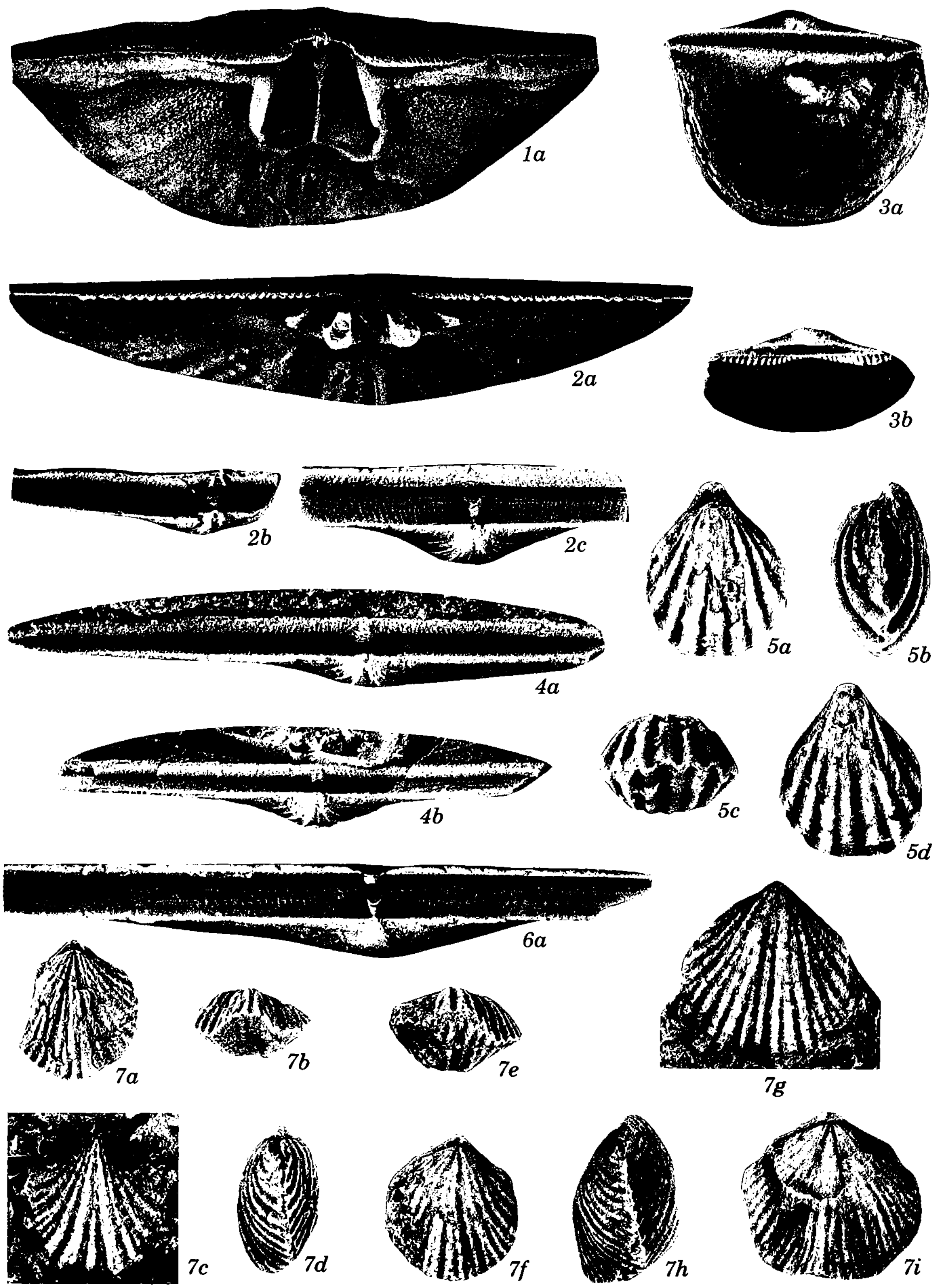
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Plate 11

STEGERHYNCHUS

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Figures 1-9.—*Stegerhynchus cliftonensis* Foerste. Topotype specimens borrowed from U.S. National Museum. Clinton bed, Clifton, Tennessee (collected by Foerste); mostly USNM accession no. 85163. 28

1a, dorsal view (×5) of steinkern, showing median septum, cruralium, and linear cardinal process. USNM 218092.

2a, dorsal view (×5) of steinkern, showing median septum, cruralium, and linear cardinal process. USNM 218093.

3a–d, ventral (×2), dorsal (×3), lateral (×2), and enlarged posterior (×5) views of steinkern. Note well-developed dental plates. USNM 218094.

4a, 4b, posterior (×5) and lateral (×2) views of steinkern. Note strong dental plates; low, relatively short dorsal median septum; and linear cardinal process. USNM 218098.

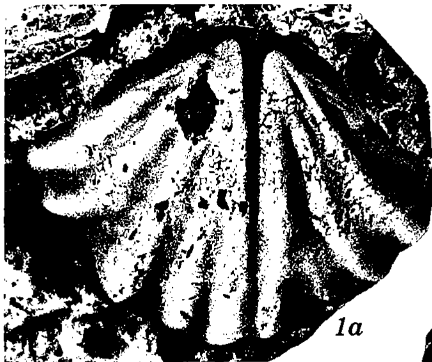
5a, ventral view (×5) of steinkern, showing dental plates. USNM 218095.

6a, anterior view (×2) of steinkern of shallow convexity. USNM 218096.

7a, ventral view (×5) of latex cast, showing costellae with well-developed fila. USNM 218097.

8a, posterior-oblique-dorsal view (×5) of steinkern. USNM 218099.

9a, 9b, ventral exterior mold and latex cast (×5), showing well-developed fila. Note two costellae in sulcus. USNM 218100.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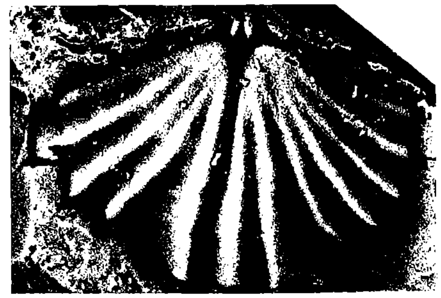
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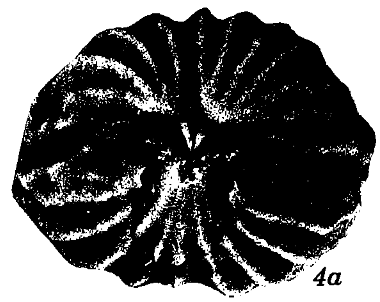
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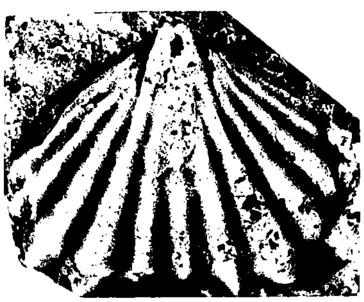
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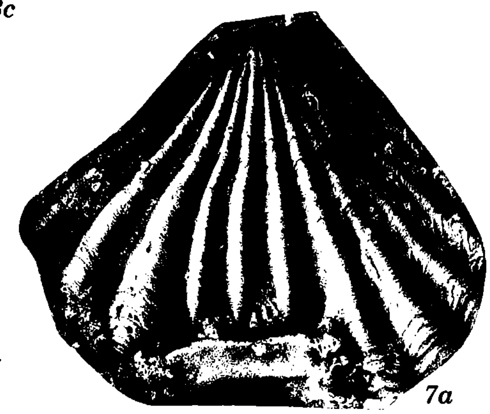
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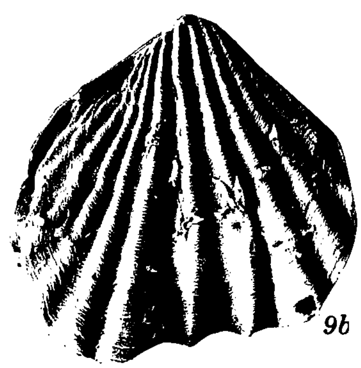
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Plate 12

PHOTOMICROGRAPHS, QUARRY MOUNTAIN FORMATION

Figure 1.—Photomicrograph from Marble City Member, showing abundant bryozoan and pelmatozoan material. A point count of this thin section shows: matrix (spar), 40 percent; pelmatozoan plates, 15.9 percent; bryozoans, 38.0 percent; ostracodes, 2.0 percent; unidentified fossil debris, 4.1 percent (expressed as percentage of total rock volume). Upper 30 feet of Marble City Member, St. Clair Lime Quarry, NE¼ sec. 14, T. 13 N., R. 23 E., Sequoyah County, Oklahoma (text-fig. 3); thin section from OGS collections.

Figure 2.—Photomicrograph from Marble City Member, showing brachiopod shells together with abundant pelmatozoan and bryozoan debris. Note articulated brachiopod shell at lower left. A point count of this thin section shows: matrix (spar), 39.2 percent; pelmatozoan plates, 16.4 percent; bryozoans, 16.0 percent; brachiopods, 11.7 percent; ostracodes, 0.4 percent; trilobites, 0.2 percent; unidentified fossil debris, 16.0 percent. Lower 20 feet of Marble City Member, SW¼SE¼SW¼ sec. 4, T. 14 N., R. 24 E., Malloy Hollow, Adair County, Oklahoma (Ad1); thin section from OGS collections.

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Plate 13

QUARRY MOUNTAIN FORMATION, TEXTURES

Figure 1.—Articulated shell of *Eospirifer* sp., which is unfilled with matrix except for some crystals of spar (slightly enlarged). Marble City Member, north end of St. Clair Lime Quarry, NE¼ sec. 14, T. 13 N., R. 23 E., Sequoyah County, Oklahoma; OGS collections.

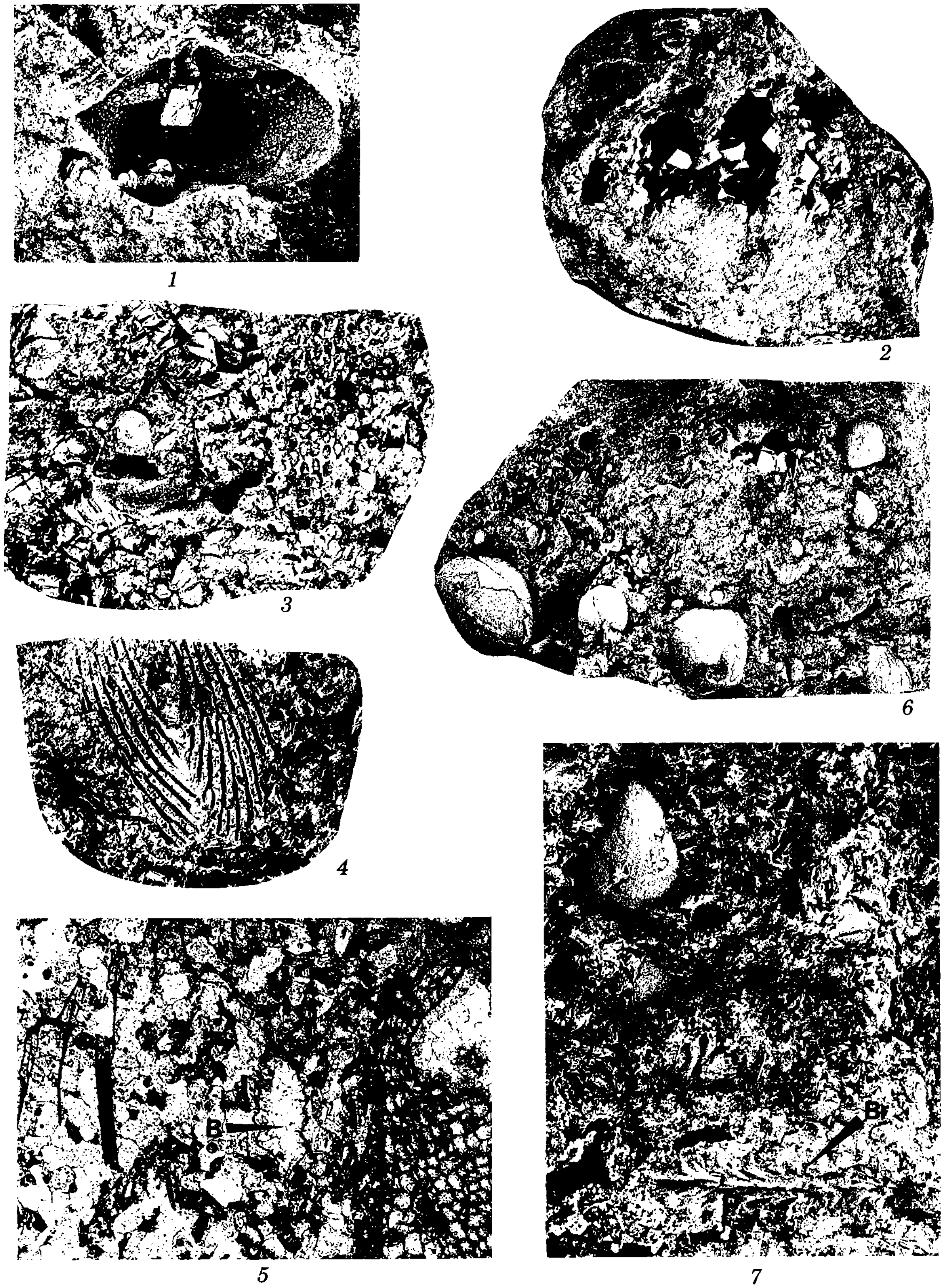
Figure 2.—Fragment of cephalopod shell that has been incompletely filled with matrix (slightly enlarged). Note spar crystals along siphuncle and septa. Barber Member, 85 feet below top of Quarry Mountain Formation, St. Clair Lime Quarry, SE¼NE¼ sec. 14, T. 13 N., R. 23 E., Sequoyah County, Oklahoma (S-18); OGS collections.

Figure 3.—Broken surface, showing bryozoan fragment, pelmatozoan plates, and trilobite fragment (×3). A point count of a thin section cut from this specimen shows: matrix (spar), 47.6 percent; pelmatozoans, 29.3 percent; bryozoans, 6.2 percent; brachiopods, 3.7 percent; trilobites, 1.1 percent; ostracodes, 0.7 percent; unidentified fossil debris, 11.4 percent (expressed as percentage of total rock volume). Barber Member, 85 feet below top of Quarry Mountain Formation, St. Clair Lime Quarry, same locality as figure 2 (S18); OGS collections.

Figure 4.—Broken surface, showing bryozoan fragment (×3). Marble City Member, St. Clair Lime Quarry, NE¼SE¼NE¼ sec. 14, T. 13 N., R. 23 E., Sequoyah County, Oklahoma; OU 8563.

Figure 5.—Photomicrograph, showing abundant bryozoan material and articulated brachiopod shell (*B*) (×10). A point count of this thin section shows: matrix (spar), 37.4 percent; pelmatozoan plates, 20.7 percent; bryozoans, 28.4 percent; brachiopods, 3.6 percent; ostracodes, 0.9 percent; trilobites, 0.5 percent. Marble City Member, upper 30 feet, north part of St. Clair Lime Quarry, NE¼SE¼NE¼ sec. 14, T. 13 N., R. 23 E., Sequoyah County, Oklahoma; OGS collections.

Figures 6, 7.—Broken surface, showing articulated brachiopods, pelmatozoan plates, trilobites, and bryozoan (*Br*) (×1½ and ×5). Thin section illustrated on plate 12, figure 2, was cut from this specimen; same level and locality.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