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**DEPARTMENT OF ENERGY,  
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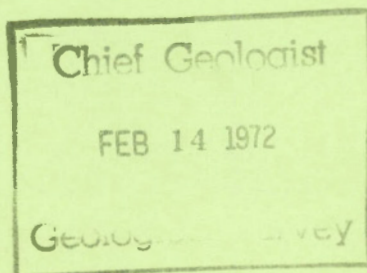
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**BULLETIN 204**

**BRACHIOPODS OF THE  
DETROIT RIVER GROUP (DEVONIAN)  
FROM SOUTHWESTERN ONTARIO  
AND ADJACENT AREAS OF  
MICHIGAN AND OHIO**

**J. A. Fagerstrom**



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Ottawa  
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1971

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DEPARTMENT OF  
ENERGY, MINES AND RESOURCES  
CANADA

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## PREFACE

The Devonian rocks of southwestern Ontario are a part of the eastern flank of the Michigan Basin; they comprise a thick sequence of carbonate and evaporite deposits that have contributed a large quantity of oil and gas to the economic wealth of Canada for over 50 years. In spite of their long history of exploration, development continues and there is a continuing need for geological investigation. This report presents the results of a paleontological study of the Detroit River Group, a widely distributed group of rocks consisting of three formations, each with a characteristic fossil assemblage. The results of the study are applied to problems of correlation within the Michigan Basin and establish the relationship between the succession there and other North American and European Devonian sequences.

Y.O. Fortier,  
Director,  
Geological Survey of Canada

Ottawa, July 13, 1970

BULLETIN 204 — Armfüßer der devonischen  
Detroit-River-Gruppe aus dem südwestlichen On-  
tario und den angrenzenden Gebieten in Michi-  
gan und Ohio  
Von J. A. Fagerstrom

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БЮЛЛЕТЕНЬ 204 — Брахиоподы группы р. Де-  
тройт (девон) юго-западной части Онтарио и  
смежных районов Мичигана и Огайо.  
Джон А. Фагерстром

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BRACHIOPODS OF THE DETROIT RIVER GROUP (DEVONIAN)  
FROM SOUTHWESTERN ONTARIO AND ADJACENT  
AREAS OF MICHIGAN AND OHIO

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ABSTRACT

The Detroit River Group is a widely distributed sequence of carbonate and evaporite deposits in the Michigan Basin and adjacent parts of the craton. In the type area, these rocks can be lithologically subdivided as follows (in ascending order): Amherstburg Dolomite, Lucas Dolomite, and Anderdon Limestone. Each of these formations is also characterized by its distinctive fossil assemblage. However, neither the formations nor the fossils maintain their identity much beyond the type area; in northwestern Ohio the section consists entirely of dolomite (the Lucas) whereas near Ingersoll, Ontario the rocks are all limestone (Detroit River Group, undifferentiated).

The most diagnostic megafossils in the Detroit River belong to the brachiopod genus *Prosserella* which originally included seven named species and subspecies; the genus is herein revised to two species, *P. modestoides* and *P. lucasi*. The total brachiopod fauna consists of sixty-seven species, of which forty-five are herein described (including three new species, *Camarotoechia(?) ehlersi*, *Meristella(?) livingstonensis*, and *Cranaena boucoti*).

Fifty-one species are restricted to the Detroit River and five additional species are long-ranging forms present both in rocks older and younger than the Detroit River; these fifty-six species have only limited value in correlation. The geographic and stratigraphic distribution of the remaining eleven species (plus *Cranaena boucoti* possibly) indicate that the Amherstburg Dolomite is correlative with the Edgecliff Member of the Onondaga Limestone in New York, Zones A-F (after Stauffer, 1909) of the lower Columbus Limestone in Ohio, the upper five feet of the "Coral Zone" (after Campbell, 1942) of the Jeffersonville Limestone at the Falls of the Ohio River, and the upper Dutch Creek Sandstone and lower Grand Tower Limestone in southwestern Illinois. Similarly, the Anderdon Limestone is correlative with the upper Onondaga, Zone H of the Columbus, the *Paraspirifer acuminatus* Zone of the Jeffersonville, and the upper Grand Tower below the occurrence of *Brevispirifer lucasensis*. These correlations are partially supported by the stratigraphic distribution of the range-zones of the following important genera in the Detroit River and correlative rocks: *Spinulicosta*, *Atribonium*, *Camarospira*, *Metaplasia*, and *Cranaena*.

All of the Detroit River species are confined to the Appalachian Faunal Province and so cannot be used for intercontinental correlation. Furthermore, the limits of the Detroit River generic range-zones overlap the Lower Devonian-Middle Devonian boundary or else the limits are so poorly known that they are of uncertain value in intercontinental correlation. However, conodonts and goniatites in the upper Onondaga and Columbus indicate that these rocks are of Eifelian (Middle Devonian) age; the Anderdon must therefore also be Eifelian. The age of the Lucas and Amherstburg is uncertain; these formations could be either lower Eifelian (Middle Devonian) or upper Emsian (Lower Devonian).

RÉSUMÉ

Le groupe de la rivière Détroit est une séquence très étendue de dépôts de carbonates et d'évaporites, située dans le bassin du Michigan et dans les parties adjacentes du craton. Dans la zone type, on peut répartir les roches d'après la lithologie, comme suit (ordre croissant): dolomie Amherstburg, dolomie Lucas, et calcaire Anderdon. Chacune de ces formations est également

caractérisée par l'assemblage particulier de ses fossiles. Cependant pas plus les formations que les fossiles ne conservent leurs caractères identifiables au-delà du type; au nord-ouest de l'Ohio la coupe est formée entièrement de dolomie (Lucas), tandis qu'aux environs d'Ingersoll, en Ontario, la roche est composée entièrement de calcaire (groupe de la rivière Détroit, non-différencié).

Les mégafossiles les plus caractéristiques du groupe de la rivière Détroit appartiennent au genre des brachiopodes *Prosserella* qui à l'origine comportait sept espèces et sous-espèces connues; on a réduit, dans le présent ouvrage, le nombre des espèces à deux *P. modestoides* et *P. lucasi*. Le groupe entier des brachiopodes comprend soixante-sept espèces, dont quarante cinq sont décrites dans le présent ouvrage (dont trois nouvelles espèces, *Camarotoechia(?) ehlersi*, *Meristella(?) livingstonensis*, et *Cranaena boucoti*).

Cinquante et une de ces espèces ne se trouvent que dans le groupe de la rivière Détroit, et cinq autres espèces sont beaucoup plus courantes et se rencontrent à la fois dans des roches plus anciennes et plus jeunes que celles de la rivière Détroit; ces cinquante-six espèces présentent peu de valeur pour les questions de corrélation. La répartition géographique et stratigraphique des onze autres espèces (ainsi que de l'espèce *Cranaena boucoti*, éventuellement) indique que la zone à dolomie Amherstburg correspond au membre Edgecliff du Calcaire Onondaga, à New York, Zones A-F (d'après Stauffer, 1909), du Calcaire Colombus inférieur en Ohio, aux cinq pieds situés dans la partie supérieure de la "Coral Zone" (d'après Campbell, 1942) au Calcaire Jeffersonville des chutes de la rivière Ohio, et au Grès Dutch Creek supérieur et au Calcaire Grand Tower inférieur au sud-ouest de l'Illinois. De même le Calcaire Anderdon correspond à l'Onondaga, zone H de Columbus, avec la zone *Paraspirifer acuminatus* de Jeffersonville au Grand Tower inférieur sous-jacent à la venue de *Previspirifer lucasensis*. Ces correspondances sont partiellement supportées par la répartition stratigraphique des genres importants suivants dans les roches de la rivière Détroit et les roches correspondantes; *Spinulicosta*, *Atribonium*, *Camarospira*, *Metaplasia* et *Cranaena*.

Toutes les espèces présentes dans les roches de la rivière Détroit ne se rencontrent que dans la province faunique des Appalaches, et par suite ne peuvent servir à ses correspondances intercontinentales. De plus, les limites de répartition des genres dans les roches de la rivière Détroit chevauchent la limite entre le Dévonien inférieur et le Dévonien moyen, ou sinon, elles sont si mal connues qu'elles ne peuvent pas servir avec précision à établir des correspondances intercontinentales. Néanmoins, les conodontes et les goniatites de l'Onondaga supérieur et du Columbus indiquent que ces roches datent de l'Eifelien (Dévonien moyen): celles de l'Anderdon doivent donc également dater de l'Eifelien. L'âge du Lucas et de l'Amherstburg est incertain; ces formations pourraient dater soit de l'Eifelien inférieur, (Dévonien moyen), soit de l'Emsien supérieur (Dévonien inférieur).

## INTRODUCTION

The rocks of the Detroit River Group include a rather heterogeneous assemblage of limestone, dolomite, and evaporite deposits; clastic materials are absent except for very local sandy limestone and oolitic beds. Fossils are mostly restricted to the carbonate units and include a rather unique brachiopod fauna having very little similarity with contemporaneous faunas in eastern North America. The Detroit River is widely distributed throughout the region of the Michigan Basin and also in adjacent portions of the craton in southwestern Ontario and in central Ohio east of the Findlay Arch (*see* Fig. 1). The outcrops from which the brachiopods described in this report were collected are restricted to the rim of the Michigan Basin in southwestern Ontario, southeastern Michigan, and northwestern Ohio (*see* Appendix I).

The Lower and Middle Devonian stratigraphic sequence in the Michigan Basin consists largely of carbonate rocks beginning with the Bois Blanc Limestone; locally in northern Michigan the Garden Island Formation underlies the Bois Blanc. The Detroit River Group succeeds the Bois Blanc except along the axis of the Findlay Arch and in southeastern Michigan where the Sylvania Sandstone intervenes. The Dundee Limestone in Michigan and northwestern Ohio and the Delaware Limestone in southwestern Ontario disconformably overlie the Detroit River and are in turn overlain by clastic rocks of the Hamilton Group.

In central Ohio the Bois Blanc Limestone and the Sylvania Sandstone are absent, except for about three inches of Sylvania reported by Dow (1962, p. 26) from a well near Sandusky; elsewhere the Detroit River unconformably overlies Upper Silurian rocks of the Bass Islands Group. The Detroit River in this area consists of brown, sparsely fossiliferous dolomite and is conformably overlain by coarsely crystalline grey limestone of the Columbus (Carman, 1927, pp. 500-502).

## Acknowledgments

Numerous individuals and institutions have contributed to this study in a variety of ways.

The major systematic work was done during a leave-of-absence granted by the Regents of the University of Nebraska which enabled the author to accept appointment as a Visiting Research Associate at the California Institute of Technology in Pasadena. During my stay at Caltech (1965) I was extended numerous courtesies by the staff; I am particularly indebted to A.J. Boucot, J.G. Johnson, and K. Lal Gauri for numerous consultations and advice on the preparation and identification of the fossil material. In addition, Dr. Boucot generously allowed access to his extensive collection of Devonian brachiopods and to his personal library.

The project could not have been undertaken without the loan of specimens by the following: D.J. McLaren, Geological Survey of Canada; E.C. Stumm, University of Michigan; F.M. Swain, University of Minnesota; J.W. Wells, Cornell University; C.G. Winder, University of Western Ontario; G.A. Cooper, U.S. National Museum; N.D. Newell, American Museum of Natural History; J. Monteith and R.R.H. Lemon, Royal Ontario Museum. Drs. McLaren and Cooper also helped on the identification of *Camarotoechia*(?) *ehlersi* and *Meristella*(?) *livingstonensis*, respectively.

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W.A. Oliver, Jr., U.S. Geological Survey and B.V. Sanford, Geological Survey of Canada also provided important information on fossil collection localities and stratigraphy. R.F. Diffendal, Jr. accompanied the author in the field during the summers of 1964 and 1966.

The manuscript was completed during the summer of 1967 when the author held a Summer Faculty Fellowship awarded by the University of Nebraska Research Council. Other financial support was provided through grants from the American Philosophical Society for field and laboratory expenses in 1964 and the Society of Sigma Xi for field expenses in 1966. Preliminary drafting was done by H. Carr and A. Carter, D. Peabody, and M. Gruner typed the original manuscript.

To all of the above, the author is extremely grateful. Without their help and interest the completion of the project would have been impossible.

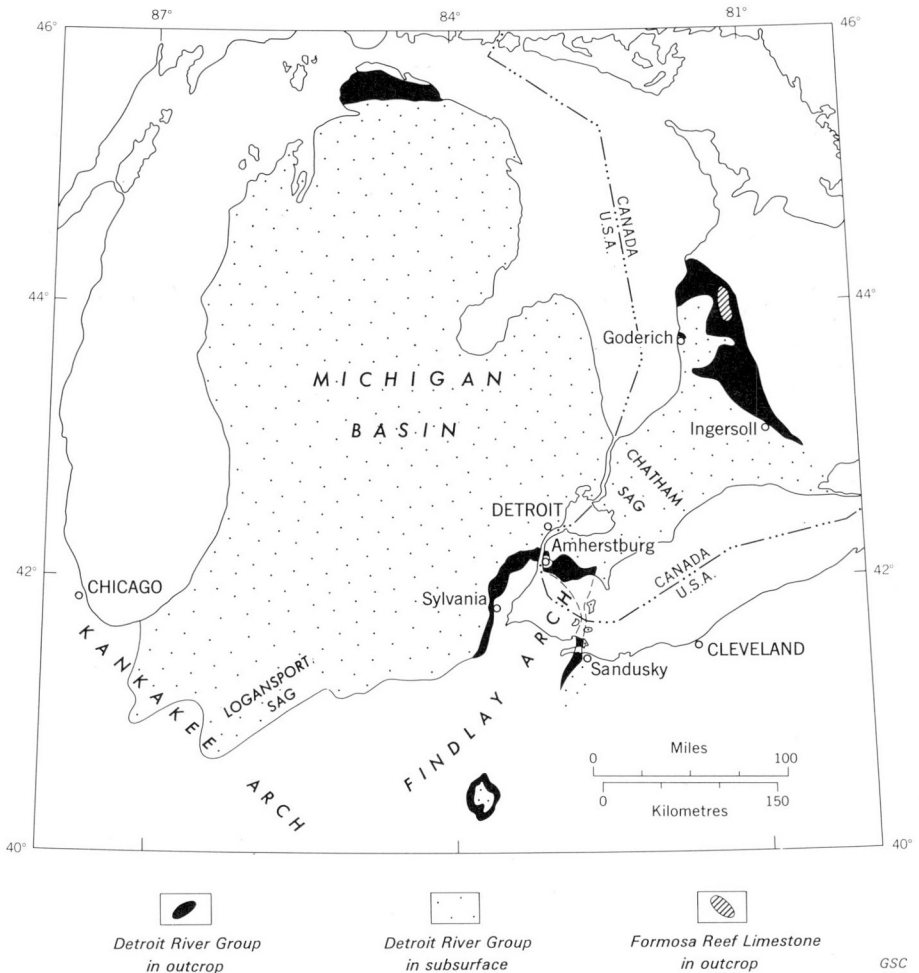


Figure 1. Index map of Michigan Basin and adjacent areas showing distribution of Detroit River Group (after Carman, 1927; Ehlers, Stumm, and Kesling, 1951; Martin, 1936; Pinsak and Shaver, 1964; Sanford, 1958; Sanford and Brady, 1955).

## STRATIGRAPHY

### Rock-stratigraphic Units

#### Nomenclature

The name Detroit River Group was proposed by Lane, Prosser, Sherzer, and Grabau (1909, p. 555) for a succession of dolomite and limestone strata exposed along the Detroit River and near Sylvania, Ohio. They included four formations, considered by them to be stratigraphically arranged in ascending order as Flat Rock Dolomite, Anderdon Limestone, Amherstburg Dolomite, and Lucas Dolomite. This usage of the name Detroit River was retained in numerous subsequent reports until Carman (1936) noted the stratigraphic and faunal similarities between the Detroit River and the underlying Sylvania Sandstone and urged that the Sylvania be included with the Detroit River. Carman's suggestion was adopted by most subsequent workers.

The complete succession of rock-stratigraphic units as listed by Lane, Prosser, Sherzer, and Grabau (1909, p. 555) has never been exposed at a single locality, except for a brief period during the excavation of a salt shaft in Detroit, Michigan. This lack of continuous exposure led to considerable difficulty in the correlation of these rocks among the various outcrops in southwestern Ontario, southeastern Michigan, and northwestern Ohio. Ehlers (1950) revised the stratigraphic succession and eliminated the Flat Rock as a separate unit; the sequence of formations in the Detroit River Group, in ascending order, was given as Sylvania Sandstone, Amherstburg Dolomite, Lucas Dolomite, and Anderdon Limestone. Landes (1951) and Sanford (1967) adopted essentially this same sequence but considered the Sylvania as a member of the Amherstburg.

Despite the faunal similarity between the Sylvania Sandstone and the overlying Amherstburg Dolomite, these two rock-stratigraphic units are strikingly dissimilar lithologic entities and therefore the Sylvania should not be included as the basal formation of the Detroit River Group. In the usage of Detroit River for the present report it consists largely of carbonate rocks and includes, in ascending order, the Amherstburg Dolomite, the Lucas Dolomite, and the Anderdon Limestone (*see* Table 1). In the type area of the Detroit River, each of these formations can be recognized as separate lithologic units but when they are followed into the Michigan Basin and on the adjacent platform, these differences become less distinct (Briggs, 1959).

The name Amherstburg was first used by Sherzer and Grabau (1909, pp. 542, 543) for an abundantly fossiliferous "bed" in "the bottom of the eastern (*or Amherstburg*) channel of the Detroit River opposite Amherstburg, Ontario" (my italics). This is Locality J, Appendix I. No rocks have ever been exposed at this locality but the channel was deepened by dredging during the early 1900s and the fossiliferous dolomite was piled along the Ontario shore of the river. It was largely from these blocks that Rev. Thomas Nattress collected the fossils described by Grabau and Sherzer (1910) as occurring in the Amherstburg. Thus, the type section of the Amherstburg was never examined by Sherzer and Grabau and both the name and the major portion of the fauna were based on dredged material.

However, from 1904 to about 1912 essentially the same rocks and fossils were exposed in a small anticline in the cut just east of Stony Island at the north end of the Livingstone Channel in the Detroit River (Locality I, Appendix I). Grabau and Sherzer (1910) regarded all of the rocks exposed in the Livingstone Channel as Amherstburg, but more recent workers have recognized that the lower Lucas was also present in the channel (LaRocque, 1950, p. 335; Ehlers, Stumm, and Kesling, 1951, p. 9). G.M. Ehlers (pers. comm.) restricts the Amherstburg to about 10 feet of dark brown, porous, coarsely crystalline dolomite containing an abundant coral and mixed-brachiopod fauna formerly exposed only in the cut just east of Stony Island. Unfortunately, this same combination of lithology and faunal abundance and diversity is not presently exposed in the Amherstburg area.

Table 1

Generalized historical development of  
rock-stratigraphic nomenclature in the type area  
of the Detroit River Group and the Sylvania Sandstone

Lane, <i>et al.</i> , 1909	Carman, 1936	Ehlers, 1950	Present report
Detroit River Series (or Upper Monroe)	Detroit River Group	Detroit River Group	Detroit River Group
Lucas Dolomite	Lucas	Anderdon Limestone	Anderdon Limestone
Amherstburg Dolomite	Amherstburg	Lucas Dolomite	Lucas Dolomite
Anderdon Limestone	Anderdon	Amherstburg Dolomite	Amherstburg Dolomite
Flat Rock Dolomite	Flat Rock	Sylvania Sandstone	Sylvania Sandstone
Middle Monroe	Sylvania		
Sylvania Sandstone			

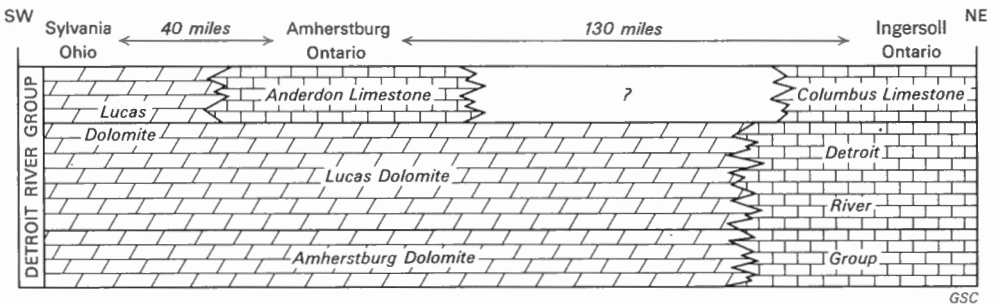


Figure 2. Generalized lithofacies relations among the various rock-stratigraphic units of the Detroit River Group.

In the vicinity of Sylvania, Ohio the section between the Sylvania Sandstone and the Dundee Limestone consists of about 125 feet of tan to light brown, moderately coarse-textured, dense dolomite named the Lucas by Prosser (1903, p. 541). Fossils are neither abundant nor diverse in the type Lucas (Locality A, Appendix I). Rocks of similar lithology are widely distributed in the Michigan Basin (where they contain interbedded evaporite deposits) and on the adjacent platform. In southeastern Michigan and the Livingstone Channel, strata correlated with the Amherstburg are overlain by brown dolomite containing an abundant but taxonomically restricted gastropod and *Prosserella* fauna. This same fauna is also present near Sylvania, Ohio in the middle portion of the Lucas as defined by Prosser, and subsequent authors (e.g. Ehlers, Stumm, and Kesling, 1951) have restricted the name Lucas to these gastropod-bearing beds. In the present report the term Lucas is used as originally defined by Prosser; it differs from the type Amherstburg in being lighter coloured, more finely crystalline, and somewhat less porous.

The name Anderdon was first used in an abstract (Sherzer and Grabau, 1908) and then more fully discussed and defined in later publications by Sherzer and Grabau (1909) and Lane, Prosser, Sherzer, and Grabau (1909); it is the same as the "Corniferous Limestone" of Nattress (1902, p. 126). The type Anderdon (Locality K, Appendix I) consists of about 25 feet of very pure, grey, fine-grained limestone. The fauna listed by Sherzer and Grabau (1910, p. 44) was collected from a reef about 6-8 feet thick which is no longer exposed; Ehlers, Stumm, and Kesling (1951, pp. 11-13) described the Anderdon as rather uniformly bedded, grey limestone and noted the presence of an unusual gastropod fauna in the upper 7-8 feet (Linsley, 1968). This same combination of lithology and fauna is not exposed elsewhere at present.

During the early 1900s a shaft was excavated in Oakwood, Michigan (a suburb in southern Detroit) to obtain salt from the deeply buried Silurian deposits. This shaft (Locality H, Appendix I) penetrated the entire thickness of the Detroit River Group and the section was briefly described by Grabau and Sherzer (1910, pp. 41, 45-46, 51) and Sherzer (1913, Fig. 21). Unfortunately, the nomenclature and correlations used by these authors were incorrect and have been a source of considerable subsequent confusion.

In the vicinity of Amherstburg, Ontario, the exposures of the Detroit River Group at this time included two coral-rich units, the Amherstburg in the bed of the river and the Anderdon in the quarry north of town. The salt shaft penetrated only one coral-rich unit and Grabau and Sherzer (1910) and Sherzer (1913) incorrectly correlated this with the Anderdon. Fagerstrom (1961a, p. 45) has discussed one possible revision of the salt shaft succession and concluded that beds called Flat Rock and Anderson (an obvious misspelling of Anderdon) by Sherzer (1913, Fig. 21) are probably correlative with the type Amherstburg and that the Anderdon is either absent from the salt shaft or has been included with the Dundee. The chief difficulty with this revision is that at the type locality of the Amherstburg, less than 12 miles to the south, this formation is only about 10-17 feet thick, whereas in the salt shaft the sum of the thicknesses for Sherzer's Flat Rock and Anderdon is 85 feet. This relatively great discrepancy in thickness may be partly the result of reef development causing local thickening of some of the units. Alternatively, the coral-bed of the salt shaft may be equivalent to the gastropod-bearing dolomite above the type Amherstburg in the Livingstone Channel and to the middle portion of the type Lucas near Sylvania, Ohio. However, since the fauna of the salt shaft coral-bed is very similar to the fauna of the type Amherstburg, the coral-bed is questionably referred to that formation in the present report.

#### Contacts

In their original summary of the stratigraphic section along the Detroit River, Lane, Prosser, Sherzer, and Grabau (1909, p. 556) indicated that the contact between the Sylvania Sandstone and the overlying Detroit River Group was



disconformable. This same relation was repeated by Sherzer and Grabau (1910, pp. 27, 40). However, Carman (1927; 1936) described the gradational nature of the Sylvania-Amherstburg contact and the faunal similarity between these units and correctly concluded that the contact was conformable.

In southwestern Ontario, except locally in Essex County (see Reavely and Winder, 1961), the Detroit River overlies the Bois Blanc Limestone. The contact is nowhere exposed but subsurface evidence suggests that it is also gradational (Sanford, 1967); Sanford and Brady (1955) logged the Detroit River and Bois Blanc as a single unit. Best (1953) regarded the contact as conformable but in the Michigan Basin Landes (1951) and Sanford (1967) described the same contact as unconformable. In central Ohio the Detroit River unconformably overlies Upper Silurian rocks.

Throughout the area of the Michigan Basin and on the adjacent platform the upper contact of the Detroit River with the overlying Dundee or Delaware Limestone is unconformable. However, in central Ohio the Detroit River is overlain by the Columbus Limestone. Stauffer (1909) regarded the contact as unconformable but Carman (1927, pp. 500-502) described it as conformable; in the present report the contact is regarded as conformable.

Ehlers and Stumm (1951) described a section of sandstone and sandy limestone about 15 feet thick in the wall of a quarry just northeast of Ingersoll, Ontario (Locality 22984, Appendix I) containing a fauna similar to the uppermost beds (zone H of Stauffer, 1909) of the Columbus Limestone in Ohio. These authors described the lower contact of their "Columbus Limestone" near Ingersoll as unconformable with the underlying Detroit River Group. However, detailed examination of the contact by the present writer indicates that it is probably conformable.

In summary, the Detroit River Group in the usage of the present report is a relatively unified sequence of carbonate rocks with occasional interbedded sandstone and evaporite deposits (Landes, 1951) that is sharply delimited in most areas from the underlying and overlying strata. The nomenclature of the Detroit River formations and their generalized lithofacies relations as used in the present report are given in Figure 2.

#### Biostratigraphic Units

When Lane, Prosser, Sherzer, and Grabau (1909, pp. 555, 556) originally discussed the nomenclature and subdivision of the rocks of the Detroit River Group they included the following sequence of biostratigraphic zones:

	Lucas Dolomite. Zone of <i>Cylindrohelium profundum</i> and <i>Acanthonema</i>
Detroit River Series	Amherstburg Dolomite. Zone of <i>Parænka canadensis</i>
Zone of <i>Prosserella</i>	Anderdon Limestone. Zone of <i>Idiostroma nattressi</i>
	Flat Rock Dolomite. Zone of <i>Syringopora cooperi</i>

The distribution of the genus *Prosserella* is nearly coincident with the geographic and stratigraphic limits of the Detroit River Group and the Sylvania Sandstone. The Pendleton Sandstone in north-central Indiana is the only other named rock-stratigraphic unit from which specimens of this genus are known. Although fossils are generally not abundant in the Detroit River and Sylvania, specimens of *Prosserella lucasi* and *P. modestoides* are present, often in large numbers and occasionally as the only fossils, at almost every fossiliferous outcrop of these rocks in Ontario, Michigan, and Ohio. The chief exceptions are reefs and coral-rich biostromes but even in these rocks a few specimens of *Prosserella* are generally present (Fagerstrom, 1966a).

The zonal index species and/or genera for each of the formations in the Detroit River Group were chosen by Lane, Prosser, Sherzer, and Grabau (1909) because they were characteristic of, restricted to, or abundant in their particular zone. However, the present writer has encountered considerable difficulty in recognizing these formal zones.

As noted by Ehlers (1950), the Flat Rock cannot be distinguished from the Amherstburg and therefore the name has been dropped from formal rock-stratigraphic nomenclature. Similarly, the *Syringopora cooperi* Zone is of very questionable validity. This species was known from only one locality (Grabau and Sherzer, 1910, p. 118) and the type specimen is too poorly preserved for identification. As the accompanying fauna (Sherzer and Grabau, 1909, p. 546; Grabau and Sherzer, 1910, pp. 115, 118, 119) is similarly of uncertain taxonomic validity, the *Syringopora cooperi* Zone is herein dropped from formal biostratigraphic nomenclature until additional well-preserved material becomes available.

Lane, Prosser, Sherzer, and Grabau (1909, p. 555) regarded *Panenka canadensis* as characteristic of, although not restricted to the Amherstburg Dolomite. This species, presently known from a single specimen from the Amherstburg, was also reported in the Lucas (LaRocque, 1950, p. 325). Neither of the original localities is available for additional collecting. In the opinion of the present writer, this species is not characteristic of the Amherstburg (see discussion of Locality I, Appendix I); the fauna from this formation consists, instead, of an abundant and diverse assemblage of corals and brachiopods (Sherzer and Grabau, 1909, pp. 547-549). Therefore, because of the apparent uncertainty regarding the stratigraphic distribution of *P. canadensis* in the Detroit River, it is suggested that this name be dropped from formal biostratigraphic nomenclature and that rocks formerly assigned to this zone be informally called the "coral-mixed brachiopod subzone" until the entire faunal assemblage has been restudied and a new zonal index species formally designated.

The fauna from exposures along the Detroit River regarded by Lane, Prosser, Sherzer, and Grabau (1909) as correlative with the type Lucas consists largely of endemic gastropods (e.g. *Acanthonema holopiforme* and *Murchisonia subcarinata*) and the nearly ubiquitous brachiopod *Prosserella lucasi*. In northwestern Ohio where the Lucas is the only formation of the Detroit River Group present, the fauna is somewhat more diverse and in the lower part includes some of the same fossils as the "coral-mixed brachiopod subzone". Lane, Prosser, Sherzer, and Grabau (1909) incorrectly regarded the entire type Lucas as correlative with just their *Acanthonema* or *Cylindrophyllum profundum* Zone along the Detroit River. However, subsequent detailed study of these rocks (Ehlers, Stumm and Kesling, 1951) indicated that the fauna of this zone is restricted to the middle Lucas at the type section and therefore that the *Acanthonema*-bearing rocks are not correlative with the entire Lucas as defined by Prosser (1903, pp. 540, 541) and as used in the present report. These relations are shown in Table 2.

The internal features of *Cylindroheliolum* Grabau (Grabau and Sherzer, 1910, p. 102) are largely unknown and so the genus has been regarded as being of uncertain validity or as synonymous with *Cylindrophyllum* (Hill, 1956, p. F280). Therefore, it is proposed that the formal name of this biostratigraphic unit be changed to the *Acanthonema holopiforme* Subzone.

Lane, Prosser, Sherzer, and Grabau (1909, pp. 555, 556) designated the *Idiostroma nattressi* Zone as coincident with the Anderdon Limestone. The original description of this species was based on some specimens from the "coral bed" of Oakwood, Michigan salt shaft (Grabau and Sherzer, 1910, Pl. 8, figs. 2, 3); however, as noted previously, these rocks are no longer considered to be correlative with the type Anderdon. Furthermore, in their revision of the Detroit River stromatoporoids, Galloway and Ehlers (1960, pp. 99-101) eliminated the salt shaft specimens from this species and placed the species in the genus *Amphipora*. Thus, on the basis of current information, *Amphipora*

Table 2.

Comparison of Rock-stratigraphic and biostratigraphic nomenclature in the type area of the Detroit River Group

Sylvania, Ohio		Amherstburg, Ont.
Lucas Dolomite	<i>Amphipora nattressi</i> Subzone	Anderdon Limestone
	<i>Acanthonema holopiforme</i> Subzone	Lucas Dolomite
	"coral-mixed brachiopod subzone"	Amherstburg Dolomite

*nattressi* is restricted to the type Anderdon and in the present report these rocks are designated as the *Amphipora nattressi* Subzone.

In summary, each of the formations of the Detroit River Group and Sylvania Sandstone as present in the area around Amherstburg, Ontario is characterized by a distinctive faunal assemblage and each of these assemblages may be designated as a separate biostratigraphic subzone. These subzones are stratigraphically arranged as follows:

<i>Prosserella</i> Zone	Detroit River Group	Anderdon Limestone; <i>Amphipora nattressi</i> Subzone
		Lucas Dolomite; <i>Acanthonema holopiforme</i> Subzone
		Amherstburg Dolomite; "coral-mixed brachiopod subzone"
	Sylvania Sandstone; no subzonal index designated	

Ehlers, Stumm, and Kesling (1951) regarded each of these subzones as a formation and were very successful in extending them throughout the type area of the Detroit River Group. Therefore, near Sylvania, Ohio, Ehlers, Stumm, and Kesling (1951, pp. 5, 6) have separately described the Anderdon, Lucas and Amherstburg Formations whereas the present author regards these same rocks as the *Amphipora nattressi*, *Acanthonema holopiforme*, and "coral-mixed brachiopod" Subzones respectively and includes them as biostratigraphic subdivisions of the type Lucas as originally defined by Prosser (1903, p. 541). This latter stratigraphic scheme maintains the conceptual distinction between rock-stratigraphic and biostratigraphic units.

Unfortunately, none of these subzones as currently understood has much biostratigraphic significance; their faunas have not been recognized beyond the type area of the Detroit River Group. Only a very few brachiopod species from the type area are present elsewhere in the Detroit River Group and the number of species extending beyond the geographic limits of the *Prosserella* Zone is exceedingly small.

The brachiopod fauna of the *Prosserella* Zone is similarly distinct from the faunas in both the underlying and overlying units. Boucot and Johnson (1968) have listed twenty-six genera and species in the Bois Blanc Limestone and of these only five species and thirteen genera have been identified from the *Prosserella* Zone. Furthermore, these jointly occurring species and genera do not include the most characteristic Bois Blanc forms (e.g. *Centronella glansfagea*, *Eodevonaria arcuata*, and *Amphigenia* spp.).

Bassett (1935, pp. 440, 441) listed twenty-eight brachiopod species in about nineteen genera from the type area of the Dundee Limestone. Of these, only one rare species (*Brachyspirifer* (?) *manni*) and nine genera also occur in the *Prosserella* Zone. A similar comparison of the Detroit River and Delaware brachiopods is much more difficult because of the lack of modern investigations of the Delaware faunas. However, in the writer's experience none of the abundant and widely distributed Delaware species (e.g. *Brevispirifer lucasensis*, "*Martinia*" *maia*, *Atrypa costata*, *Muscrospirifer* sp.) is present in the Detroit River.

In summary, the brachiopod fauna of the Detroit River Group and the Sylvania Sandstone is very highly endemic; it is sharply distinct from the preceding, contemporaneous, and succeeding faunas in the Michigan Basin and adjacent parts of the craton. This endemism has been partially responsible for the previous confusion regarding the age and stratigraphic relations of these rocks.

#### Age

Grabau and Sherzer (1910, pp. 217-223) were greatly impressed by the supposed Silurian affinities of the *Acanthonema holopiforme* Subzone gastropods and despite the admitted Devonian affinities of the Amherstburg and Anderdon corals and brachiopods, they regarded the Detroit River Group as Late Silurian in age. Almost immediately there followed a succession of contradictory reports (e.g. Nattress, 1911, 1912a, 1912b; Stauffer, 1915, pp. 285, 286; Stauffer, 1916), each presenting evidence of questionable validity to assert the Devonian age of these rocks. It was not until M.Y. Williams' (1919, pp. 19-22) detailed analysis of the Detroit River fauna that the age was generally accepted as Devonian. Subsequent study indicates that none of the taxa ascribed to Silurian forms were correctly identified by Grabau (*in* Grabau and Sherzer, 1910) and a few of the species have been redescribed as new or reassigned to Devonian genera. Most recent evidence indicates that the age of the Detroit River Group is largely early Middle Devonian (early Eifelian) with some possibility that the Amherstburg Dolomite is late Early Devonian (late Emsian). (For a detailed discussion of the age of the Detroit River Group the reader's attention is directed to the section of the present report entitled "Intercontinental Correlation".)

SPECIES OF THE GENUS PROSSERELLA

Taxonomic Criteria

Grabau (*in* Grabau and Sherzer, 1910) was very inconsistent in his application of various morphological features of *Prosserella* as taxonomic criteria for systematic subdivision of the genus. Thus, for some species he stressed the form of the fold and sulcus, for others the shape of the valves, and for yet another species the convergence of the dental plates. Unfortunately, he failed to consider the simultaneous variation of several features among his taxa so that the present author was unable to establish any unity of features by which each could be recognized. The degree of variation for several morphological features of *Prosserella* is so great that discrete and unique groups (species) having biological meaning and stratigraphic usefulness cannot be determined on the basis of single taxonomic characters.

Therefore, each potential taxonomic criterion has been investigated independently and also in conjunction with other criteria to determine the range of variation of each. The intention was to discover pairs or groups of features that varied in a co-ordinated manner and so could be used in the establishment of easily recognized subdivisions of the genus. Although over 1,000 specimens of *Prosserella* were available for this study, the writer restricted the sample to approximately 300 specimens from the type region of the Detroit River Group for which reasonably accurate collection data were available. The reason for restricting the sample to topotypic material was to provide as objective a basis as possible for increasing the size of the hypodigms from which Grabau's types were selected. Since Grabau had established a group of species names having priority, it was necessary to integrate his type specimens into the revision of the genus in the present report. (For a detailed discussion of the taxa of *Prosserella* recognized by Grabau and the nature of his type material, the reader is referred to Appendix II).

The chief obstacle in this investigation was the general lack of clearly defined potential taxonomic criteria, especially features of external ornamentation. In addition, the nature of the preservation and the small number of brachial valves further limited the number of features studied. Therefore, only four criteria were investigated in detail and the results from these were rather disappointing. Nonetheless they do indicate the problem of subdivision of highly variable, endemic, small populations of what was probably a specialized evolutionary sideline and dead-end. The four criteria studied were as follows:

I. Fold and sulcus

Although neither the fold nor the sulcus is a prominent, clearly defined feature, they typically appear early in the ontogeny and their general form can be readily determined in most specimens. However, the presence of these features is not universal for the genus and there is a complete range in their importance from shells in which they are absent to shells in which both features are relatively well developed.

Grabau stressed the form of the fold and sulcus in his descriptions of *P. modestoides*, *P. lucasi*, and *P. planisinosus*. Out of a total of ten type specimens for these three species not one specimen consists of both valves joined. Thus, in each case Grabau was forced to assume either that disassociated opposite valves were once joined or that there was a very direct relation between the form of the fold and sulcus, e.g. that the form of the fold could be predicted from the form of the sulcus and vice versa.

Examination of the type specimens indicates that the assumed original articulation of presently dissociated valves is unwarranted because, in most cases, there is a significant discrepancy in size between the opposite valves.

Furthermore, examination of all available complete specimens (both topotypic and non-topotypic) with the opposite valves joined indicates that variation in prominence and form of the fold may be quite unrelated to the prominence and form of the sulcus. In some shells (e.g. UMMP 14065) the fold is a high, well-defined feature whereas the associated sulcus is very shallow and poorly defined (Pl. VII, figs. 4-6). However, in no specimen examined by the writer is a deep sulcus associated with a low fold. Furthermore, there is no apparent relation between the prominence of the fold and sulcus (high, deep) and the shape (rounded, flattened, costate). It is true, however, that in the majority of specimens both fold and sulcus begin near the umbones, flare moderately, and become moderately prominent features producing a gently flexed uniplicate anterior commissure.

On the basis of these observations the following conclusions may be drawn: (1) the presence or absence of a fold and sulcus are useful taxonomic features because they generally develop early in ontogeny and can thus be discerned in immature shells, (2) the maximum width of both fold and sulcus are closely correlated and may be determined by simple inspection of the anterior commissure, and (3) the prominence and shape of the fold and sulcus are not closely correlated and so are of relatively little value in taxonomy.

## II. Costation

Grabau apparently regarded costation of minor taxonomic importance. The type specimens of each of his taxa included both smooth and costate forms except for *P. subtransversa alta* which was based on a single costate pedicle valve.

The majority of the topotypic specimens of *Prosserella* are smooth. When costation is present it is usually subdued, the costae are low, rounded, and begin in the anterior half of the valve (Pl. VI, fig. 20; Pl. VIII, fig. 25). This suggests that costation is normally an adult feature; however, in a few shells the costae extend into the umbonal region (Pl. VIII, fig. 15).

The development of costation is unrelated to the nature of the fold and sulcus. Some costate specimens lack a fold and sulcus (the anterior commissure is rectimarginate) whereas in others the fold and sulcus are well developed and of variable shapes and widths.

The present writer concludes that Grabau underestimated the taxonomic importance of costation. The presence or absence of costae is a rather objective feature of both valves but because the costae are generally restricted to the anterior half of large (mature) shells, costation is less important in taxonomy than the nature of the fold and sulcus.

## III. Length-width (shape) of valves

Grabau stressed the proportionately greater width, especially of the brachial valve, in his description of *P. subtransversa* and also remarked on the relatively wide pedicle valve of *P. planisinosus*. His type specimens of *P. planisinosus* include only one pedicle valve (UMMP 13103) and the anterior margin of this is so incomplete (Pl. VII, fig. 12) that it is difficult to estimate the actual length of the valve; thus, there is considerable doubt whether the valve actually is proportionately wider than other specimens of *Prosserella*.

Simple biometrical methods were used to determine the importance of valve shape as a taxonomic criterion. Because of the relatively great importance of the nature of the fold and sulcus, as noted above, the topotypic material was subdivided into two groups: one group contained those specimens lacking a fold and/or sulcus (rectimarginate anterior commissure) or specimens with a very narrow, almost linear, shallow sulcus or low fold; the other group contained those specimens with a moderately well-developed, wide, shallow to deep, or low to high sulcus and fold. Thus, in those specimens with a fold or

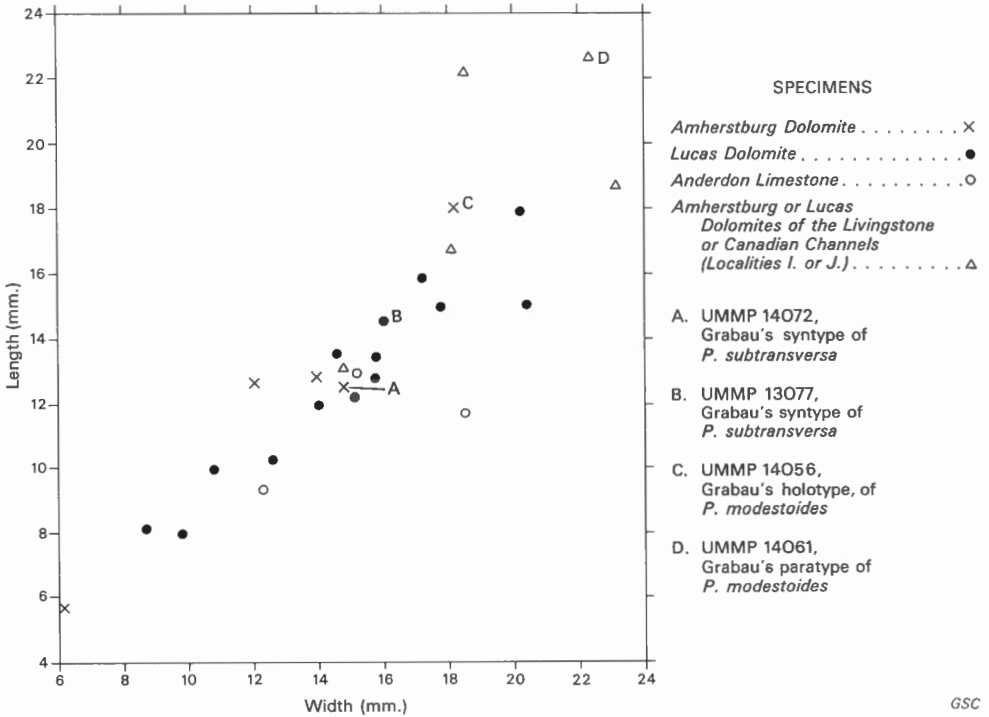


Figure 3. Scatter diagram showing length-width relations for twenty-seven pedicle valves, either lacking a sulcus or with a narrow, shallow sulcus (*Prosserella modestoides* of the present report) from the type region of the Detroit River Group. Crosses are for specimens from the Amherstburg Dolomite, dots are from the Lucas Dolomite, open circles are from the Anderdon Limestone, and open triangles are from either the Amherstburg or Lucas Dolomites of the Livingstone of Canadian Channels (Localities I or J).

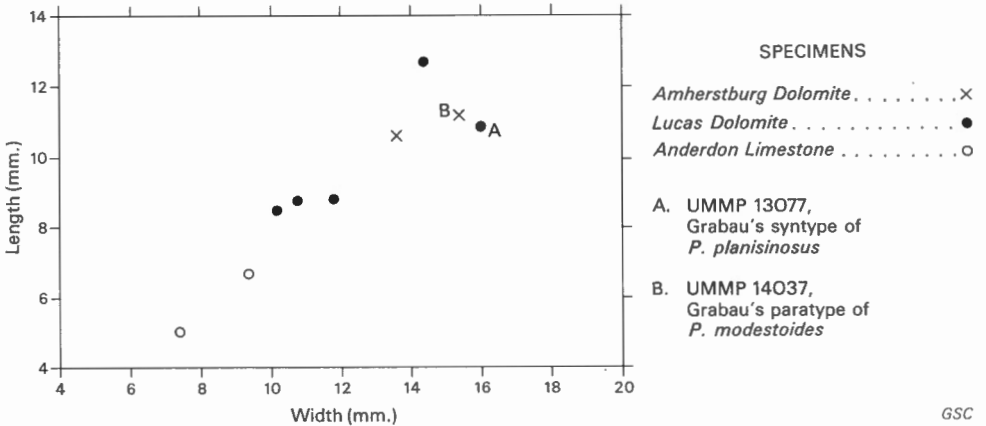


Figure 4. Scatter diagram showing length-width relations for nine brachial valves, either lacking a fold or with a narrow, low fold (*Prosserella modestoides* of the present report) from the type region of the Detroit River Group. Crosses are for specimens from the Amherstburg Dolomite, dots are from the Lucas, and open circles are from the Anderdon Limestone.

sulcus the chief criterion for subdivision was the width of the feature, not the depth, height, or shape (round, flattened, costate). The separation of the topotypic material into these groups was rather objective with very few specimens not falling clearly into one or the other group. Nonetheless, it is important to note that gradational specimens do occur.

Then, for each specimen that was sufficiently well preserved, joint measurements of length and width were made and the results plotted (*see* Figs. 3-6). On the basis of the data presented on these figures, the following conclusions may be drawn:

1. Length and width are well correlated.
2. Growth was approximately isometric.
3. Grabau's type specimens of *Prosserella subtransversa* are not significantly wider than the other topotypic specimens and shell shape as estimated by length and width is not an important criterion for subdivision of the genus into species and subspecies.
4. Shape of the valves (e.g. wide as against narrow) is unrelated to stratigraphic occurrence.
5. Shells with a fold or sulcus are more than twice as abundant in the type region of the Detroit River Group as shells lacking these features.

The specimens used for each of these figures are extremely heterogeneous with regard to both geographic and stratigraphic location. Furthermore, if homogeneous subsamples are made by restriction of the material to the same geographic and stratigraphic location, the number of specimens per subsample becomes very small. Unfortunately, this difficulty cannot be overcome by additional collecting because the most important localities are no longer accessible. This means that biologically significant conclusions regarding similarities and/or differences in growth curves cannot be made. However, the degree of variation indicates that relatively wide and narrow shells are present in both the group without a fold or sulcus or with a narrow fold and sulcus (Figs. 3 and 4) and in the group with a wide fold and sulcus (Figs. 5 and 6). Thus, it appears as if the shape of the valve is unrelated to the development of the fold and sulcus.

Costation is also apparently unrelated to shell shape. Costate individuals are present among both the wide and the narrow specimens in Figures 3-6 and are most common among the larger individuals.

#### IV. Dental plates

The importance of the arrangement of the dental plates in Grabau's (*in* Grabau and Sherzer, 1910, pp. 146, 147) description of *Prosserella unilamellosus* is noted in the remarks on this species in Appendix II. Grabau also described various aspects (length, spacing, thickness) of the dental plates in each of his other species and subspecies, except *P. planisinosus*, but did not stress these features.

In the description of *P. modestoides* Grabau (*in* Grabau and Sherzer, 1910, p. 140), the dimensions of paratype UMMP 14061 are given. The measurements for the length and width have been confirmed by the present writer but the length of the dental plates is only 5.9 mm rather than 9 mm as given by Grabau. The length of the dental plates in the holotype (UMMP 14056) cannot be measured; paratype UMMP 14037 is a brachial valve.

Grabau (*in* Grabau and Sherzer, 1910, p. 144) described the dental plates in *P. subtransversa* as about one-third the length of the pedicle valve. Measurements of the length of the dental plates in the type specimens indicate that they range from about one-fifth (UMMP 14070; Pl. VIII, fig. 15) to nearly one-half (UMMP 14072; Pl. VI, fig. 9) the length of the valve.

Observations on the form of the dental plates in *Prosserella* by the present writer indicate that posterodorsally they are separated by an amount equal to the width of the delthyrium (Pl. VIII, fig. 7). These plates converge



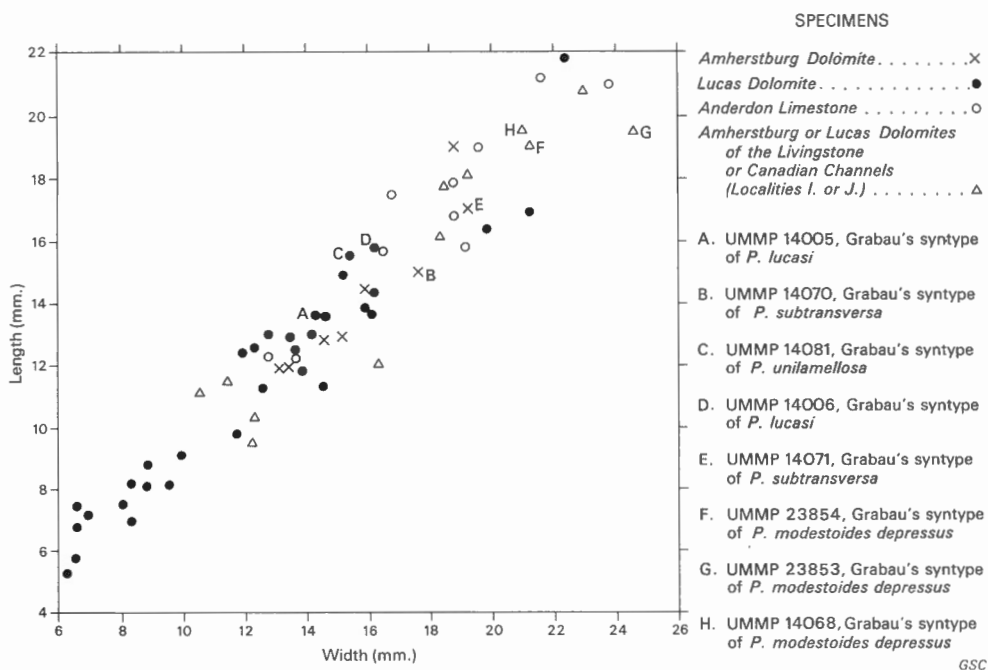


Figure 5. Scatter diagram showing length-width relations for sixty-three pedicle valves with a wide, moderately well-developed sulcus (*Prosserella lucasi* of the present report) from the type region of the Detroit River Group. Stratigraphic data for specimens same as for Fig. 3.

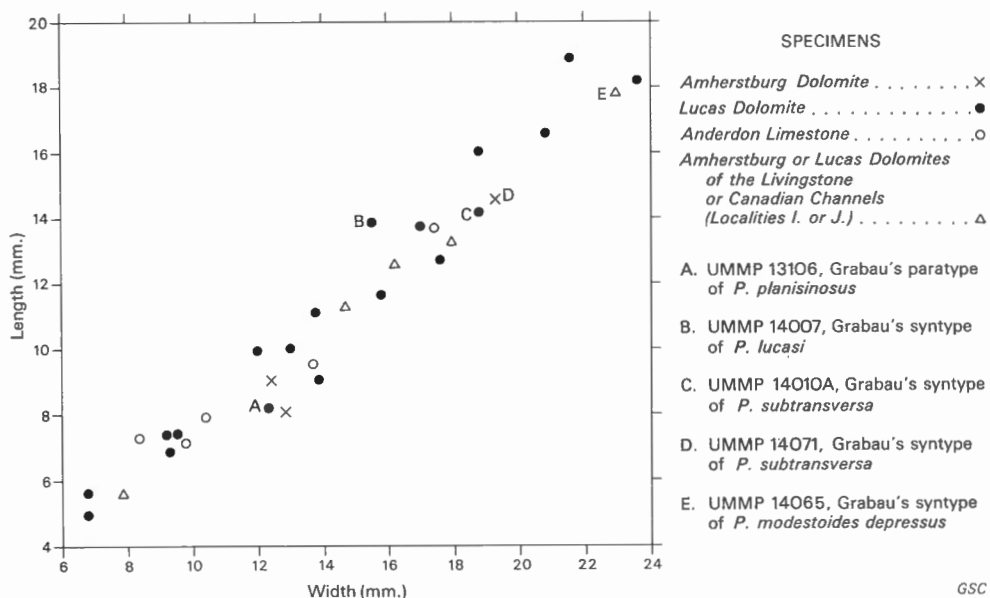


Figure 6. Scatter diagram showing length-width relations for thirty-two brachial valves with a wide, moderately well-developed fold (*Prosserella lucasi* of the present report) from the type region of the Detroit River Group. Stratigraphic data for specimens same as for Fig. 3.

rapidly, both posteriorly and ventrally, from the delthyrium but typically fail to join at their junction with the floor of the valve and extend forward in a closely spaced, parallel arrangement to about one-third the length of the pedicle valve (Pl. VI, fig. 24). In some specimens from several localities and stratigraphic horizons the plates join at the floor of the valve as is the case in one syntype (UMMP 1408; Pl. VIII, fig. 21) of *P. unilamellosus* but in no case do they form a spondylium supported by a median septum. In a few specimens, the lines of junction of the plates with the floor of the valve converge anteriorly (Pl. VIII, fig. 5) rather than remaining parallel, whereas in others the lines of junction actually diverge anteriorly (Pl. VIII, figs. 19, 20, 22).

The spacing between the plates in their usual parallel arrangement is generally from 0.5-1.0 mm. Because slight differences in spacing would produce relatively great variation in the apparent form of the plates, and because of divergence or convergence of the plates in some specimens, no attempts were made to biometrically assess the variation and taxonomic significance of the spacing between the dental plates.

Conversely, the length of these lines of junction of the dental plates and the floor of the valve measured in a plane parallel to the commissure proved to be a rather objective dimension so assessment of the variation and taxonomic significance of this feature was undertaken. Just as in the biometrical study of length-width (shape) of the valves, the sample of the topotypic material was subdivided into the same two groups for study of the length of the dental plates. Joint measurements of the length of the dental plates and both the length and width of the pedicle valve were made for each group and the results plotted in Figures 7 and 8.

Variation in the length of the dental plates was compared with variation in the shape of the pedicle valve by the methods described by Imbrie (1956, pp. 239-241) and the results tabulated in Table 3. Inspection of Figures 3-8 and the data in Table 3 indicates that the length of the dental plates is much more variable than the length-width (shape) of the pedicle valve for both the non-sulcate group and the group with a wide sulcus.

Thus, on the basis of the relatively great variability in the form (convergence, divergence, spacing, and length) of the dental plates the present writer concludes that they are not an important criterion for the establishment of species and subspecies of *Prosserella*. No attempts were made to relate the form of the dental plates to the development of costae or to the shape of the sulcus.

Table 3

Total correlation coefficients ( $r$ ) and coefficients of relative dispersion about the reduced major axis ( $Dd$ ) for paired dimensions of pedicle valves ( $N$ )

	$N$	$r$	$Dd$
A. Sulcus absent or narrow			
1. length-width of valve	27	.88	13.19
2. length of valve-length, dental plates	23	.79	20.05
3. width of valve-length, dental plates	29	.83	17.61
B. Sulcus wide			
1. length-width of valve	63	.96	8.45
2. length of valve-length, dental plates	56	.84	17.48
3. width of valve-length, dental plates	70	.83	17.90

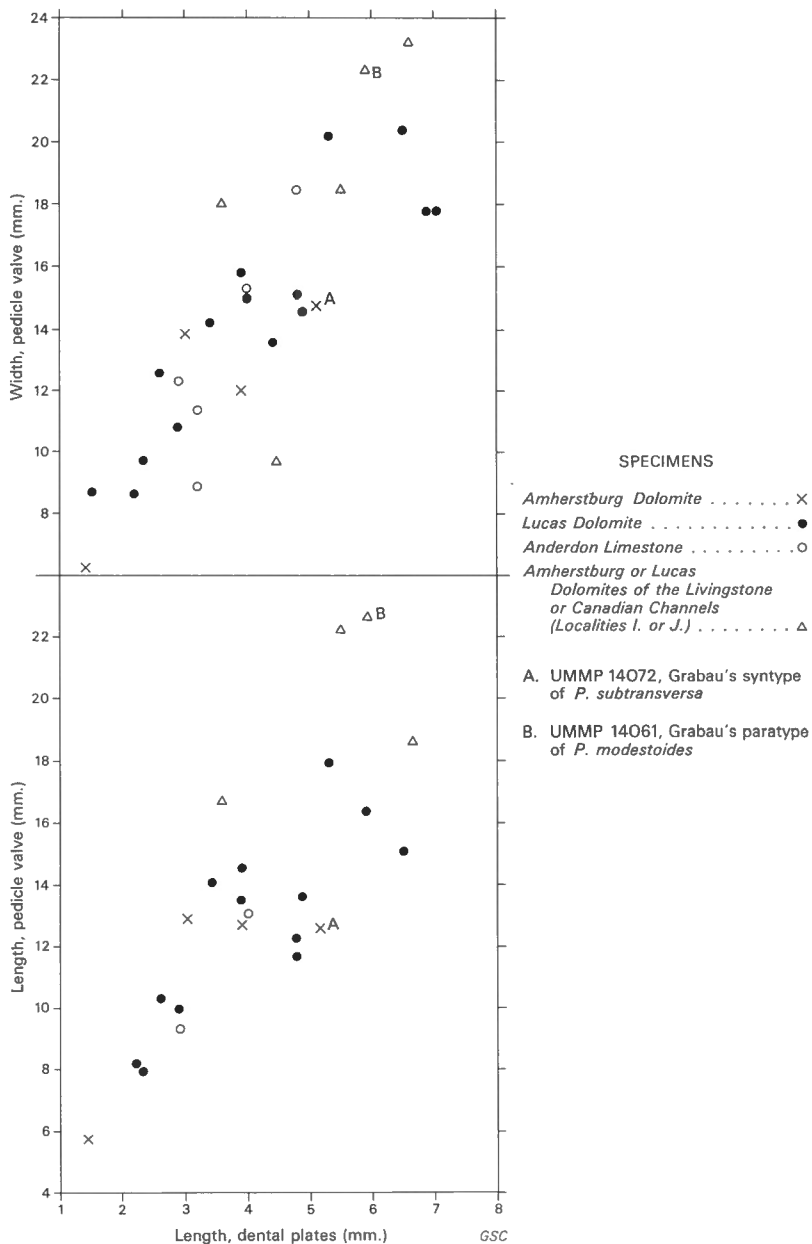


Figure 7. Scatter diagrams showing relations between length of dental plates and length and width of pedicle valves, either lacking a sulcus or with a narrow, shallow sulcus (*Prosserella modestoides* of the present report) from the type region of the Detroit River Group. Stratigraphic data for specimens same as for Fig. 3.

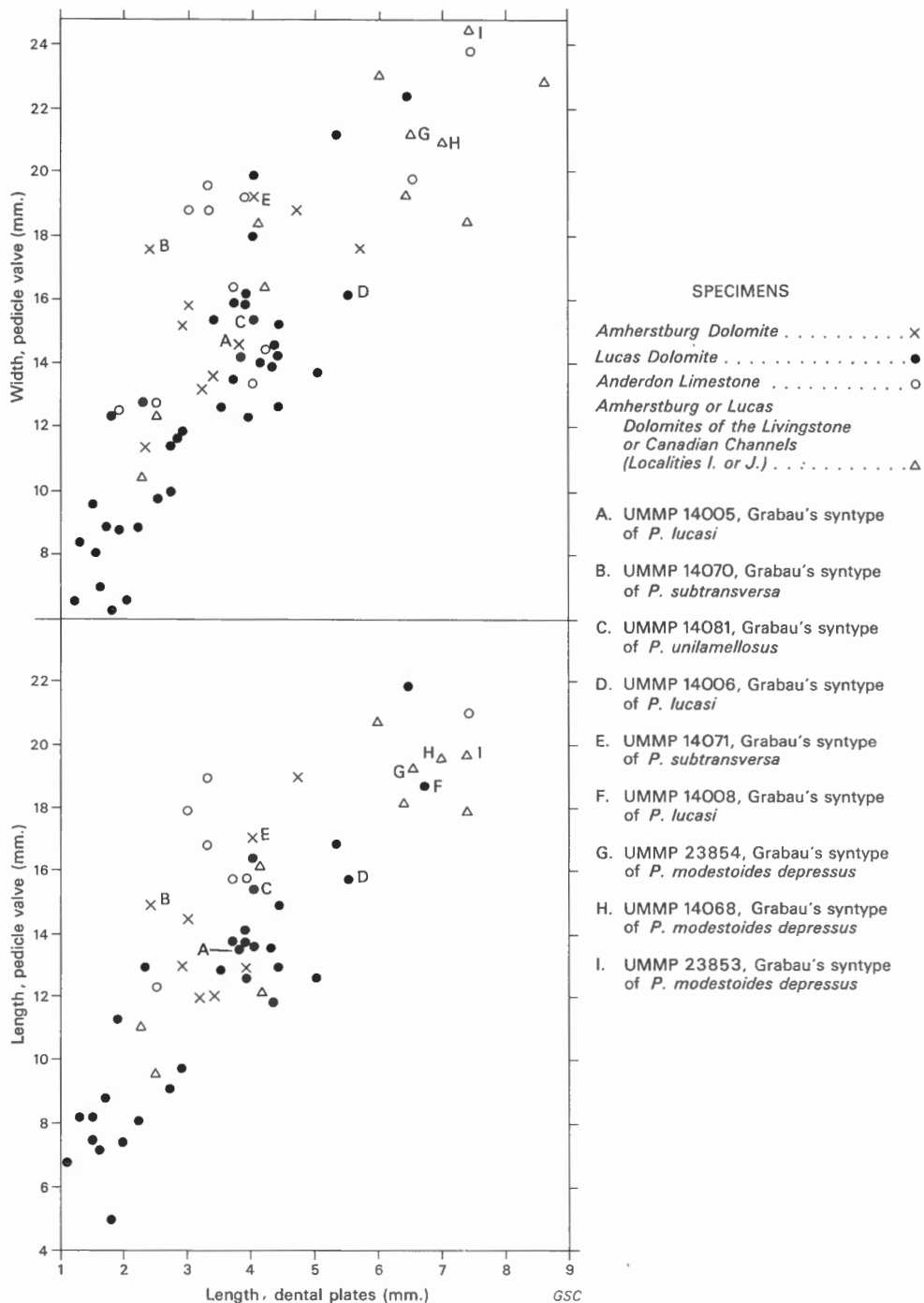


Figure 8. Scatter diagrams showing relations between length of dental plates and length and width of pedicle valves with a wide, moderately well-developed sulcus (*Prosserella lucasi* of the present report) from the type region of the Detroit River Group. Stratigraphic data for specimens same as for Fig. 3.

V. Other features

A myophragm (Grabau, *in* Grabau and Sherzer, 1910 consistently referred to this as a median septum) is variably developed in one or both valves (most commonly in the brachial valve) in about half the topotypic specimens of *Prosserella*. Neither the presence or absence of, nor the length or height of this feature is taxonomically significant in *Prosserella*.

The interior of the brachial valve of *Prosserella* contains several structures of potential taxonomic significance in establishing lower taxa (e.g. crural plates, cardinal process, socket ridges). However, no detailed studies were made of these features because of the relatively few topotypic brachial valves, especially those with the pedicle valve attached. Thus, it was impossible to relate internal features of a few, mostly isolated, brachial valves in any taxonomically useful manner to a large number of isolated pedicle valves that were known to be extremely variable. To do so would merely compound inferences derived from small, variable populations with results similar to those of Grabau.

Present Revision

The above review of the species and subspecies of *Prosserella* described by Grabau (*in* Grabau and Sherzer, 1910), the nature of the topotypic material (Appendix II), and the various potential taxonomic criteria, strongly suggests that the genus has been "oversplit". In fact, the temptation is nearly as strong to consider the genus as monotypic. However, one of the purposes of paleontological taxonomy is to subdivide the evolutionary continuum into reasonably discrete morphological "packets" (taxa) that can be recognized by other workers. Such taxa can be established for the genus *Prosserella*.

Table 4

Key to the species and morphotypes of the genus *Prosserella*

- 
- A. Fold and sulcus absent or fold narrow, low and sulcus narrow, shallow. . . . . *Prosserella modestoides*
    - 1. Exterior smooth. . . . . *P. modestoides*, smooth morphotype
    - 2. Exterior costate . . . . . *P. modestoides*, costate morphotype
  
  - B. Fold and sulcus wide; of variable height, depth, and shape. . . . . *Prosserella lucasi*
    - 1. Exterior smooth. . . . . *P. lucasi*, smooth morphotype
    - 2. Exterior costate . . . . . *P. lucasi*, costate morphotype
- 

The present revision is based on consideration of the preservation of the topotypic material and evaluation of the relative importance of several taxonomic criteria and is designed for maximum use by other workers. The writer makes no claim for finality; future collecting of large samples from each of the formations of the Detroit River Group, especially the Amherstburg and Lucas, will undoubtedly refine our knowledge of the variability of the genus.

Formal descriptions of each of the presently recognized taxa are to be found in the section "Systematic Paleontology." The following is merely a brief synopsis and key (Table 4) to these taxa and informal morphotypes.

Because of the early development of both the fold and the sulcus in ontogeny and their ready recognition, primary emphasis is placed on these features in the present revision. On this basis, two major divisions (species) of *Prosserella* are recognized. The first species, *P. modestoides*, is characterized by either the absence of a fold and sulcus (rectimarginate anterior commissure) or if present the fold and sulcus are narrow and low or shallow (very weakly uniplicate). The other species, *P. lucasi*, is characterized by a wide fold and sulcus (widely uniplicate); the height, depth, and shape (round, flattened, costate) of these features is extremely variable and are therefore not so important as width.

Although neither the fold nor the sulcus is usually prominent or well defined, nearly all specimens can be assigned to one or the other species with a high degree of objectivity. In general, the fold and sulcus are more prominent and well defined in *P. lucasi* than in the weakly uniplicate specimens of *P. modestoides*. This classification was used in the preparation of the scatter diagrams in Figures 3-8.

Further subdivision is based on costation. Both *P. modestoides* and *P. lucasi* contain smooth as well as costate specimens but because the prominence and numbers of costae are so completely gradational no additional systematic names have been used. Informally, these may be referred to as the smooth and costate morphotypes of each species. No attempt was made to separate the smooth and costate morphotypes in the preparation of Figures 3-8. However, as noted previously, the costate morphotypes of both species are generally concentrated among the large specimens and the costae are commonly restricted to the anterolateral half of the valves.

In the present classification of the species and morphotypes of *Prosserella*, neither the shape of the valves (length-width), nor the length and spacing of the dental plates has been used because of the relatively great variability of these features. Nonetheless, it is important to note that the form of the dental plates is the chief qualitative taxonomic criterion for recognition of both species of the genus *Prosserella*.

SYSTEMATIC PALEONTOLOGY

Introduction

Fossils are generally neither abundant nor well preserved in the Detroit River Group. The most notable exceptions are in rather pure limestone biostromes and bioherms. In dolomitic beds the mode of preservation is typically as internal casts (steinkerns) whereas in limestone beds the original shells are commonly preserved. The internal cavities of most brachiopods with the shell still present are filled with large, secondary, vug-filling calcite crystals that have destroyed the internal structures making positive generic and/or specific determinations impossible. In many specimens, however, some of the internal features may be investigated by heating to calcine the original shell material and then scraping it away with bevelled, thin, piano-wire or phonograph needles. A few specimens have been serially sectioned to determine the nature of the internal structures but in general the results have not been particularly rewarding. Silicified valves are unknown from these rocks.

Morphologic terminology for fossil brachiopods has become enormous making the comprehension of systematic descriptions difficult for all but the specialist. Fortunately, the extensive glossary in the *Treatise on Invertebrate Paleontology* (Williams, *et al.*, 1965, pp. H 139-H 155) includes most of these terms and every effort has been made in the present report to conform with the 'Treatise' usage; exceptions are given with appropriate citations. In the following descriptions the writer has used the term "palintrope" for the 3-dimensional shelf-like structure located "in the posterior sector of either valve which was reflexed to grow anteriorly (mixoperipheral growth)" (Williams, *et al.*, 1965, p. H 149) and the term "interarea" for the external 2-dimensional surface of the palintrope. The arrangement of genera also follows the 'Treatise' with one exception; the genus *Prosserella* was placed in the Family Ambocoeliidae in the 'Treatise' (p. H 675) but is here considered a member of the Family Reticulariidae.

Prior to the present study, the chief systematic work on Detroit River brachiopods was done by A.W. Grabau (1910, pp. 119-162). Nearly all of Grabau's material is deposited in the Museum of Paleontology at the University of Michigan and was examined by the writer. The type specimens of the following species, originally described by Grabau, are so poorly preserved that the present author regards them as unidentifiable:

1. *Stropheodonta praeplicata* Grabau, 1910, pp. 126, 127, Pl. 17, fig. 12. The original mold is apparently lost. Three plaster of Paris casts and two gutta-percha casts (UMMP 13112).
2. *Spirifer modestus* Grabau, 1910, pp. 137, 138, Pl. 16, fig. 11. A mold of pedicle interior (UMMP 14077).
3. *Spirifer modestus* Grabau, 1910, pp. 137, 138, Pl. 16, figs. 24, 25. A mold of exterior with low, concentric growth lines (UMMP 14080).
4. *Camarotoechia simplicata* Grabau, 1910, pp. 129-131, Pl. 16, fig. 14. A mold of pedicle interior (UMMP 14083).
5. *Camarotoechia simplicata* Grabau, 1910, pp. 129-131, Pl. 16, fig. 13; Pl. 20, fig. 12. A mold of beak region of both valves (UMMP 14088). This species was also reported from the Sylvania Sandstone by Carman (1936, p. 261).
6. *Atrypa reticularis* Grabau, 1910, p. 162, Pl. 20, fig. 1. A mold of exterior (ROM 22451). The genus is probably *Atrypa* but the species cannot be determined.

In addition to the above, *Spirifer modestus* Grabau (1910, pp. 137, 138, Pl. 16, fig. 12) is probably a species of *Prosserella*. It is a mold of the pedicle beak with rather closely spaced dental plates (UMMP 14076).

Carman (1936, pp. 260-262) briefly discussed the fauna of the Sylvania Sandstone and listed eight brachiopod species. However, A.L. LaRocque has been unable to locate the specimens at the Ohio State University Museum so the writer was unable to confirm Carman's identifications.

#### Systematic Descriptions

All known occurrences of each species in the Detroit River Group and Sylvania Sandstone are listed. Occurrences of the biostratigraphically significant taxa beyond the limits of the Detroit River and Sylvania are discussed in the section "Correlation."

The repositories of the type and figured specimens are as follows:

GSC - Geological Survey of Canada, Ottawa, Ontario

UMMP - Museum of Paleontology, University of Michigan, Ann Arbor, Michigan.

USNM - U.S. National Museum, Washington, D.C.

ROM - Royal Ontario Museum, Toronto, Ont.

AMNH - American Museum of Natural History, New York, N.Y.

UM - Dept. of Geology, University of Minnesota, Minneapolis, Minn.

#### *Schizophoria prima* Stauffer

Plate I, figure 6

*Schizophoria prima* Stauffer, 1918, pp. 557, 558, Pl. 2, fig. 3.

Remarks. This species appears to be very similar in size to *S. propingua* (Hall) but the shape of the muscle field in *S. prima* is much longer, narrower, and more deeply impressed than in *S. propingua* (Hall, 1867, Pl. 5, fig. 3g).

Material and occurrence. Holotype, UM 4840a, a steinkern of brachial valve, Amherstburg Dolomite, Loc. I, collected by C.R. Stauffer; hypotypes, GSC 22969 and 22970, steinkerns, probably from the Amherstburg Dolomite, Loc. 4368, collected by C.R. Stauffer.

#### Subfamily Rhipidomellinae Schuchert

Diagnosis. Boucot, Johnson, and Walmsley, 1965, pp. 333, 334; Boucot, Gauri, and Johnson, 1966, p. 158.

#### Genus *Dalejina* Havlíček

*Dalejina* Havlíček, 1953, p. 5.

*Rhipidomelloides* Boucot and Amsden, 1958, pp. 165-169.

Diagnosis. Boucot, Johnson, and Walmsley, 1965, p. 337; Fagerstrom, 1966b, p. 1237; Harper, Boucot, and Walmsley, 1969, pp. 75, 76.



*Dalejina intermedia* (Stauffer)

Plate I, figures 4, 5

*Rhipidomella intermedia* Stauffer, 1918, pp. 556, 557, Pl. 2, figs. 1, 2.

Remarks. This species is very similar to *Dalejina alsa* known from the Bois Blanc Formation. In *D. alsa* each marginal internal crenulation bears a single median groove and is rectangular in cross-section (Pl. I, figs. 1, 2), whereas in *D. intermedia* only about half of the crenulations are grooved and the others are rounded in cross-section (Pl. I, figs. 4, 5). In addition, the anterior commissure in *D. alsa* is rectimarginate whereas in *D. intermedia* the commissure is broadly uniplicate. The external ornamentation in *D. intermedia* is unknown.

Material and occurrence. Holotype, UM 4839a, a steinkern, Amherstburg Dolomite, Loc. I, collected by C.R. Stauffer.

*Dalejina*(?) sp.

Plate I, figure 3

Description. Shells small, biconvex, pseudopunctate. Outline transverse; length/width ratio about 1.2; greatest width about midlength. Hinge line short, straight; cardinal extremities rounded; lateral margins rounded; anterior margin nearly straight. Anterior commissure apparently broadly uniplicate; flanks gently convex in anterior profile. Apical angle about 100°. Interarea triangular, concave, with moderately protruding beak. Lateral profile gently convex anteriorly becoming moderately convex posteriorly. Sulcus low, broad, indistinct.

Radial ornamentation well developed, consisting of numerous, rounded, costae which arise by intercalation. Costae generally closely and evenly spaced but with occasional more closely spaced paired costae. Concentric ornamentation subdued, consisting of occasional, irregularly spaced growth lines.

Interior unknown.

Material and occurrence. Figured specimen, GSC 22973 a poorly preserved exterior, Formosa Reef Limestone, south end of Loc. 23635, collected by J.A. Fagerstrom.

*Rhipidomella* sp.

Plate I, figures 7-10

Description. Shells biconvex, of average size for genus. Dorsal outline subcircular to subquadrate; hinge line straight, long or short. Cardinal extremities obtusely rounded; lateral margins convex and smoothly rounded to nearly straight; anterolateral margins rounded; anterior margin straight to gently rounded. In lateral profile valves approximately equally deep; brachial valve moderately and evenly convex; pedicle valve nearly straight anteriorly with increasing convexity posteriorly. In anterior profile brachial valve moderately and evenly convex, pedicle valve less convex laterally becoming flattened medially; anterior commissure broadly uniplicate to nearly rectimarginate (Pl. I, fig. 7). Brachial fold very poorly defined, apparent only near anterior margin. Pedicle sulcus moderately well defined, broad, rounded, and arising at about midlength. Radial ornamentation evenly

ramicostellate to parvicostellate; costae and interspaces rounded and of about equal width; medial costae straight, posterolateral costae curved (Pl. I, fig. 8). Concentric ornamentation subdued, consisting of occasional, irregularly spaced rugae. Shell structure pseudopunctate.

Pedicle muscle field well defined, subcircular to moderately transverse, impressed centrally but slightly elevated marginally, extending posteriorly to about midlength of the valve, and bearing a low, wide median ridge in the posterior half of the field. Individual muscle scars not discernible. Articulatory and delthyrial structures and vascular markings unknown.

Brachiophores short and stout, with rounded ventral and anterolateral surfaces, becoming higher anterolaterally and supported throughout by stout brachiophore plates. Shell somewhat thickened anterolaterally beyond termination of brachiophores. Brachiophores joined to lateral margins of cardinal process and diverge at about  $110^\circ$ . Notothyrial cavity almost completely filled by large, ventrally protruding cardinal process that is buttressed anteriorly by a broad, low, thickened ridge. Sockets relatively short and narrow located between brachiophore plates, and slightly overhanging inner edge of palintrope. Muscle scars not impressed. Cardinalia and vascular markings unknown.

Lateral and anterior interal borders of both valves thickened and bear numerous, very closely spaced crenulations. Crenulations and interspaces smoothly rounded and without medial grooves (Pl. I, figs. 9, 10).

Remarks. The above description has been generalized to apply to a group of variable and generally poorly preserved shells from two localities in southwestern Ontario. Additional collecting of well-preserved material may indicate that the specimens belong to more than one species.

The significance of the specimens is that they can be positively placed in the genus *Rhipidomella*, *sensu stricto* (Boucot and Amsden, 1958, pp. 165-168) and record the presence of this genus in the upper Detroit River Group. The value of the rhipidomellids in correlation has been discussed by Fagerstrom (1966b).

Material and occurrence. Figured specimen, GSC 22975, upper Detroit River Group, Loc. 23588, collected by E.W. Best; figured specimen, GSC 22992, Detroit River Group, Loc. 13491, collected by J.A. Fagerstrom; referred specimen, GSC 22990, upper Detroit River Group, Loc. 23588, collected by E.W. Best; referred specimens, GSC 22991, 22993, 22994, Detroit River Group, Loc. 13491, collected by J.A. Fagerstrom.

*Strophodonta (Strophodonta) homolostriata* Grabau

Plate II, figures 1-7

*Stropheodonta demissa* mut. *homolostriata* Grabau, 1910, p. 126, Pl. 17, fig. 6.  
*Strophodonta homolostriata* Fagerstrom, 1961a, p. 19, Pl. 8, fig. 1.

Description. Shells concavo-convex, of average size for the genus. Hinge line long, straight; cardinal extremities generally obtusely angular, occasionally becoming very slightly mucronate. Lateral and anterior margins smoothly and evenly rounded giving the valves a generally semicircular outline in dorsal view. Length/width ratio 0.7-0.8; greatest width slightly anterior to hinge line. Pedicle valve moderately deep, curvature even and moderate in lateral profile. Commissure rectimarginate throughout.

Radial ornamentation well developed, parvicostellate to ramicostellate; additional costellae arise at irregular intervals, generally by intercalation but occasionally by bifurcation, and rapidly attaining the size and shape of costae (Pl. II, figs. 1, 2). Costae sharply elevated, angular to slightly rounded in cross-section; gently curving toward lateral margins, straight

toward anterior margin. Interspaces somewhat wider, shallow, and smoothly rounded. Concentric ornamentation poorly developed; consisting only of occasional, irregularly spaced growth lines.

Pedicle interior with well developed, broadly transverse ventral process which protrudes slightly over hinge line and bears a pair of secondary teeth along the anterodorsal margin. Hinge line completely denticulate except for medial portion occupied by ventral process. Posteromedial region of valve floor contains three depressed areas: a relatively large, well defined medial muscle field, and a pair of smaller, less well defined lateral cavities for the reception of the cardinal process lobes (Pl. II, fig. 6). Muscle field elongate, suboval, containing a medial pair of elevated, lanceolate adductor tracks separated by a flat, shallow, median depression, and lateral, depressed, poorly defined, broadly elongate diductor tracks. Posterolateral margin of muscle field marked by a narrow ridge separating muscle field from cardinal process receptor cavities. These cavities, located below and anterolaterally from secondary teeth, are suboval, deeply impressed posteriorly, rising anteriorly to merge with valve floor. Teeth, dental plates, and foramen absent.

Brachial interior with well developed, bilobed cardinal process; cardinal process lobes divergent, disjunct, extending posteriorly beyond hinge line (Pl. II, figs. 3, 4); diductor attachment sites directed posterodorsally. Adductor muscle field slightly elevated, elongate, consisting of poorly defined scars separated posteriorly by a flat, shallow, median depression which rises anteriorly to become a sharp ridge terminating at the coarsely tuberculate anterior margin of the muscle field. A pair of well defined, bean-shaped depressions bound the posterolateral margins of the adductor field. Notothyrium, chilidium, and socket plates absent.

Interior surfaces of both valves marked by poorly defined, radially striate (? lemniscate) vascular markings. Lateral and anterior internal borders of valves may bear broad, low, rounded, radial crenulations separated by shallow, angular interspaces. Shell structure pseudopunctate; tubercles moderately large, irregularly arranged. Body chamber thin, concavo-convex, subcircular in dorsal view.

Material and occurrence. Neotype (herein designated), GSC 22976, a brachial valve with ornamentation, probably from the Amherstburg Dolomite, Loc. 4368, collected by C.R. Stauffer; plastotype of holotype, UMMP 13109, probably from the Amherstburg Dolomite, Loc. J, collected by Thomas Nattress, the original specimen (holotype) has been lost but was illustrated by Grabau and Sherzer, 1910, Pl. 17, fig. 6; hypotype, UMMP 56621 and 56622, steinkerns of pedicle valves, probably from the Amherstburg Dolomite, Loc. I; hypotype, UMMP 56623, a brachial valve, probably from the "coral-mixed brachiopod subzone" (? Amherstburg Dolomite), Loc. C; hypotypes, GSC 22977, 22978, steinkerns of both valves, probably from the Amherstburg Dolomite, Loc. 4368, collected by C.R. Stauffer; hypotype, GSC 22979, a brachial valve, Detroit River Group, Loc. 15111, collected by E.W. Best; hypotype, GSC 22980, a brachial valve, Detroit River Group, Loc. 13491, collected by J.F. Caley. This species was also reported from the Sylvania Sandstone by Carman (1936, p. 261).

#### Genus *Megastrophia* Caster, 1939

Remarks. Specimens belonging to at least two species of *Megastrophia* and perhaps as many as five species are moderately abundant and widely distributed, both geographically and stratigraphically, in the Detroit River Group. These species are distinguished largely on the basis of ornamentation as follows:

1. *Megastrophia* (*M.*) *inequiradiata* - characterized by numerous, impersistent, subdued primary costae with each pair separated by 2-7, closely

spaced costellae (Pl. II, fig. 15). Concentric ornamentation is absent to very obscure. None of the ornamentation is reflected on the interior of the valves.

2. *M. (M.) proxicostellata* - typically with only about 15-20 prominent, persistent, primary costae (Pl. II, fig. 11) with each pair separated by 10-25 very fine and closely spaced costellae. Concentric ornamentation consists of rugae developed between primary costae on the posterior portion of the valves and very fine and closely spaced filia; the costellae and filia produce a dictyate ornament pattern (Caster, 1939, p. 32; Fagerstrom, 1961a, Pl. 8, fig. 6.) The primary costae are indicated on the interior surfaces of the valves as rounded depressions, generally persistent about halfway to the beaks.

3. *M. sp. A* - this species is similar in most respects to *M. (M.) proxicostellata* except for the presence of a pronounced geniculation in the anterior portion of the valves. *Megastrophia sp. B* (Fagerstrom, 1961a, p. 20) may be an immature specimen of *M. sp. A*.

4. ?*M. sp.* - a single, large pedicle valve from the type Anderdon is tentatively referred to this genus. The specimen has a large median callus nearly filling the apical cavity and a very poorly developed ventral process. This may be a gerontic individual of one of the other species of *Megastrophia*.

*Megastrophia (Megastrophia) proxicostellata* Fagerstrom

Plate II, figures 8-11

- Stropheodonta inequiradiata* Hall, 1867, *partim*, pp. 87, 88, Pl. 11, fig. 31;  
?Pl. 11, figs. 24, 25, 30 *non* Pl. 13, figs. 6-9.  
? *Stropheodonta vasculosa* Grabau, 1910, pp. 124-126, Pl. 17, figs. 8-11.  
? *Stropheodonta delicatula* Stauffer, 1918, p. 558, Pl. 2, figs. 4, 5.  
*Megastrophia (Megastrophia) proxicostellata* Fagerstrom, 1961a, pp. 19, 20,  
Pl. 8, figs. 4-8.

Emended description. Pedicle interior with moderately well-developed, broadly transverse ventral process (Pl. II, fig. 10) which bears a pair of secondary teeth along the anterodorsal margin. Hinge line completely denticulate except for medial portion occupied by ventral process. Posteromedial region of valve floor contains three depressed areas: a moderately well defined, relatively large medial muscle field, and a pair of smaller lateral cavities for the reception of the cardinal process lobes. Muscle field elongate, suboval, containing a medial pair of poorly defined, elevated adductor tracks separated by a shallow median depression, and lateral, obscure diductor tracks. Cardinal process receptor cavities suboval, moderately depressed posteriorly, rising anterolaterally to merge with valve floor, and bounded along posteromedial and posterolateral margins by well defined broad ridges. Primary costae reflected on interior of valve as shallow, rounded depressions, extending from the lateral and anterior margins about halfway to the beak.

Remarks. The possible synonymy of *M. (M.) proxicostellata* and *Stropheodonta vasculosa* Grabau is uncertain for three reasons. First, the specimen of *S. vasculosa* illustrated by Grabau (1910) on Pl. 17, fig. 11 and presumably showing some of the ornamentation has not been definitely located; there is some possibility that the specimen is either ROM 22511 or UMMP 13102 but in both cases there are some significant differences between the illustration and these specimens. Thus, the precise nature of the ornamentation in

*S. vasculosa* is uncertain. Secondly, since the specimen illustrated by Grabau (1910) on Pl. 17, figs. 8 and 9 (ROM 22439) is a cast of the ventral interior (steinkern) there is again uncertainty regarding the ornamentation. In a few places around one of the lateral margins there is sufficient evidence of parvicostellate ornamentation to strongly suggest that the specimen is a species of *Megastrophia*; however, it is not possible to determine the size, shape, or number of costellae between the primary costae. Furthermore, the primary costae do not seem to be nearly as persistent toward the beak as in *M. (M.) proxicostellata*. Finally, in none of the specimens of *M. (M.) proxicostellata* are the vascular markings nearly so deep and well developed as in *S. vasculosa*.

In addition, the possible synonymy of *M. (M.) proxicostellata* and *Strophodonta delicatula* Stauffer is uncertain because of the poor preservation of Stauffer's type specimens (UM 4841a). Again, the specimens are sufficiently well preserved to be certain that it is a species of *Megastrophia* but the number, size, and shape of the costae and/or costellae cannot be determined. However, the costae are persistent to the beak as in *M. (M.) proxicostellata*.

Material and occurrence. Hypotype, GSC 22981, a steinkern of brachial valve, probably from the Amherstburg Dolomite, Loc. 4368, collected by C.R. Stauffer; hypotype, GSC 22982, a steinkern of pedicle valve, Detroit River Group, Loc. 23654, collected by E.W. Best; hypotypes, GSC 22983, 22984, steinkerns of brachial valves, Detroit River Group, Loc. 13491, collected by J.F. Caley; hypotype, GSC 22985, a steinkern of brachial valve, probably from the Amherstburg Dolomite, Loc. 4517, collected by M.Y. Williams; hypotype, UMMP 56624, a steinkern of brachial valve, probably from the Amherstburg Dolomite, Loc. I.

In addition, the following type specimens of species originally described by other authors are here included in the hypodigm of *Megastrophia (Megastrophia) proxicostellata*: syntype of *Strophodonta inequiradiata* Hall (1867, pp. 87, 88, Pl. 11, fig. 31), AMNH 2819/1, exterior of brachial valve, Schoharie Grit, Albany Co., N.Y., collected by James Hall; possibly syntype of *Stropheodonta vasculosa* Grabau (*in* Grabau and Sherzer, 1910, pp. 124-126, Pl. 17, figs. 8, 9), ROM 22439, cast of interior of pedicle valve, probably from the Amherstburg Dolomite, Loc. J, collected by Thomas Nattress; possibly syntype of *Stropheodonta vasculosa* Grabau, ROM 22511, interior of brachial valve, probably from the Amherstburg Dolomite, Loc. J, collected by Thomas Nattress; possibly syntypes of *Stropheodonta delicatula* Stauffer (1918, p. 558, Pl. 2, figs. 4, 5), UM 4841a, probably from Amherstburg Dolomite, Loc. J, collected by C.R. Stauffer; possibly *Stropheodonta vasculosa* Grabau, UMMP 13102, mold of exterior of brachial valve, probably from Amherstburg Dolomite, Loc. J, collected by Thomas Nattress.

*Megastrophia (Megastrophia) inequiradiata* (Hall)

Plate II, figures 12-15

*Strophodonta inequiradiata* Hall, 1867, *partim*, pp. 87, 88, Pl. 13, figs. 6-9; ?Pl. 13, figs. 10, 11; *non* Pl. 11, fig. 31.

Description. Shells concavo-convex, large, of average size for the genus. line long, straight; cardinal extremities generally somewhat mucronate (Pl. II, fig. 14), occasionally becoming right angled. Lateral and anterior margins smoothly and evenly rounded. Length/width ratio from about 0.75 in typical specimens to as little as 0.55 in extremely mucronate specimens. Greatest width at hinge line. Pedicle valve moderately deep, curvature even in lateral profile. Commissure rectimarginate throughout.

Radial ornamentation subdued, finely and unevenly parvicostellate, consisting of numerous, low, closely spaced primary costae separated by 2-7 costellae (averaging about 4) (Pl. II, figs. 14, 15). Costae and costellae rounded, impersistent, arising at irregular intervals, and separated by narrower, shallow, rounded interspaces. Concentric ornamentation consisting only of very obscure filia. Shell structure pseudopunctate; tubercles moderately large, arranged in radial rows.

Pedicle interior with well developed, broadly transverse ventral process which bears a pair of secondary teeth along the anterodorsal margin. Hinge line completely denticulate except for medial portion occupied by ventral process. Posteromedial region of valve floor contains three depressed areas: a well defined, relatively large medial muscle field, and a pair of less well defined and smaller lateral cavities for the reception of the cardinal process lobes (Pl. II, fig. 12). Muscle field subcircular, containing a medial pair of poorly defined, medial, elevated adductor tracks separated by a median depression, and lateral, obscure diductor tracks. Posterolateral margin of muscle field marked by a broad ridge separating muscle field from cardinal process receptor cavities. These cavities, located below and laterally from secondary teeth, are suboval, moderately depressed posteriorly, rising anterolaterally to merge with valve floor. Radial ornamentation and vascular markings not apparent on interior of valves. Teeth, dental plates, and foramen absent.

Brachial interior unknown.

Material and occurrence. Lectotype (here designated), AMNH 2819/8, exterior of a partially exfoliated pedicle valve, Onondaga Limestone, Clarence Hollow, N.Y., illustrated by Hall (1867, Pl. 13, fig. 6); paralectotype, AMNH 2819/4, exterior of pedicle valve, Onondaga Limestone, Unionville, N.Y., illustrated by Hall (1867, Pl. 13, fig. 7); paralectotype, AMNH 2819/3, steinkern of pedicle valve, Onondaga Limestone, Schoharie, N.Y., illustrated by Hall (1867, Pl. 13, figs. 8, 9); hypotype, GSC 22986, a partially exfoliated pedicle valve, upper Anderdon Limestone, Loc. 20879, collected by E.W. Best; hypotype, GSC 22987, exterior of pedicle valve, upper Anderdon Limestone, Loc. 20879, collected by E.W. Best.

*Megastrophia* sp. A

Plate II, figures 16, 17

*Megastrophia* sp. A Fagerstrom, 1961a, p. 20, Pl. 8, figs. 9, 10.

Material and occurrence. Figured specimen, GSC 22988, steinkern of a brachial valve, upper Anderdon Limestone, Loc. 4518, collected by G.S. Hume and M.Y. Williams.

*Megastrophia*(?) sp.

Plate II, figures 18-20

Remarks. One large, deeply convex pedicle valve was collected from the type section of the Anderdon Limestone and may be a gerontic individual of *M. (M.) inequiradiata*. However, the ornamentation is not sufficiently well preserved to be certain. The apical cavity is filled by a rather massive median callus (Pl. II, fig. 19). The ventral process has apparently been resorbed but the lateral cavities for the reception of the cardinal process lobes are well developed. The muscle field is poorly defined but apparently is transversely elongate and there is a median depression separating the adductor tracks. Both the cardinal process receptor cavities and the muscle field are bounded laterally by a massive ridge.

Material and occurrence. Figured specimen, GSC 22989, a partially exfoliated brachial valve, upper Anderdon Limestone, Loc. 20879, collected by E.W. Best.

Genus "*Schuchertella*" Girty, 1904

Remarks. Specimens of perhaps as many as four species of the genus "*Schuchertella*" are present in the Detroit River Group but are generally rare except locally in the Formosa Reef Limestone. Preservation is generally poor but the specimens presently available show no evidence of pseudopunctate shell structure.

There is considerable variety in the nature of the costation and this feature offers most promise for recognition of species. However, the poor preservation and lack of abundant specimens make it impossible to rigorously subdivide the shells assigned to this genus at the present time. In addition, the destruction of former outcrops yielding specimens of the genus makes it unlikely that this situation will be improved in the near future.

"*Schuchertella*" *varicostata* Fagerstrom

Plate I, figure 15

*Schuchertella interstriata* Grabau, 1910, *partim*, p. 123, Pl. 17, fig. 5; *non* Pl. 17, fig. 4, Pl. 32, fig. 1; *non Orthis interstriata* Hall, 1852, p. 326, Pl. 74, figs. 1, 2.

*Schuchertella varicostata* Fagerstrom, 1961a, p. 21, Pl. 8, figs. 19-25.

Material and occurrence. Hypotype, GSC 22995, exterior of pedicle valve, Formosa Reef Limestone, Loc. 23635, collected by J.A. Fagerstrom; hypotype, GSC 22996, exterior of pedicle valve, Detroit River Group, Loc. 23536, collected by E.W. Best; hypotype, GSC 22997, exterior of (?) brachial valve, lower Anderdon Limestone, Loc. 76000, collected by J.A. Fagerstrom; hypotype, GSC 22998, exterior of pedicle valve, Detroit River Group, Loc. 23564, collected by J.A. Fagerstrom; hypotype, GSC 22999, interior of pedicle valve, Detroit River Group, Loc. 13491, collected by J.F. Caley; plastotypes, UMMP 13107, the original mold of *Schuchertella interstriata* Grabau (1910, Pl. 17, fig. 5) has apparently been lost but was probably collected from the Amherstburg Dolomite, Loc. J by Thomas Nattress.

*Schuchertella interstriata* was also listed as present in the Sylvania Sandstone by Carman (1936, p. 261).

"*Schuchertella*" *amherstburgense* Grabau

Plate I, figure 14

*Schuchertella amherstburgense* Grabau, 1910, p. 124, Pl. 17, figs. 1-3.

Remarks. The distinguishing features of this species are rather uncertain since Grabau's original description was probably based on a small number of immature pedicle valves, none of which showed internal structures. In addition, all of Grabau's specimens are apparently lost so even the details of the ornamentation cannot be determined except by reference to the description. There is, however, a single very small pedicle valve from either the Amherstburg or the Lucas Dolomite, formerly exposed at the Patrick Quarry, which conforms to Grabau's description and is here included in this species and designated the neotype.

Material and occurrence. Neotype, UMMP 56625, steinkern of pedicle valve, from either the "coral-mixed brachiopod" or *Acanthonema holopiiforme* Subzone (?Amherstburg or ?Lucas Dolomite), Loc. F, collector unknown; plastotypes, UMMP 14096, the specimen illustrated by Grabau (1910, Pl. 17, figs. 1-3) has apparently been lost but was probably collected from the Amherstburg Dolomite, Loc. J by Thomas Nattress; hypotype, ROM 262.S, mold of exterior of pedicle valve, probably from the Amherstburg Dolomite, Loc. J, collected by Thomas Nattress.

*"Schuchertella"* sp. cf. *"S." amherstburgense* Grabau

Plate I, figures 11-13

Remarks. Rare specimens, differing from *"S." amherstburgense* mostly by their larger size, are present in the Amherstburg Dolomite and the Anderdon Limestone in the type region and from near the base of the Detroit River at Castalia, Ohio.

The pedicle valve from the Amherstburg has about thirty-four prominent, smoothly rounded and evenly spaced costae nearly all of which are persistent nearly to the umbo (Pl. I, fig. 13). Additional costae are only added along the hinge line near the cardinal extremities. The hinge line is long and straight. The interarea is anacline, slightly concave, with a large, broadly flaring, marginally thickened delthyrium that is completely covered by a convex pseudodeltidium (Pl. I, fig. 11). The dental plates are very low, smoothly rounded, broadly flaring, short ridges on the floor of the valve.

Fragments of somewhat similar specimens from the Anderdon have narrower, more closely spaced costae which arise by bifurcation and intercalation and are equidistant from the adjacent costae.

Material and occurrence. Figured specimen, UMMP 56626, a steinkern of pedicle valve, probably from the Amherstburg Dolomite, Loc. I, collector unknown; figured specimen, GSC 23000, a mold of exterior, *Amphipora nattressi* Subzone, Lucas Dolomite, east wall of west quarry, Loc. A, collected by J.A. Fagerstrom.

*"Schuchertella"* sp.

Plate I, figures 16, 17

Description. Shells large for the genus, both valves slightly to moderately convex. Cardinal margin long, straight; pedicle umbo greatly extended posteriorly, irregular in shape due to cemented attachment area (Pl. I, fig. 17); brachial umbo small, poorly defined, not extending posterior to cardinal margin. Cardinal extremities obtusely angular, lateral margins smoothly rounded, anterior margin becoming almost straight. Greatest width about midlength; length/width ratio about 0.7-0.8. Anterior commissure recti-marginate. Shell structure impunctate.

Radial ornamentation consisting of numerous, closely spaced, low, rounded to slightly angular costae, most of which are persistent to the umbo. Additional costae arise by intercalation and are spaced equidistant between the adjacent costae (Pl. I, fig. 16). Concentric ornamentation consisting of a few continuous to oblique, prominent rugae located mostly toward the valve margins. Additional irregular, moderately large, node-like to elongate protruberances occur widely scattered over the shell surface.

Remarks. The above description is based on two rather poorly preserved, isolated, opposite valves that may never have been joined. However, both



valves are much larger than for any other species of "*Schuchertella*" from the Detroit River Group.

Material and occurrence. Figured specimen, UMP 56627, a partially exfoliated pedicle valve, *Amphipora nattressi* Subzone (?Anderdon Limestone), Loc. G, collector unknown; referred specimen, UMP 56628, an almost completely exfoliated brachial valve, *Amphipora nattressi* Subzone (?Anderdon Limestone), Loc. G, collector unknown.

Genus *Spinulicosta* Nalivkin, 1937

*Productella* Hall, 1867, p. 153 (partim).

*Spinulicosta* Nalivkin, 1937, pp. 49, 140; Muir-Wood and Cooper, 1960, pp. 153-155, Pls. 32, 33.

*Spinulicosta navicella* (Hall)

Plate I, figure 18

*Productella navicella* Hall, 1867, pp. 156, 157, Pl. 23, figs. 1-3, 9-11.

*Spinulicosta navicella* Fagerstrom, 1961a, p. 21, Pl. 8, figs. 27-30.

Remarks. The distinction between *S. navicella* and *S. spinulicosta* is not entirely clear from Hall's original descriptions of these species. The specimens from the Detroit River Group are somewhat larger and with more densely spaced spine bases than the illustrations of these species given by Hall (1867, Pl. 23) and of *S. spinulicosta* given by Muir-Wood and Cooper (1960, Pl. 32, figs. 1-4).

Material and occurrence. Hypotypes, GSC 23001 and 23002, exteriors of pedicle valves, probably from the Detroit River Group, Loc. 15126, collected by J.F. Caley; hypotype, GSC 23003, exterior of pedicle valve, probably from Detroit River Group, Loc. 13493, collected by J.F. Caley.

*Gypidula* (?) sp.

Plate I, figures 19, 20

Description of pedicle valve. Outline broadly subpyriform, posterolateral margins straight, lateral and anterior margins evenly rounded; length and width about equal, greatest width slightly ahead of midlength. Anterior commissure sulcate. Fold broad, flat, low, and rather poorly defined.

Ornamentation consists of numerous (five on each flank and about four on fold) low, broadly rounded costae confined to the anterior and anterolateral portions of the valve and several crowded growth lines along the anterior margin. Posterior portion of valve smooth.

Interarea well developed in both length and width; divided medially by a long, narrow delthyrium. Delthyrial margins descend sharply to form a relatively narrow and deep spondylium which is supported posteriorly by a short, thin median septum.

Remarks. Because this species is represented by a single pedicle valve it is impossible to determine whether it belongs to the genus *Gypidula* or to *Sieberella*. However, since *Sieberella* is unknown from rocks as young as the Detroit River Group it appears unlikely that the valve belongs to this genus.

Material and occurrence. Figured specimen, GSC 23004, a steinkern of pedicle valve, probably from the Amherstburg Dolomite, Loc. 4368, collected by C.R. Stauffer.

*Pentamerella arata* (Conrad)

Plate I, figures 25, 26

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

*Pentamerella arata* Hall, 1867, p. 375, Pl. 58, figs. 1-10, 13-21;

Kindle, 1901, p. 615; Amsden, 1964, pp. 233-235, Pl. 40, figs. 9-15; Text-fig. 5.

Remarks. Amsden (1964, pp. 233, 234) has noted that in *P. arata* new costae commonly arise by bifurcation. In the experience of the present author, the presence or absence of bifurcating costae is a highly variable feature among specimens of this species from the Detroit River Group and therefore is of uncertain taxonomic importance. However, the costae are more numerous and considerably higher in *P. arata* than in *P. pavilionensis* (Kindle, 1901, pp. 612, 615; Fagerstrom, 1961a, p. 18).

Material and occurrence. Hypotypes, UMMP 56629 and 56630, steinkerns of brachial valves, probably from the Amherstburg Dolomite, Loc. I, collector unknown.

?*Pentamerella arata* (Conrad)

Plate I, figure 24

Remarks. The fossil assemblage from Livingstone Channel contains a single mold of the exterior of a valve with a moderately well-developed fold. Unfortunately, it cannot be determined which valve is represented; if it is the brachial the specimen belongs to the genus *Pentamerella* whereas if the valve is the pedicle it is *Gypidula*. The generally low convexity of the beak suggests that the correct genus is *Pentamerella* and the relatively high, long costae suggest that the species is *P. arata*.

Material and occurrence. Figured specimen, GSC 23005, a mold of the exterior of one valve, probably from the Amherstburg Dolomite, Loc. 4368, collected by C.R. Stauffer.

*Pentamerella pavilionensis* (Hall)

Plate I, figures 21-23

*Pentamerus pavilionensis* Hall, 1860, p. 86.

*Pentamerella pavilionensis* Hall, 1867, p. 377; Kindle, 1901, pp. 612, 613,

Pl. 7, figs. 1, 1a; Cooper, 1944, p. 305, Pl. 115, figs. 16-18; Fagerstrom, 1961a, p. 18, Pl. 7, figs. 7-30.

Emended description (emended to Fagerstrom, 1961a, p. 18). Valves smooth to multicostate. Costae low, rounded, of variable number from 2-5 (most commonly three) on the flanks, 1-4 (most commonly two) in the sulcus, 1-6 (most commonly three) on the fold, generally wider than interspaces, persistent nearly to umbones, and usually increasing by intercalation.

Brachial interior with broadly flaring inner plates; brachial processes convergent, non-carinate; outer plates unite at floor of valve to form a smoothly rounded cruralium extending forward nearly to midlength (Pl. I, fig. 23).

Remarks. This species is extremely variable as evidenced by the large sample from the Formosa Reef Limestone (Fagerstrom, 1961a). The availability of additional material indicates that smooth forms are considerably more abundant than heretofore suspected. These smooth individuals are the only ones illustrated in the present report because the more common multi-costate forms have been adequately illustrated in the references cited in the synonymy.

The chief differences between *P. papilionensis* and *P. arata* involve the costae. In the former the costae are lower, more rounded, and generally wider. Furthermore, smooth forms are apparently unknown in *P. arata*.

Material and occurrence. Hypotype, GSC 23006, a steinkern of brachial valve, Amherstburg Dolomite, Loc. 4517, collected by M.Y. Williams; hypotypes, GSC 23007 and 23008, pedicle valves, probably from Detroit River Group, Loc. 11294, collected by J.F. Caley; hypotype, GSC 23009, a brachial valve, probably from Detroit River Group, Loc. 15126, collected by J.F. Caley; hypotypes, UMMP 56631 and 56632, steinkerns of pedicle valve, from sandy layers in "coral-mixed brachiopod subzone" (?Amherstburg Dolomite), Loc. C, collector unknown; hypotype, GSC 23010, a pedicle valve, Formosa Reef Limestone, Loc. 23635, collected by J.A. Fagerstrom; hypotype, UMMP 56633, a nearly complete specimen, Formosa Reef Limestone, Loc. 23635, collected by G.M. Ehlers, E.C. Stumm, and R.V. Kesling.

*Cupularostrum(?) tethys* (Billings)

Plate III, figures 1, 2

*Rhynchonella? tethys* Billings, 1860, p. 270, figs. 20-22.

*Camarotoechia tethys* (Billings); Fagerstrom, 1961a, p. 27, Pl. 9, figs. 1-12.

Remarks. The interior of this species has never been adequately described so it is uncertain whether or not the septalium is covered in the manner described by Sartenaer (1961, p. 2) as characteristic of *Cupularostrum*.

In a rather poorly preserved steinkern (UMMP 56634) the dental plates are thin, moderately divergent, and extend anteriorly about one-third the length of the pedicle valve. The septalium is small and supported by a thin median septum extending forward to about midlength.

Material and occurrence. Hypotype, UMMP 56634, a steinkern with both valves joined, sandy beds in "coral-mixed brachiopod subzone" (?Amherstburg Dolomite), Loc. C, collector unknown; hypotypes, GSC 23011 and 23012, steinkerns with both valves joined, probably from the Detroit River Group, Loc. 15126, collected by J.F. Caley.

*Camarotoechia(?) ehlersi* n. sp.

Plate III, figures 3-12; Text-figures 9-11

Description. Shells small, biconvex. Dorsal outline subtriangular; cardinal margin short, subterebratulid, posterolateral margins straight, lateral and anterolateral margins gently and evenly rounded, anterior margin straight to slightly convex. Length and width approximately equal; greatest

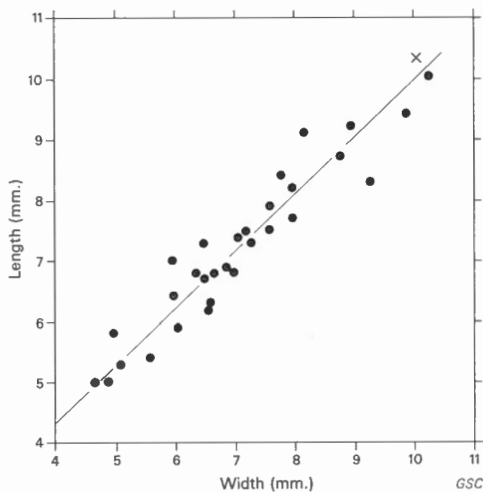


Figure 9.  
Scatter diagram showing length-width relations of thirty-one pedicle valves of *Camarotoechia(?)ehlersi*.

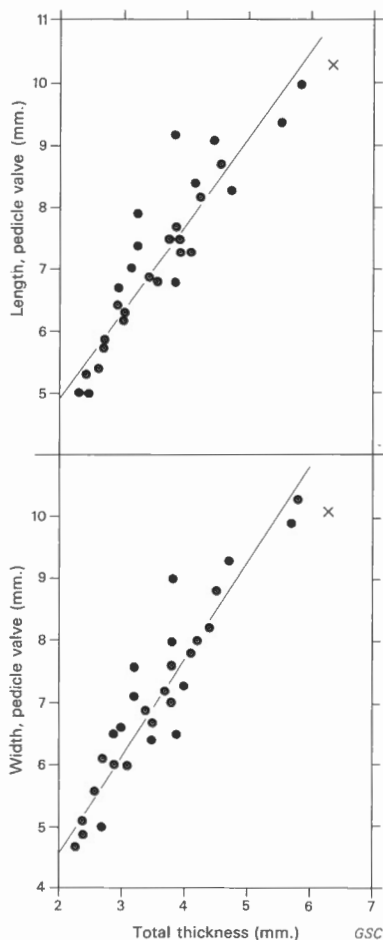


Figure 10.  
Scatter diagrams showing relations between total thickness and length and width for thirty pedicle valves of *Camarotoechia(?)ehlersi*.

width about midlength. In lateral profile small specimens sublenticular; large specimens relatively thicker, gently and evenly convex; brachial valve somewhat deeper than pedicle. Anterior commissure rectimarginate in very small specimens becoming broadly episulcate in large specimens; anterolateral commissures rectilinear in small specimens, zig-zag in large specimens; posterolateral commissures rectimarginate. Small shells smooth (Pl. III, figs. 11, 12); large shells costate and with well defined fold and linguiform sulcus. Costae on flanks variably elevated, smoothly rounded, short, separated by shallow, smoothly rounded interspaces, and numbering 2-5 on each flank. Fold and sulcus begin at about midlength, and contain 1-3 very low, rounded, short costae. Concentric ornamentation consists of numerous, generally fine, rather uniformly spaced growth lines. Shell structure impunctate. Muscle scars and vascular markings unknown.

Apical angle of pedicle valve about 90°; beak suberect; foramen small, submesothyridid. Pedicle interarea short, narrow; delthyrium broadly triangular. Teeth presumably bent sharply inward to join sockets. Dental plates thin, divergent; laterally convex becoming almost vertical posteriorly and planar anteriorly; extending forward about one-fourth valve length.

Apical angle of brachial valve about 135°; beak not covered by pedicle valve; interarea absent. Cardinalia weak. Septalium of variable size and shape, thickened posteriorly and along internal ventral margins by medial edges of crural bases. Cardinal process absent. Crura apparently blade-like. Septalial plates thin, joining dorsally to form relatively thin, high median septum. Septum extends forward about one-third valve length. Sockets wide, shallow, divergent; bounded by thickened, overhanging socket ridges.

Remarks. The above description is based upon a relatively large and varied sample; Text-figures 9 and 10 and Table 5 indicate the general variability and the equations for growth lines. Although there is some suggestion that the relations between thickness and both length and width in Text-figure 10 are allometric, the calculations have been made on the assumption that growth was isometric.

Table 5

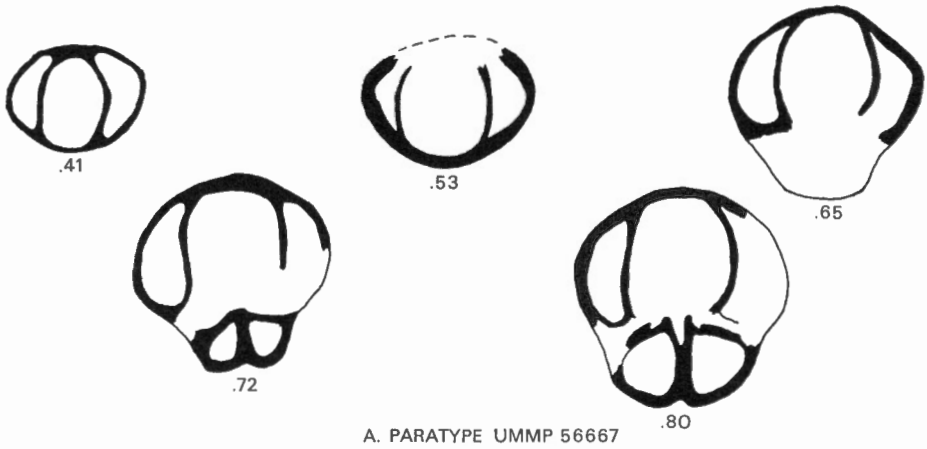
Statistical characterization of sample of *Camarotoechia(?) ehlersi* from the Sibley Quarry (Locality G, Appendix I). Measurements (in millimetres) based on thirty-one complete specimens.

	Mean	Standard deviation		r	Dd
length	7.31	1.41	length-width	.96	5.86
width	7.19	1.51	length-thickness	.92	8.32
thickness	3.65	.98	width-thickness	.93	8.49

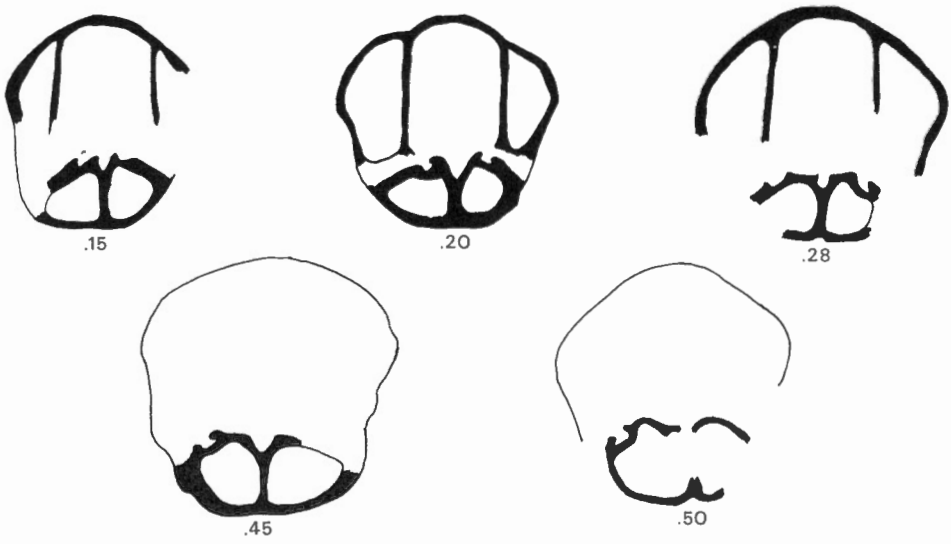
r= correlation coefficient

Dd= coefficient of relative dispersion about the reduced major axis

The familial and generic relations of this species are very uncertain. Both the external and internal features are generalized; furthermore, the small size of the specimens makes it possible that none has attained well-developed adult structures. *C. (?) ehlersi* perhaps belongs to a new genus, but until other similar species are known for inclusion in such a genus the conservative course is followed here and the species is regarded simply as a generalized member of the Camarotoechiidae (Williams, *et al.*, 1965, p. H 579).



A. PARATYPE UMMP 56667



B. PARATYPE UMMP 56668

Figure 11. *Camarotoechia(?)ehlersi* n. sp.; camera lucida drawings of serial transverse sections x 10; distances are in mm forward from the crest of the umbo.

Material and occurrence. Holotype, UMMP 56636, a complete specimen with valves joined, *Amphipora nattressi* Subzone (?Anderdon Limestone), Loc. G, collected by G.M. Ehlers and R.M. Linsley; paratypes, UMMP 56637-56666, complete specimens with valves joined, *Amphipora nattressi* Subzone (?Anderdon Limestone), Loc. G, collected by G.M. Ehlers and R.M. Linsley; paratypes, UMMP 56667-56669, the remains of serially sectioned specimens with valves joined, *Amphipora nattressi* Subzone (?Anderdon Limestone), Loc. G, collected by G.M. Ehlers and R.M. Linsley; paratype, UMMP 56670, a specimen with valves joined, *Amphipora nattressi* Subzone (?Anderdon Limestone), Loc. A, collected by G.M. Ehlers and R.M. Linsley; paratypes, GSC 23014-23019, near top of the Detroit River Group, Loc. 23651, collected by J.A. Fagerstrom.

*Camarotoechia*(?) *ambigua* Fagerstrom

*Camarotoechia ambigua* Fagerstrom, 1961a, p. 28, Pl. 9, figs. 13-16.

Emended description. Dental plates moderately divergent and very short, extending forward only about one-fifth the length of the pedicle valve. Median septum in brachial valve extending forward about one-third the length of the valve.

Remarks. This species has been sufficiently well illustrated by Fagerstrom (1961a), so none is needed in the present report.

Material and occurrence. Hypotype, GSC 23013, a complete specimen, Detroit River Group, Loc. 23654, collected by E.W. Best.

*Camarotoechia*(?) sp. cf. *C. formosensis* Fagerstrom

Remarks. A single, rather incomplete specimen having the thin, lenticular form of *Camarotoechia formosensis* Fagerstrom (1961a, pp. 27, 28, Pl. 9, figs. 17-23) is here compared to this species. However, in this specimen the fold is much less prominent than in *C. formosensis* and there are only 2-3 low, rounded costae on the fold and sulcus. The exterior of *C. formosensis* has been sufficiently well illustrated so that additional figures are not necessary; the interior is still unknown.

Material and occurrence. Referred specimen, UMMP 56635, an incomplete specimen with valves joined, *Amphipora nattressi* Subzone (?Anderdon Limestone), Loc. G, collected by G.M. Ehlers and R.M. Linsley.

Genus *Atribonium* Grant

*Stenosisma* Conrad, 1839, pp. 58, 58 (*partim*).  
*Atribonium* Grant, 1965, pp. 37-40.

*Atribonium halli* (Fagerstrom)

*Stenosisma halli* Fagerstrom, 1961a, p. 29, Pl. 9, figs. 48-51.  
*Atribonium halli*, Grant, 1965, pp. 52, 53.

Remarks. *A. halli* is one of a group of species having great external similarity occurring in rocks of Onondaga and Hamilton age. Other species in this group include *A. gainesi* (including *A. gainesi cassensis*), *A. illinoisensis* (Cooper), and *A. savagei* (Cooper). The differences between some of these

species have been noticed by Cooper (1945, p. 483) and Grant (1965, p. 40) has considered them all valid.

There seems to be little doubt that *A. halli* pre-dates both *A. illinoisensis* and *A. savagei* which occur with a species of *Paraspirifer* intermediate in character between *P. acuminatus* of Onondaga age and *P. bowmocker* of Hamilton age (Cooper, 1945, pp. 487, 488).

Material and occurrence. Hypotype, GSC 23020, a brachial valve, Detroit River Group, Loc. 23536, collected by E.W. Best.

#### Genus *Atrypa* Dalman

#### *Atrypa* spp.

Plate III, figures 20-29

Remarks. The distribution of specimens of the genus *Atrypa* consists of distinct assemblages or "pockets" which differ from one another in such relatively minor characters as size, convexity of the valves, nature of the costae (both internal and external), and shape of the commissure. Many of these differences result from differences in preservation.

Since the number of specimens in each assemblage and the number of assemblages is not large all of the specimens are here described simply as *Atrypa* spp. and some of the morphological variation illustrated (see also Fagerstrom, 1961a, pp. 29, 30, Pl. 9, figs. 30-40). None of the distinct morphological assemblages, or morphotypes appears to be of any biostratigraphic value at the present time.

Material and occurrence. Figured specimen, GSC 23021, a steinkern of both valves joined, Anderdon Limestone, Loc. K, collected by J.A. Fagerstrom; figured specimen, GSC 23022, the mold of the exterior of a brachial valve, Anderdon Limestone, Loc. K, collected by J.A. Fagerstrom; figured specimen, GSC 23023, a partially exfoliated (?) brachial valve, probably from the Detroit River Group, Loc. 15126, collected by J.F. Caley; figured specimen, GSC 23024, a steinkern of pedicle valve, probably from the Amherstburg Dolomite, Loc. 4368, collected by C.R. Stauffer; figured specimen, GSC 23025, a steinkern of both valves joined, probably from the Amherstburg Dolomite, Loc. 4368, collected by C.R. Stauffer; figured specimen, UMMP 56671, a steinkern of both valves joined and partial molds of the exterior, probably from the Amherstburg Dolomite, Loc. I, collector unknown; referred specimens, GSC 23026-23028, steinkerns, probably from Amherstburg Dolomite, Loc. 4368, collected by C.R. Stauffer; referred specimen, GSC 23029, a steinkern of posterior half of both valves joined, Detroit River Group, Loc. 13491, collected by J.F. Caley.

#### Genus *Meristina* Hall

*Meristina* Hall, 1867, p. 299.

*Meristella* (partim) Hall, 1860, pp. 74, 93, *emend.* Boucot, Johnson, and Staton, 1964, pp. 820, 821.

Remarks. Boucot, Johnson, and Staton (1964, pp. 820, 821; *in* Williams, *et al.*, 1965, p. H 656) have emphasized the relatively great length of the dental plates and narrow pedicle muscle field bounded by the dental plates or their anterior extensions on the floor of the valve in species of the genus *Meristina*. This configuration of the dental plates and muscle field adequately characterizes the pedicle interior of *M. nasuta* from the lower Detroit River Group. However, in specimens of *M. formosensis* from these same rocks the dental plates are relatively long but the muscle field is not confined to the



region between the dental plates. Nonetheless, the length of the dental plates and the rather long, narrow shape of the muscle field indicate that *M. formosensis* should be included in the genus *Meristina* as conceived by Boucot, Johnson, and Staton (1964).

*Meristina nasuta* (Conrad)

Plate IV, figure 1

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

*Meristella nasuta*, Hall, 1860, p. 93; Hall, 1867, p. 299, Pl. 48, figs. 1-25; Fagerstrom, 1961a, p. 33, Pl. 11, figs. 1-4.

Material and occurrence. Hypotype, GSC 23031, a steinkern of pedicle valve, probably from the Amherstburg Dolomite, Loc. 4517, collected by M.Y. Williams; hypotype, UMMP 56672, a steinkern of brachial valve, "coral-mixed brachiopod subzone" (?Amherstburg Dolomite), Loc. C, collector unknown.

*Meristina barrisi* (Hall)

Plate IV, figure 7

*Meristella barrisi* Hall, 1860, p. 84; Hall, 1867, p. 304, Pl. 49, figs. 9-12. Fagerstrom, 1961a, p. 33, Pl. 11, figs. 5-10.

*Meristina barrisi* (Hall), Boucot, Johnson, and Staton, 1964, p. 821.

Remarks. The interior of the pedicle valve of this species in the Detroit River Group is known from two specimens. In one of these (UMMP 56673) the dental plates are clearly defined and extend forward about one-fourth the length of the valve. The outline of the pedicle muscle field is uncertain but there is some slight indication of longitudinal striations on the valve floor just anterior to the area between the dental plates.

Material and occurrence. Hypotypes, UMMP 56673 and 56674, steinkerns with both valves joined, "coral-mixed brachiopod subzone" (?Amherstburg Dolomite), Loc. C, collector unknown.

*Meristina formosensis* (Fagerstrom)

Plate IV, figures 3-6

*Meristella formosensis* Fagerstrom, 1961a, p. 33, Pl. 11, figs. 11-15.

Emended description. Dental plates high, narrow, laterally convex, extending forward about one-third the length of the pedicle valve (Pl. IV, fig. 6). Dental plates converge and nearly join on dorsal surface of a relatively narrow, elevated, longitudinally striate muscle field that extends ahead of midlength. Muscle field not bounded by dental plates.

Septalium well developed, moderately long, of variable depth and width, and supported by a narrow, relatively high median septum that extends anteriorly to about midlength (Pl. IV, fig. 3).

Material and occurrence. Hypotype, GSC 23032, a steinkern with both valves joined, probably from the Amherstburg Dolomite, Loc. 4368, collected by C.R. Stauffer; hypotype, GSC 23033, a crushed steinkern with both valves joined, probably from the Amherstburg Dolomite, Loc. 4521, collected by M.Y. Williams.

*Meristina* sp.

Plate IV, figure 2

*Whitfieldella* sp. Grabau, 1910, pp. 157, 158, Pl. 21, fig. 10.

Remarks. Although this specimen is too incomplete for certain identification, the form of the dental plates and the muscle field suggest that it belongs in the genus *Meristina*.

Material and occurrence. Figured specimen, UMMP 13071B, an incomplete steinkern of the pedicle valve, probably from the Amherstburg Dolomite, either Loc. I or J, collector unknown.

*Meristella(?) livingstonensis* n. sp.

Plate IV, figures 8-11

Description. Shells of moderate size, elongate, biconvex, and smooth. Cardinal margin short, terebratulid, posterolateral margins nearly straight, lateral margins gently convex, anterolateral margins nearly straight and making sharp, obtuse angle with moderately convex anterior margin. Pedicle umbo narrow, moderately extended behind cardinal margin and brachial umbo. In lateral profile brachial valve gently and evenly convex; pedicle valve deeper and evenly convex. In anterior profile both valves moderately and rather evenly convex; fold and sulcus absent (Pl. IV, fig. 10). Commissure rectimarginate throughout. Interareas, delthyrial structures, ornamentation, and shell structure unknown.

Pedicle valve length/width ratio about 2.4; greatest width at mid-length. Teeth relatively high and narrow, supported by thin, laterally convex dental plates extending forward on floor of valve to about one-fifth valve length (Pl. IV, fig. 9). Delthyrial chamber relatively deep, narrow, and short. Muscle scars and vascular markings unknown.

Brachial valve length/width ratio about 2.2; greatest width slightly posterior to midlength. Sockets relatively deep and narrow. Inner socket ridges well developed, over hanging margin of socket, and supported dorsally by a pair of short, slightly convergent (but not joining) plates attached medially to cardinal plate to form a small, very narrow, notothyrial chamber (Pl. IV, fig. 11). Cardinal plate free, apparently imperforate, relatively narrow, convex ventrally, bearing a very low median ridge, and supported laterally by a pair of short, divergent plates extending forward about one-fifth valve length. A very low myophragm extends forward from just behind anterior margin of cardinal plate to about one-fourth valve length. Muscle scars and vascular markings apparently absent; brachidia unknown.

Remarks. This species is known from a single steinkern. The pedicle valve is somewhat crushed and less complete than the brachial valve.

The species is characterized by an unusual combination of features: (1) the rectimarginate commissure, (2) the ventrally convex cardinal plate and divergent supporting plates, and (3) the almost vertical plates attached to the cardinal plate and supporting the inner socket ridges. The chamber below the cardinal plate is suggestive of the pedicle valve in members of the *Meristellidae*. However, there seems little doubt that the species belongs to a new genus to be described if additional material becomes available. Until such time the species is questionably referred to the genus *Meristella*.

Material and occurrence. Holotype, GSC 23034, a steinkern with both valves joined, probably from the Amherstburg Dolomite, Loc. 4368, collected by C.R. Stauffer.

Genus *Athyris* M'Coy

*Athyris cora* Hall

*Athyris cora* Hall, 1860, p. 94; Hall, 1867, p. 291, Pl. 47, figs. 1-7;  
Fagerstrom, 1961a, p. 34, Pl. 10, fig. 27, Pl. 11, figs. 37-41.

Material and occurrence. Hypotype, GSC 23048, a complete specimen, upper Detroit River Group, Loc. 23588, collected by E.W. Best.

*Athyris*(?) *minuta* Fagerstrom

*Athyris minuta* Fagerstrom, 1961a, pp. 34, 35, Pl. 11, figs. 42-44.

Remarks. The identification of several small specimens, mostly from the Formosa Reef Limestone, has been very difficult because of the lack of material suitable for serial sectioning. These specimens are smaller than is typical for the genus *Athyris*. Furthermore, they are longer than wide, whereas in *A. cora* width is greater than length. Nonetheless, the possibility does exist that *A. minuta* merely comprises the immature individuals of *A. cora* and that the length-width relation is allometric during ontogeny.

Another possibility is that *A. minuta* is synonymous with *Meristospira michiganense* Grabau (1910, pp. 159, 160); this problem can only be solved with detailed serial sectioning of better preserved material than is presently available.

Material and occurrence. Hypotype, GSC 23035, a partially exfoliated specimen with the valves joined, Detroit River Group, Loc. 23654, collected by E.W. Best; hypotypes, GSC 23036-23047, exteriors of both valves joined, Formosa Reef Limestone, south end of Loc. 23635, collected by J.A. Fagerstrom.

*Meristospira michiganense* Grabau

Plate IV, figures 14-22

*Meristospira michiganense* Grabau, 1910, pp. 159, 160, Pl. 20, figs. 5-11;  
Pl. 21, figs. 4-6.

Remarks. Grabau's original description of this species appears to be essentially correct except for his notation of a median septum in each valve. The floor of the pedicle valve is marked by radial depressions (probably the vascular markings arranged in a very simple digitate pattern) that extend posteriorly as faint striations into the delthyrial chamber; Grabau may have mistaken one of these as a median septum. There is a short myophragm in the brachial valve (Pl. IV, figs. 16, 19).

Material and occurrence. Syntypes, UMMP 14078 and 14079, steinkerns of both valves joined, probably from the "coral-mixed brachiopod subzone" (?Amherstburg Dolomite), Loc. D, collector unknown. This species was also reported from the Sylvania Sandstone by Carman (1936, p. 261).

?*Meristospira michiganense* Grabau

Plate IV, figures 12, 13

Remarks. A single moderately well preserved steinkern conforms in all essential features to *M. michiganense* except that the interior of the shell is completely smooth. In this specimen the dental plates are rather poorly developed and short, the cardinal plate is free and appears to be pierced apically, and the fold is very low, broad, and indistinct. If this specimen actually is *M. michiganense* it greatly extends the previously reported geographic and stratigraphic occurrence of the species.

Material and occurrence. Figured specimen, UMMP 56675, a steinkern of both valves joined, Anderdon Limestone, Loc. K, collected by G.M. Ehlers and R.M. Linsley.

*Nucleospira(?) livingstonensis* Stauffer

*Nucleospira livingstonensis* Stauffer, 1918, pp. 558, 559, Pl. 2, fig. 6.

Remarks. The adductor track in the pedicle valve is long and narrow and divided by a myophragm. The relative length of the adductor track and the myophragm is uncertain due to incomplete preservation. Dental plates are absent. The brachial valve is unknown.

Material and occurrence. Holotype, UM 4838a, an incomplete steinkern of the pedicle valve, Lucas Dolomite, Loc. I, collected by C.R. Stauffer. This specimen was originally described by Stauffer as occurring in the Amherstburg Dolomite; however, the surrounding dolomite matrix contains numerous molds of *Murchisonia subcarinata*, a gastropod that is apparently restricted to the Lucas Dolomite, *Acanthonema holopiforme* Subzone at Loc. I.

*Ambocoelia(?)* sp.

Plate III, figures 17-19

?*Spirifer modestus* Grabau, 1910, pp. 137, 138, Pl. 16, fig. 11, ?24, ?25, non Pl. 16, fig. 12; non Hall, 1857, p. 61; non Hall, 1859, p. 203, Pl. 28, fig. 1.

Description. Shells small, of about average size for the genus. Valves unequally biconvex; pedicle valve deep, gibbous; brachial valve shallow, almost plane (Pl. III, fig. 19). Cardinal margin megathyridid, cardinal extremities obtusely rounded, lateral and anterior margins smoothly rounded. Lateral commissures rectimarginate, anterior commissure broadly uniplicate (Pl. III, fig. 17). Flanks of both valves flat to slightly convex in anterior profile. Valves smooth, impunctate.

Pedicle interarea long, concave; inclination apsacline. Delthyrium probably open with thickened margins, and containing pedicle opening. Sulcus very shallow and poorly defined, beginning about midlength. Dental plates absent.

Brachial valve subpentagonal in outline, length/width ratio about 0.8, greatest width slightly posterior to midlength. Umbo small, nonprotruding. Interarea absent. Fold low and poorly defined, beginning about midlength. Interior unknown.

Remarks. The generic assignment of this species is uncertain. It differs from typical species of the genus *Ambocoelia* in having a relatively shorter, curved hinge line, obtusely rounded cardinal extremities, uniplicate anterior commissure, and poorly defined sulcus and fold.

Grabau (1910, Pl. 16, figs. 11, 12, 24, 25) illustrated some small, very poorly preserved shells and referred them to *Spirifer modestus* Hall. The specimen illustrated in fig. 12 (UMMP 14076) probably is an undetermined species of *Prosserella*. There is a slight possibility that the specimens for figs. 11 (UMMP 14077), 24, and 25 (UMMP 14080) might be conspecific with *Ambocoelia(?)* sp. described above.

Species of the genus *Ambocoelia* are rather uncommon in Lower Devonian rocks of Europe and according to Boucot (1959a, p. 23) are unknown in North America prior to the Middle Devonian.

Material and occurrence. Figured specimen, UMMP 56705, a nearly complete specimen, *Amphipora nattressi* Subzone (?Anderdon Limestone), Loc. G, collected by G.M. Ehlers and R.M. Linsley; referred specimen, UMMP 56706, a brachial valve, *Amphipora nattressi* Subzone (?Anderdon Limestone), Loc. G, collected by G.M. Ehlers and R.M. Linsley.

*Crurithyris*(?) sp.

Plate III, figures 13-16

Description. Shells very small, of small size for the genus. Valves unequally biconvex; pedicle valve deep, gibbous; brachial valve shallow, almost plane (Pl. III, fig. 16). Cardinal margin megathyridid; hinge line short, straight; cardinal extremities obtusely rounded, lateral and anterior margins smoothly rounded. Lateral commissures rectimarginate; anterior commissure very slightly sulcate (Pl. III, fig. 14). Flanks of both valves smooth and flat in anterior profile. Valves impunctate.

Pedicle valve slightly transverse in outline, length/width ratio about 0.9, greatest width slightly posterior to midlength. Umbo prominent, curved toward the hinge line but not overhanging; apical angle about 75°. Interarea longer than wide (Pl. III, fig. 13), very slightly concave; inclination catacline. Beak ridges diverge at about 60°. Delthyrium apparently closed; pseudodeltidium narrow, strongly convex. Sulcus shallow and narrow but nonetheless well defined, commencing at the umbo. Dental plates absent.

Brachial valve transverse in outline, length/width ratio about 0.8, greatest width considerably posterior to midlength. Umbo small; interarea absent. Sulcus shallow, somewhat broader and less well defined than pedicle sulcus. Interior unknown.

Remarks. The generic assignment of this species is uncertain because the interior of the brachial valve is unknown. It differs from *Ambocoelia*(?) sp. in having a sulcus in both valves and a more nearly rectimarginate anterior commissure; it also differs from species of *Echinocoelia* in having smooth, nonspinose valves. Additional material and study will be necessary to correctly identify this species. The genus *Crurithyris* is present but not common in Devonian rocks.

Material and occurrence. Figured specimen, GSC 23049, a nearly complete specimen, Formosa Reef Limestone, south end of Loc. 23635, collected by J.A. Fagerstrom.

*Acrospirifer*(?) *macrothyris* (Hall)

Plate V, figures 7-14

*Spirifer macrothyris* Hall, 1857, p. 132; Hall, 1867, pp. 202, 203, Pl. 30, figs. 16-18, 20, *non* Pl. 30, fig. 19.

Description. Shells large for genus. Outline subtriangular, transverse; length/width ratio varies from about 0.3 in small specimens to about 0.5 in large specimens. Hinge line long, straight; cardinal extremities vary from slightly mucronate in small specimens (Pl. V, fig. 10) to rounded in large specimens (Pl. V, fig. 12). Anterolateral margins straight or slightly concave in small specimens to convex, evenly rounded in large specimens. Anterior margin straight or slightly concave. Anterior commissure parasulcate; lateral commissures straight. Flanks of brachial valve concave in anterior profile (Pl. V, fig. 14).

Valves costate; costae low, smoothly rounded, and separated by narrower, moderately deep, smoothly rounded interspaces. Medial costae persistent to beaks; additional costae added to hinge line at very acute angles beginning about midway between beaks and cardinal extremities (Pl. V, figs. 7, 10); number of costae per flank varies from about 8-12. Concentric ornament consists of rather uniform, closely spaced, low growth lines bearing numerous, very closely spaced protuberances.

Pedicle beak protrudes moderately over the rather long, concave, apsacline, trapezoidal interarea (Pl. V, fig. 11). Delthyrium open. Pedicle valve moderately and evenly convex in lateral profile. Sulcus moderately deep, poorly defined, flaring broadly anteriorly and smooth except for a low, smoothly rounded riblet in posteromedial portion of some specimens.

Brachial beak protrudes slightly over short, slightly concave, anacline interarea. Brachial valve strongly and evenly convex, becoming gibbous in large specimens. Fold moderately high, subacuminate, poorly defined, narrower than sulcus, and smooth.

Delthyrial margins of palintrope greatly thickened, extending dorsally to form teeth ridges. Dental plates short, thick; flare broadly to delimit the posterolateral margin of the muscle field. Muscle field large, elongate, divided medially by a moderately elevated, broadly rounded longitudinal ridge; anterior margin slightly impressed, smoothly rounded in large specimens, not impressed in small specimens; posterolateral margins straight, more deeply impressed posteriorly; posterior margin lobate, very deeply impressed and extending posteriorly under a shelf of thickened shell material. Diductor attachments longitudinally and radially striate; corrugated in gerontic specimens (Pl. V, fig. 11). Adductor tracks very long and narrow; adjacent to medial longitudinal ridge.

Sockets shallow to moderately deep, elongate; begin at lateral margins of broadly triangular, slightly depressed diductor attachment area and diverge sharply to become subparallel to hinge line (Pl. V, fig. 8). Inner socket ridges laterally elongate; form base of sockets; begin at anterolateral margins of diductor attachment area, are relatively thick and high, and lie generally anterior and parallel to sockets. Outer socket ridges formed by medial posteriorly curving portion of palintrope and slightly overhang the posterior margin of sockets. Crural plates not present. Depression marking fold terminates abruptly posteriorly ahead of diductor attachment area; bears a low posterior myophragm that divides the muscle field. Muscle field transverse, moderately impressed posteriorly becoming poorly defined anterolaterally and anteriorly; posterolateral margins marked by junction of inner socket ridges and floor of brachial valve.

Costae and interspaces on interior of shells very low and rounded; vary from about 6-8 on each flank; posterolateral costae not apparent on internal molds. Umbonal chambers shallow in pedicle valve, absent on brachial valve.

Remarks. The generic designation of this species is doubtful for several reasons. Amsden and Ventress (1963, p. 108) and Pitrat (*in Williams, et al.*, 1965, p. H683) have noted the external similarity of the genera *Acrospirifer* and *Hysterolites* and also the uncertainty regarding the precise differences in the interiors of the type species of these genera. The genus *Euryspirifer* is also quite similar to both *Acrospirifer* and *Hysterolites*; the chief differences are the presence of a low riblet in the sulcus and a more mucronate outline in *Euryspirifer*. Havlíček (1959, p. 237) has also noted the presence of concentric rows of spines in both *Acrospirifer* and *Hysterolites*; spines have not been reported in *Euryspirifer*.

The posterior portion of the sulcus in a few specimens of *Acrospirifer* (?) *macrothyris* has a low riblet suggestive of *Euryspirifer*; however, the impersistent nature of the riblet and less mucronate outline of these specimens make it unlikely that they should be included in the genus *Euryspirifer*. Present information indicates that dental plates are lacking or poorly developed in *Acrospirifer* and are better developed in *Hysterolites* (Amsden and Ventress, 1963, p. 108). Since the dental plates in all the specimens of *A.* (?) *macrothyris* examined by the present writer are very short it appears as though this species is most closely related to *Acrospirifer*. However, no spines were observed.

*A. (?) macrothyris* is somewhat similar to *A. speciosus* from the Upper Emsian to Givetian rocks in Europe (Scupin, 1900, p. 325). The chief differences are the large size of the valves and the heart-shaped pedicle muscle field in *A. (?) macrothyris*; the muscle field in *A. speciosus* is lanceolate (Schnur, 1853, Pl. 32, figs. 2a-2e).

*A. (?) macrothyris* is also quite similar to *A. hercyniae* from the Lower Emsian of Europe and *A. hercyniae* var. *atlanticus* (Clarke) from Maine and Quebec. The chief differences are the lower and wider, and perhaps also fewer costae in *A. (?) macrothyris*.

Boucot (1959b, pp. 743, 744) described a heterogeneous assemblage of specimens from the Kanouse Sandstone of New York as *Hysterolites macrothyris*. On the basis of the accompanying illustrations it appears as though the smaller shells (Pl. 91, figs. 11-13, 15, 16) are probably *Acrospirifer duodenaria* (Hall) and that the larger ones (Pl. 91, figs. 10, 14; Pl. 92, figs. 4, 5) are either *A. hercyniae* var. *atlanticus* or *A. (?) macrothyris*. The prominence of the costae on the brachial steinkern in Plate 92, fig. 5 suggest that *A. hercyniae* var. *atlanticus* is the more likely correct identification.

Material and occurrence. Syntypes, AMNH 3060/1 and 3060/2, partially exfoliated specimens with the valves joined, Onondaga Limestone (probably the Edgecliff Member), Clarence Hollow and Williamsville, N.Y., collected by James Hall; hypotypes, USNM 36610 and 157838, partially exfoliated specimens with the valves joined, upper Columbus Limestone, Marion, Ohio, collected by Carl Rominger; hypotypes, USNM 157839 and 157840, pedicle valves, Grand Tower Limestone, near Grand Tower, Ill., collected by G.A. Cooper; hypotypes, GSC 23050-23052, partially exfoliated brachial valves, upper Anderdon Limestone, Loc. 20879, collected by E.W. Best; hypotype, GSC 23053, a partially exfoliated pedicle valve, upper Anderdon Limestone, Loc. 20879, collected by E.W. Best.

#### Genus *Howellella* Kozlowski

*Howellella* Kozlowski, 1946, p. 295; Boucot, 1957, pp. 315-317.

Remarks. The precise stratigraphic range of this genus is rather uncertain due largely to the incomplete preservation of the growth ornamentation in most specimens making precise identification impossible. Boucot (1957, p. 316) has given the range as Upper Llandovery to Lower Gedinnian but later revised the range upward to the base of the Onondaga Limestone (Boucot, 1959b, p. 735) or approximately Upper Emsian or Lower Eifelian in North America. Boucot and Johnson (in press) have reported the occurrence of "*Howellella*" *gaspensis* Billings in the upper York River Sandstone in eastern Quebec which they correlate with the Lower Emsian of Rhineland.

If the specimens described below as *Howellella (?) submersa* (Grabau) and *H. (?)* sp. from the Detroit River Group are true representatives of *Howellella* they are the youngest reported occurrence of the genus known to the writer.

#### *Howellella (?) submersa* (Grabau)

Plate VII, figures 15-23

*Spirifer sulcata* mut. *submersa* Grabau, 1910, pp. 136, 137, Pl. 18, figs. 4-6.

*Kozlowskiellina* (*Megakozlowskiella*) *submersa*, Fagerstrom, 1961a, p. 30, Pl. 10, figs. 16-20.

Remarks. Grabau (1910, p. 136) described a median septum in the pedicle valve of this species. The presence of such a septum was then used by Boucot (1957, pp. 320-323) as the basis for including this species in his new genus *Kozlowskiella*, later emended to *Kozlowskiellina* (Boucot, 1958, p. 1030). However, study of a large collection of specimens, including Grabau's types, indicates that there is no median septum in the pedicle valve;

instead, the structure is merely a myophragm having only minor taxonomic significance (Pl. VII, fig. 22).

Preservation of the specimens is not sufficiently good to be certain whether the growth lines are frilly or lamellose. If the growth lines are frilly the species would belong to the genus *Hedeina*, which according to Boucot (1957, p. 324) is confined to Middle and Upper Silurian rocks. Thus, the presence of this genus in the Detroit River Group seems very unlikely and the present species probably belongs in the genus *Howellella*. The presence of weak, poorly developed crural plates (Pl. VII, fig. 20) in the Detroit River material indicates that this species does not belong in the genus *Acrospirifer*.

*H. (?) submersa* is quite similar to *Spirifer ezquerri* Verneuil as described by Comte (1938, pp. 62, 63, Pl. 1, figs. 11, 12) from rocks of Siegenian age in Spain. However, the relatively great discrepancy in age between these two species suggests that the resemblance is superficial.

Material and occurrence. Lectotype (here designated) ROM 22500, an incomplete exterior of brachial valve, illustrated by Grabau (1910, Pl. 18, fig. 6), probably from the Amherstburg Dolomite, probably from Loc. J, collected by Thomas Nattress; paralectotype, ROM 262.S, an incomplete steinkern of pedicle valve, illustrated by Grabau (1910, Pl. 18, fig. 4), probably from the Amherstburg Dolomite, probably from Loc. J, collected by Thomas Nattress; paralectotype, UMMP 43967, a mold of brachial exterior, probably from the Amherstburg Dolomite, Loc. I or J, collected by Thomas Nattress; paralectotype, UMMP 23852, a brachial valve, illustrated by Grabau (1910, Pl. 18, fig. 5), probably from the Amherstburg Dolomite, Loc. I or J, collected by Thomas Nattress; hypotype, UMMP 14691, a mold of pedicle exterior, probably from the Amherstburg Dolomite, Loc. I, collector unknown; hypotypes, GSC 23054 and 23055, steinkerns of brachial valves, Lucas Dolomite, *Acanthonema holopiforme* Subzone, east quarry Loc. A, collected by J.A. Fagerstrom; hypotype, GSC 23056, a mold of brachial exterior, Lucas Dolomite, *Acanthonema holopiforme* Subzone, east quarry Loc. A, collected by J.A. Fagerstrom; hypotype, GSC 23057, a pedicle steinkern probably from the Amherstburg Dolomite, Loc. 4368, collected by C.R. Stauffer; hypotype, GSC 23058, a steinkern of brachial valve, probably from the Amherstburg Dolomite, Loc. 4368, collected by C.R. Stauffer; hypotype, GSC 23059, a mold of brachial exterior, Detroit River Group, Loc. 13491, collected by J.F. Caley; hypotype, GSC 23060, a steinkern of brachial valve, Detroit River Group, Loc. 13491, collected by J.A. Fagerstrom; hypotype, GSC 23061, an incomplete steinkern of both valves joined, probably from the Amherstburg Dolomite, Loc. 4368, collected by C.R. Stauffer; hypotype, GSC 23062, a pedicle valve, Formosa Reef Limestone, south end of Loc. 23635, collected by J.A. Fagerstrom; hypotypes, GSC 23063-23065, incomplete specimens with both valves joined, Formosa Reef Limestone, south end Loc. 23635, collected by J.A. Fagerstrom. This species was also reported from the Sylvania Sandstone by Carman (1936, p. 261).

*Howellella(?)* sp.

Plate VII, figures 24-26

Description. Shells biconvex, transverse. Hinge line long, straight, cardinal extremities somewhat rounded to slightly mucronate, anterolateral margins gently convex, anterior commissure uniplicate. Greatest width at or slightly ahead of hinge line. In lateral profile pedicle valve moderately and evenly convex, umbo prominent but not extending over hinge line, brachial valve gently convex, umbo small; pedicle valve deeper than brachial valve. Radial ornamentation consisting of 2-3 relatively low, broad, rounded costae on each flank separated by shallow, rounded interspaces of approximately the same width as the costae. Concentric ornamentation unknown.



Length/width ratio of pedicle valve about 0.5-0.7. Sulcus large, relatively deep, commencing at beak, non-costate but with 1-3 very low, rounded, medial ridges on interior extending forward somewhat beyond mid-length. Interarea triangular, relatively long, slightly concave, apsacline. Delthyrium large, apparently open, with margins thickened and continued ventrally as dental plates. Dental plates high, narrow, extending forward nearly to midlength (Pl. VII, fig. 26). Muscle field unknown.

Length/width ratio of brachial valve about 0.6. Fold large, sharply elevated, smoothly rounded to slightly flattened, commencing at beak, and non-costate but may bear a low myophragm of variable length. Sockets broadly divergent, relatively shallow and short. Inner socket ridges sharply elevated and extending medially where they are sharply bent dorsally to form relatively short but well defined crural plates (Pl. VII, figs. 24, 25). Diductor attachment area vertically striate; adductor field unknown.

Remarks. This species is known only from steinkerns which makes it impossible to determine the genus. The absence of a median septum in the pedicle valve, the well developed dental plates, the non-costate fold and sulcus, and the small crural plates are suggestive of either the genus *Howellella* or *Hedeina* (Boucot, 1957, pp. 315, 316, 323, 324). Since species of *Hedeina* are unknown in Devonian rocks it appears as though the specimens from the Detroit River Group probably belong to *Howellella* but until it can be determined whether or not the growth lines are lamellose the generic designation is uncertain.

*Howellella*(?) sp. is larger and has fewer, more rounded costae than *Howellella*(?) *submersa* (Grabau) and lacks the pair of prominent ridges on the interior of the sulcus in "*Spirifer*" sp.

Material and occurrence. Figured specimen, GSC 23066, a steinkern of brachial interior, Detroit River Group, Loc. 23654, collected by E.W. Best; figured specimen, GSC 23067, a pedicle steinkern, Detroit River Group, Loc. 13491, collected by J.F. Caley; referred specimen, GSC 23068, a brachial steinkern, Detroit River Group, Loc. 13491, collected by J.F. Caley; referred specimens, GSC 23069-23071, pedicle steinkerns, Detroit River Group, Locs. 23654, 15112, and 13491 respectively; referred specimen, UMMF 56678, a pedicle steinkern, probably from the Amherstburg Dolomite, Loc. I, collector unknown.

*Brachyspirifer*(?) *manni* (Hall)

Plate V, figures 4-6

*Spirifer manni* Hall, 1867, p. 211, Pl. 31, figs. 20-22, 24-30, ?23

Remarks. The generic designation for this species is uncertain because of incomplete preservation and inconsistency by previous authors in the essential characters of the genus *Brachyspirifer*. Cooper (1944, p. 323) noted the presence of a short median septum in the brachial valve and included *Spirifer audaculus* Conrad in the genus *Brachyspirifer* which extends the upper limit of the range to the Hamilton (= Givetian) in North America. In Pitrat's (in Williams, A., et al., 1965, pp. H 684, H 685) diagnosis of *Brachyspirifer* he mentions only external features, describes the fold as carinate, the sulcus as "v"-shaped, and restricts the occurrence to the Siegenian and Emsian of Europe. The fold is not carinate, nor is the sulcus "v"-shaped in either "*Spirifer*" *audaculus* or "*S.*" *manni*. In addition, there is no indication of a brachial median septum in *S. manni* (Hall, 1867, p. 211). It is beyond the scope of the present report to reinvestigate the genus *Brachyspirifer* so the inconsistencies noted above remain unresolved.

Material and occurrence. Hypotypes, GSC 23072 and 23073, pedicle valves, upper Anderdon Limestone, Loc. 20879, collected by E.W. Best.

Genus *Fimbrispirifer* Cooper

Remarks. The genus *Fimbrispirifer* is endemic to North America where it includes four species: *F. venustus* (Hall; the type species), *F. divaricatus* (Hall), *F. grieri* (Hall), and *F. tricostatus* Fagerstrom. Some of the problems of nomenclature and identity of these species have been noted by Fagerstrom (1961a, pp. 32, 33). However, because of the potential value of *F. divaricatus* (*sensu stricto*) in correlation a review of these problems is necessary.

In 1857 Hall described and named *Spirifer divaricatus* and in 1860 he described and named *Spirifer venustus*. In neither case were the original descriptions accompanied by illustrations. Then in 1867 (p. 213) Hall considered *S. venustus* a junior synonym of *S. divaricatus* and illustrated an exterior and an interior from the Onondaga Limestone (Pl. 32, figs. 1, 9) and the exterior of another specimen from the Hamilton Group (Pl. 32, figs. 2-8).

Although the specimens illustrated by Hall (1867) are vastly different in outline and costation, the usages of the names *S. venustus* and *S. divaricatus* by subsequent authors has been very inconsistent. As conceived by the present author (Fagerstrom, 1961a, pp. 31, 32), *Fimbrispirifer divaricatus* (*sensu stricto*) is larger, has a relatively longer hinge line, a more transverse outline, fewer costae on both the fold and the flanks, and the costae are lower and wider than in *F. venustus* (see also Stauffer, 1909, p. 190). These differences are readily apparent from the illustrations cited in the synonymy of *F. divaricatus* given below.

Another probable source of confusion is the overlap in the stratigraphic ranges of *F. divaricatus* and *F. venustus*. The latter species ranges from rocks of Bois Blanc age (Ehlers, 1945, Pl. 11, fig. 3; Amsden and Ventress, 1963; Boucot and Johnson, 1968) to the lower Ludlowville Formation (Givetian; see Rickard, 1964) or to the Tichenor Limestone (Cooper, 1944, p. 323). The stratigraphic range of *F. divaricatus* is middle Bois Blanc (Ehlers, 1945, Pl. 11, fig. 4) to about the Moorehouse Member of the Onondaga Limestone. Thus, it is apparent that both species occur in rocks of Bois Blanc to Moorehouse age. However, *F. venustus* is unknown from the Detroit River Group.

*Fimbrispirifer divaricatus* (Hall)

Plate V, figures 1-3

*Spirifer divaricatus* Hall, 1857, p. 133; Hall, 1867, Pl. 32, figs. 1, ?9; non Hall, 1867, Pl. 32, figs. 2-8; Nettleroth, 1889, p. 113, Pl. 12, figs. 5-11; non Nettleroth, 1889, Pl. 11, figs. 6-11; non Kindle, 1901, Pl. 8, figs. 5, 5a; non Willard, 1936, pp. 67-69.

*Fimbrispirifer divaricatus*, Cooper, 1944, p. 323, Pl. 123, figs. 1, 2; Ehlers, 1945, Pl. 11, fig. 4; non Ehlers, 1945, Pl. 11, fig. 3; Boucot, et al., 1958, Pl. 1, fig. 10; Fagerstrom, 1961a, pp. 31, 32, Pl. 10, figs. 1-7; non Amsden and Ventress, 1963, pp. 180-182, Pl. 18, figs. 2-11.

Emended description. (emended to Fagerstrom, 1961a, pp. 31, 32). Brachial interior with thickened, vertically striate posteromedial diductor attachment area. Sockets relatively long, narrow, and shallow; sharply divergent so that they are essentially parallel to hinge line (Pl. V, fig. 3). Inner socket ridges narrow, sharply elevated, and sharply depressed medially to merge with short crural plates rising from floor of valve (Pl. V, fig. 2). Cardinal areas relatively long, wide, triangular, and slightly concave.

Adductor scars and pallial markings not impressed on interior of valve. Myophragm present on some specimens.

Material and occurrence. Hypotypes, GSC 23074-23076, steinkerns of brachial valves, probably from the Amherstburg Dolomite, Loc. 4368, collected by C.R. Stauffer.

"*Spirifer*" sp.

Plate VII, figure 27

? "*Spirifer*" sp. B Fagerstrom, 1961a, pp. 32, 33, Pl. 10, figs. 14, 15.

Description. Shells transverse; hinge line long, straight, cardinal extremities perpendicular to slightly acute, anterolateral margins straight to slightly convex. Costae prominently elevated, rounded, persistent nearly to beaks and numbering 4-6 on each flank. Interspaces rounded and about same width as costae.

Pedicle valve moderately convex, beak protrudes somewhat beyond hinge line and is nearly straight. Length/width ratio about 0.6-0.8 with greatest width at hinge line. Dental plates narrow, relatively short, moderately divergent. Interior of sulcus marked by a pair of long, narrow, parallel, moderately elevated ridges commencing somewhat behind midlength and extending forward nearly to anterior margin.

Remarks. This species is known from only one very incomplete and poorly preserved pedicle valve. The pair of long, parallel ridges on the interior of the sulcus is the most distinctive feature and is unknown in other spiriferoid brachiopods in the Detroit River Group.

Material and occurrence. Figured specimen, GSC 23077, pedicle steinkern, Loc. 23536, collected by E.W. Best.

?Superfamily Reticulariacea Waagen, 1883

?Family Reticulariidae Waagen, 1883

Genus *Prosserella* Grabau, 1910

*Prosserella* (nom. nud.) Sherzer and Grabau, 1909, p. 547.

*Spirifer* (*Prosserella*) Grabau, in Grabau and Sherzer, 1910, pp. 138, 139.

*Reticularia* (*Prosserella*), Schuchert, 1913, p. 412; Bassler, 1915, pp. 1102-1104, 1419.

*Prosserella*, Williams, M.Y., 1919, p. 19 and all subsequent authors.

?*Prosserella* Pitrat, in Williams, A., et al., 1965, p. H 675 (partim).

non *Rhynchospirifer* Paulus, 1957, p. 51; non *Rhynchospirifer* Pitrat, in Williams, A., et al., 1965, p. H 675.

Type species. *Spirifer* (*Prosserella*) *modestoides* Grabau; subsequent designation by Bassler, 1915, p. 1102.

Description. Shells biconvex with short, straight hinge line and rounded cardinal extremities. Pedicle interarea nearly as long as wide; brachial interarea much wider than long. Delthyrium large, elongate, open; notothyrium small, short, apparently open. Fold and sulcus absent to moderately well developed; anterior commissure rectimarginate to uniplicate. Flanks, fold and sulcus generally smooth, occasionally costate. Concentric ornamentation consists only of fine growth lines. Shell structure impunctate.

Pedicle interior with relatively high, narrow dental plates converging, but generally not joining, posteriorly and ventrally to form a very deep, narrow delthyrial chamber and extending forward along floor of valve in a very characteristic closely spaced, parallel arrangement. Muscle attachments unknown.

Brachial interior with inner socket ridges curving anteriorly and merging with low, short crural plates. Crural plates converge medially, but do not join. Cardinal process elevated, longitudinally striate. Adductor scars weakly impressed, longitudinally striate.

Remarks. The name *Prosserella* was first used in faunal lists of the Detroit River Group (Sherzer and Grabau, 1909) and in a discussion of the stratigraphic relations of these rocks (Lane, Prosser, Sherzer, and Grabau, 1909). Systematic descriptions were not included in either of these reports but in both it was clearly indicated that *Prosserella* was intended as a taxon of generic rank. Then in 1910 Grabau (*in* Grabau and Sherzer, 1910, pp. 138, 139) formally described *Prosserella* as a subgenus of *Spirifer*. His characterization of the subgenus was generally accurate but incomplete, especially for the brachial interior.

Schuchert (1913, p. 412) and Bassler (1915, p. 1102) regarded *Prosserella* as a subgenus of *Reticularia*. Then in 1919 M.Y. Williams used *Prosserella* as a genus and this usage has been followed by all subsequent authors.

In his discussion of the taxonomic affinities of *Prosserella*, Grabau (*in* Grabau and Sherzer, 1910, pp. 138, 139) compared it with *Martinia* McCoy, *Martinopsis* Waagen, *Spirifer modestus* Hall, and *Spirifer inflatus* Schnur. However, *Prosserella* differs significantly from all these taxa, chiefly in regard to the presence and arrangement of the dental plates. *Martinia* has no dental plates nor does *Spirifer inflatus* (= *Martinia inflata* Jux and Strauch, 1965). *Spirifer modestus* (= *Howellella modesta* Boucot, 1957, p. 317) is a lower Devonian species of the Appalachian region with anteriorly divergent dental plates that are much more widely spaced than those of *Prosserella* (Bowen, 1967, pp. 47, 48). The dental plates in *Martinopsis* are relatively short and widely spaced in comparison to *Prosserella* and in addition *Martinopsis* has much higher and longer crural plates than *Prosserella*. The type species of *Martinopsis* (*Martinopsis inflata*; not to be confused with *Martinia inflata*) is from the Permian of India; although Cooper (1944, p. 329) indicated affinities of three species from the North American Devonian with "*Martinopsis*" it is doubtful that the lower limit of the *Martinopsis* range zone extends into Devonian rocks (Pitrat *in* Williams, A., *et al.*, 1965, p. 726).

Pitrat (*in* Williams, A., *et al.*, 1965) included *Prosserella* in the Family Ambocoeliidae. However, the presence of a relatively large, longitudinally striate cardinal process suggests that *Prosserella* has closer affinities with the Family Reticulariidae. Despite this similarity, the affinities are probably not very close to the other reticulariid genera because the growth lamellae and/or spires, etc. typical of these brachiopods are not present in *Prosserella*.

Pitrat (*in* Williams, A., *et al.*, 1965, p. H 675) questionably placed *Rhynchospirifer* Paulus (1957) in synonymy with *Prosserella*. However, there are several important differences between these two genera, especially in the brachial valve. The brachial valve of *Rhynchospirifer* has a well-developed, free cardinal plate. Although Grabau (*in* Grabau and Sherzer, 1910, p. 138, Pl. 21, fig. 25) indicated the presence of a median septum in the brachial valve of *Prosserella*, this feature is merely a myophragm; furthermore, *Prosserella* has no cardinal plate. In addition, the brachial palintrope in *Rhynchospirifer* is relatively long in comparison to *Prosserella* and contains a large notothyrium. The chief similarities between these genera apparently is in the long, parallel arrangement of the dental plates. In *Rhynchospirifer halleri*, the type species, the dental plates appear to be essentially the same

as in *Prosserella* (Paulus, 1957, p. 53, Pl. 1, fig. 7). However, in none of the other species of *Rhynchospirifer* described and illustrated by Paulus (1957) are the dental plates as long or parallel as in either *R. halleri* or the species of *Prosserella*. Thus, on the basis of the marked differences in the brachial valve and what may also be dissimilar arrangements of the dental plates it is clear that *Rhynchospirifer* is not a junior synonym of *Prosserella*.

In summary, the very close, parallel arrangement of the dental plates, the presence of low, short crural plates, and the absence of a cardinal plate, growth lamellae, and spines in *Prosserella* make the taxonomic placement of this genus uncertain. It is here questionably placed in the Family Reticulariidae on the basis of its general external form, the common absence of costation, and the presence of a relatively large, longitudinally striate cardinal process. The phylogenetic ancestors and descendants of *Prosserella* are also uncertain.

For an extended discussion of the taxonomic problems concerning the taxa included in the genus *Prosserella* the reader is directed to Appendix II and the section of the present report entitled "Species of the Genus *Prosserella*".

*Prosserella modestoides* (Grabau)

Plate VI, figures 1-26. Figures 3, 4, 7

- Spirifer* (*Prosserella*) *modestoides* Grabau, in Grabau and Sherzer, 1910, pp. 139-141, Pl. 16, figs. 20, 22, 23; Pl. 21, figs. 28-30.  
*S. (P.) subtransversa* Grabau, in Grabau and Sherzer, 1910, *partim*, pp. 143-145, Pl. 19, figs. 1, 5, 6; *non* Pl. 18, figs. 7, 9, Pl. 19, figs. 4, 7, 8, 12, 13.  
*S. (P.) subtransversa* *mut. alta* Grabau, in Grabau and Sherzer, 1910, *partim*, pp. 145, 146, *non* Pl. 18, fig. 10.

Emended description. Shells ventribiconvex (Pl. VI, figs. 7, 12), of average size for the genus. Cardinal margin submegathyridid, cardinal extremities obtuse, gently rounded, lateral and anterolateral margins convex, evenly rounded and anterior margin gently convex to almost straight. In lateral profile pedicle valve relatively deep, gently convex anteriorly, moderately convex medially, strongly convex posteriorly; pedicle beak nearly straight to suberect, slightly overhanging concave, apsacline interarea; brachial valve relatively shallow, gently and evenly convex; brachial beak small, not protruding or overhanging the short anacline interarea. In anterior profile both valves convex with convexity increasing medially; anterior commissure rectimarginate (Pl. VI, fig. 8) to weakly and narrowly uniplicate. Valves smooth (Pl. VI, figs. 11, 15) to weakly costate; costae generally arise near midlength, are low, rounded, and wider than interspaces (Pl. VI, fig. 20). Concentric ornamentation consists only of numerous, fine, very closely spaced growth lines. Shell structure impunctate.

Pedicle valve generally transverse, commonly elongate, length/width ratio about 1.1, greatest width about midlength. Posterolateral margins straight; apical angle 90°-110°. Interarea small, nearly as long as wide; beak ridges rather poorly defined (Pl. VI, fig. 22). Delthyrium relatively large, elongate, open. Sulcus absent to narrow, almost linear, relatively shallow, and poorly defined. Dental plates well developed, located along margins of delthyrium (Pl. VI, figs. 6, 17, 22), converging posteriorly and ventrally but not joining; forming a deep, narrow, flat-floored delthyrial chamber; extending forward along floor of valve in a closely spaced, parallel arrangement (Pl. VI, figs. 9, 15, 24) and terminating about one-third of valve length. Myophragm commonly present between anterior ends of dental plates and extending forward ahead of midlength (Pl. VI, fig. 14). Muscle scars not apparent either

on floor of valve or on inner surfaces of dental plates. Vascular markings absent. Teeth unknown.

Brachial valve moderately transverse, length/width ratio about 0.75, greatest width slightly posterior to midlength. Interarea very short, relatively wide. Fold absent to narrow, relatively low, and poorly defined. Brachial interior apparently as in *Prosserella lucasi*.

Remarks. The interior of the brachial valve cannot be described in detail because of poor preservation; the topotypic material consists of only four specimens of the interior and these are all small and incomplete. However, they appear to be similar to the well-preserved brachial interiors of *P. lucasi*.

The characteristic feature of *P. modestoides* is the absence of a fold and sulcus, or if these features are present they are relatively narrow and poorly developed. Costae are variable in their development and generally restricted to the anterior half of the valves. Smooth and costate morphotypes of *P. modestoides* may be readily distinguished on the basis of the absence or presence of costae. These are purely informal designations and therefore have not been given formal taxonomic names.

Material and occurrence. Holotype (designated by Grabau (1910) in explanation to Pl. 16, figs. 22, 23), UMMP 14056, a smooth pedicle valve, from the "coral bed" ("coral-mixed brachiopod subzone; ?Amherstburg Dolomite), Loc. H, probably collected by W.H. Sherzer; paratype, UMMP 14061, a costate pedicle steinkern, Amherstburg or Lucas Dolomite, Loc. I, collected by A.W. Grabau or W.H. Sherzer; paratype, UMMP 14037, a smooth brachial valve, from "the coral bed" ("coral-mixed brachiopod subzone; ?Amherstburg Dolomite), Loc. H, probably collected by W.H. Sherzer; hypotype, UMMP 14072, a smooth steinkern with both valves joined, "coral-mixed brachiopod subzone" (?Amherstburg Dolomite), Loc. D, collected by A.W. Grabau or W.H. Sherzer; hypotype, UMMP 14084, an incomplete (?smooth) pedicle steinkern, Lucas Dolomite (?*Acanthonema holopiforme* Subzone), Loc. F, collected by A.W. Grabau or W.H. Sherzer; hypotype, UMMP 13104, a very poorly preserved (?costate) brachial valve, Lucas Dolomite (?*Acanthonema holopiforme* Subzone), Loc. H, probably collected by W.H. Sherzer; hypotype, UMMP 13077, an incomplete, smooth external mold, Lucas Dolomite (?*Acanthonema holopiforme* Subzone), Loc. F, collected by A.W. Grabau or W.H. Sherzer; hypotype, UMMP 56679, a steinkern of posterior parts of both (?smooth) valves joined, probably from the Amherstburg Dolomite, Loc. I, collector unknown; hypotype, UMMP 13100, a smooth pedicle valve, probably from "the coral bed" ("coral-mixed brachiopod subzone"; ?Amherstburg Dolomite), Loc. H, collector unknown; hypotype, UMMP 30552, a smooth pedicle steinkern, Lucas Dolomite, *Acanthonema holopiforme* Subzone, Loc. A, collector unknown; hypotypes, UMMP 56680 and 30553, costate pedicle steinkerns, Amherstburg or Lucas Dolomite, Loc. I, collected by Thomas Nattress; hypotype, UMMP 14013, exterior mold of smooth brachial valve, Lucas Dolomite, *Acanthonema holopiforme* Subzone, Loc. E, collected by A.W. Grabau or W.H. Sherzer; hypotype, UMMP 56681, a costate pedicle valve, Lucas Dolomite, *Acanthonema holopiforme* Subzone, Loc. E, collector unknown; hypotype, UMMP 56682, a smooth pedicle valve, Lucas Dolomite, Loc. I, collected by Thomas Nattress; hypotype, UMMP 56683, a smooth brachial valve, Lucas Dolomite, "coral-mixed brachiopod subzone", Loc. A, collected by G.M. Ehlers and E.C. Stumm; hypotype, UMMP 56684, a smooth pedicle steinkern, Amherstburg or Lucas Dolomite, Loc. I, collector unknown; hypotype, UMMP 56685, a smooth pedicle steinkern, probably from the *Acanthonema holopiforme* Subzone, Lucas Dolomite, Loc. E, collector unknown; hypotype, UMMP 56686, a smooth brachial steinkern, probably from the *Acanthonema holopiforme* Subzone, Lucas Dolomite, Loc. E, collector unknown; hypotype, UMMP 56687, a smooth pedicle steinkern and mold of its exterior, Lucas Dolomite, Loc. I, collector unknown; hypotype, GSC 23082, a smooth, nearly complete specimen with both valves joined, Detroit

River Group, upper bench, Loc. 76001, collected by J.A. Fagerstrom; hypotype, GSC 23083, a costate pedicle steinkern, Anderdon Limestone, Loc. K, collected by E.T. Tozer; hypotype, GSC 23091, a smooth brachial steinkern, probably from the Amherstburg Dolomite, Loc. I, collected by J.A. Fagerstrom; hypotype, GSC 23084, a smooth pedicle steinkern, probably from the Lucas Dolomite, Loc. I, collected by J.A. Fagerstrom; hypotype, GSC 23085, a smooth pedicle steinkern, probably from the Amherstburg Dolomite, Loc. I, collected by J.A. Fagerstrom; hypotype, GSC 23086, a smooth brachial steinkern, probably from the Lucas Dolomite, Loc. I, collected by J.A. Fagerstrom; hypotype, GSC 23087, a costate pedicle steinkern, Amherstburg or Lucas Dolomite, Loc. I, collected by J.A. Fagerstrom; hypotypes, GSC 23088 and 23089, smooth pedicle valves, upper Lucas Dolomite Loc. 76000, collected by J.A. Fagerstrom; hypotype, GSC 23090, a smooth pedicle steinkern, Lucas Dolomite, *Amphipora nattressi* Subzone, west quarry, Loc. A, collected by J.A. Fagerstrom.

For a discussion of the type specimens for the taxa of *Prosserella* described by Grabau (1910), the reader's attention is directed to Appendix II and the section of the present report entitled "Species of the Genus *Prosserella*".

*Prosserella lucasi* (Grabau)

Plate VII, figures 1-14; Plate VIII, figures 1-25. Figures 5, 6, 8

- Spirifer* (*Prosserella*) *lucasi* Grabau, in Grabau and Sherzer, 1910, pp. 142, 143, Pl. 16, fig. 21; Pl. 19, figs. 2, 3; Pl. 21, fig. 23.
- S. (P.) modestoides* mutation *depressus* Grabau, in Grabau and Sherzer, 1910, pp. 141, 142, Pl. 21, figs. 24-26, 31-33.
- S. (P.) subtransversa* Grabau, in Grabau and Sherzer, 1910, *partim*, pp. 143-145, Pl. 18, fig. 7, ?9; Pl. 19, figs. 4, 7, 8, 12, ?13; *non* Pl. 19, figs. 1, 5, 6, Pl. 21, fig. 27
- S. (P.) subtransversa* mut. *alta* Grabau, in Grabau and Sherzer, 1910, Pl. 18, fig. 10.
- S. (P.) unilamellosus* Grabau, in Grabau and Sherzer, 1910, pp. 146, 147, Pl. 19, fig. 11, ?9, ?10.
- S. (P.) planisinosus* Grabau, in Grabau and Sherzer, 1910, *partim*, pp. 147, 148, Pl. 16, figs. 19, 26; *non* Pl. 18, fig. 8.

Emended description. Shells ventribiconvex (Pl. VIII, fig. 3), of average size for the genus. Cardinal margin submegathyridid, cardinal extremities obtuse, gently rounded, lateral margins convex, evenly to somewhat acutely convex, anterolateral margins moderately convex to almost straight, anterior margins slightly convex to straight. In lateral profile pedicle valve relatively deep, gently convex anteriorly, moderately convex medially, strongly convex posteriorly; pedicle beak nearly straight to suberect, slightly overhanging concave, apsacline interarea; brachial valve relatively shallow, slightly and evenly convex, brachial beak small, not protruding or overhanging the anacline interarea. In anterior profile both valves convex, with increasing convexity medially; anterior commissure widely uniplicate (Pl. VII, figs. 5, 9). Valves smooth to costate; costae generally arise near midlength, are low to moderately elevated, rounded, and wider than interspaces (Pl. VIII, figs. 19, 25). Concentric ornamentation consists only of numerous, fine, very closely spaced growth lines. Shell structure impunctate.

Pedicle valve generally transverse, occasionally elongate, length/width ratio about 1.1, greatest width about midlength. Posterolateral margins straight; apical angle 90°-100°. Interarea small, nearly as long as wide; beak ridges rather poorly defined (Pl. VIII, fig. 7). Delthyrium relatively large, elongate, open. Sulcus moderately well developed, relatively wide

(Pl. VII, fig. 13); of variable depth (relatively deep to shallow) and shape (rounded to flattened); and may bear one very low, rounded medial costa. Dental plates well developed, located along margins of delthyrium (Pl. VIII, figs. 14, 16), converging posteriorly and ventrally but not joining; forming a deep, narrow, flat-floored delthyrial chamber (Pl. VII, figs. 2, 7, 8); extending forward along floor of valve in a closely spaced, parallel arrangement, and terminating about one-third of valve length (Pl. VIII, figs. 11, 13, 15). Myophragm commonly present between anterior end of dental plates and extending forward beyond midlength (Pl. VIII, fig. 19). Muscle scars not apparent either on floor of valve or on inner surfaces of dental plates. Vascular markings absent. Teeth unknown.

Brachial valve moderately transverse, length/width ratio about 0.75, greatest width slightly posterior to midlength. Interarea very short, relatively wide; beak ridges moderately well defined. Notothyrium relatively small, transverse, apparently open. Fold moderately well developed, relatively wide; of variable height (relatively high to low) and shape (rounded to flattened) (Pl. VIII, figs. 2, 17); and rarely may bear one very shallow, rounded, median furrow. Sockets very broadly flaring, nearly parallel to hinge line, deep, narrow; bounded by relatively high, narrow outer socket ridges and somewhat thicker inner socket ridges, and terminating laterally about midlength of hinge line where inner and outer socket ridges merge (Pl. VIII, figs. 1, 24). Inner socket ridges medially depressed, curved anteriorly to merge with thick, low, short crural plates (Pl. VIII, fig. 23). Crural plates convergent dorsally but not joining; inner margins separated by thickened median callosity on valve floor. Cardinal process relatively large, elevated, subtriangular, longitudinally striate; nearly fills apex of notothyrium. Margins of cardinal process and notothyrium separated by narrow, sharply depressed furrows. Adductor muscle scars arise at interior ends of crural plates and extend to about midlength; slightly impressed, longitudinally striate, and generally separated by a short myophragm. Vascular markings absent. Crural bases, crura, and spiralia unknown.

Remarks. The characteristic feature of *P. lucasi* is the presence of a moderately well-defined, relatively wide fold and sulcus. Costae are variable in their development and generally restricted to the anterior half of the valves. Smooth and costate morphotypes of *P. lucasi* may be readily distinguished on the basis of the absence or presence of costae. These are purely informal designations and therefore have not been given formal taxonomic names.

Material and occurrence. Lectotype (here designated), UMMP 14007, exterior mold of a costate brachial valve, Lucas Dolomite, Loc. B, collected by A.W. Grabau or W.H. Sherzer; paralectotype, UMMP 14005, a smooth pedicle steinkern, Lucas Dolomite, Loc. H, probably collected by W.H. Sherzer; paralectotype, UMMP 14006, a smooth pedicle steinkern, Lucas Dolomite (?*Acanthonema holopiiforme* Subzone), Loc. B, collected by A.W. Grabau or W.H. Sherzer; paralectotype, UMMP 14008, a smooth pedicle steinkern, Lucas Dolomite, *Acanthonema holopiiforme* Subzone, Loc. F, collected by A.W. Grabau or W.H. Sherzer; hypotype, UMMP 23853, a costate pedicle valve, Amherstburg or Lucas Dolomite, Loc. I, collected by A.W. Grabau or W.H. Sherzer; hypotype, UMMP 14010A, a costate brachial steinkern, Lucas Dolomite, *Acanthonema holopiiforme* Subzone, Loc. E, collected by A.W. Grabau or W.H. Sherzer; hypotypes, UMMP 13106 and 13110, smooth brachial steinkerns, Lucas Dolomite, Loc. H, probably collected by W.H. Sherzer; hypotypes, UMMP 14070 and 14071, costate steinkerns of both valves joined, "coral-mixed brachiopod subzone" (?Amherstburg Dolomite), Loc. D, collected by A.W. Grabau or W.H. Sherzer; hypotype, UMMP 14081, a costate pedicle steinkern, Lucas Dolomite, Loc. F, collected by A.W. Grabau or W.H. Sherzer; hypotypes, UMMP 14068 and 23854, costate pedicle steinkerns, Amherstburg or Lucas Dolomite, Loc. I, collected by A.W. Grabau or W.H. Sherzer; hypotype, UMMP 14065, smooth steinkern of both valves joined, Amherstburg or



Lucas Dolomite, Loc. I, collected by A.W. Grabau or W.H. Sherzer; hypotype, UMMP 13103, a smooth pedicle valve, Lucas Dolomite, Loc. H, probably collected by W.H. Sherzer; hypotype, UMMP 30548, a smooth pedicle steinkern, Lucas Dolomite, "coral-mixed brachiopod subzone", Loc. A, collector unknown; hypotypes, UMMP 30550, 30551, 30556, and 30557, smooth pedicle steinkerns, Lucas Dolomite, *Acanthonema holopiiforme* Subzone, Loc. A, collector unknown; hypotype, UMMP 30549, a costate pedicle steinkern, Amherstburg or Lucas Dolomite, Loc. I, collector unknown; hypotype, UMMP 30554, a smooth pedicle steinkern, "coral-mixed brachiopod subzone" (?Amherstburg Dolomite), Loc. C, collector unknown; hypotype, UMMP 4473, a smooth brachial steinkern, Lucas Dolomite, Loc. I, collector unknown; hypotype, UMMP 56688, a smooth brachial steinkern with attached pedicle interarea and umbo, Lucas Dolomite (?*Acanthonema holopiiforme* Subzone), Loc. E, collector unknown; hypotypes, UMMP 56689-56691, smooth pedicle steinkerns, Lucas Dolomite (?*Acanthonema holopiiforme* Subzone), east quarry, Loc. A, collector unknown; hypotype, UMMP 56692, a smooth pedicle steinkern, probably from the Lucas Dolomite (?*Acanthonema holopiiforme* Subzone), Loc. I, collector unknown; hypotype, UMMP 56693, a costate, partially exfoliated brachial valve, Anderdon Limestone, Loc. K, collected by Ward Austin; hypotype, UMMP 56694, a costate specimen with both valves joined, Anderdon Limestone, Loc. K, collected by Ward Austin; UMMP 56695, external mold of a costate pedicle valve, Lucas Dolomite, *Acanthonema holopiiforme* Subzone, Loc. F, collected by A.W. Grabau or W.H. Sherzer; hypotypes, UMMP 56696 and 56697, costate brachial steinkerns, from sandy beds near base of Lucas Dolomite, "coral-mixed brachiopod subzone," north end of east quarry, Loc. A, collector unknown; hypotypes, UMMP 56698-56701, costate pedicle steinkerns, from sandy beds near base of Lucas Dolomite, "coral-mixed brachiopod subzone," north end of east quarry, Loc. A, collector unknown; hypotypes, UMMP 56702-56704, smooth brachial steinkerns, Lucas Dolomite, *Acanthonema holopiiforme* Subzone, Loc. F, collected by A.W. Grabau or W.H. Sherzer; hypotype, GSC 23092, a smooth pedicle steinkern, probably from the Amherstburg Dolomite, Loc. 4517, collected by M.Y. Williams; hypotypes, GSC 23093 and 23116, smooth, incomplete steinkerns of both valves joined, probably from the Amherstburg Dolomite, Loc. 4517, collected by M.Y. Williams; hypotypes, GSC 23094-23100, nearly complete, smooth specimens with valves joined, Formosa Reef Limestone, south end of Loc. 23635, collected by J.A. Fagerstrom; hypotype, GSC 23101, a partially exfoliated, costate pedicle valve, Detroit River Group, Loc. 23616, collected by E.W. Best; hypotype, GSC 23102, a costate brachial steinkern, probably from the Lucas Dolomite, Loc. 4383, collected by C.R. Stauffer; hypotypes, GSC 23103 and 23104, costate pedicle valves, Anderdon Limestone, Loc. K, collected by E.T. Tozer; hypotypes, GSC 23105 and 23106, smooth pedicle steinkerns, Lucas Dolomite, Loc. 4383, collected by C.R. Stauffer; hypotype, GSC 23107, a partially exfoliated, costate pedicle valve, upper Anderdon Limestone, Loc. 20879, collected by E.W. Best; hypotypes, GSC 23108-23115, smooth pedicle steinkerns, probably from the Amherstburg Dolomite, Loc. 4517, collected by M.Y. Williams; hypotype, GSC 23117, a costate pedicle steinkern, probably from the Amherstburg Dolomite, Loc. 4517, collected by M.Y. Williams; hypotype, GSC 23118, a costate pedicle steinkern, probably from the Amherstburg Dolomite, Loc. 4368, collected by C.R. Stauffer; hypotypes, GSC 23119 and 23120, smooth pedicle steinkerns, probably from the Amherstburg Dolomite, Loc. 4368, collected by C.R. Stauffer; hypotypes, GSC 23121 and 23122, nearly complete, smooth specimens, Detroit River Group, Loc. 23536, collected by J.A. Fagerstrom and E.W. Best; hypotypes, GSC 23123-23125, nearly complete, smooth specimens, Detroit River Group, Loc. 22984, collected by J.F. Caley and E.W. Best; hypotype, GSC 23126, a nearly complete, smooth specimen, Detroit River Group, Loc. 15111, collected by J.F. Caley; hypotype, GSC 23127, a nearly complete, smooth specimen, Detroit River Group, upper bench, Loc. 76001, collected by J.A. Fagerstrom; hypotypes, GSC 23128-23132, partially exfoliated, smooth pedicle valves, lower Anderdon Limestone, Loc. 76000, collected by J.A. Fagerstrom.

For a discussion of the type specimens for the taxa of *Prosserella* designated by Grabau (1910) the reader's attention is directed to Appendix II and the section of the present report entitled "Species of the Genus *Prosserella*".

*Cranaena boucoti* n. sp.

Plate IV, figures 23-26

*Terebratula sullivanii* Hall, 1867, *partim*, ?Pl. 60, figs. 8-10, *non* Pl. 60, figs. 5-7.

*Cranaena romingeri* Fagerstrom, 1961a, p. 35, Pl. 11, figs. 20-24; *non* Hall, 1867, pp. 389, 390, Pl. 60, figs. 17-25, 66, 67; *non* Cloud, 1942, pp. 138, 139, Pl. 24, figs. 2-12.

**Description.** Shells small for genus. Outline subpentagonal, elongate, length/width ratio about 1.25. Greatest width about midlength. Posterolateral and anterolateral margins straight to slightly convex, anterior margin straight to slightly concave. Apical angle of pedicle valve about 90° and of brachial valve about 135°. Cardinal margin subterebratulid. Anterior commissure rectimarginate to broadly uniplicate; lateral commissures rectimarginate. Sulcus in uniplicate specimens very shallow and generally confined to anterior half of valve.

Pedicle valve moderately and evenly convex, somewhat deeper than dorsal valve. Pedicle beak moderately long, suberect. Deltidial plates conjunct, slightly convex. Pedicle foramen permesothyridid, marginate; pedicle collar thin and short (Pl. IV, figs. 24, 25). Brachial valve gently and evenly convex.

Shells smooth except for concentric ornamentation consisting of fine, closely spaced growth lines, and prominent irregularly spaced rugae mostly present on mature portions of valves. Shell structure endopunctate.

Dental plates thin becoming somewhat dilated anteriorly; abruptly terminated at 1/5-1/4 total length of valve (Pl. IV, fig. 23). Deltidial margins somewhat thickened by teeth ridges. Medial margins of deltidial plates thickened. Pedicle muscle field shallow, poorly defined, marks of individual muscles not clearly separable; adductor tracks apparently narrow, elongate, may be separated by a very low, rounded myophragm; diductor tracks apparently elongate, somewhat wider and longer than adductor tracks and located laterally from adductors. Vascula media relatively straight, narrow, low, rounded impressions extending ahead of midlength, and without branches (Pl. IV, fig. 26).

Cardinal plate free, apically perforated by a narrow foramen, and consisting of a relatively short, slightly concave transverse band. Crural bases short, narrow, sharply depressed ventrally. Form of loop uncertain but appears to be short and simple (cranaeniform). Cardinal process absent; diductors apparently attached to cardinal plate. Sockets narrow, elongate, adjacent and parallel to posterolateral margin of valve. Brachial muscle field shallow, poorly defined; apparently consists of paired, subovate adductor impressions separated by a low, rounded myophragm. Vascula media narrow, elongate, located between adductors, and separated by a very low, rounded ridge.

**Remarks.** *Cranaena boucoti* is rather similar to both *C. romingeri* (Hall) and *C. sullivanii* (Hall; as designated by Cloud, 1942, p. 134). The chief differences are the characteristic pentagonal outline of *C. boucoti* with the greatest width at midlength. In addition, *C. boucoti* is larger and less gibbous than *C. romingeri*. The greatest width is closer to the beak in *C. boucoti* than in *C. romingeri*, whereas in *C. sullivanii* it is relatively closer to the anterior margin. Furthermore, the beak is somewhat narrower in *C. sullivanii* than in *C. boucoti*.

In his original description of *C. sullivanii*, Hall (1867, p. 387, Pl. 60, figs. 8-10) included two specimens from Cayuga, Ontario which have generally the same outline as *C. boucoti*. Unfortunately, all of the specimens designated as *C. sullivanii* by Hall are apparently lost (Cloud, 1942, p. 134) so the possible occurrence of *C. boucoti* in the Cayuga area cannot be verified except by future collecting.

Material and occurrence. Holotype, GSC 23078, a steinkern with valves joined, probably from the Amherstburg Dolomite, Loc. 4368, collected by C.R. Stauffer; paratype, UMMP 36318, a complete specimen, Formosa Reef Limestone, illustrated by Fagerstrom (1961a, Pl. 11, figs. 20-24); paratype, GSC 23079, a nearly complete specimen, Formosa Reef Limestone, Loc. 23635, collected by J.A. Fagerstrom; paratype, GSC 23080, a brachial valve, Formosa Reef Limestone, south end Loc. 23635, collected by J.A. Fagerstrom; paratype, GSC 23081, a partially exfoliated specimen with both valves joined, from upper Detroit River Group or lower Delaware Limestone collected by J.F. Caley at the dam at Brussels, Huron County, Ontario.

## CORRELATION

### Introduction

Brachiopods are generally regarded as somewhat less precise than ammonoid cephalopods and conodonts for the widespread correlation of Devonian rocks (House, 1962; Glenister and Klapper, 1966). However, ammonoids are generally rare in rocks as old as the Detroit River Group in North America and have not been reported from the Detroit River. Conodonts are present in the Detroit River (Orr, 1968) but are not common (Winder, 1967) and have not as yet been used for detailed correlation of these rocks. In view of the wide variety of rock types and depositional environments of the Detroit River, the potential for discovery of abundant and diverse conodont faunas is great; their study may refine many of the correlations described below.

Brachiopods are the most abundant, widely distributed, and diverse macrofossils in the Detroit River Group and therefore have great potential for local and regional correlation. At numerous outcrops brachiopods, especially species of *Prosserella*, are the only macrofossils. However, there is considerable endemism; several species are restricted to specialized depositional environments, e.g. reefs, biostromes, or to single outcrops making it difficult to separate faunal similarities due to contemporaneity from similarities due to recurrent ecological factors.

The known brachiopod fauna of the Detroit River Group consists of a total of sixty-seven species distributed among approximately thirty-three genera. Many of the specimens are too poorly preserved for certain identification at the generic and/or specific level so that only forty-three of the species have been given formal specific taxonomic names and only twenty-three of the genera can be positively determined. In addition to the species described in the present report, the brachiopod fauna of the Detroit River includes the following twenty-one species known only from the Formosa Reef Limestone in Bruce and Huron Counties, Ontario (*see* also Fagerstrom, 1961a and 1961b):

*Dalejina*(?) sp.  
*Megastrophia* sp. B  
*Cymostrophia* sp. A; *Cymostrophia*(?) sp. B  
*Rhytistrophia cooperi* Fagerstrom  
"Schuchertella"(?) sp.  
*Pentamerella*(?) sp.  
*Camarotoechia*(?) *lamellosa* Fagerstrom; *Camarotoechia*(?) *formosensis*  
Fagerstrom  
*Stenosisma* sp. (now *Atribonium* sp.)  
*Atrypa* sp. A; *Atrypa* sp. B  
*Metaplasia uniplicata* Fagerstrom  
*Crurithyris* sp.  
*Elytha formosensis* Fagerstrom (now *Elita formosensis*)  
*Fimbrispirifer tricostatus* Fagerstrom  
"Spirifer" sp. A; "Spirifer" sp. B  
*Meristina angustisinuata* Fagerstrom; *Meristina subrotunda* Fagerstrom  
*Camarospira* sp.

The following twelve other species are restricted to a single outcrop of the Detroit River Group (exclusive of the Formosa Reef Limestone) and are also of no value in correlation at present:

*Schizophoria prima* Stauffer  
*Dalejina intermedia* (Stauffer)  
*Megastrophia*(?) sp.  
"Schuchertella" sp.

*Gypidula(?)* sp.  
*?Pentamerella arata* (Conrad)  
*Camarotoechia(?)* sp. cf. *C. formosensis* Fagerstrom  
*Meristella(?)livingstonensis* n. sp.  
*Meristospira michiganense* Grabau; *?Meristospira michiganense*  
*Nucleospira(?) livingstonensis* Stauffer  
*Ambocoelia(?)* sp.

Eighteen other species are known from more than one outcrop of the Detroit River Group (including the Formosa Reef Limestone) and may be used for intra-group (local) correlation but not for correlation of the Detroit River with other rock-stratigraphic units. These species are:

*Rhipidomella* sp.  
*Strophodonta (Strophodonta) homolostriata* Grabau  
*Megastrophia* sp. A  
*"Schuchertella" varicostata* Fagerstrom  
*"Schuchertella" amherstburgense* Grabau  
*"Schuchertella" sp. cf. "S." amherstburgense*  
*Camarotoechia(?) ambigua* Fagerstrom; *Camarotoechia(?) ehlersi* n. sp.  
*Atrionium halli* (Fagerstrom)  
*Atrypa* sp.  
*Meristina formosensis* (Fagerstrom)  
*Athyris(?) minuta* Fagerstrom  
*Howellella(?) submersa* (Grabau); *Howellella(?)* sp.  
*"Spirifer" sp.*  
*Prosserella modestoides* Grabau; *Prosserella lucasi* Grabau  
*Cranaena boucoti* n. sp.

The final tabulation consists of those species present in the Detroit River and other rock-stratigraphic units and so are potentially the most useful for local and/or regional correlation. This list includes the following sixteen species:

*Isorthis propinqua* (Hall)  
*Pholidostrophia (Pholidostrophia) naerea* (Hall)  
*Megastrophia (Megastrophia) proxicostellata* Fagerstrom  
*Megastrophia (Megastrophia) inequiradiata* (Hall)  
*Spinulicosta navicella* (Hall)  
*Pentamerella grandis* Fagerstrom  
*Pentamerella arata* (Conrad)  
*Pentamerella pavilionensis* (Hall)  
*Cupularostrum(?) tethys* (Billings)  
*Meristina nasuta* (Conrad)  
*Meristina barrisi* (Hall)  
*Athyris cora* Hall  
*Acrospirifer(?) macrothyris* (Hall)  
*Brachyspirifer(?) mammi* (Hall)  
*Fimbrispirifer divaricatus* (Hall)  
*Cryptonella lens* (Hall)

In the following discussion, local correlation will concern aspects of correlation of rocks regarded as Detroit River within the Michigan Basin and regional correlation will concern correlation of the Detroit River with other rock-stratigraphic units on the surrounding cratonic platform regions; intercontinental correlation is self-explanatory.

### Local Correlation

One of the chief difficulties in faunal correlation from outcrop to outcrop where rocks of the Detroit River Group are exposed results from the confusion by the early workers in establishing the proper succession of rock units in the type region (Sherzer and Grabau, 1909; Lane, Prosser, Sherzer, and Grabau, 1909; Grabau and Sherzer, 1910; Ehlers, 1950). The history of the development of stratigraphic nomenclature has been reviewed previously in the present report and therefore will not be considered here. However, it is important to note that considerable doubt still exists regarding the stratigraphic position within the Detroit River from which a large number of previously established type specimens were collected. Since numerous old localities can no longer be recollected it seems unlikely that some of these doubts will be resolved in the foreseeable future. Thus, for a variety of reasons, the local correlations to be discussed below are founded on rather uncertain data and may need revision with the discovery of additional information.

In the area of southwestern Ontario northeast of the Chatham Sag, the lithologic and faunal subdivisions of the Detroit River Group established in the type region by Grabau and Sherzer (1910) cannot be recognized. Furthermore, with the exception of the quarries near Beachville, the exposures are not large and the rocks are not particularly fossiliferous. Even in the Beachville area brachiopods are not abundant and the collecting data for the specimens used in the present report are incomplete with regard to stratigraphic occurrence. Therefore, the chief emphasis in the present section will concern the stratigraphic relations between the Formosa Reef Limestone and the units of the type Detroit River.

Although the fossils from the Formosa reefs described by Fagerstrom (1961a) were collected from eleven different localities, most specimens came from just two essentially contemporaneous outcrops 2.5 miles north of Formosa (Localities 6 and 12 of Fagerstrom, 1961a, pp. 4, 5). However, field and subsurface lithologic evidence indicates that other individual reefs are distributed through approximately 200 feet of the Detroit River Group (Fagerstrom, 1961b). Faunal differentiation from reef to reef within the cluster has not been studied in sufficient detail to establish biostratigraphically significant variations for use in determining the relative ages of individual reefs. Consequently, the most valuable correlations are between the reef outcrops north of Formosa and the type Detroit River.

Table 6 is a list of brachiopod species present in the type area of the Detroit River Group, the Sylvania Sandstone, and the Formosa Reef Limestone (Localities 6 and 12 of Fagerstrom, 1961a, pp. 4, 5). Each species included in the table occurs in more than one of the formations and with the exception of *Prosserella lucasi*, none is present in all the formations. The coral-brachiopod biostrome of the Amherstburg has the greatest brachiopod diversity (sixteen species) and contains essentially the same species as the Sylvania (four and possibly seven species in common). The Formosa Reef Limestone contains twelve species also present in the type Detroit River. Each of the twelve occurs in the Amherstburg whereas only three are also present in the Anderdon and one in the Lucas. Thus, on the basis of this evidence the conclusion is inescapable that the Amherstburg and type Formosa Reef Limestone are correlative and confirms the previous correlations of Fagerstrom (1961a, p. 45; 1966).

With regard to Table 6, it is interesting to note that every species present in the Lucas and Anderdon also occurs in the Amherstburg. These species apparently evolved so slowly that they are of only limited value for correlation.

Because of the very widespread distribution of the unconformity at the top of the Detroit River in both the type area and the area northeast of the Chatham Sag there has been considerable uncertainty as to whether or not the uppermost Detroit River rocks are contemporaneous throughout Ontario. In addition to the four, or perhaps five species from the Anderdon listed in Table 6, this formation contains eleven other species. Of these, nine are

restricted to the type area of the Anderdon and *Atrypa* sp. is too widely distributed in the Detroit River to be used for correlation. The remaining species is *Camarotoechia(?) ehlersi* which also occurs in the youngest Detroit River beds at St. Marys, Ontario. Thus, on the basis of the rather limited data presently available it appears as if *C.(?) ehlersi* is stratigraphically restricted to the upper Detroit River and that correlative rocks extend toward the northeast at least as far as St. Marys.

Specimens of *Prosserella* are the most diagnostic faunal criteria for the recognition of the Detroit River throughout the area of outcrop. Although fossils are generally not extremely abundant in these rocks, specimens of *Prosserella* are present in almost every outcrop. The chief exceptions to this generalization are unfossiliferous outcrops with abundant "gashes" or casts of evaporite crystals, reefs (cf. Fagerstrom, 1966), and coral- and stromatoporoid-rich biostromes.

In contrast to the tremendous importance of *Prosserella* for the recognition of the Detroit River Group as a whole, the genus is useless for correlation of subdivisions of the group from outcrop to outcrop. In the course of the present study, great attention was given to the possibility of discovering one or more morphotypes having restricted stratigraphic distribution. Unfortunately, each of the important morphologic features (potential taxonomic criteria) discussed in the chapter on "Species of the genus *Prosserella*" was found to exhibit a continuous range of variation within each formation in the type region. Thus, each species and morphotype of *Prosserella* occurs in every formation of the type Detroit River and the smooth morphotype of *P. lucasi* is also present in the type section of the Formosa Reef Limestone. Evidence for these conclusions is apparent from inspection of Figures 3-8. However, Figure 8 gives some suggestion of relatively short dental plates in the majority of specimens of *P. lucasi* from the Anderdon. Future collecting and study is necessary before the taxonomic validity of this feature can be proven and only then can its biostratigraphic importance be tested.

#### Regional Correlation

Despite the relatively high degree of endemism in the brachiopods of the Detroit River Group, the fauna can be recognized as part of the Appalachian Faunal Province (Boucot, 1960; Boucot, Johnson, and Talent, 1967; Boucot and Johnson, 1967) and contains several important species for use in the correlation of the Detroit River with contemporaneous rocks in the province. As is so common in correlation problems of this type, some of these widely distributed species are of considerably more significance than others.

#### Long-ranging species

Out of the total of sixty-seven brachiopod species in the Detroit River fauna only sixteen species occur in other rock units in the Appalachian Province. Furthermore, of these sixteen species the following five species range from rocks of undoubted pre-Detroit River age to rocks of undoubted post-Detroit River age and therefore are of very little value in regional correlation:

*Isorthis propingua* (Hall)  
*Pentamerella arata* (Conrad)  
*Pentamerella papilionensis* (Hall)  
*Cupularostrum(?) tethys* (Billings)  
*Meristina nasuta* (Conrad)

Table 6.

Stratigraphic distribution of selected brachiopod species in the type areas of the Detroit River Group (revised from Grabau and Sherzer, 1910, pp. 211, 212), the Sylvania Sandstone (Carman, 1936, p. 261), and the Formosa Reef Limestone (after Fagerstrom, 1961a).

Species	Rock Units				
	Sylvania* Sandstone	Amherstburg Dolomite	Lucas Dolomite	Anderdon Limestone	Formosa Reef Limestone
<i>Strophodonta (S.) homolostriata</i>	X	X		X	X
<i>Megastrophia (M.) proxicostellata</i>	?	X			X
" <i>Schuchertella</i> " <i>varicostata</i>	?	X		X	X
" <i>Schuchertella</i> " <i>amherstburgense</i>		X	X		
" <i>Schuchertella</i> " sp. cf. " <i>S.</i> " <i>amherstburgense</i>		X		X	
<i>Pentamerella pavilionensis</i>		X			X
<i>Cupularostrum(?) tethys</i>		X			X
<i>Meristina formosensis</i>		X			X
<i>Meristina nasuta</i>		X			X
<i>Meristina barrisi</i>		X			X
<i>Meristospira michiganensis</i>	X	X	?		
<i>Howellella(?) submersa</i>	X	X		?	X
<i>Fimbrispirifer divaricatus</i>		X			X
<i>Prosserella modestoides</i>	?	X	X	X	
<i>Prosserella lucasi</i>	X	X	X	X	X
<i>Cranaena bouoti</i>		X			X

\*The specimens listed by Carman have not been examined by the writer.



The stratigraphic distribution of the remaining twelve species outside the Detroit River Group is given in Table 7. From an inspection of this table it is readily apparent that the brachiopods of the Detroit River consist of a few widely distributed species, some of which occur elsewhere only in rocks older than the Detroit River, and some of which occur only in rocks younger than the Detroit River. In addition, it is important to note that none of the species is known with certainty to be restricted to the Detroit River and correlative rocks.

#### Species restricted to Detroit River and pre-Detroit River rocks

Considering first those species found only in Detroit River and older rocks, there are only two major taxa involved - the Strophodontidae and the Spiriferacea.

Detailed examination of the ornamentation in numerous specimens of *Megastrophia* (*Megastrophia*) from the Schoharie Formation of New York collected by James Hall and Arthur J. Boucot indicate that two species are present in these rocks. *M. (M.) inequiradiata* Hall is characterized by numerous, non-persistent costae which arise by intercalation and are separated by 4-8 costellae, whereas in *M. (M.) proxicostellata* Fagerstrom the costae persist to the beak, are much more widely spaced, and separated by about twice as many costellae.

The writer has also examined specimens of *M. (M.) inequiradiata* from the Onondaga Limestone at Williamsville and Clarence Hollow, N.Y. and the type Anderdon in Ontario. This species has also been reported from the Columbus Limestone (Stauffer, 1909, pp. 99, 113, 136, 138) and Dundee Limestone (Stewart, 1955, p. 172) in Ohio, the Camden Chert (Boucot and Johnson, in prep.) of Tennessee, and the lower Grand Tower Limestone (Savage, 1910, p. 120) in Illinois but the present writer has not examined these latter specimens and therefore is uncertain whether they are *M. (M.) inequiradiata* (*sensu stricto*). *M. (M.) proxicostellata* is known with certainty only from the Schoharie, the Amherstburg Dolomite, and the Formosa Reef Limestone and possibly (as *Strophodonta vasculosa*) from the Sylvania Sandstone (Carman, 1936, p. 261).

Thus, on the basis of present data both these species of *Megastrophia* are restricted to rocks of Detroit River and Schoharie age and may have considerable potential for correlation.

The geographic and stratigraphic distribution of *Acrospirifer*(?) *macrothyris* is as follows:

a. Previously reported occurrences of this species in New York are somewhat contradictory and suggest that further study will be required before these differences are resolved. Two of Halls' type specimens almost certainly are from the Edgecliff Member of the Onondaga Limestone at the old Fogelsanger Quarry at Williamsville (Oliver, pers. comm.). However, this species was not reported from any of the members of the Onondaga by Oliver (1954, 1956) or from the Bois Blanc (Boucot and Johnson, in prep.). Thus, excluding those possible specimens from the Kanouse Sandstone described by Boucot (1959b, Pl. 91, figs. 10, 14, Pl. 92, figs. 4, 5), it appears as though *A. (?) macrothyris* is restricted to the Edgecliff Member in New York (cf. Rickard, 1964).

b. Ehlers and Stumm (1951, p. 1885) reviewed the distribution of this species in Ohio and concluded that although it is characteristic of Zone E in the middle Columbus Limestone in central Ohio (Wells, 1947, p. 121), it ranges into the upper Columbus at Sandusky (cf. Stauffer, 1909, p. 172). This upward revision of the range is confirmed by specimens (USNM 36610) from the upper Columbus (C.W. Summerson, pers. comm.) at Marion, Ohio.

Table 7

Stratigraphic distribution of twelve brachiopod species present in the Detroit River Group and other rock-stratigraphic units in the Appalachian Faunal Province.

Other Occurrences Detroit River Brachiopods	Older than Detroit River				Correlative with Detroit River				Younger than Detroit River		
	Bois Blanc	Schoharie	Kanouse	Clear Creek	Onondaga	Columbus	Jeffersonville	Grand Tower	Delaware	Dundee	Hamilton
<i>Pholidostrophia nacrea</i>					X	?	X		?		X
<i>M. (M.) proxicostellata</i>		X									
<i>M. (M.) inequiradiata</i>		X			X	?		?		?	
<i>Spinulicosta navicella</i>					X						X
<i>Pentamerella grandis</i>		X									
<i>Meristina barrisi</i>							X	X	X		X
<i>Athyris cora</i>											X
<i>Acrosp. (?) macrothyris</i>	X		?	X	X	X		X			
<i>Brachyspirifer (?) manni</i>	?				X	X	X		X	X	
<i>Fimbrisp. divaricatus</i>	X				X	X	?				
<i>Cranaena boucoti</i>	?				?						
<i>Cryptonella lens</i>					X	X	X			?	

c. In the Niagara Peninsula of Ontario it has been reported by Stauffer (1915, pp. 19, 79, 85, 90) from the Springvale Sandstone and the Bois Blanc Limestone. The species is also present in the "Columbus Limestone" at Beachville (Ehlers and Stumm, 1951) and the upper Anderdon Limestone at Amherstburg.

d. *A. (?) macrothyris* has also been reported from the lower Grand Tower Limestone and the underlying Clear Creek Formation in Illinois (Savage, 1910, p. 127; Amsden and Ventress, 1963, p. 159).

In summary, it appears as though *A. (?) macrothyris* is a moderately long-ranging form, appearing earliest in the Springvale and Bois Blanc and continuing into the upper Columbus and Anderdon. The author knows of no reports of the species in post-Columbus, post-Detroit River, or post-Edgecliff in their respective areas of occurrence.

The geographic and stratigraphic distribution of *Fimbrispirifer divaricatus* (*sensu stricto*) is as follows:

a. The specimens illustrated by Hall (1867, Pl. 32, Fig. 1, ?9) were almost certainly collected from the Edgecliff Member of the Onondaga Limestone (Oliver, pers. comm.) at Williamsville, N.Y. Oliver (1954, 1956) reported *F. divaricatus* from both the Edgecliff and Moorehouse Members of the Onondaga but these specimens have not been examined by the present author and so it cannot be determined whether they are *F. divaricatus* or *F. venustus*. Rickard (1964) has also given the range of *F. divaricatus* as Edgecliff through Moorehouse.

b. In the Michigan Basin *F. divaricatus* is present in the middle Bois Blanc on Garden Island (Ehlers, 1945, Pl. 11, fig. 4), the Formosa Reef Limestone (Fagerstrom, 1961a), and the type section of the Amherstburg Dolomite. The author has also examined the specimens listed by Wilson (1953, p. 68, Locality H 120) from the lower Albany River Formation in the James Bay Lowland and confirms these as *F. divaricatus*.

c. Because Stauffer's (1909, p. 190) conception of the differences between *F. divaricatus* and *F. venustus* are essentially the same as the present author's, his reports of the distribution of these species in Ohio are very useful. He notes that *F. venustus* is restricted to rocks of Hamilton age and that *F. divaricatus* "is to be found in the Columbus (Onondaga) Limestone throughout the state..." *F. divaricatus* occurs in Zones D, E, and F of the Columbus in central Ohio, and in the northern part of the state at Marblehead and on Kelley's Island in the upper Columbus (Stauffer, 1909, pp. 33-35, 98, 136, 141).

d. The stratigraphic occurrence of *F. divaricatus* in the region of the Falls of the Ohio is rather uncertain because some previous authors have not made the distinction between *F. divaricatus* and *F. venustus*; both species are present in the region. In his summary of the biostratigraphy of the Jeffersonville Limestone, Campbell (1942, pp. 1058-1060) lists "*Spirifer*" *divaricatus* from the basal coral zone. Since *F. divaricatus* (*sensu stricto*) is known to occur in the Jeffersonville (e.g. the specimen illustrated by Cooper, 1944, Pl. 123, figs. 1, 2) it appears quite likely that "*S.*" *divaricatus* as used by Campbell is the same as *F. divaricatus* of the present report and that the species is typical, if not restricted to the coral zone of the lower Jeffersonville (see also Stumm, 1964, pp. 7, 9).

e. Bassett (1935, p. 441) listed *Spirifer divaricatus* from the Dundee Limestone in southeastern Michigan. Examination of a single, very incomplete pedicle valve in Bassett's collection at the University of Michigan bearing a label with the name "*Spirifer divaricatus*, Sibley Quarry" indicates that this is probably a specimen of *Fimbrispirifer venustus* as conceived by the present author. Neither *F. divaricatus* nor *F. venustus* is listed from the Dundee (= Delaware) of northwestern Ohio by Stauffer (1909, p. 181) or Stewart (1955, p. 173).

f. Neither *F. divaricatus* nor *F. venustus* has been reported from the Grand Tower Limestone.

In summary, on the basis of present information it appears as though *Fimbrispirifer divaricatus* (*sensu stricto*) is restricted to the Bois Blanc and lower Onondaga Limestone, the lower Detroit River Group, the Columbus Limestone, and the (?) lower Jeffersonville Limestone and is thus one of the most important species for the correlation of these rocks. The presence of this species in the Hudson Bay Lowlands is excellent evidence for rocks of this same age as suggested by Wilson (1953, p. 76).

The importance of *Pentamerella grandis* in correlation is very uncertain; this species is characterized by its relatively large size, slightly incurved pedicle beak, shallow sulcus, and long costae persistent to the umbo (Fagerstrom, 1961a, pp. 18, 19) and is known from one specimen from the Schoharie Formation and one specimen from the Formosa Reef Limestone. However, in the experience of the writer the species of *Pentamerella* show extreme morphologic variation among samples of large populations (e.g. *Pentamerella papilionensis* Fagerstrom, 1961a, p. 18, Pl. 7, figs. 7-30) and are therefore of relatively uncertain value in correlation. Additional collecting may indicate either that *P. grandis* was erected for unusually large individuals of *P. papilionensis* and thus belong to a long-ranging species or that the species is valid, of short duration, and of considerable biostratigraphic significance.

Species restricted to Detroit River and post-Detroit River rocks

*Pholidostrophia (Pholidostrophia) nacrea* is a relatively long-ranging species that appears first in New York in the Moorehouse Member of the Onondaga Limestone (Oliver, 1954) and extends through the Hamilton Group to the Tully Limestone. The species is also present in the Jeffersonville Limestone of Indiana (Nettleroth, 1889, pp. 146, 147), the Formosa Reef Limestone (Fagerstrom, 1961a, p. 19), and possibly in the Columbus and Delaware Limestones (as *P. iowensis* in central Ohio (Stauffer, 1909, p. 164).

*Spinulicosta navicella* is another long-ranging species that in New York arose first in the Nedrow Member of the Onondaga (Oliver, 1956), increased in abundance in the Moorehouse and Seneca, and extends into the Hamilton. The species has not been reported from Ohio by either Stauffer (1909) or Stewart (1955) but may be included as *Productella spinulicosta* in faunal lists given by these authors. *Spinulicosta navicella* is very rare in the Detroit River Group; only three specimens from a single locality of the Formosa Reef Limestone have been identified (Fagerstrom, 1961a, pp. 21, 27).

The specimens of meristellid brachiopods in the rocks of the Detroit River Group are extremely varied morphologically and therefore difficult to assign to discrete specific taxa with a high degree of certainty. The author has felt caught between the temptation toward "oversplitting" on the one hand, and the equally strong temptation to include all the specimens in one highly variable species. Because of the general uncertainty in the specific identifications there is considerable doubt regarding the value of these brachiopods for correlation.

Assuming that the previous identifications of *Meristina barrisi* are correct, it appears as if this species arose first in the Jeffersonville (Kindle, 1901, pp. 655, 656), middle Grand Tower (Savage, 1908, p. 106), and lower Detroit River, and did not reach New York until early Hamilton (Marcellus) time (Hall, 1867, p. 304). The species has not been reported in either the Columbus (Stauffer, 1909) or the Onondaga (Oliver, 1954, 1956).

The presence of *Athyris cora* in the Detroit River Group is also surprising because this species is unknown elsewhere from pre-Hamilton rocks. The specimens from the Formosa Reef Limestone described by Fagerstrom (1961a, p. 34) are somewhat smaller than Hall's types of *A. cora* and with detailed study of the interiors may prove to be a new species.

The geographic and stratigraphic distribution of *Brachyspirifer(?) marni* is as follows:

- a. In New York it is present in the Edgecliff and Nedrow Members of the Onondaga Limestone (Oliver, 1956; Hall, 1867, p. 211).
- b. In Ohio this species is widely distributed in the Columbus Limestone (Stauffer, 1909) and has been reported also from the Dundee (Stewart, 1955, p. 172; Bassett, 1935, p. 438).
- c. Kindle (1901, Pl. 10, fig. 1) has illustrated typical specimens of *B.(?) marni* from the Jeffersonville Limestone at the Falls of the Ohio.

d. In Ontario the species occurs in the lower Onondaga Limestone (or perhaps Bois Blanc) at Ridgemoor (Stauffer, 1915, pp. 17-20), the Columbus Limestone on Pelee Island (Stauffer, 1915, pp. 208, 211, 213), the type Anderdon Limestone, and the Delaware Limestone at Goderich (Stauffer, 1915, p. 135).

Thus, on the basis of this distribution it appears as if *Brachyspirifer(?) manni* ranges from rocks of lower Onondaga, or possibly Bois Blanc age, to the Dundee and Delaware, and therefore its occurrence in the Anderdon is of only limited significance in correlation. However, it is interesting to note that in the Onondaga it is restricted to the lower half of the formation whereas it is known only from the uppermost formation of the Detroit River Group.

The possible occurrence of *Cranaena boucoti* in the vicinity of Cayuga, Ontario has been noted in the systematic description of this species. In addition to difficulties in the identification of Hall's original specimens, there is considerable doubt regarding the rock unit from which his specimens were collected. In the Cayuga area, the Bertie-Akron (Silurian), the Bois Blanc, and lower Onondaga crop out (Oliver, pers. comm.). There seems to be little possibility that the specimens came from the Bertie-Akron because the genus *Cranaena* is unknown from Silurian rocks elsewhere, but it cannot be determined whether Hall's material came from the Bois Blanc or Onondaga.

*Cryptonella lens* is widely distributed in rocks of Detroit River age. This species has been reported from the Onondaga in New York (Hall, 1860, 1867), and may be restricted to the Edgecliff Member (Oliver, 1956, pp. 1452, 1469). It also occurs in the Formosa Reef Limestone of Ontario (Fagerstrom, 1961a, p. 35), the Columbus of central Ohio (Stauffer, 1909, pp. 132, 163), and the Jeffersonville at the Falls of the Ohio (Kindle, 1899, p. 188). *C. lens* was also reported by Stauffer (1909, p. 180) from the Dundee in northwestern Ohio but this occurrence was not confirmed by either Bassett (1935) or Stewart (1955). Therefore, on the basis of present data it appears as if this species is unknown from pre-Detroit River rocks and is probably not present in post-Detroit River rocks.

#### Correlation at the generic level

The discussion of the correlation of the Detroit River Group thus far has concerned the distribution of various species of brachiopods and the significance of the known range of each species in rocks deposited beyond the limits of the Michigan Basin. However, it is also possible to determine the relative age of these rocks on the basis of the known ranges of certain genera. Boucot (1959b, pp. 735, 736) and Amsden and Ventress (1963, pp. 196, 197) have recently summarized the distribution of several important genera in the New York standard section and much of their information has been utilized in the following discussion.

The genus *Metaplasia* is widely distributed in eastern North America in rocks of Oriskany Sandstone through Onondaga Limestone age (Boucot, 1959a, pp. 16, 17). On the craton, species of this genus are also present in the Camden Chert of western Tennessee (Dunbar, 1919), the Clear Creek Formation of southwestern Illinois (Savage, 1920), the Columbus Limestone of central Ohio (Stauffer, 1909, p. 164), and the Formosa Reef Limestone in Ontario (Fagerstrom, 1961a, p. 30). These cratonic occurrences all fall within the Oriskany through Onondaga range; furthermore, the Columbus, Formosa Reef, and Onondaga species appear to define the upper limit of the range.

The genus *Spinulicosta* is rather widely distributed in the Detroit River and equivalent rocks and the base of the range zone appears to have considerable significance for biostratigraphic purposes. Previous reports of the earliest occurrence of this genus (generally reported as *Productella* by most authors) on the North American craton are as follows:

1. New York: "Corniferous" (= Onondaga) Limestone (Hall, 1867, p. 157); Nedrow Member, Onondaga Limestone (Oliver, 1954, 1956).

2. Ontario: Formosa Reef Limestone (Fagerstrom, 1961a, pp. 21, 27).
3. Central Ohio: Middle and Upper Columbus Limestone (Stauffer, 1909, pp. 34, 35, 164; Stewart, 1955, p. 164).
4. Southern Indiana: Upper Jeffersonville Limestone (Hall, 1867, Pl. 23, figs. 6-8; Campbell, 1942, pp. 1059, 1060; Muir-Wood and Cooper, 1960, p. 154).
5. South Illinois: Probably in the Dutch Creek Sandstone (as *Productella* sp.; Savage, 1910, p. 120; Savage, 1920); certainly in the upper Grand Tower Limestone (Savage, 1910, pp. 125-127).

The base of the *Atribonium* range zone in North America occurs in the lower Detroit River Group and correlative rocks. *A. halli* (Fagerstrom, from the Formosa Reef Limestone and *A. gainesi* (Nettleroth) and *A. gainesi cassensis* (Kindle) from southern Indiana and northern Kentucky appear to be the first representatives of the genus on this continent. The stratigraphic occurrence of *A. gainesi* was originally given by Nettleroth (1889, p. 76) as "the rotten hornstone" which in modern terms is the Sellersburg Formation (Bassler, 1908, p. 123). Kindle (1901, pp. 587, 588) reported this same species in both the Sellersburg and in the Jeffersonville Limestone and also described *A. gainesi cassensis* from the Jeffersonville. However, Campbell (1942, p. 1068) notes that *A. gainesi* is restricted to post-Jeffersonville rocks. Thus, perhaps *A. halli* pre-dates the Indiana and Kentucky forms but resolution of this problem must await further detailed biostratigraphic studies.

Cooper (1945, pp. 483-485) described two species of *Atribonium* (see Grant, 1965, p. 40) from rocks "between the crystalline Grand Tower limestone and base of St. Laurent limestone Devils Backbone, north of Grand Tower, Illinois." However, these rocks are apparently slightly younger than the Jeffersonville, Columbus, and Onondaga (Cooper, 1945, pp. 487, 488) and therefore represent a slightly later arrival of *Atribonium* than in the Formosa Reef Limestone and Jeffersonville described above. Savage (1910, p. 123) listed *Atribonium gainesi* (as *Camaxophoria gainesi*) from the Grand Tower and if his identification was correct it extends the range of the genus to rocks below those containing the specimens described by Cooper (1945). Thus, the lower limit of the *Atribonium* range zone in southwestern Illinois is uncertain.

The distribution of species of the genus *Camaxospira* in the North American craton also has considerable biostratigraphic significance. The type species, *C. eucharis*, was described by Hall (1867, p. 368) from the Onondaga Limestone of "Canada West" (probably the Niagara Peninsula). Cooper (1944, p. 333) indicates that the species is also present in New York although it was not listed by Oliver (1954, 1956). The precise stratigraphic occurrence of *C. eucharis* in Ontario is uncertain; however, it is apparently not present in the Bois Blanc (Boucot and Johnson, 1968) which suggests that Hall's types at least, came from the Edgecliff or perhaps younger Onondaga strata.

*Camaxospira eucharis* was reported by Stauffer (1909, pp. 99, 163) from the Columbus and Delaware Limestones of central Ohio and from the Jeffersonville in southern Indiana (Kindle, 1901, p. 661), and *Camaxospira* sp. is present in the Formosa Reef Limestone in southwestern Ontario (Fagerstrom, 1961a, p. 34). The genus has not been reported from Grand Tower Limestone.

Thus, on the basis of present scattered and incomplete information it appears as though the base of the *Camaxospira* range zone is in the lower Onondaga (Edgecliff perhaps), Columbus, and lower Detroit River Group. Unfortunately, specimens of the genus are not common but additional detailed collecting may refine the position of the base of the range zone and thereby enhance its value in biostratigraphy.

The lower limit of the range of the genus *Cruxithyris* has not been carefully determined in eastern North America. It was not listed by either Boucot (1959b) or Amsden and Ventress (1963) and is apparently absent in the Onondaga, Columbus, Jeffersonville, and Grand Tower Limestones. Furthermore,

additional collecting and detailed investigation of the internal features of specimens from the Detroit River Group assigned herein to this genus may indicate that this generic identification is incorrect and that the genus does not range into rocks this old. Thus, the presence of *Crurithyris* (?) sp. in the Detroit River is of only slight biostratigraphic significance.

Cloud (1942, p. 132) has given the range of *Cranaena* in North America as "rocks of Onondagan or Oriskany age to at least as high as Spergen limestone." Investigation of the stratigraphic distribution of each species assigned by Cloud (1942, pp. 135-137) to *Cranaena* indicates that the earliest species appeared almost simultaneously at four widely separated areas on the North American craton. The species and their reported occurrences are as follows:

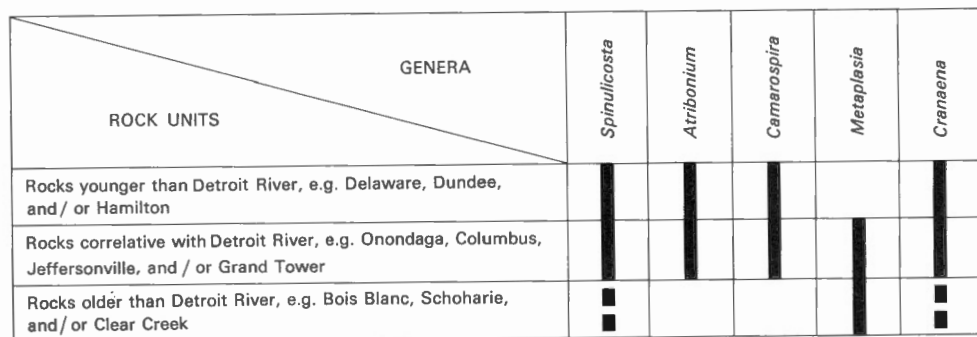
1. *C. harmonia* (Hall) 1867, p. 389, Pl. 60, figs. 11-16: Jeffersonville Limestone at the Falls of the Ohio, "and also from the Corniferous limestone of Canada West," (Cayuga, Ontario; Hall, 1867, Pl. 60, figs. 12, 13).

2. *C. sullivanii* (Hall) as interpreted by Cloud (1942, p. 134): Columbus Limestone near Columbus, Marion, and in northern Ohio (also listed by Stauffer, 1909, pp. 115, 163 as *Eumella sullivanii*), and the upper Grand Tower Limestone of southwestern Illinois (Savage, 1910, p. 126 as *Eumella sullivanii*).

3. *C. linklaeni* (Hall): Columbus and Delaware Limestones (Zones C through L of Stauffer, 1909) in central Ohio, and in younger rocks in New York (Hall, 1867, pp. 397, 398) and Indiana (Nettleroth, 1889, p. 155).

4. *C. boucoti*, n. sp.: Formosa Reef Limestone and Amherstburg Dolomite in southwestern Ontario and perhaps the specimens designated by Hall (1867, Pl. 60, figs. 8-10) as *Terebratula sullivanii* from near Cayuga, Ontario.

There is considerable uncertainty regarding the precise stratigraphic occurrence of Hall's type specimens of both *C. harmonia* and *C. sullivanii* from the vicinity of Cayuga, Ontario. The stratigraphic section in the quarry just west of Cayuga has been described by Hewitt (1960, pp. 138-140) as consisting of 54 feet of Silurian rocks unconformably overlain by 5 feet of Bois Blanc Limestone. Hall's specimens certainly were not collected from the Silurian and therefore may have come from the Bois Blanc. However, "Hall could have been referring to the town of North or South Cayuga rather than to the village so the brachiopods did not necessarily come from this quarry. Within the towns of Cayuga there are Onondaga as well as Bois Blanc outcrops" (W.A. Oliver, pers. comm., dated Oct. 14, 1966).



Note: The chart is generalized because it has been assumed that if a genus is present in a particular rock-unit it ranges throughout the unit. Solid lines represent known ranges; dashed lines represent uncertain ranges.

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Figure 12. Stratigraphic distribution of five selected brachiopod genera present in the Detroit River Group and other rock-stratigraphic units in the Appalachian Faunal Province.

Thus, it appears as if the lower limit of the *Cranaena* biozone in North America occurs in either the lower Detroit River and its correlatives or in the Bois Blanc. If Hall's types are from the Bois Blanc near Cayuga they are the only reported pre-Detroit River occurrence of this genus in eastern North America.

Figure 12 summarizes the stratigraphic distribution of five selected brachiopod genera and clearly indicates the equivalence of the Detroit River, Onondaga, Columbus, Jeffersonville, and Grand Tower Limestones based upon the nearly simultaneous appearance in these rocks of *Atribonium*, and *Camarospira*, and perhaps also *Spinulicosta* and *Cranaena*. *Metaplasia* appears to be the only genus present in the Detroit River that becomes extinct in these and equivalent rocks.

### Conclusions

On the basis of the paleontologic data presented above, the following conclusions may be drawn regarding the regional stratigraphic relations of the Detroit River Group, the Sylvania Sandstone, and associated rocks (see Fig. 13):

1. The joint occurrence of species of *Prosserella* in the Pendleton Sandstone of central Indiana, the Detroit River, and the Sylvania leaves little doubt that these units are approximately correlative. These relations have been previously noted by Cooper, *et al.* (1942, p. 1776) who concluded that the Pendleton and Amherstburg were equivalent.

Examination of the Pendleton brachiopods by the present author indicates that the fauna includes both the smooth and costate morphotypes of *Prosserella lucasi*, the smooth morphotype of *P. modestoides*, a species of *Atrypa* as well as *Conocardium* sp., and both rugose and favositid corals were also observed. Cooper, *et al.* (1942, p. 1776) also reported *Pentamerella* aff. *P. arata*, *Panenka*, and *Proetus crassimarginatus*. On the basis of present information it appears as if none of these forms is sufficiently restricted within the Detroit River to determine which formation in the group is correlative with the Pendleton. However, Pinsak and Shaver (1964, p. 57), Ells (1958, p. 32), and Landes (1951, pp. 11, 15) agree that the Sylvania and Amherstburg are absent in northern Indiana so perhaps the Pendleton correlates with the Lucas or Anderdon. Ells (1958, p. 16) suggested that the Pendleton and the Garden Island Formation of the Michigan Basin were equivalent but the paleontologic data demonstrate conclusively that this is incorrect.

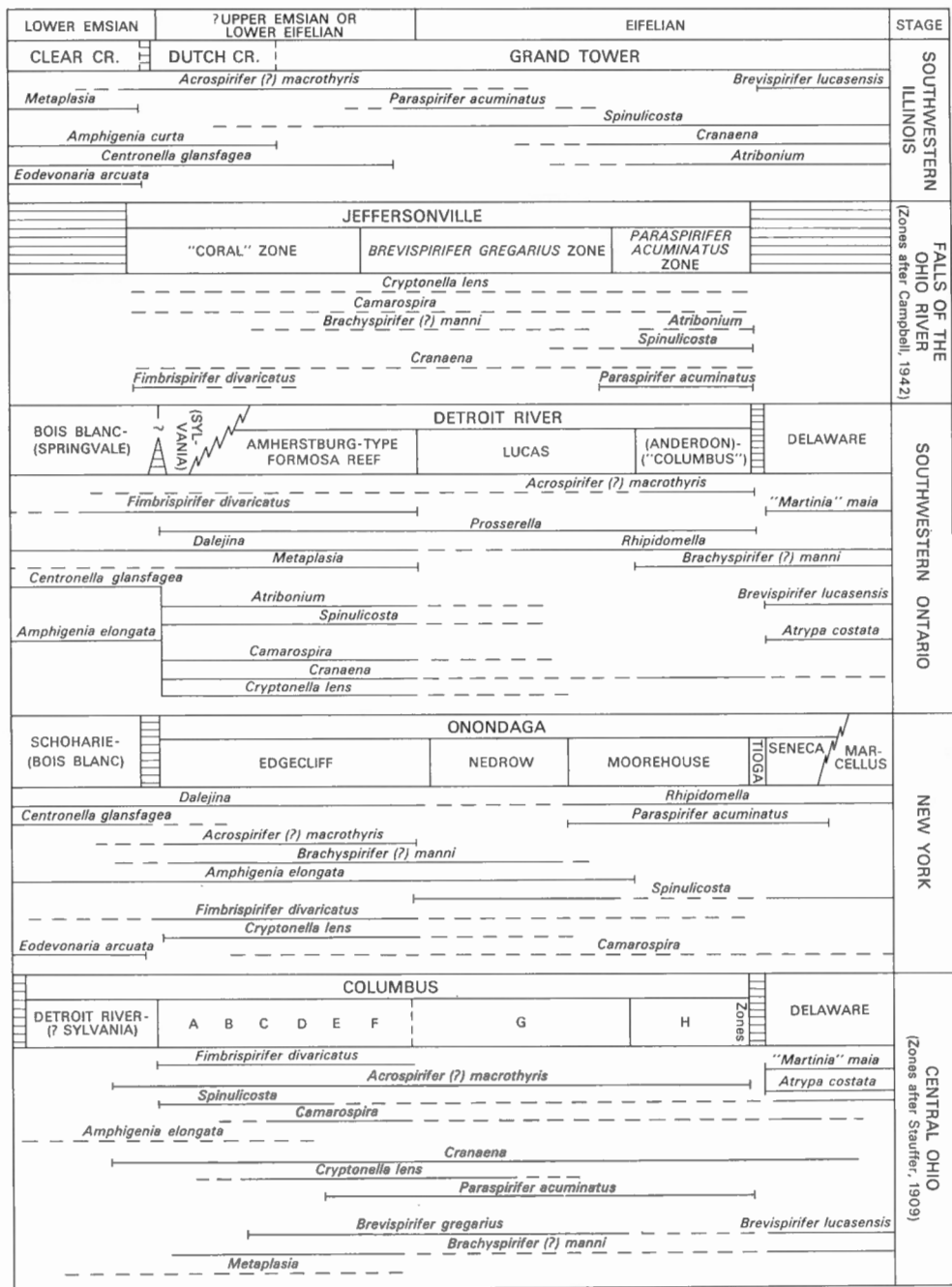
The distribution of the Sylvania is restricted to the area of the axis of the Findlay Arch and the southeastern portion of the Michigan Basin (Landes, 1951). The Pendleton is known only from a few outcrops in the vicinity of the village of Pendleton located near the axis of the Kankakee Arch (Pinsak and Shaver, 1964). Perhaps the relations of the Sylvania to the Findlay Arch and the Pendleton to the Kankakee Arch are closely analogous and that the mode of origin of these two sandstones is essentially the same.

2. As indicated on Table 7, seven and perhaps eight species occur jointly in the Detroit River and the Onondaga Limestone of New York suggesting the equivalence of these units and supporting the previous correlations of Fagerstrom (1961a, pp. 44, 45) and Oliver (1960, 1966). However, of these seven or eight species only *Cryptonella lens* may be restricted to Detroit River and correlative strata.

The Detroit River-Onondaga correlation is further strengthened by the nearly simultaneous joint occurrence of the base of the *Camarospira* range zone, and perhaps also the *Spinulicosta* and *Cranaena* range zones, and the top of the *Metaplasia* range zone in these rocks (Fig. 12).

More precise correlation of subdivisions of the Detroit River and the Onondaga have been described by Fagerstrom (1966). The evolution of rhipidomellid internal crenulations from those typical of the genus *Dalejina* in the Bois Blanc and lower Detroit River to those typical of





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Figure 13. Correlation of the Detroit River Group and associated rocks in the eastern North American craton including local range zones (dashed where inferred or uncertain) of biostratigraphically important brachiopod species and genera.

*Rhipidomella* in the upper Detroit River and Delaware has been carefully documented in southwestern Ontario and is illustrated in Plate I of the present report. Thus, on the basis of similarity in form of the internal marginal crenulations of these rhipidomellid genera, it appears as if the Amherstburg Dolomite of the Detroit River correlates with the Edgecliff Member of the Onondaga Limestone and that the upper Detroit River is no older than about the age of the Moorehouse or possibly Nedrow Members. The restriction of specimens of *Fimbrispirifer divaricatus* to the Amherstburg and also probably to the Edgecliff further supports this correlation and the presence of *Cryptonella lens* in the Formosa Reef Limestone and the Edgecliff also indicates that these units are probably correlative.

The distribution of *Acrospirifer* (?) *macrothyris* in the Detroit River and Onondaga appears to be quite anomalous. In the Detroit River this species is known only from the type Anderdon whereas in New York it appears to be restricted to the Edgecliff. However, in Ohio this species ranges upward to rocks correlative with the upper Onondaga so that migration to the Detroit River Group was almost certainly from Ohio and was delayed (probably by environmental factors) until after the extinction of the species in New York. Conversely, the genus *Spinulicosta* probably reached the Michigan Basin before its arrival in New York.

3. As early as 1950 Ehlers (*in Landes*, 1950, p. 3) suggested that perhaps the Detroit River and Columbus were correlative. Examination of Table 7 indicates that at least four biostratigraphically significant brachiopod species occur in both these rock units and thus support Ehlers' suggestion.

The apparent restriction of *Fimbrispirifer divaricatus* to Zones D-F of the Columbus (Stauffer, 1909, pp. 29-38) and to the Amherstburg indicates the probable correlation of these units. The data are somewhat meagre regarding the distribution of *Cryptonella lens* in the Columbus but it appears as if the lower limit is at about Zones E or F (Stauffer, 1909, pp. 131, 132); the lower limit of this same species in the Detroit River occurs near the base of the unit. Furthermore, the bases of the *Camarospira* and *Spinulicosta* range zones are in the Amherstburg and Zones D-F intervals and thus lend additional support to this correlation.

*Acrospirifer* (?) *macrothyris* is the only biostratigraphically significant brachiopod species listed in Table 7 that is present in both the Detroit River Group and the lower Columbus (Zones A-C). However, this is a relatively long-ranging species in the Columbus and probably also has a long range in the Detroit River and therefore is of only limited value in the detailed correlation of these rocks. In fact, recent discovery of conodonts in Zones A-C similar to those in the Schoharie and Bois Blanc of New York (Ramsey, 1969) indicates that these rocks are of pre-Detroit River age.

Ehlers and Stumm (1951) listed the fauna and described the stratigraphic relations of a 15-foot section of sandstone and sandy limestone overlying the Detroit River near Ingersoll and concluded that these rocks were equivalent to Zone H of the Columbus. Among the fossils from the upper beds at Ingersoll is *Acrospirifer* (?) *macrothyris* which is also present in the Anderdon and suggests the correlation of these units. This possibility is further enhanced by the general similarity of the stromatoporoid faunas in the Anderdon and the upper Columbus in north-central Ohio (Fagerstrom, 1962, pp. 429, 430).

4. Numerous previous authors have generally described the stratigraphic distribution of fossils in the Jeffersonville Limestone in the area of the Falls of the Ohio River at Louisville, Kentucky (e.g. Campbell, 1942, pp. 1057-1060; Oliver, 1960; Perkins, 1963; Stumm, 1964). According to Oliver (1960, pp. B173, B174) the lowest 4 feet of the Jeffersonville contain a coral fauna of pre-Detroit River age. Among the fossils in these lowest beds is *Fimbrispirifer divaricatus* which is suggestive of a possible Amherstburg correlation but this species is known to also occur in other pre-Detroit River rocks (Ehlers, 1945, Pl. 11, fig. 4). The upper limit of the *F. divaricatus*

range zone in the Jeffersonville is uncertain but specimens are most abundant in the lower 2 feet of the formation. Four other brachiopod species are present in both the Detroit River and Jeffersonville (see Table 7) but each of these, except for *Cryptonella lens*, is known to also occur in younger rocks and so is severely limited for correlation. The occurrence of *C. lens* is known only from the report of Kindle (1899, p. 188).

The base of the *Spinulicosta* range zone is apparently in upper Jeffersonville beds (Campbell, 1942, pp. 1059, 1060) which if correct means that the genus arrived in this area after it had reached the Michigan Basin, New York, and Ohio. Kindle (1901, pp. 587, 588) reported *Rhynchonella gainesi* and *R. gainesi cassensis* (both now in the genus *Atribonium*; see Grant, 1965, p. 40) from the Jeffersonville but Campbell (1942, p. 1068) indicates that the former is restricted to post-Jeffersonville rocks. Thus, the direct faunal correlation of the Detroit River and Jeffersonville is relatively uncertain; no species or genera of brachiopods are presently known to occur at precisely the same stratigraphic positions in each. However, both the Detroit River and Jeffersonville can be correlated with relatively high precision with the Columbus and therefore must be essentially equivalent except for the lower 4 feet of the Jeffersonville, which is of Bois Blanc age.

5. Only two or perhaps three biostratigraphically significant brachiopod species occur jointly in the Detroit River Group and the Grand Tower Limestone of southwestern Illinois and one of these (*Meristina barrasi*) is known to also occur in younger rocks (see Table 7). Savage (1910) has listed *Acrospirifer(?) macrothyris* from the Dutch Creek Sandstone and lower Grand Tower and *Paraspirifer acuminatus* from the middle Grand Tower. However, Cooper (pers. comm., July 26, 1965) indicates that these two species occur at the same stratigraphic position in the Grand Tower and therefore the range of one or both species extends beyond the limits suggested by Savage.

The base of the *Spinulicosta* range zone is located near the base of both the Detroit River and Grand Tower whereas the *Atribonium* and *Cranaena* range zones begin near the base of the Detroit River and near the top of the Grand Tower (reported as *Camaxophoria gainesi* and *Cranaena sullivanti* by Savage, 1910, pp. 123-126). Thus, it is readily apparent that these units cannot be correlated with much precision. However, the general equivalence of the Grand Tower and Detroit River is quite certain because of the considerable faunal similarity of each with the Columbus and Onondaga.

The Dutch Creek Sandstone is the basal member of the Grand Tower in southwestern Illinois and unconformably overlies the cherty Clear Creek Limestone (Meents and Swann, 1965, pp. 18-20). Boucot and Johnson (1968) have noted the similarity of the Clear Creek, Bois Blanc, and Schoharie faunas as evidence for their correlation. Furthermore, the Clear Creek - unconformity - Dutch Creek - Grand Tower succession is structurally and lithologically similar to the Bois Blanc - ? unconformity - Sylvania - Detroit River succession in southwestern Ontario.

As noted previously, both the Dutch Creek and Detroit River contain specimens of *Acrospirifer(?) macrothyris*; otherwise their faunas are wholly different at the species level. Yet the Dutch Creek fauna is an interesting combination of forms typical of pre-Detroit River rocks (e.g. *Centronella glansfagea* and *Amphigenia curta*) and rocks of Detroit River age (e.g. *A. (?) macrothyris* and *Spinulicosta* which was reported by Savage, 1910, p. 120 as *Productella*). Thus, the precise stratigraphic relations between the Dutch Creek and Detroit River are uncertain but the Dutch Creek is approximately of Sylvania or Amherstburg age.

6. The occurrence of the Tioga Bentonite lends additional nonpaleontologic support for the correlation of the Moorehouse Member of the Onondaga Limestone, the upper Columbus, upper Jeffersonville, and upper Grand Tower Limestones and by inference the upper Detroit River. The distribution of the Tioga in the Appalachian Basin has been discussed by Dennison (1961, pp. 36-39) and Oliver, *et al.* (1967, p. 1019) and in the Illinois Basin by Meents and Swann (1965, p. 10) and Collinson, *et al.* (1967, p. 954).

In New York the Tioga occurs at Moorehouse-Seneca contact. Near Sandusky in north-central Ohio it is at the Columbus-Delaware contact, in southwestern Indiana it occurs from 10 to 35 feet below the top of the Jeffersonville, and in southeastern Illinois from 6 to 15 feet below the top of the Grand Tower. The Tioga is absent at the Falls of the Ohio and at the type section of Grand Tower in southwestern Illinois and has not been recognized in the Michigan Basin.

Unless unrecognized major unconformities exist below the Tioga in the Appalachian and Illinois Basins, this single ash bed and the rock below it are correlative and mark one of the most useful datum planes in the entire Devonian of the eastern North American craton. If the Tioga is present in the Michigan Basin it should occur approximately at the Detroit River-Delaware contact.

7. Martison (1953, p. 29; Fig. 2), Wilson (1953, p. 76), and Hogg, Satterly, and Wilson (1953, pp. 117, 120-124) have noted the similarity between the faunas of the Detroit River Group and the Middle and Upper Abitibi River Formation in the Hudson Bay Lowlands. However, none of the evidence presented by these authors is conclusive regarding this suggested correlation. Of the 82 brachiopod species listed by Martison (1953, pp. 38, 39) from the Abitibi River Formation only *Camarotoechia* (now *Cupularostrum*(?)) *tethys*, *Fimbrispirifer divaricatus*, and *Meristella* (now *Meristina*) *nasuta* also occur in the Detroit River and none of these is restricted to rocks of Detroit River age. The author has examined the specimens of *F. divaricatus* identified by Wilson (1953, p. 68, Location H 120) and confirms that they are conspecific with specimens from the type Formosa Reef Limestone and the Amherstburg Dolomite. However, this same species is also present in the Bois Blanc and at the base of the Jeffersonville Limestones. Nevertheless, the presence of *Paraspirifer acuminatus* in the Abitibi River (Martison, p. 39) is presumptive evidence that at least part of this formation is equivalent to the upper Onondaga and Columbus and therefore also to the upper Detroit River. Study of the upper Abitibi River corals (Cranswick and Fritz, 1958) confirms this conclusion. In addition, the presence of the stromatoporoid *Syringostroma aurora* Parks from the Hudson Bay Lowlands and the Detroit River Group (Galloway and Ehlers, 1960, pp. 92, 93) supports these correlations.

More recently Sanford, Norris, and Bostock (1968, pp. 26-33, Fig. 2) revised the stratigraphic nomenclature of the Devonian rocks in the Hudson Bay Lowlands. The result of their work was to eliminate the Abitibi River Formation as a formal rock unit and substitute for it the Stooeping River, Kwataboahagan, Moose River, and Murray Island Formations (in ascending order). These authors also suggested that the Kwataboahagan was correlative with the Amherstburg and the Moose River with the Lucas but presented no faunal evidence to support their correlations.

8. Furthermore, on the basis of the correlations described above it may also be concluded that at the time of deposition of the rocks of the Detroit River Group the eastern North American craton from the Hudson Bay Lowlands on the north to the Falls of the Ohio on the south, and from the Appalachian Mountains on the east to southwestern Illinois on the west was an unusually extensive area of predominant carbonate deposition. The Detroit River dolomites, limestones, and evaporites accumulated in the Michigan Basin which at this time was probably a region of restricted circulation resulting in sharper and more diverse ecological gradients than existed in the surrounding platform regions. The effect of these ecological factors was to produce a highly endemic fauna within the basin having only a few species, of presumed wide ecological tolerance limits, in common with contemporaneous platform communities. Periodically within the basin, circulation became so restricted that extensive areas became "salt pans" (see Landes, 1951; Briggs, 1959; Hanev and Briggs, 1964) with extremely restricted faunas whereas near the basin rim numerous small reefs developed from time to time with remarkably abundant and diverse faunas (Fagerstrom, 1961a).

Clastic deposition, at this time, was minimal and consisted of relatively local sandstone stringers (e.g. Filer Sandstone of Landes, 1951) in the Michigan Basin. However, just prior to or perhaps even coincident with the deposition of early Detroit River and equivalent strata, clastic sediments accumulated near the axes of the Findlay (Sylvania Sandstone) and Kankakee Arches (Pendleton Sandstone), in the Allegheny Basin (Schoharie Formation), and in southwestern Illinois (Dutch Creek Sandstone). Similarly, just prior to the cessation of the deposition of Detroit River and correlative beds, sands accumulated near the axis of the Findlay (or Algonquin) Arch ("Columbus" Limestone of Ehlers and Stumm, 1951) and also very local oolites in the upper Detroit River near Goderich, Ontario; these clastic materials are probably indicative of very shallow water environments preceding the development of the Detroit River (= Columbus) - Delaware unconformity.

#### Intercontinental Correlation

The Detroit River Group cannot be correlated with a high degree of precision by direct faunal means beyond the limits of the Appalachian Faunal Province. There are two major reasons for this difficulty: (1) the known Detroit River fauna consists entirely of species restricted to this province, and (2) the genera common to both the Detroit River and non-Appalachian Province rocks are nearly all long-ranging forms of relatively limited biostratigraphic significance. Nevertheless, there are several indirect faunal methods by which the relative age of the Detroit River may be determined; the chief emphasis in this regard will concern correlations with the standard section for the Devonian System in western Europe, especially the Rheinisch Schiefergebirge.

Boucot and Johnson (1968) have discussed the evolution and biostratigraphic significance of the Early Devonian acrospiriferid brachiopods in eastern North America and concluded that the Schoharie and Bois Blanc Formations are of Early Emsian age. Unfortunately, the post-Early Emsian evolution of these brachiopods is rather uncertain so that the importance of *Acrospirifer(?) macrothyris* in the Detroit River and equivalent rocks for correlation with the Rheinisch Province has not been determined. In fact, no well-documented Upper Emsian faunas have been recognized in the entire Appalachian Province. Thus, on the evidence of the stage of evolution of the acrospiriferids the only firm conclusion that can be reached as yet is that the base of the Detroit River is post-Early Emsian in age.

Oliver (1956a) and Sweet and Miller (1956, pp. 811-813) have reviewed the reported occurrences of late Early Devonian and early Middle Devonian ammonoid cephalopods in North America and House (1962) has reinvestigated their value for correlation with the standard Devonian succession in Europe. Ammonoids are unknown from the Detroit River Group but have been described from the Nedrow Member of the Onondaga Limestone (Oliver, 1956) and Zone D of the Columbus Limestone (Sweet and Miller, 1956) and House (1962, p. 253) concluded that all these specimens are of Eifelian age (*Anarcestes* Zone).

In their recent study of the Schoharie, Bois Blanc, and Onondaga conodonts, Klapper and Ziegler (1967) have confirmed the Eifelian age of the Nedrow, Moorehouse, and Seneca Members but were unable to reach a positive conclusion regarding the age of the Schoharie, Bois Blanc, and Edgecliff.

Although the brachiopod genus *Paraspirifer* is unknown from the Detroit River Group, specimens of *P. acuminatus* are moderately abundant and characteristic of the upper Onondaga, upper Columbus, upper Jeffersonville, and middle Grand Tower Limestones (see Fig. 13) and are the oldest representatives of the genus in North America. Cooper, *et al.* (1942, p. 1775) have discussed the biostratigraphic significance of this genus and concluded that "the Onondaga appears to correlate with the Upper Coblenzian (*Emsian*) rather than with the Eifelian as hitherto claimed," (my italics). However, species

of *Paraspirifer* are widely distributed in Europe and North Africa in both the Upper Emsian and Lower Eifelian (Drot, 1964, pp. 56, 57). Thus, the presence of Eifelian ammonoids and conodonts in rocks containing *P. acuminatus* indicates rather conclusively that this genus did not reach North America until after its Emsian appearance in the Old World.

It has been amply demonstrated in the preceding section that the upper Detroit River, Onondaga, Columbus, and Jeffersonville are correlative. Therefore, the age of the upper Detroit River is Eifelian. The only remaining problem concerns the age of the Lower Detroit River. Are these rocks upper Emsian or lower Eifelian? Again, there is no direct faunal solution to this problem.

Evidence for correlation of the Amherstburg Dolomite and the Edgecliff Member of the Onondaga have also been discussed in the previous section. Oliver (1960, p. B174) has described the stratigraphic distribution of rugose corals in the Bois Blanc and Onondaga and concluded, "that the nearest faunal affinities of the corals and cephalopods from the Onondaga ... and its correlatives are with the Couvinian (early Middle Devonian) of Europe." On this basis the Amherstburg appears to be Eifelian.

Grant (1965, pp. 1, 29, 37) has noted that the genus *Atribonium* was the earliest representative of the Superfamily Stenoscismatacea. However, his age of earliest Middle Devonian for the base of superfamily and genus range zones merits some further discussion. In Eurasia *Atribonium transuralica* (Tschernyshev) occurs in Eifelian and Coblenzian (late Early Devonian) rocks (Khodalevitch, 1951, p. 60); in North America *A. halli* in the lower Detroit River seems to be the earliest representative. Therefore, if the genus appeared simultaneously in these two continents the age of the lower Detroit River is Coblenzian or Upper Emsian. Alternatively, *Atribonium* arose in Eurasia during the late Early Devonian and did not arrive in North America until early Middle Devonian.

The first representatives of the genus *Spinulicosta* in North America also occur in lower Detroit River rocks, e.g. *S. navicella* in the type Formosa Reef Limestone, whereas the earliest occurrence of the genus in Asia is Givetian (late Middle Devonian) according to Nalivkin (1937). Thus, the base of the *Spinulicosta* biozone in North America is considerably older than in Asia and cannot be used in correlation.

In summary, the precise location of the Early Devonian (Emsian) - Middle Devonian (Eifelian) boundary in the Michigan Basin and the adjacent platform is uncertain. It occurs somewhere above the Bois Blanc and correlative rocks (see Boucot and Johnson, 1968) and below the Nedrow Member of the Onondaga and its equivalents. Oliver (1960, p. B174) has placed it at the base of the Edgecliff Member but fails to give well-documented evidence to support his conclusion. If Oliver is correct, the boundary in the Michigan Basin is near the base of the Amherstburg Dolomite (or Sylvania Sandstone where this formation is present)

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APPENDIX I  
LOCALITY INDEX



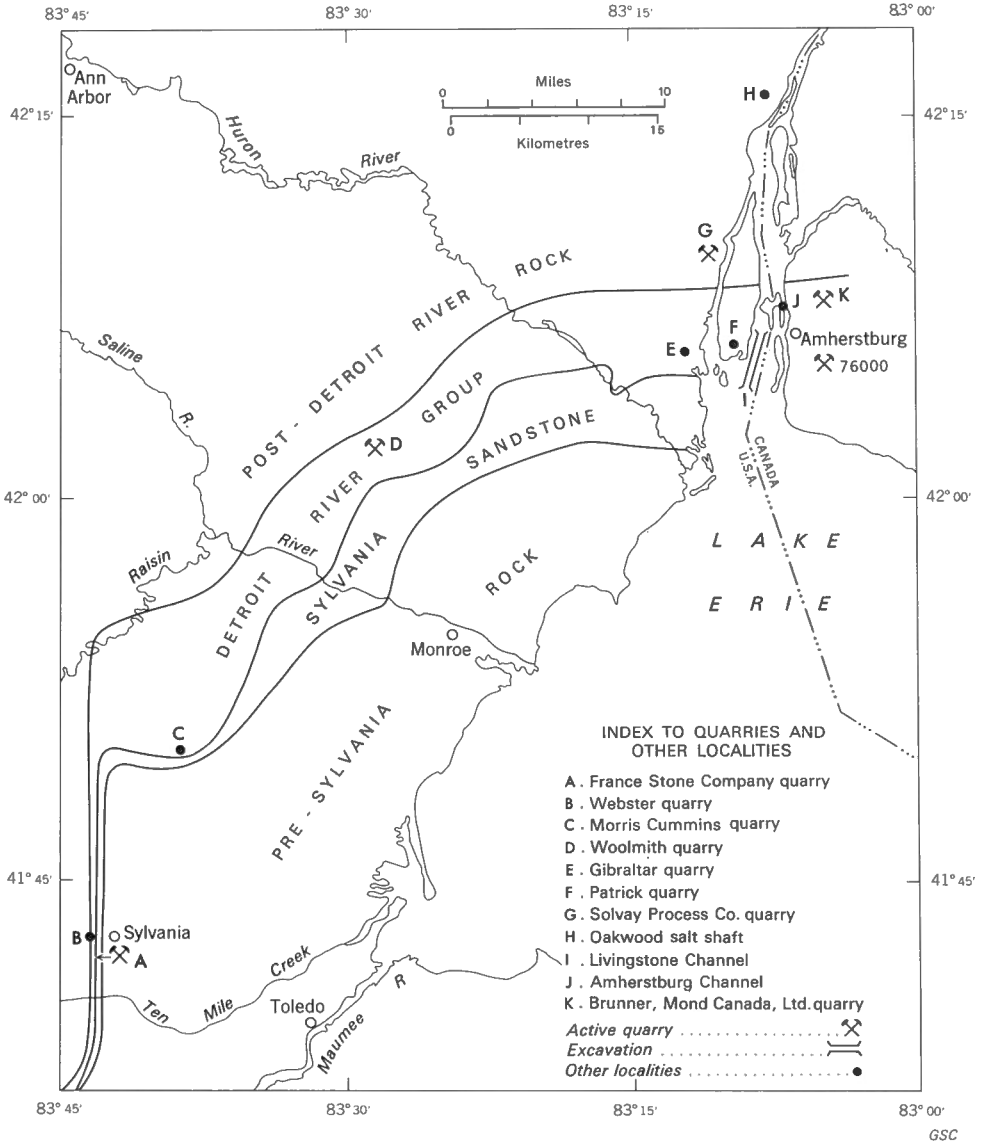


Figure 14. Locality index map.

### Introduction

The following list of locality descriptions includes only those exposures of strata of the Detroit River Group from which the fossil brachiopods described in the present report were collected. They are arranged by major outcrop areas from northwestern Ohio to southeastern Michigan, and then eastward into the peninsula of southwestern Ontario; the list contains no localities in northern Michigan or central Ohio. The assignment of arabic letters to the localities in Ohio and Michigan is arbitrary for the purposes of the present report; localities in Ontario have been assigned numerical designations by the Geological Survey of Canada and are on file in Ottawa.

#### I. Localities in northwestern Ohio

A. East and west quarries of the France Stone Company in the vicinity of Silica (about 2.5 miles southwest of Sylvania), Lucas Co., Ohio. Both quarries are large and the composite stratigraphic succession has been carefully described by Ehlers, Stumm, and Kesling (1951, pp. 4-7).

This is the general area of the type section of the Lucas Dolomite as defined by Prosser (1903, pp. 540-541); this is probably the "Silica quarry" referred to by Grabau and Sherzer (1910, p. 53).

B. "Webster quarry ... west of Sylvania, Ohio" (Grabau and Sherzer, 1910, p. 53). The writer inquired about the location of this quarry from O.D. Hawkey, quarry foreman of the France Stone Co. at Silica, Ohio and learned that Mr. Hawkey had never heard of the quarry since his arrival in the Sylvania area in 1926. However, he observed that there was a small quarry operated prior to 1926 located just east of Centennial Road and south of the present stone crusher. This may have been either the Webster quarry of Sherzer and Grabau or perhaps their "Silica quarry". The stratigraphy section at the Webster quarry is unknown.

#### II. Localities in southeastern Michigan

C. Morris Cummins quarry (= Little Sink quarry of Sherzer, 1900, pp. 88, 89), SE $\frac{1}{4}$ , sec. 2, T.8S., R.6E., Monroe Co., Mich. This is Locality 20 of LaRocque (1950, p. 341). The stratigraphic section has been described by Sherzer (1900, pp. 88, 89).

The quarry has been abandoned for many years and therefore is of very little geological significance at present.

D. Woolmith quarry, SE $\frac{1}{4}$ , sec. 29, T.5S., R.8E., Monroe Co., Mich. This is Locality 23 of LaRocque (1950, p. 342). The stratigraphic section has been described by Sherzer (1900, pp. 78-82).

The quarry was abandoned for many years and then reopened in 1958 by the Maumee Stone Co. Unfortunately, the writer has been unable to obtain permission to enter the quarry.

E. Gibraltar quarry, south-central part, sec. 35, T.4S, R.10E, Wayne Co., Mich. This is Locality 22 of LaRocque (1950, p. 342). The stratigraphic section was described by Grabau and Sherzer (1910, pp. 49, 51, 52).

This quarry has been abandoned for over 50 years and is filled with water. Locally it is known as Gibraltar Lake, and on U.S. Geol. Surv. maps it is designated as "Quarry Lake".

F. Patrick quarry in the southeast corner of Grosse Ile, within the property of the Grosse Ile Naval Air Station, Wayne Co., Mich. This is Locality 26 of LaRocque (1950, p. 342). The stratigraphic section was described by Sherzer and Grabau (1909, p. 543) and Grabau and Sherzer (1910, pp. 50, 51).

This quarry has been abandoned for over 60 years and is filled with water. It is designated as "Quarry Lake" on U.S. Geol. Surv. maps.

G. Solvay Process Co. quarry (= Sibley quarry of Grabau and Sherzer, 1910, p. 46), W $\frac{1}{2}$ , sec. 7, T.4S., R.11E., Wayne Co., Mich. The stratigraphic section was carefully described by Ehlers, Stumm, and Kesling (1951, pp. 14-17).

This extensive quarry has been abandoned for many years and is now owned by the Detroit Edison Co.

H. Oakwood salt shaft, International Salt Co., Fort and Sanders Streets, Detroit, Michigan. This is Locality A of Galloway and Ehlers (1960, p. 81). The stratigraphic succession was described by Sherzer (1913, Fig. 21, opposite p. 278) but the part above the Sylvania Sandstone is here revised as follows:

Rock-stratigraphic unit	Thickness (ft.)	Depth to base (ft.)
Drift	83	83
Dundee Limestone (the Anderdon Limestone may be present at base)	63	146
Lucas Dolomite	189	335
Amherstburg Dolomite (the upper 38 feet is the "coral bed" of Grabau and Sherzer, 1910)	85	420

This is the first of two shafts sunk at this location; excavation of the first shaft began in 1904 and ended in 1909 (Sherzer, 1913, pp. 279-280). Apparently W.H. Sherzer was the only geologist that examined the walls of the shaft.

### III. Locality in both southeastern Michigan and southwestern Ontario.

I. Livingstone Channel in the bed of the Detroit River about 1 mile west of Amherstburg, Ontario between Bois Blanc Island and the southern end of Grosse Ile. (See also discussion of Locality J).

The purpose for excavation of the Livingstone Channel was to provide a passage for deep-draft down-bound vessels through this approximately 12-mile-long segment of the Detroit River. Work began originally in 1908 and the channel was dry until about 1912 during which time it was excavated to an average depth of about 20 feet and a width of about 350-400 feet. It was again deepened "in the dry" between 1932 to 1935 and has subsequently been dredged "in the wet" several times. Geological interest in the channel has been centred on the northern end at the cut just east of Stony Island. At this locality a small anticline striking approximately NW-SE (G.M. Ehlers, pers. comm.) was exposed; the dip of the beds on the southwest limb is approximately 100 feet per mile (Stauffer, 1915, p. 281).

The stratigraphic succession exposed during excavation of the Stony Island cut was described by Nattress (1912, pp. 283-286), Stauffer (1915, pp. 280-285), and LaRocque (1950, p. 335): Toward the northern end of the cut strata correlative with the type Amherstburg Dolomite as defined by Sherzer and Grabau (1909, pp. 542, 543) were exposed. The rocks in the remaining part of the Stony Island cut, although lithologically and faunally distinct from

the type Amherstburg, were regarded as Amherstburg by early geologists visiting the channel. Thus, all the fossils described by Grabau and Sherzer (1910) from the channel were indicated as present in the Amherstburg Dolomite.

The fossils from the southern part of the Stony Island cut consist almost entirely of very unusual and endemic gastropods and *Prosserella lucasi*; all these forms are typical of rocks regarded as Lucas at both the Patrick (Locality F) and Gibraltar (Locality E) quarries and in the middle Lucas at the type locality southwest of Sylvania, Ohio (Locality A). Thus, it seems quite clear that these rocks should be regarded as Lucas. However, the problem of precisely placing the Amherstburg-Lucas contact cannot be solved on the basis of published data.

Although several geologists examined the rocks of the Stony Island cut, apparently the only measured section was made by Rev. Thomas Nattress of the Amherstburg (Nattress, 1912, pp. 284, 285; Stauffer, 1915, pp. 281, 282). The faunal succession in the cut may be summarized as follows:

(top of section)

"Zone of smaller gastropods"; also contains *Prosserella*, *Cladopora bifurcata*, "*Clathrodictyon ostiolatum*", "*Orthoceras*", and some larger gastropods.

Zone characterized by *Panenka canadensis*; also contains rare "*Orthoceras*", larger gastropods, and *Prosserella* sp.

"The Coral Zone"; contains branching, spreading, and cup-corals, *Conocardium*, "*Schuchertella*", "*Cyrtoceras*", "*Dawsonoceras*", and "*Loxonema*".

This sequence of faunal assemblages cannot be reconciled with the lithologic succession in the cut, e.g. unit 7 of Stauffer (1915, p. 281) includes both small gastropods and *Panenka canadensis*. Furthermore, Lane, Prosser, Sherzer, and Grabau (1909, pp. 555, 556) noted that *P. canadensis* was characteristic of the Amherstburg but this species is also present in the Lucas at the Gibraltar quarry (LaRocque, 1950). Nattress (1912, p. 284) indicated that the coral zone includes only four strata. If these are units 1-4 of Stauffer (1915, p. 282) the total thickness is about 16 feet 7 inches. In the opinion of the present author these beds are approximately equivalent to the type Amherstburg. However, G.M. Ehlers has visited the channel both in the early 1900s and in the 1930s when it was dry and remembers the coral-bearing beds as totalling only about ten feet (pers. comm.). This discrepancy in thickness cannot be resolved until the channel is again exposed for geological investigations.

In summary, the stratigraphic succession in the Livingstone Channel just east of Stony Island consists of about 100 feet (Stauffer, 1915, pp. 281, 282) of brown dolomite of which the lower 10-17 feet contain an abundant coral and mixed brachiopod faunal assemblage correlative with the type Amherstburg; the upper 85-90 feet contain a fauna dominated by gastropods and *Prosserella lucasi* correlative with the middle part of the type Lucas near Sylvania, Ohio (Locality A).

#### IV. Localities in southwestern Ontario

J. Amherstburg Channel in the Detroit River, immediately west of Amherstburg, Ontario and east of Bois Blanc Island and the Livingstone Channel (Locality I). In earlier reports this has been called the "eastern channel" (e.g. Sherzer and Grabau, 1909, p. 543) or the "Canadian channel" (e.g. Grabau and Sherzer, 1910, p. 48) and fossils from this locality were commonly described by Grabau and Sherzer (1910) as occurring "in the bed of the Detroit River, opposite Amherstburg, Ontario". This is the same as Locality 21 of LaRocque (1950, p. 341). (See also discussion of Locality I.)

Deepening of this channel to provide passage for up-bound, deep-draft vessels was begun at least as early as 1901 (Nattress, 1902, p. 127). Work in this channel has always been done "in the wet" and the loose blocks have been piled on the breakwater marking the western shore of the channel;

therefore, the stratigraphic succession in the bed of the river at this locality has never been exposed. Nonetheless, these dredged blocks originally constituted the "type section" of the Amherstburg Dolomite (Sherzer and Grabau, 1909, pp. 542, 543). In addition, a great many of the fossils described by Grabau and Sherzer (1910, pp. 48, 49) were collected by Rev. Thomas Nattress from these blocks (Sherzer and Grabau, 1909, p. 543).

The fauna obtained from these dredged rocks includes a wide variety of species, including several gastropods characteristic of the Lucas Dolomite; however, Grabau and Sherzer (1910) regarded the entire fauna as Amherstburg. The failure of these geologists to recognize the presence of two strikingly different lithological and faunal units in both the Amherstburg and Livingstone (Locality I) Channels has been the source of considerable subsequent biostratigraphic confusion. The policy adopted in the present report is to include all coelenterate-bearing rocks from either the Amherstburg Channel or the Livingstone Channel as derived from the Amherstburg Dolomite, and all gastropod-bearing rocks as Lucas. The stratigraphic occurrence of all other fossils is uncertain; they could have come from either of these formations or perhaps some species occur in both formations.

K. Brunner, Mond Canada, Ltd. quarry located about  $1\frac{1}{2}$  miles north-east of Amherstburg, Anderdon Tp., Essex Co., Ontario. This is the same locality as the "Anderdon quarry" of Sherzer and Grabau (1909, p. 542) and of Grabau and Sherzer (1910). This is a very large, active quarry and the stratigraphic section has been carefully described by Ehlers, Stumm, and Kesling (1951, pp. 11-13); it is also the type section of the Anderdon Limestone.

During the early 1900s, about 30 feet of the Anderdon were exposed in this quarry (Sherzer and Grabau, 1909, p. 542). Apparently, near the base of the formation a relatively small reef was exposed that yielded all of the fossils described by Grabau and Sherzer (1910, pp. 43, 44). Later quarrying operations have deepened and extended the quarry; as a result, this reef has been removed and a rather different sequence of uniformly bedded fine-grained limestones is presently exposed. These rocks contain an abundant stromatopoid, coral, and gastropod fauna. (See also Hewitt, 1960, pp. 164-167).

NOTE: Localities A-K constitute the type area for the rocks of the Detroit River Group and all of the fossil brachiopods described by Grabau and Sherzer (1910) were collected from these locations.

The following localities, all in southwestern Ontario, were established by various officers of the Geological Survey of Canada and are arranged in numerical order.

- 4368 Livingstone Channel dry cut. The precise location within the channel from which these specimens were collected is uncertain but they probably came from the general vicinity of Stony Island; therefore, this locality is approximately synonymous with Locality I.
- 4383 Southern end of Livingstone Channel. This locality is approximately synonymous with Locality I.
- 4517 Rock dump from dry cut; Detroit River at old railway crossing. This locality is approximately synonymous with Locality I.
- 4518 East side, Brunner, Mond Canada, Ltd. quarry. This locality is partially synonymous with Locality K.
- 4521 North 200 yards of rock dump from cut in Detroit River. This locality is approximately synonymous with Locality I.
- 11294 About 1,000 feet north of the bridge crossing the Teeswater River, one-third mile west of the village of Chepstow, Greenock Tp., Bruce Co., Ont. This segment of the river has been deepened by dredging and the rock piled mainly along the east bank. Consequently, the geologic

occurrence of fossil specimens from this locality is uncertain but the collections include material from both the cherty Bois Blanc Limestone and the Detroit River Group. (See Caley, 1943, p. 48.)

- 13357 Small, abandoned, partially water-filled quarry on an unnamed tributary of the Penetangore River approximately 2 miles east of Kincardine; Lots 11 and 12, Con. IS, Kincardine Tp., Bruce Co., Ont.
- 13362 Two concessions east of Kincardine, Ont.
- 13491 Just below falls on Teeswater River; Lot 4, Con. III, and Lot 4, Con. IV, Culross Tp., Bruce Co., Ont. This locality is approximately synonymous with locality (3) of Fagerstrom (1961b, p. 347).
- 13493 In creek valley one-half mile east on Kinloss - Huron Township line and one-fourth mile north of south boundary of Walkerton sheet, Bruce Co., Ont.
- 15002 Road cut in side of hill (in drift) on east of bridge over Teeswater River, one concession north of Chepstow, Greenock Tp., Bruce Co., Ont.
- 15110 Old quarry, north side of Trout Creek, 2 1/4 miles east of St. Marys, Downie Tp., Perth Co., Ont. (See Goudge, 1938, p. 274.)
- 15111 Outcrops in low ledges along shore of Lake Huron at McRae Point; Con. A, Kincardine Tp., Bruce Co., Ont.
- 15112 On Teeswater River below Teeswater Falls; Lot 4, Con. III, and Lot 4, Con. IV, Culross Tp., Bruce Co., Ont. This locality is approximately synonymous with locality (3) of Fagerstrom (1961b, p. 347).
- 15113 Abandoned quarry southwest of Beachville, Oxford Co., Ont.
- 15114 Large, active quarry of the Chemical Lime Ltd., approximately 1 1/2 miles northeast of Ingersoll, North Oxford Tp., Oxford Co., Ont. The stratigraphic section at this locality has been described briefly by Ehlers and Stumm (1951, p. 1881) and by Hewitt (1960, pp. 155-157).
- 15126 In field, 4 1/2 miles west of Teeswater, Bruce Co., Ont.
- 20879 Along the north face of Brunner, Mond Canada, Ltd. quarry about 1 1/4 miles northeast of Amherstburg, Essex Co., Ont. This locality is partially synonymous with Locality K.
- 20880 Northwest corner of Brunner, Mond Canada, Ltd. quarry about 1 1/4 miles northeast of Amherstburg, Essex Co., Ont. This locality is partially synonymous with Locality K.
- 22984 Northwest corner of large, active quarry of the Chemical Lime Ltd., approximately 1 1/2 miles northeast of Ingersoll, North Oxford Tp., Oxford Co., Ont. This locality is partially synonymous with GSC Locality 15114.
- 23536 Northeast corner of large active quarry of the North American Cyanamid Ltd. approximately 2 miles southwest of Beachville, North Oxford Tp., Oxford Co., Ont. This locality is partially synonymous with Locality 11 of Caley (1941, p. 52) who briefly described the stratigraphic section. (See also Hewitt, 1960, pp. 152-154.)
- 23541 Several small outcrops along west bank of the Maitland River, approximately 1 1/2 miles northeast of Wingham; Lot 20, Con. VIII, Turnberry Tp., Huron Co., Ont.
- 23551 North of Teeswater River; Lot A, Con. III, Culross Tp., Bruce Co., Ont.
- 23563 Approximately 150 feet below falls on Teeswater River. This locality is approximately synonymous with GSC Locality 13491.

- 23564 West end, large, active quarry of the Chemical Lime Ltd., quarry approximately  $1\frac{1}{2}$  miles northeast of Ingersoll, North Oxford Tp., Oxford Co., Ont. This locality is partially synonymous with GSC Locality 15114.
- 23566 Northwest corner of large, active quarry of the North American Cyanamid, Ltd., approximately 2 miles southwest of Beachville, North Oxford Tp., Oxford Co., Ont. This locality is partially synonymous with GSC Locality 23536.
- 23588 East end of outcrop on south bank of Maitland River, east edge of Goderich, Goderich Tp., Huron Co., Ont. This is approximately synonymous with Locality 5 of Stumm, Kellum, and Wright (1956, p. 16) who briefly described the stratigraphic section.
- 23616 East end of large, active quarry of the North American Cyanamid, Ltd., approximately 2 miles southwest of Beachville, North Oxford Tp., Oxford Co., Ont. This locality is partially synonymous with GSC Locality 23536.
- 23635 North end of road cut, approximately 2 1/2 miles north of Formosa, Ont. (See Locality 6 of Fagerstrom, 1961a, p. 4.)
- 23640 East end of a series of small outcrops in the bed of the Penetangore River, approximately  $2\frac{1}{2}$  miles southeast of Kincardine; Lots 9 and 10, Con. III, Kincardine Tp., Bruce Co., Ont.
- 23641 Middle part of outcrops described above in GSC Locality 23640.
- 23651 Old, abandoned quarry of the Standard White Lime Co., in St. Marys; Lot 16, Con. XVIII, Blanshard Tp., Perth Co., Ont. This locality is synonymous with Locality III of Caley (1943, p. 38). The stratigraphic section was briefly described by Goudge (1938, p. 274).
- 23654 Outcrop on west bank of Teeswater River, approximately 500 feet below the falls; Lot 4, Con. III, and Lot 4, Con. IV, Culross Tp., Bruce Co., Ont. This locality is approximately synonymous with GSC Locality 13491.
- 76000 Large, active quarry of Amherst Quarries Ltd. on Pike Road, approximately 1 1/2 miles southeast of Amherstburg; Lot 22, Con. III, Malden Tp., Essex Co., Ont. The stratigraphic section on the south wall of the quarry consists of approximately 35 feet of Lucas Dolomite overlain by 4 feet of the Anderdon Limestone. (See also Goudge, 1938, p. 219 and Hewitt, 1960, p. 168.)
- 76001 Large, active quarry of Canada Cement Co., Ltd., approximately  $3\frac{1}{2}$  miles south of the village of Embro; Lots 2 and 3, Con. III, West Zorra Tp., Oxford Co., Ont. The entire stratigraphic section consists of the Detroit River Group (undifferentiated) and has been briefly described by Hewitt (1960, pp. 159, 160).

APPENDIX II  
SPECIES OF *PROSSERELLA*  
RECOGNIZED BY GRABAU



APPENDIX II

SPECIES OF *PROSSERELLA* RECOGNIZED BY GRABAU

Grabau (*in* Grabau and Sherzer, 1910) originally subdivided the genus *Prosserella* into five species, two of which were further subdivided into what Grabau called "mutations" thus giving a total of seven named taxa of *Prosserella*. The International Code of Zoological Nomenclature (Stoll, *et al.*, 1961) makes no provision for the validity of such mutation names but authors subsequent to Grabau's original designations have treated his mutation names as subspecies; this practice will be followed in the present report. Grabau's original seven species and subspecies of *Prosserella* were based upon twenty-six type specimens plus an undetermined number of additional specimens examined by Grabau and included in his locality descriptions but not illustrated. All of the original types are deposited in the Museum of Paleontology, University of Michigan (UMMP) except for the only type specimen of *P. subtransversa alta* and a specimen of *P. planisinosus* from the Cobleskill Limestone of New York; both these specimens have apparently been lost.

The nature of the preservation of Grabau's types has created some problems in recognizing his taxa. Twelve of the specimens are internal molds (steinkerns) of the pedicle valve, one specimen is the exterior of a pedicle valve, three specimens are internal molds of the brachial valve, five specimens are exteriors of brachial valves, three specimens are internal molds of both valves joined, and one specimen is an exterior of both valves joined. The important points to be noted regarding the preservation of these specimens are: (1) the large number of pedicle steinkerns, (2) the small number of exteriors of either valve or of both valves joined, and (3) the small number of pedicle exteriors. The remarkably high proportion of separated pedicle valves is typical of most occurrences of *Prosserella*. Apparently the valves were not securely joined by well developed articulatory structures and so were easily separated after death by currents and scavengers. The reason for the scarcity of brachial valves is uncertain but may be partly due to the absence of internal supporting structures comparable to the well developed dental plates of the pedicle valve. Thus, the brachial valves may have been destroyed by crushing during compaction of the matrix whereas the associated pedicle valves resisted crushing.

Grabau described his species without due regard for differences in the mode of preservation of the specimens he considered conspecific. Thus, the types for several of his taxa consist entirely of isolated valves, both interiors and exteriors, collected from a variety of geographic and stratigraphic locations. Examination of several hundred specimens from many more localities than were available to Grabau, indicates that the morphologic variation in the species of *Prosserella* is far greater than he assumed. Therefore, the ability to predict which isolated valves are conspecific is severely limited and considerable doubt is cast on the validity of most of Grabau's taxa of *Prosserella*.

In the following discussion of the species and subspecies of *Prosserella* recognized by Grabau (*in* Grabau and Sherzer, 1910), the writer has sought to clarify the difficulties he encountered in attempting to establish the distinguishing features of each. Because of the drastic revision of each of Grabau's taxa in the present report, it was also necessary to compile the collection data for each of Grabau's type specimens (*see* Appendix I) and to revise the stratigraphic occurrence to agree with the arrangement described in the section entitled "Stratigraphy". Nearly all of the type specimens designated by Grabau are illustrated in the plates accompanying the present report.

The following information is presented for the benefit of future taxonomists in separating Grabau's conception of each taxon from the much simplified classification of *Prosserella* used by the writer.

I. *Prosserella modestoides* Grabau, 1910, pp. 139-141.

Grabau's type specimens: holotype (designated by Grabau) UMMP 14056, exterior of pedicle valve, Amherstburg Dolomite, Locality H, illustrated by Grabau, 1910, Pl. 16, figs. 22, 23; paratype UMMP 14037, exterior of brachial valve, Amherstburg Dolomite, Locality H, illustrated by Grabau, 1910, Pl. 16, fig. 20; paratype UMMP 14061, interior of pedicle valve, Amherstburg or Lucas Dolomite, Locality I, illustrated by Grabau, 1910, Pl. 21, figs. 28-30. Grabau also reported this species from the Amherstburg Dolomite, Locality F, but none of these specimens can now be recognized with certainty.

The chief difficulty in understanding this species is that each type specimen is an isolated valve and there is no assurance that the descriptions of the separate valves apply to the same species. Paratype UMMP 14061 is costate; the others are smooth.

Poor development of the fold and sulcus is characteristic of all three specimens, a feature noted by Grabau.

II. *Prosserella modestoides depressus* Grabau, 1910, pp. 141, 142.

Grabau's type specimens: syntype UMMP 14068, interior of pedicle valve, illustrated by Grabau, 1910, Pl. 21, fig. 33; syntype UMMP 14065, internal mold of both valves joined, illustrated by Grabau, 1910, Pl. 21, figs. 24, 25; syntype UMMP 23853, interior of pedicle valve, illustrated by Grabau, 1910, Pl. 21, fig. 26; syntype UMMP 23854, interior of pedicle valve, illustrated by Grabau, 1910, Pl. 21, figs. 31, 32. All type specimens are from either the Amherstburg or Lucas Dolomite, Locality I.

The fold is very well developed and the sulcus nearly imperceptible on UMMP 14065; the other three types have a shallow, but rather well-defined sulcus. Low, rounded costae are present on UMMP 14068 and 23853 whereas UMMP 14065 and 23854 are smooth. None of the features described by Grabau is restricted to or especially well developed in Grabau's type specimens but instead fall within the normal range of variation of all specimens from the type region of the Detroit River Group.

III. *Prosserella lucasi* Grabau, 1910, pp. 142, 143.

Grabau's type specimens: syntype UMMP 14005, interior of pedicle valve, Lucas Dolomite, Locality H, illustrated by Grabau, 1910, Pl. 16, fig. 21; syntype UMMP 14006, interior of pedicle valve, Lucas Dolomite, Locality B, illustrated by Grabau, 1910, Pl. 19, fig. 2; syntype UMMP 14007, mold of exterior of brachial valve, Lucas Dolomite, Locality B, illustrated by Grabau, 1910, Pl. 19, fig. 3; syntype UMMP 14008, interior of pedicle valve, Lucas Dolomite, Locality F, illustrated by Grabau, 1910, Pl. 21, fig. 23. Grabau also reported this species from the Lucas at Locality D and from the Anderdon Limestone at Locality K but none of these specimens can be recognized.

The problem in understanding this species is whether the isolated brachial valve is conspecific with the three isolated pedicle valves. Furthermore, each of the pedicle valves is from a different locality. All of the specimens are smooth except for UMMP 14007 which has low, rounded costae.

IV. *Prosserella subtransversa* Grabau, 1910, pp. 143-145.

Grabau's type specimens: syntype UMMP 13077, a mold of the exterior of the brachial valve and the posterolateral portion of the attached pedicle valve, Lucas Dolomite, Locality F, illustrated by Grabau, 1910, Pl. 19, fig. 1; syntype UMMP 13111, an unidentifiable plaster cast of the interior of a brachial valve (the original specimen has apparently been lost), Amherstburg or Lucas Dolomite, Locality I or J, illustrated by Grabau, 1910, Pl. 18, fig. 9; syntype UMMP 13113, an unidentifiable plaster cast of exterior umbonal regions of both valves (the original specimen has apparently been lost), Amherstburg Dolomite, Locality I or J, illustrated by Grabau, 1910, Pl. 19, fig. 13; syntype UMMP 14010A, interior of brachial valve, Lucas Dolomite, Locality E, illustrated by Grabau, 1910, Pl. 21, fig. 27, Pl. 19, fig. 12; syntype UMMP 14013A, mold of exterior of brachial valve and umbo of attached pedicle valve, Lucas Dolomite, Locality E, illustrated by Grabau, 1910, Pl. 18, fig. 7; syntype UMMP 14070, interior of pedicle valve, Amherstburg Dolomite, Locality D, illustrated by

Grabau, 1910, Pl. 19, fig. 4; syntype UMMP 14071, internal mold of both valves joined, Amherstburg Dolomite, Locality D, illustrated by Grabau, 1910, Pl. 19, figs. 7, 8; syntype UMMP 14072, internal mold of both valves joined, Amherstburg Dolomite, Locality D, illustrated by Grabau, 1910, Pl. 19, figs. 5, 6. Grabau also reported this species from the Lucas at Locality H and from the same formation at Silica, Ohio (probably Locality B) but none of these specimens can be recognized with certainty.

The chief characteristic of this species is the greater than normal width, especially for the brachial valve. All the other characters are extremely variable, i.e. the valves may be smooth or costate and the fold and sulcus may be well developed or absent.

V. *Prosserella subtransversa alta* Grabau, 1910, pp. 145-147.

Grabau's type specimen: the holotype (designated by Grabau) was illustrated by Grabau, 1910, Pl. 18, fig. 10 but has apparently been lost.

Grabau (1910, p. 146) also mentioned some additional forms of *Prosserella subtransversa* and referred to them as mutations X and B illustrated on Plate 13, an obvious printing error. However, in the explanation of Plate 19 he referred figure 4 to *P. subtransversa* mut. A and figures 5 and 6 to *P. subtransversa* mut. B. In view of the loss of the holotype of *P. subtransversa alta* and the confusion of the forms referred to on page 146 and the explanation of Plate 19, all these forms are here considered unidentifiable.

VI. *Prosserella unilamellosus* Grabau, 1910, pp. 146, 147.

Grabau's type specimens: syntype UMMP 14081, interior of pedicle valve and umbo of attached brachial valve, illustrated by Grabau, 1910, Pl. 19, fig. 11; syntype UMMP 14084, interior of a very small pedicle valve, illustrated by Grabau, 1910, Pl. 19, figs. 9, 10. Both specimens from the Lucas Dolomite, Locality F.

Grabau (1910, p. 146) described the dental plates as "uniting into a spondylium, the union being close to the shell but far enough away to allow the formation of a very low, single median septum". Examination of the type specimens by the present author indicates that the dental plates actually join in only one specimen (UMMP 14081) and that the junction is so near the floor of the valve that the presence of a discrete supporting median septum is highly unlikely. In the other specimen (UMMP 14084) the dental plates remain separate throughout their length. The other characters noted by Grabau fall within the range of variation of specimens of *Prosserella* from the type region of the Detroit River Group.

VII. *Prosserella planisinosus* Grabau, 1910, pp. 147, 148.

Grabau's type specimens: holotype (designated by Grabau) UMMP 13103, interior of pedicle valve, Lucas Dolomite, Locality H, illustrated by Grabau, 1910, Pl. 16, fig. 26; paratype UMMP 13104, an unidentifiable mold of exterior of brachial valve, Lucas Dolomite, Locality H, the costate specimen described by Grabau (1910, p. 147) but not illustrated; paratype UMMP 13106, interior of brachial valve, Lucas Dolomite, Locality H, illustrated by Grabau, 1910, Pl. 16, fig. 19. Grabau also illustrated, under the name *P. planisinosus*, a specimen (probably the exterior of a brachial valve) from the Cobleskill Limestone of New York on Plate 18, figure 8. The specimen has apparently been lost but the locality data indicate that Grabau's identification must certainly be erroneous; the Cobleskill is of Silurian age.

Grabau's description of this species was based primarily on one pedicle valve (the holotype). His brief remarks on the brachial valve were based on smaller specimens found associated with, but not joined to the holotype. Thus, there is no assurance that these specimens are all conspecific.

The original description stressed the form of the fold and sulcus. The sulcus in the holotype is very poorly defined and shallow and the fold in UMMP 13106 is low, flattened, and sharply defined. These features also fall within the range of variation of specimens of *Prosserella* from the type region of the Detroit River Group.

PLATES I-VIII

PLATE I

Figures 1-2: *Dalejina alsa* (Hall)

1. Rubber impression of interior of brachial valve (X1). Bois Blanc Limestone, Loc. 11294. Hypotype, GSC 22971.
2. Internal marginal crenulations of pedicle valve (X3). Note the median groove and rectangular cross-section of each crenulation. Bois Blanc Limestone, Loc. 11294. Hypotype, GSC 22972.

Figure 3: *Dalejina* (?) sp.

Exterior of (?) pedicle valve showing radial ornamentation and shallow sulcus (X2). Figured specimen, GSC 22973.

Figures 4-5: *Dalejina intermedia* (Stauffer)

4. Rubber impression of interior of pedicle valve (X1). Holotype, UM 4839a.
5. Internal marginal crenulations of pedicle valve (X3). Note the median groove and the rectangular cross-section of most of the crenulations. Same specimen as Fig. 4.

Figure 6: *Schiaophoria prima* Stauffer

Ventral view of steinkern of pedicle valve (X2). Hypotype, GSC 22969.

Figures 7-10: *Rhipidomella* sp.

7. Anterior view of steinkern showing broadly uniplicate anterior commissure (X1). Figured specimen, GSC 22992.
8. Dorsal view showing brachiophores, radial ornamentation, and internal marginal crenulations (X1). Same specimen as Fig. 7.
9. Lateral internal marginal crenulations (X3). Note the absence of grooves and the rounded cross-section of the crenulations. Figured specimen, GSC 22975.
10. Anterior internal marginal crenulations (X3). Same specimen as Fig. 9.

Figures 11-13: "*Schuchertella*" sp. cf. "*S.*" *amherstburgense* Grabau

11. Posterior view of interarea of steinkern of pedicle valve (X2). Note the closed delthyrium with thickened margins. Figured specimen, UMP 56626.
12. Ventral view of same specimen as Fig. 11 (X2).
13. Mold of exterior showing bifurcation and intercalation of costae (X4). Figured specimen, GSC 23000.

Figure 14: "*Schuchertella*" *amherstburgense* Grabau

Ventral view of broken steinkern of pedicle valve (X4). Note that all costae appear to arise by intercalation. Neotype, UMP 56625.

Figure 15: "*Schuchertella*" *varicostata* Fagerstrom

Exterior of pedicle valve showing variable prominence and intercalation of costae (X4). Hypotype, GSC 22995.

Figures 16-17: "*Schuchertella*" sp.

16. Partially exfoliated pedicle valve (X1). Figured specimen, UMP 56627.
17. Detail of ornamentation (X3). Same specimen as Fig. 16.

Figure 18: *Spinulicosta navicella* (Hall)

Exterior of pedicle valve (X2). Note small attachment cicatrix in umbonal region. Hypotype, GSC 23001.

Figures 19-20: *Gypicula* (?) sp.

19. Ventral view of steinkern of pedicle valve showing subdued, impersistent costae and short median septum (X1). Figured specimen, GSC 23004.
20. Dorsal view of same specimen as Fig. 19 (X1). Note long interarea, narrow delthyrium, and thin median septum.

Figures 21-23: *Pentamerella papilionensis* (Hall)

21. Anterior view of smooth (?) immature specimen with broadly uniplicate commissure (X2). Hypotype, UMP 56633.
22. Dorsal view of same specimen as Fig. 21 (X2). Note that the beaks of both valves have been scraped to reveal internal structures.
23. Dorsal view of steinkern of brachial valve (X1). Note the long cruralium resting on the floor of the valve and the apparent absence of costae. Hypotype, GSC 23006.

Figure 24: ? *Pentamerella arata* (Conrad)

Clay impression of a (?) brachial valve showing variable prominence of the costae and their addition by intercalation (X1). Figured specimen, GSC 23005.

Figures 25-26: *Pentamerella arata* (Conrad)

25. Dorsal view of steinkern of brachial valve (X1). Note the long cruralium and the short, prominent costae. Hypotype, UMP 56629.
26. Oblique posterior view of same specimen as Fig. 25 (X2). Note that the cruralium rests on the floor of the valve and extends posteriorly to the beak.

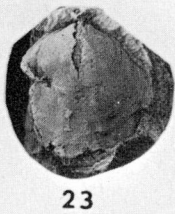
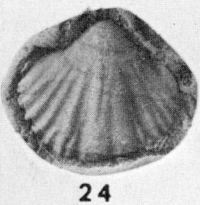
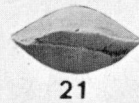
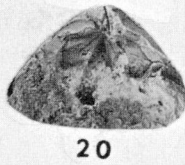
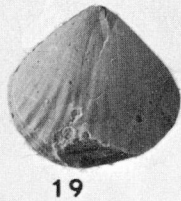
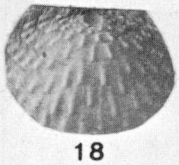
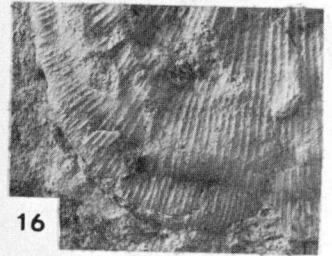
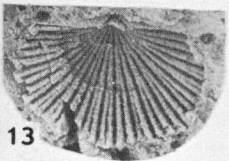
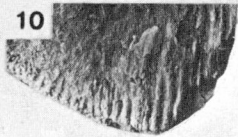
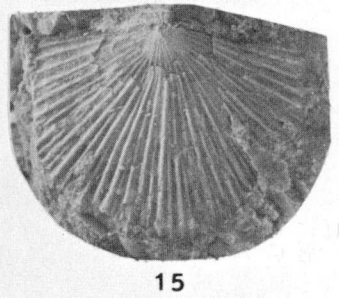
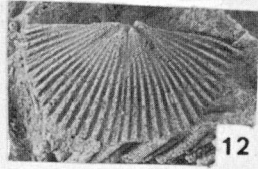
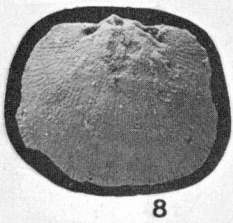
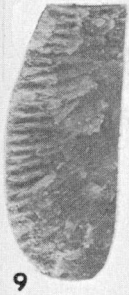
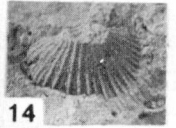
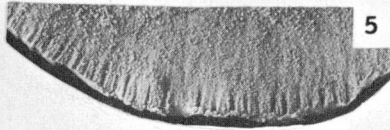
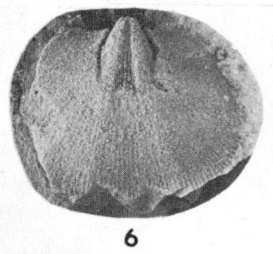
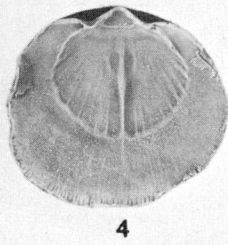
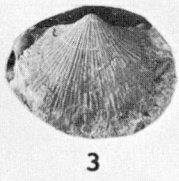
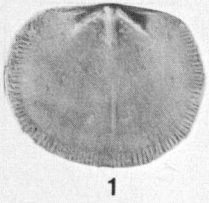


PLATE II

Figures 1-7: *Strophodonta (S.) homolostrata* Grabau

1. Mold of exterior showing ornamentation (X2). Neotype, GSC 22976.
2. Detail of umbonal region showing addition of costae by intercalation and bifurcation (X4). Same specimen as Fig. 1.
3. Dorsal view of steinkern (X2). Note the well developed bilobed cardinal process and adductor muscle field bounded posterolaterally by bean-shaped depressions. Hypotype, GSC 22978.
4. Rubber impression of steinkern of brachial valve with broad, low marginal crenulations (X2). Hypotype, GSC 22997.
5. Rubber impression of steinkern of pedicle valve showing denticulate hinge, flabellate muscle field, and paired lateral cavities (X1). Hypotype, UMMP 56622.
6. Ventral view of steinkern of pedicle valve showing details of muscle field (X1). Hypotype, UMMP 56621.
7. Posterior view of same specimen as Fig. 6 (X2). Note cavity formed by broadly transverse ventral process with paired secondary teeth and large delthyrial chamber leading anteriorly into deeply impressed diductor tracks.

Figures 8-11: *Megastrophia (M.) proxioostellata* Fagerstrom

8. Steinkern of pedicle valve showing impersistent primary costae along anterior margin (X1). Hypotype, ROM 22439.
9. Oblique lateral view of same specimen as Fig. 8 showing primary costae and well developed branching vascular markings along lateral margin (X1).
10. Rubber impression of pedicle valve showing ventral process and denticulate hinge (X2). Hypotype, GSC 22982.
11. Steinkern of brachial valve with moderately persistent primary costae (X1). Hypotype, GSC 22981.

Figures 12-15: *Megastrophia (M.) inequiradiata* (Hall)

12. Posterior view of steinkern of pedicle valve (X1). Note cavity formed by broadly transverse ventral process. Hypotype, GSC 22986.
13. Ventral view of same specimen as Fig. 12 (X1).
14. Ventral view of pedicle valve (X1). Hypotype, GSC 22987.
15. Detail of ornamentation on same specimen as Fig. 14 (X3).

Figures 16-17: *Megastrophia* sp. A

16. Lateral view of steinkern of brachial valve showing anterior geniculation (X1). Figured specimen, GSC 22988.
17. Dorsal view of same specimen as Fig. 16 (X1). Note impersistent impressions of some primary costae.

Figures 18-20: *Megastrophia* (?) sp.

18. Ventral view of partially exfoliated pedicle valve (X1). Note anterior extensions of adductor tracks and posteromedian depression. Figured specimen, GSC 22989.
19. Posterior view of same specimen as Fig. 18 (X1). Note the very small, narrow cavity for the ventral process, large depressions for the cardinal process lobes, and the well defined ridges marking the posterolateral margins of the muscle field.
20. Lateral view of same specimen as Fig. 18 (X1). Note the deeply concave profile of the steinkern and the ridge marking the margin of the muscle field.

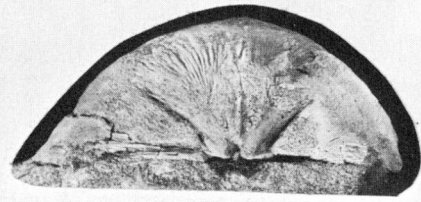
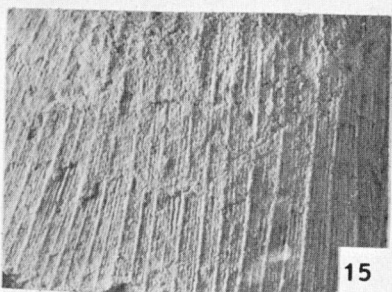
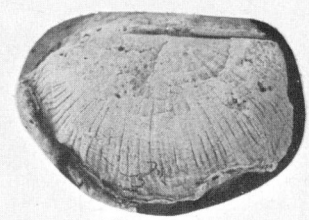
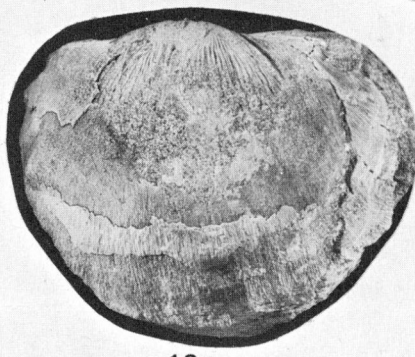
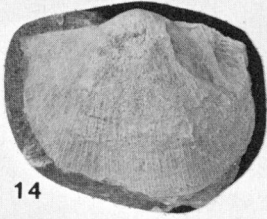
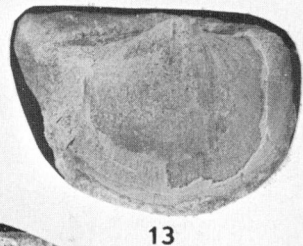
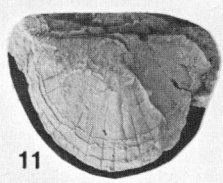
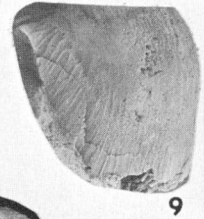
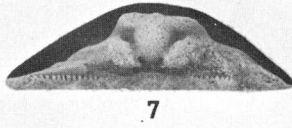
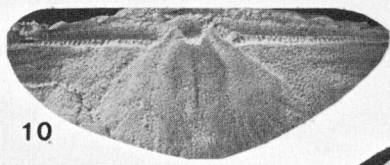
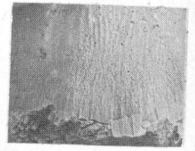
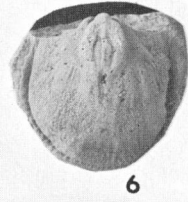
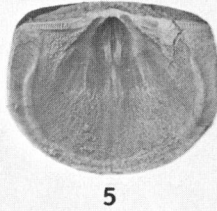
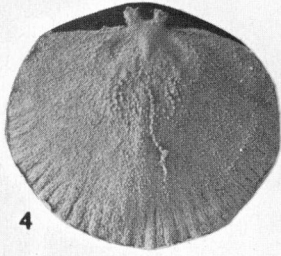
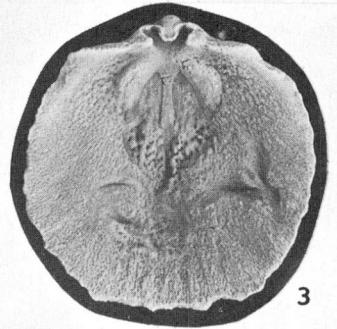
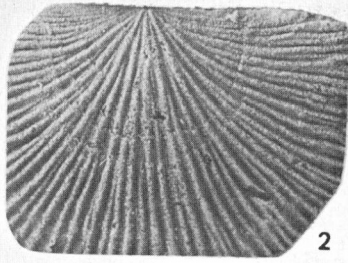
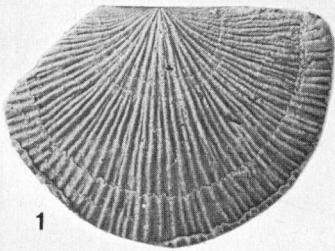




PLATE III

Figures 1-2: *Cupularostrum* (?) *tethys* (Billings)

1. Posterior view of steinkern (X3). Note that the brachial valve has been slightly crushed and the very small septalium. Hypotype, UMMP 56634.
2. Ventral view of same specimen as Fig. 1 (X2). Note the laterally curving dental plates.

Figures 3-12: *Camazotoechia* (?) *ehlersi* n. sp.

3. Dorsal view of nearly complete specimen showing short median septum (X2). Paratype, UMMP 56670.
4. Posterior view of same specimen as Fig. 3 (X2).
5. Anterior view of same specimen as Fig. 3 (X2).
6. Dorsal view of nearly complete specimen with typical costation (X2). Holotype, UMMP 56636.
7. Lateral view of same specimen as Fig. 6 (X2).
8. Anterior view of same specimen as Fig. 6 (X2).
9. Ventral view of nearly complete specimen (X2). Paratype, UMMP 56638.
10. Anterior view of specimen with well developed costation (X2). Paratype, UMMP 56637.
11. Anterior view of smooth specimen with well defined fold and sulcus (X2). Paratype, UMMP 56639.
12. Dorsal view of same specimen as Fig. 11 (X2).

Figures 13-16: *Crurithyris* (?) sp.

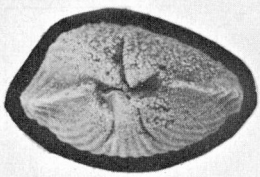
13. Posterior view of specimen with broken pedicle umbo (X4). Note the long, narrow interarea, prominent beak ridges, and strongly convex pseudodeltidium. Figured specimen, GSC 23049.
14. Anterior view of same specimen as Fig. 13 (X4). Note the opposite folding and the slightly sulcate anterior commissure.
15. Dorsal view of same specimen as Fig. 13 (X4).
16. Lateral view of same specimen as Fig. 13 (X4).

Figures 17-19: *Ambocoelia* (?) sp.

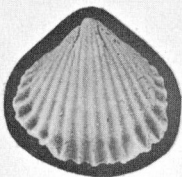
17. Anterior view of specimen with broken pedicle umbo (X4). Note the broadly uniplicate anterior commissure. Figured specimen, UMMP 56706.
18. Dorsal view of same specimen as Fig. 17 (X4 1/2).
19. Lateral view of same specimen as Fig. 17 (X4). Note that the pedicle valve is considerably deeper than the brachial valve.

Figures 20-29: *Atrypa* spp.

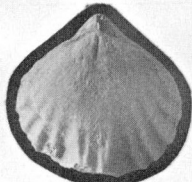
20. Rubber impression of external ornamentation of brachial valve (X1). The pattern is typical of *A. "reticularis"*. Figured specimen, GSC 23022.
21. Ventral view of steinkern showing depressed muscle field and irregularly arranged pits on interior of pedicle valve (X1). Figured specimen, GSC 23021.
22. Dorsal view of same specimen as Fig. 21 (X1). Note the depressed adductor scars separated by a broad ridge and the irregularly arranged pits on the interior of the brachial valve.
23. Anterior view of same specimen as Fig. 21 (X1).
24. Posterior view of steinkern (X3). Note the very narrow sockets and that both valves are shallow. Figured specimen, UMMP 56671.
25. Dorsal view of same specimen as Fig. 24 (X3). Note the posteromedial ridge and the broad, low costae.
26. Dorsal view of a steinkern with short marginal costae (X1). Figured specimen, GSC 23025.
27. Dorsal view of rubber impression of interior of brachial valve (X1). Note the prominent costae that persist to the beak. Figured specimen, GSC 23024.
28. Detail of cardinalia of the same specimen as Fig. 27 (X4). Note the shallow, flat-floored sockets and the weak socket ridges.
29. Exterior of (?) brachial valve showing well developed, rounded costae probably persistent to beak (X1). Figured specimen, GSC 23023.



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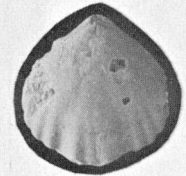
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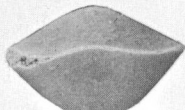
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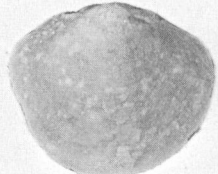
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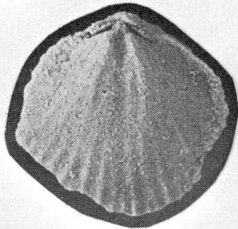
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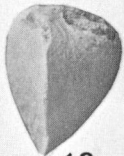
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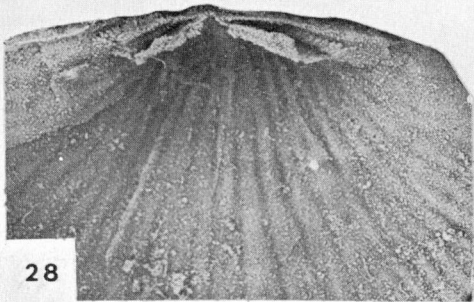
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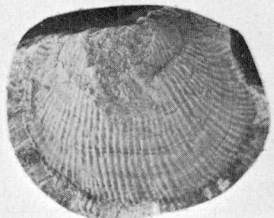
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PLATE IV

Figure 1: *Meristina nasuta* (Conrad)

Ventral view of steinkern of pedicle valve (X1). Note the short dental plates and the narrow, raised, striate muscle field bounded laterally by the anterior extensions of the dental plates which appear as thickened margins of the muscle field. Hypotype, GSC 23031.

Figure 2: *Meristina* sp.

Ventral view of steinkern of pedicle valve (X1). Note the very short dental plates and narrow, longitudinally striate muscle field. Figured specimen, UMP 13071B.

Figures 3-6: *Meristina formosensis* (Fagerstrom)

3. Posterior view of steinkern (X2). Note the small, shallow septalium supported by a thin, high median septum and the laterally convex dental plates nearly tangent to the floor of the valve. Hypotype, GSC 23032.
4. Dorsal view of same specimen as Fig. 3 (X1).
5. Anterior view of same specimen as Fig. 3 (X1).
6. Ventral view of deformed steinkern (X2). Note the well developed, ventrally convergent dental plates and the elevated (thickened), longitudinally striate muscle field not bounded by the dental plates. Hypotype, GSC 23033.

Figure 7: *Meristina barrisi* (Hall)

Ventral view of steinkern of pedicle valve with short, laterally convex dental plates (X1). Hypotype, UMP 56673.

Figures 8-11: *Meristella* (?) *livingstonensis* n. sp.

8. Dorsal view of deformed steinkern (X1). The posterior end of the filling of the chamber beneath the cardinal plate is broken to reveal the narrow notothyrial chamber. Holotype, GSC 23034.
9. Ventral view of same specimen as Fig. 8 (X1). Note the short, laterally convex dental plates.
10. Anterior view of same specimen as Fig. 8 (X1). Note the rectimarginate anterior commissure, an unusual feature among meristelloid brachiopods.
11. Posterior view of same specimen as Fig. 8 (X2). Note (a) the ventrally convex cardinal plate supported by laterally divergent plates, (b) the pair of medially convergent plates attached to the cardinal plate and laterally defining the notothyrial chamber, and (c) the laterally convex dental plates nearly tangent to the floor of the valve.

Figures 12-13: *Meristospira michiganense* Grabau

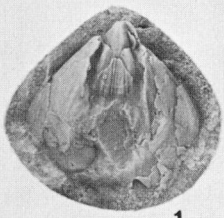
12. Dorsal view of incomplete steinkern (X3). Note that the valves appear to be smooth. Figured specimen, UMP 56675.
13. Oblique posterior view (pedicle valve above) of same specimen as Fig. 12 (X3). Note the short dental plates and what appears to be a free cardinal plate.

Figures 14-22: *Meristospira michiganense* Grabau

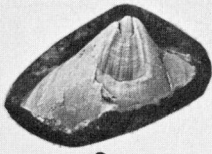
14. Ventral view of steinkern (X3). Note the short, anteriorly convergent dental plates and the radial depressions (? vascular markings). Syntype, UMP 14079.
15. Lateral view of same specimen as Fig. 14 (X3).
16. Posterior view of same specimen as Fig. 14 (X3). Note the prominent delthyrial chamber and the myophragm in the brachial valve.
17. Anterior view of same specimen as Fig. 14 (X3).
18. Ventral view of steinkern (X3). Syntype, UMP 14078.
19. Dorsal view of same specimen as Fig. 18 (X3). Note the myophragm and radial depressions (? vascular markings) on the floor of the valve.
20. Lateral view of same specimen as Fig. 18 (X3).
21. Posterior view of same specimen as Fig. 18 (X3).
22. Anterior view of same specimen as Fig. 18 (X3). Compare shape of anterior commissure with Fig. 17.

Figures 23-26: *Craena boucoti* n. sp.

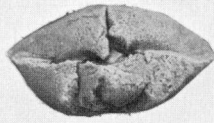
23. Ventral view of steinkern (X2). Note the short, divergent dental plates, the longitudinally striate muscle tracks, and the very weak myophragm. Holotype, GSC 23078.
24. Posterior view of same specimen as Fig. 23 (X2). Note the permesothyridid foramen and pedicle collar around the ventral margin.
25. Dorsal view of same specimen as Fig. 23 (X2). Note the thickened delthyrial margins, conjunct deltidial plates, and myophragm.
26. Ventral view of steinkern (X2). The specimen has been scraped to show the form of the dental plates and the media. Paratype, GSC 23081.



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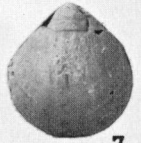
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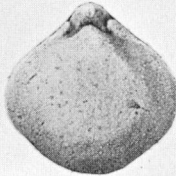
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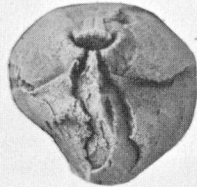
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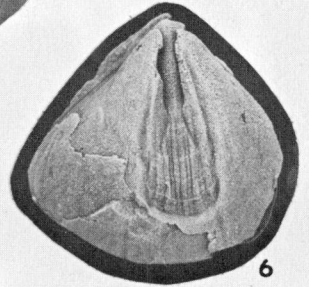
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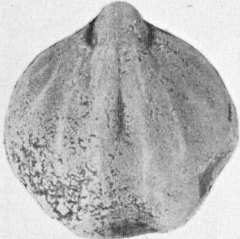
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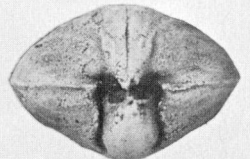
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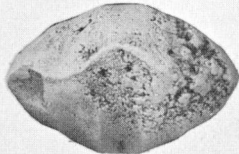
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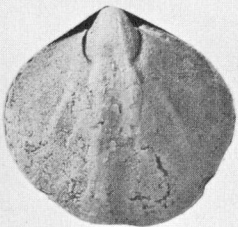
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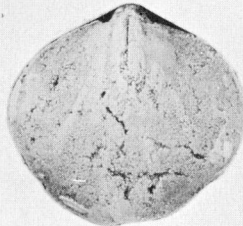
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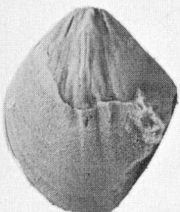
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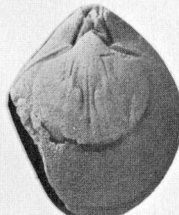
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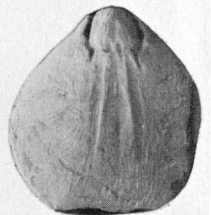
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PLATE V

Figures 1-3: *Pimbrispirifer divaricatus* (Hall)

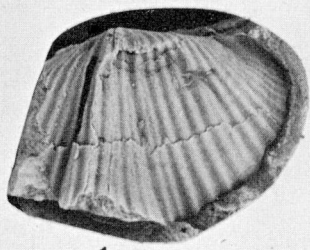
1. Dorsal view of steinkern of brachial valve (X1). Hypotype, GSC 23074.
2. Posterior view of same specimen as Fig. 1 (X2). Note vertically striate diductor attachment area, well developed short crural plates, and short myophragm.
3. Slightly oblique posterior view of steinkern of brachial valve showing (a) long, narrow sockets almost parallel to hinge line, (b) well developed inner socket ridges and crural plates, and (c) myophragm (X2). Hypotype, GSC 23075.

Figures 4-6: *Brachyspirifer* (?) *manni* (Hall)

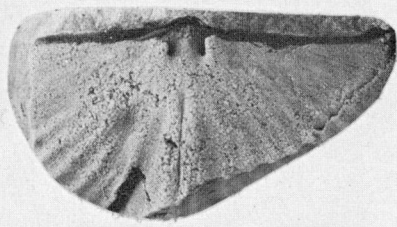
4. Lateral view of pedicle valve showing the long, concave interarea (X1). Hypotype, GSC 23072.
5. Ventral view of same specimen as Fig. 4 (X1). Note the smoothly rounded sulcus.
6. Dorsal view of interarea of same specimen as Fig. 4 (X1). The delthyrium is relatively long, narrow, and apparently open.

Figures 7-14: *Aerospirifer* (?) *macrothyris* (Hall)

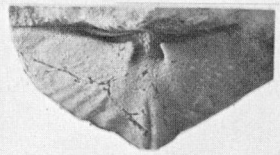
7. Ventral view of pedicle valve (X1). Note convex anterolateral margins and relatively narrow sulcus. Grand Tower Limestone, near Grand Tower, Illinois. Hypotype, USNM 157839.
8. Ventral view of rubber impression of brachial valve showing large, anterolaterally flaring sockets (X1). Anderdon Limestone, Loc. 20879. Hypotype, GSC 23050.
9. Dorsal view of nearly complete specimen with very low costae (X1). Columbus Limestone, Marion, Ohio. Hypotype, USNM 157838.
10. Ventral view of partially exfoliated pedicle valve with low, rounded costae, slightly mucronate cardinal extremities, and large, deeply impressed, anteriorly striate diductor scar (X1). Grand Tower Limestone, near Grand Tower, Illinois. Hypotype, USNM 157840.
11. Posterior view of partially exfoliated specimen showing long, trapezoidal interarea and deeply impressed muscle field in pedicle valve (X1). Onondaga Limestone (probably the Edgecliff Member), Williamsville, New York. This specimen was also illustrated by Hall (1867, Pl. 30, figs. 18, 20). Syntype, AMNH 3060/1.
12. Ventral view of partially exfoliated, (?) gerontic pedicle valve with very large, deeply impressed, and radially striate to corrugated diductor scars (X1). Columbus Limestone, Marion, Ohio. Hypotype, USNM 36610.
13. Dorsal view of partially exfoliated brachial valve (X1). Note the concave anterolateral margins and slightly mucronate cardinal extremities. Anderdon Limestone, Loc. 20879. Hypotype, GSC 23051.
14. Anterior view of same specimen as Fig. 13 (X1). Note the high, subacuminate fold and concave flanks.



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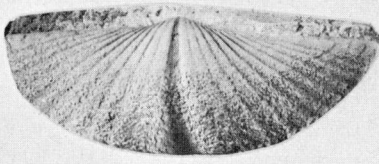
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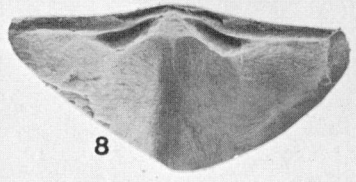
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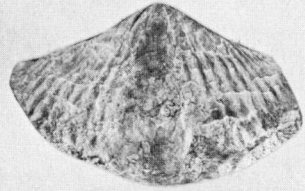
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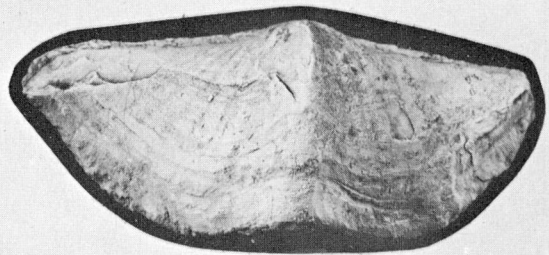
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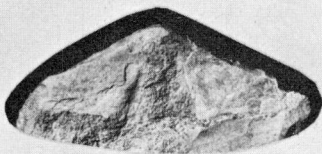
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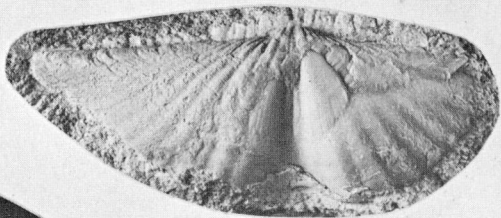
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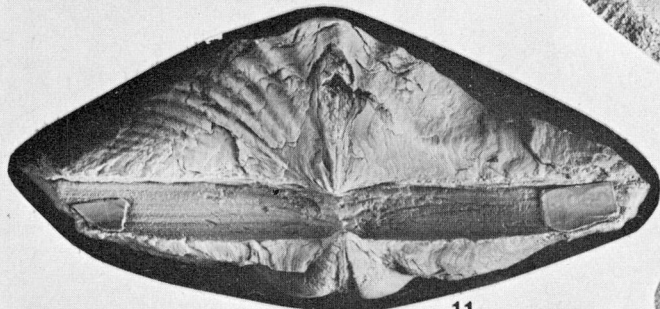
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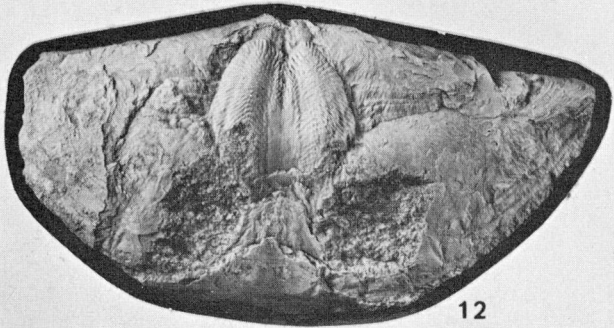
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PLATE VI

Figures 1-19: *Prossarella modestoides* Grabau, smooth morphotype

1. Dorsal view of brachial valve with subdued radial striations (not costae) around anterolateral margin (X3). Paratype, UMMP 14037.
2. Ventral view of pedicle valve (X1). Note the very narrow and shallow sulcus. Holotype, UMMP 14056.
3. Lateral view of same specimen as Fig. 2 (X1).
4. Anterior view of same specimen as Fig. 2 (X1). Anterior commissure has been broken.
5. Oblique dorsal view of steinkern of brachial valve showing well developed cardinal process, short crural plates, and myophragm (X4). Hypotype, GSC 23086.
6. Posterior view of steinkern (X2). Note thickened delthyrial margins. Hypotype, UMMP 14072.
7. Lateral view of same specimen as Fig. 6 (X2).
8. Anterior view of same specimen as Fig. 6 (X2).
9. Ventral view of same specimen as Fig. 6 (X2).
10. Dorsal view of same specimen as Fig. 6 (X2).
11. Dorsal view of nearly complete specimen (X3). Note very fine radial striations (not costae) and more prominent growth lines. Hypotype, GSC 23082.
12. Lateral view of same specimen as Fig. 11 (X3).
13. Posterior view of same specimen as Fig. 11 (X3). Note very narrow sulcus in pedicle valve extending to the beak.
14. Ventral view of steinkern of pedicle valve (X3). Note the anteriorly diverging dental plates separated by a myophragm. Hypotype, GSC 23085.
15. Ventral view of steinkern of pedicle valve broken parallel to commissure showing internal arrangement of dental plates (X2). Hypotype, GSC 23084.
16. Ventral view of steinkern of pedicle valve (X5). Note anteriorly converging dental plates that fail to join. Hypotype, UMMP 14084.
17. Posterior view of same specimen as Fig. 16 (X5). Note ventral convergence of dental plates that fail to join.
18. Oblique posterior view of incomplete steinkern (X2). The filling of the delthyrial chamber is missing and the fillings of the umbonal chambers have been broken and repaired. Note well developed cardinal process, short crural plates, and myophragm. Hypotype, UMMP 56679.
19. Oblique dorsal view of incomplete steinkern of brachial valve (X4). Note the prominent cardinal process and narrow sockets. Hypotype, GSC 23091.

Figures 20-26: *Prossarella modestoides* Grabau, costate morphotype

20. Oblique lateral view of steinkern of pedicle valve with one umbonal chamber removed (X1). Note the well developed costae in the anterolateral region. Hypotype, GSC 23087.
21. Lateral view of same specimen as Fig. 19 (X2). Umbonal chamber has been removed to show lateral aspect of dental plates.
22. Posterior view of steinkern of pedicle valve (X1). Note thickened delthyrial margins, very closely spaced dental plates, and weakly impressed beak ridges. Paratype, UMMP 14061.
23. Lateral view of same specimen as Fig. 21 (X1).
24. Ventral view of same specimen as Fig. 21 (X1). Note characteristic closely spaced, parallel arrangement of dental plates and poorly developed costae.
25. Anterior view of same specimen as Fig. 21 (X1). The commissure has been broken. Note the poorly developed costae.
26. Ventral view of steinkern of pedicle valve with costae generally confined to anterolateral margins (X2). Hypotype, UMMP 30553.

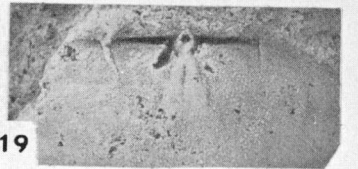
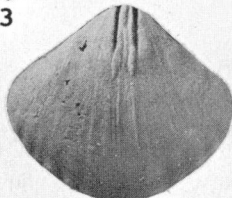
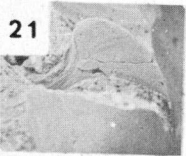
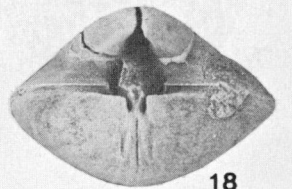
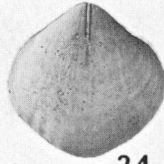
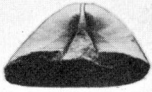
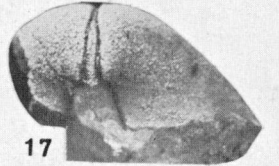
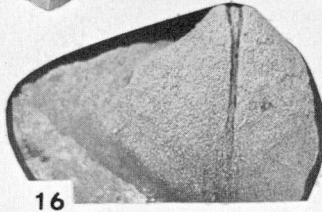
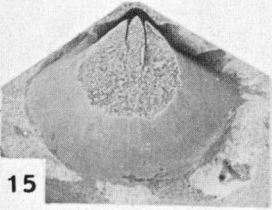
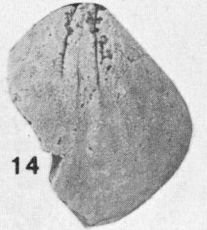
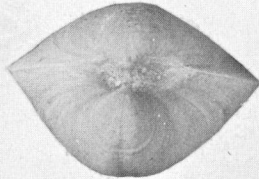
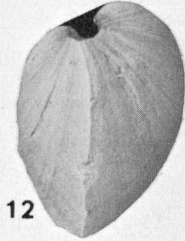
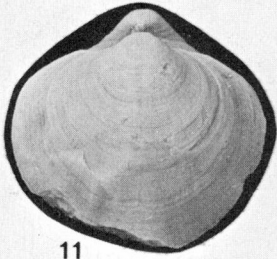
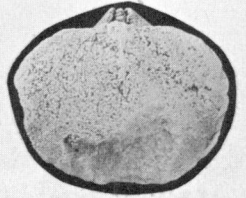
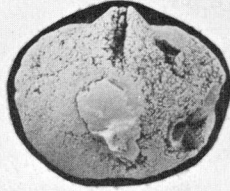
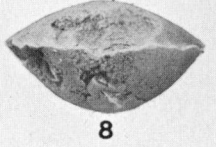
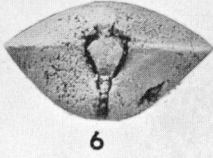
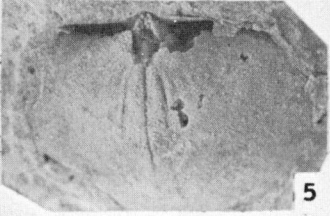
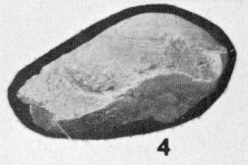
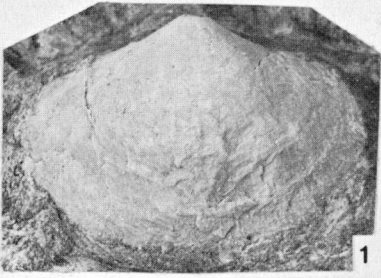




PLATE VII

Figures 1-14: *Prosserella lucasi* Grabau, smooth morphotype

1. Ventral view of steinkern of pedicle valve (X2). Paralectotype, UMMP 14005.
2. Posterior view of steinkern of pedicle valve (X3). The umbonal chamber fillings have been removed to show the shape of the delthyrial chamber. Hypotype, UMMP 56692.
3. Ventral view of steinkern of pedicle valve (X1). Note anteriorly converging dental plates. Paralectotype, UMMP 14006.
4. Dorsal view of incomplete steinkern with well developed fold and short myophragm (X1). Hypotype, UMMP 14065.
5. Anterior view of same specimen as Fig. 4 (X2). Note high and rounded form of the fold, the strongly uniplicate anterior commissure, and the very shallow sulcus.
6. Lateral view of same specimen as Fig. 4 (X1). The pedicle valve is considerably deeper than the brachial valve.
7. Ventral view of steinkern of pedicle valve (X2). The umbonal chamber fillings have been removed to show shape of delthyrial chamber. Hypotype, GSC 23092.
8. Posterior view of same specimen as Fig. 7 (X2). Note the flattened ventral surface of the delthyrial chamber.
9. Anterior view of nearly complete specimen with well developed fold and broadly uniplicate anterior commissure (X3). Hypotype, GSC 23094.
10. Ventral view of incomplete steinkern (X2). Filling of delthyrial chamber is missing. Note elongate, striate vascular markings. Hypotype, GSC 23093.
11. Dorsal view of steinkern of brachial valve (X1). Note the early appearance of the prominent, rounded fold. Hypotype, UMMP 13106.
12. Ventral view of steinkern of pedicle valve with broken anterolateral margin (X1). Hypotype, UMMP 13103.
13. Ventral view of a typical pedicle valve with closely spaced, parallel dental plates and well developed, rounded sulcus (X1). Hypotype, GSC 23106.
14. Dorsal view of cardinal area of steinkern of pedicle valve (X1). Note thickened delthyrial margins. Paralectotype, UMMP 14008.

Figures 15-23: *Howellella* (?) *submersa* (Grabau)

15. Dorsal view of incomplete specimen with well developed growth ornamentation (X2). Hypotype, GSC 23063.
16. Posterior view of same specimen as Fig. 15 (X2).
17. Ventral view of pedicle valve (X2). Hypotype, GSC 23062.
18. Lateral view of same specimen as Fig. 17 (X2).
19. Dorsal view of incomplete steinkern of brachial valve (X3). Note short myophragm on fold. Hypotype, GSC 23054.
20. Posterior view of same specimen as Fig. 19 (X2). Note the short crural plates.
21. Dorsal view of steinkern of brachial valve with very weak myophragm and very short crural plates (X3). Hypotype, GSC 23055.
22. Dorsal view of steinkern of pedicle valve (X1). Note the myophragm offset by the crack and the moderately well developed growth ornamentation. Lectotype, ROM 22500.
23. Dorsal view of steinkern of brachial valve (X3). Paralectotype, UMMP 23852.

Figures 24-26: *Howellella* (?) sp.

24. Posterior view of steinkern with thickened crural plates and very narrow sockets (X2). Hypotype, GSC 23066.
25. Dorsal view of same specimen as Fig. 22 (X2). Note long myophragm and well developed crural plates.
26. Ventral view of steinkern of pedicle valve (X1). Note widely divergent dental plates, weak myophragm, and medial ridges. Hypotype, GSC 23067.

Figure 27: "*Spirifer*" sp.

Ventral view of steinkern of pedicle valve showing paired medial ridges in sulcus (X2). Figured specimen, GSC 23077.

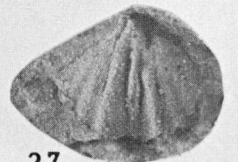
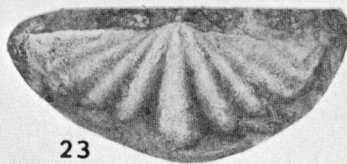
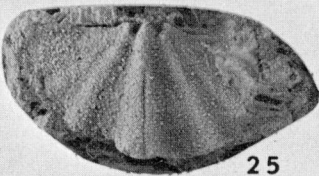
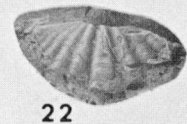
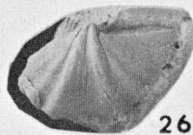
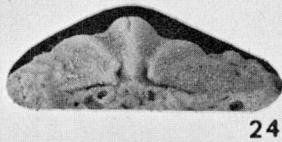
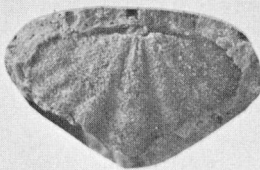
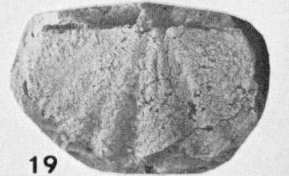
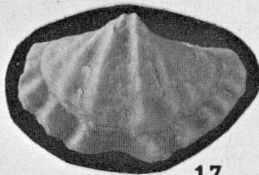
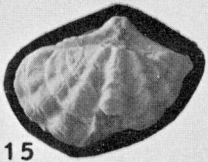
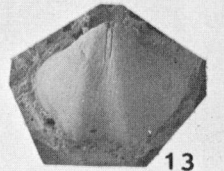
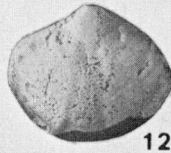
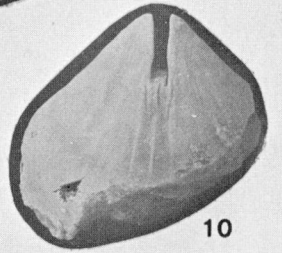
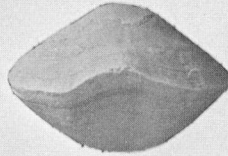
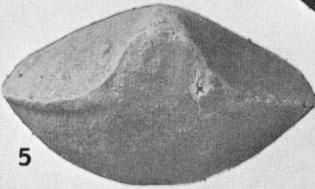
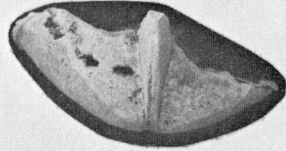
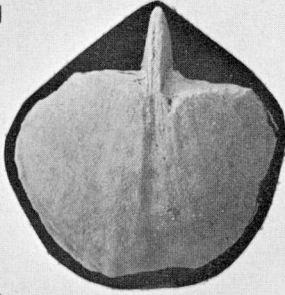
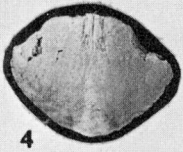
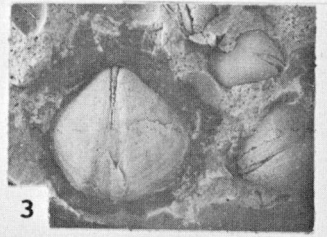
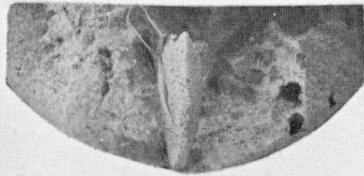
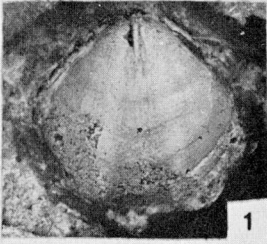


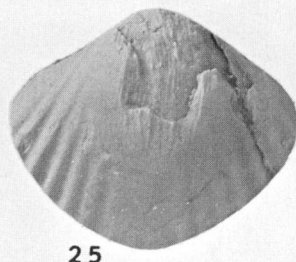
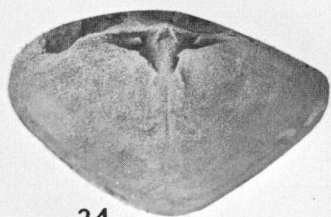
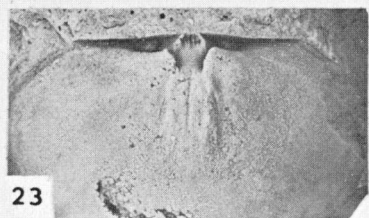
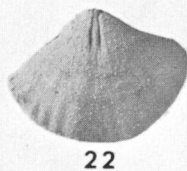
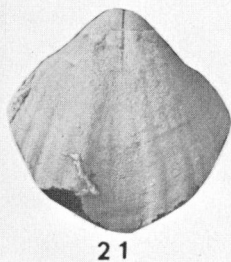
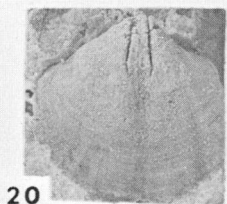
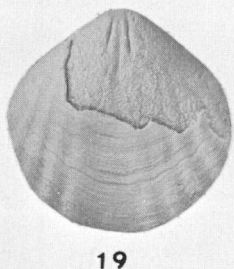
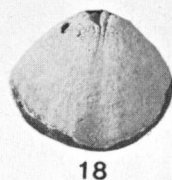
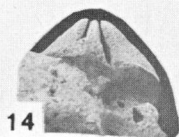
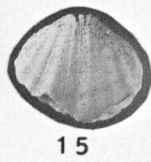
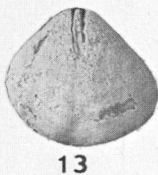
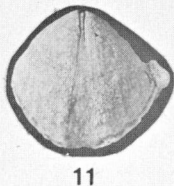
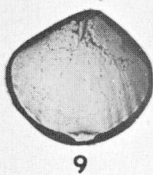
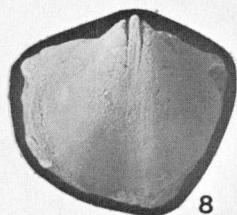
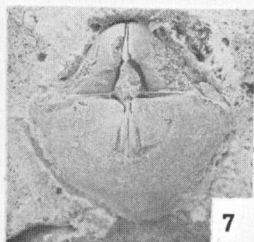
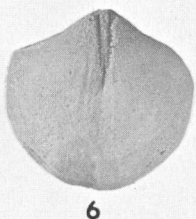
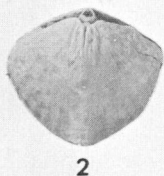
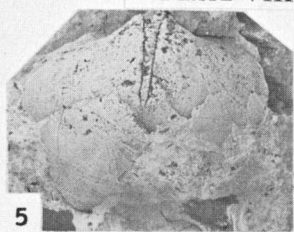
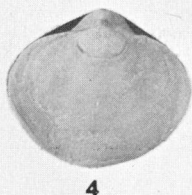
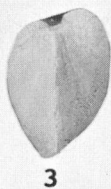
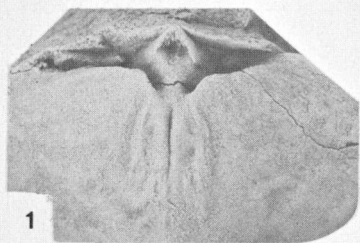
PLATE VIII

Figures 1-8: *Prosserella lucasi* Grabau, smooth morphotype

1. Oblique dorsal view of steinkern of brachial valve (X3). Note the prominent cardinal process, inner socket ridges, crural plates, and short myophragm. Hypotype, UMMP 4473.
2. Dorsal view of same specimen as Fig. 1 (X1). Note the rather narrow, well defined fold.
3. Lateral view of nearly complete specimen (X3). Beak of pedicle valve has been scraped to reveal dental plates. Hypotype, GSC 23095.
4. Dorsal view of same specimen as Fig. 3 (X3).
5. Ventral view of steinkern of pedicle valve with anteriorly convergent dental plates (X2). Hypotype, GSC 23105.
6. Ventral view of steinkern of pedicle valve with anteriorly convergent dental plates (X2). Hypotype, UMMP 56689.
7. Oblique posterior view of steinkern (X2). Note beak ridges, thickened delthyrial margins, convergent dental plates, well developed crural plates, and brachial myophragm. Hypotype, UMMP 56688.
8. Ventral view of steinkern of pedicle valve with typical rounded sulcus and short, parallel dental plates (X2). Hypotype, UMMP 30550.

Figures 9-25: *Prosserella lucasi* Grabau, costate morphotype

9. Ventral view of steinkern with poorly defined sulcus (X1). Hypotype, UMMP 14071.
10. Anterior view of same specimen as Fig. 9 (X1).
11. Ventral view of steinkern of pedicle valve with well defined sulcus (X1). Hypotype, UMMP 14068.
12. Anterior view of same specimen as Fig. 11 (X1).
13. Ventral view of steinkern of pedicle valve (X1). Hypotype, UMMP 23854.
14. Dorsal view of cardinal area of same specimen as Fig. 13 (X1).
15. Ventral view of incomplete steinkern with well developed costae persistent to umbo (X1). Hypotype, UMMP 14070.
16. Dorsal view of same specimen as Fig. 15 (X1).
17. Dorsal view of plaster cast of exterior of brachial valve (X1). Note broad, flattened, well defined fold and short rounded costae. Lectotype, UMMP 14007.
18. Ventral view of nearly smooth steinkern of pedicle valve. Hypotype, UMMP 23853.
19. Ventral view of partially exfoliated pedicle valve (X2). Note anteriorly divergent dental plates, well developed costae, and prominent growth lines. Hypotype, GSC 23107.
20. Ventral view of steinkern of pedicle valve with anteriorly divergent dental plates (X2). Hypotype, GSC 23103.
21. Ventral view of steinkern of pedicle valve (X2). Note that the dental plates have converged ventrally to meet at the floor of the valve and form a structure resembling a spondylium. Hypotype, UMMP 14081.
22. Ventral view of incomplete steinkern of pedicle valve (X2). Hypotype, GSC 23104.
23. Dorsal view of steinkern of brachial valve (X3). Note the prominent, longitudinally striate cardinal process, the crural plates, and the myophragm. Hypotype, UMMP 14010A.
24. Oblique posterior view of steinkern of brachial valve (X2). Note the sockets nearly parallel to the hinge line, the prominent inner socket ridges, and crural plates. Hypotype, GSC 23102.
25. Ventral view of a pedicle valve; the umbo has been scraped to reveal the dental plates (X2). Note the well developed costae. Hypotype, GSC 23101.



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