Articulate brachiopod communities sensitive to environmental factors, especially depth and distance from shore, are described from the upper Middle Devonian (upper Eifelian and Givetian; Cazenovia, Tioughnioga, and Taghanic stages of eastern North America) of eastern North America. The Subrensselandia, Cupularostrum, Mediospirifer, Tropidoleptus, Devonochonetes, Mucrospirifer, Atrypid-Strophodontid, Ambocoeliid, Pacificoecelia, Truncalosa, and Camarotoechia Communities are described from the Hamilton Group of the Appalachian and Illinois Basins. The Cupularostrum, Rhipidothyris, Orthospirifer, Tropidoleptus, Mucrospirifer, Elytha, Spinatrypa, Hypothyridina-Ambocoeliid, Rhyssochonetes, and Leiorhynchus Communities are described from the Tully Formation of the Appalachian Basin. The Subrensselandia, Stringocephalus, Rhipidothyris, Cupularostrum, Atrypid-Gypidulinid, Devonochonetes, Cyrtina-Athyris, Camarotoechia, and Longispina Communities are
described from the sub-Taghanic Traverse Group of the Michigan Basin. The *Rensselandia*, Chonetid, *Pentamerella-Orthospirifer-Cranaena*, Spiriferid-Atrypid, *Mucrospirifer*, *Emanuella*, and *Leiorhynchus* Communities are described from the Cedar Valley Formation and correlative strata exclusive of the Appalachian Basin. The *Subrens selandia*, *Tropidoleptus*, *Mucrospirifer-Pholidostrophia*, Atrypid-Gypidulinid, Chonetid-*Leptaena*, *Brevispirifer*, *Emanuella*, and *Warrenella* Communities are described from the Dundee and Rogers City Formations and correlative strata exclusive of the Appalachian Basin.

The evolution of these brachiopod communities is traced from the Emsian through the early Famennian by assigning related communities to Community Groups. The temporal changes in the Community Groups are discussed in terms of the constituent genera and communities. Communities not assigned to Community Groups are also considered.

The *Leptaena-Schizophoria* Assemblage Zone is defined to include strata correlative with the Union Springs and Cherry Valley Formations of New York. The *Fimbrispirifer-Pentagonia* Assemblage Zone is defined to include strata correlative with the Centerfield Member of New York. The *Rhyssochonetes-Hypothyridina* Assemblage Zone is defined to include strata which correlate with the Tully Formation of New York. These assemblage zones are the basis for detailed correlation of the upper Middle Devonian strata of eastern North America.
The late Middle Devonian fauna of eastern North America represents a mixture of older Eastern Americas Realm and Old World Realm faunas; many older Eastern Americas Realm stocks died out during the earlier Eifelian. Other Old World Realm genera migrated into the Eastern Americas Realm during transgressions associated with the Leptaena-Schizophoria and Rhysochonetes-Hypothyridina Assemblage Zones; these genera distinguish these zones from older and younger rocks.

The Eastern Americas Realm of the late Middle Devonian is divisible into two subprovinces. The Appohimchi Subprovince occupies the Appalachian and Illinois Basins and the clastic shelf to the east of the Appalachian Basin. The Michigan Basin-Hudson Bay Lowland Subprovince occupies a broad carbonate platform extending from Michigan west to Iowa and north to Hudson Bay. Provinciality between these subprovinces rose from the base of the Cazenovia to a peak at the time of the deposition of the Skaneateles Formation, fell during the Fimbrispirifer-Pentagonia Assemblage Zone, rose during the upper Tioughnioga, and declined sharply during the Taghanic. The Fimbrispirifer-Pentagonia Assemblage Zone is associated with a transgression and change in current patterns which allowed Appohimchi genera to migrate onto the Michigan carbonate platform.

Profiles of depositional topography are constructed for several intervals of late Middle Devonian time. Shelf (undathem), slope
(clinothem), and basinal (fondathem) deposits are distinguished on these profiles. Chains of communities occur along these profiles. Benthic Assemblages 1 and 2 are on the shelf, Benthic Assemblage 3 ranges from shelf through slope, Benthic Assemblage 4 from slope to basin, and Benthic Assemblage 5 is basinal. Migrations of community chains and shelf margins correspond to transgressions and regressions. Biostratigraphic and lithostratigraphic data allow tracing of seven transgressive-regressive events over much of eastern North America; these cycles can be used to refine correlations based on other stratigraphic techniques.
Brachiopod Paleoecology, Paleobiogeography, and Biostratigraphy in the upper Middle Devonian of Eastern North America: An Ecofacies Model for the Appalachian, Michigan, and Illinois Basins

by

William Frederick Koch II

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INTRODUCTION

The upper Middle Devonian strata of eastern North America are commonly considered to be a well-known body of rocks. The biostratigraphy of these rocks is presented in detail by Cooper and others (1942), and the symposium volume edited by Oswald (1967) summarizes both lithostratigraphic and biostratigraphic data. The lithostratigraphy and biostratigraphy of the type Hamilton and Tully of New York are summarized by Rickard (1975). The paleontology of upper Middle Devonian megafossils is treated in such detail by Hall and other paleontologists of the nineteenth century that little work has been done since.

Yet, few studies probe the paleoecology and paleobiogeography of these faunas. The realization that various groups of fossils characterize certain sedimentological facies is, however, expressed by some students of these rocks. Cooper (1930), for example, discusses the "Marcellus or Leiorhynchus fauna" and the "Hamilton fauna" which characterize, respectively, the black shale and sandstone facies of the Hamilton Group in New York.

This study considers the community paleoecology of the
articulate brachiopods of the Eastern Americas Realm (Boucot, 1975) of the upper Middle Devonian (uppermost Eifelian and Givetian) of eastern North America. Relationships are explored among the brachiopod communities of this region and the sedimentary rocks which represent the environments in which these animals lived. The distribution of these communities is studied to determine their paleogeographic ranges and to establish paleobiogeographic units. The close relationship of these brachiopod communities to paleoenvironmental conditions are reflected in a series of paleogeographic maps. The distribution of the brachiopod communities with respect to the late Middle Devonian shorelines also reflects patterns of cyclic sedimentation. Possible eustatic and tectonic causes for this pattern of sedimentary cycles are investigated. Adjustments in stratigraphic correlations are considered in the light of these studies.

**Limits of Study**

The rocks involved in this study are contained within the Cazenovia, Tioughnioga, and Taghanic Stages of the Erian Series (Rickard, 1975). These units are equivalent to the uppermost part of the Eifelian and most of the Givetian Stages of Europe. The lower stratigraphic boundary of this study is taken to be the horizon of the Tioga Bentonite. This marker bed, representing a volcanic ash fall, occurs widely in the Appalachian Basin and the Midwest, forming a convenient
base for the upper Middle Devonian (Oliver and others, 1967; Dennison and Hasson, 1976, 1977; Collinson, 1967). In New York, the Tioga forms the division between the Southwood and Cazenovia Stages and divides the Moorehouse from the Seneca Member of the Onondaga Limestone (Rickard, 1975).

Delimiting the upper boundary of this study is a more complex task. Recent evidence from conodonts (Ziegler, Klapper, and Johnson, 1976) suggests that the top of the Middle Devonian in New York occurs within rocks of the Genesee Group. However, since the rocks of the Genesee Group are more closely related to rocks in the Upper Devonian of New York, both in aspects of sedimentation and in their brachiopod faunas, than to the underlying rocks of the Tully Formation and the Hamilton Group, they will not be considered. The upper boundary of this study in New York and the Appalachian Basin is the top of the Tully Limestone or an equivalent position in rocks of other facies that correlate with the Tully.

In the Michigan Basin, the rocks of the Whiskey Creek and Thunder Bay Formations are the uppermost units included in this work. The top of the Cedar Valley Limestone of Iowa, Illinois, and Missouri, and the top of the Milwaukee Formation of Wisconsin are considered as upper boundaries, although conodont studies (Ziegler, Klapper, and Johnson, 1976) suggest that the boundary between the Middle and Upper Devonian may lie within these formations. This is
done on the basis of the lithological and faunal unity of these formations. In northern Indiana, the Little Rock Creek Limestone of Cooper (1941) is included in this work, as is the lowest part of the New Albany Shale of southern Indiana and Illinois. In the James Bay region of Canada, the highest rocks included in the Williams Island Formation (Sanford and Norris, 1975) are investigated.

The geographic limits of this study are set, as far as possible, at the outcrop limits of the eastern North American upper Middle Devonian. The western limit follows the outcrop belt from northwestern Arkansas, through Missouri and Iowa, to the area of Milwaukee, Wisconsin. Several outcrops occur in a small area near James Bay in Canada. The northern boundary drops to the outcrop belt of southwestern Ontario and western New York, with a single locality in the area of Montreal. On the east, the study is bounded by the extent of the Appalachian outcrops, including the Green Pond outlier in New York and New Jersey, and the outlier at Massanutten Mountain in Virginia. The southern limits are set at the poorly known Ragland Sandstone of Alabama, the Pegram Limestone of Tennessee, and the Clifty Formation in northwestern Arkansas.

**Previous Studies**

The upper Middle Devonian strata of eastern North America are among the most intensively studied rocks on the continent. Much of
this work is concentrated in New York, which has been considered by many as the type area for the North American Devonian. Cooper (1930) summarizes the paleontologic and stratigraphic studies accomplished prior to his studies of the stratigraphy of the Hamilton Group. Further work by Cooper (1933, 1934) extends this study into eastern New York and revises the names of several members which were previously occupied (1941); these works remain the basis for studies of the Hamilton Group in New York.

Major contributors to Hamilton stratigraphy in New York since the work of Cooper include the reports of Smith (1935) on the Skaneateles Quadrangle, Goldring on the Berne Quadrangle (1935) and the Coxsackie Quadrangle (1943), Chadwick (1944) on the Catskill and Kaaterskill Quadrangles, Sutton on the Batavia Quadrangle (1951), and Rickard and Zenger (1964) on the Richfield Springs and Cooperstown Quadrangles. Oliver (1951) has studied several coral beds which occur in the Ludlowville Formation, while Rickard (1952) has considered the Cherry Valley Member of the Marcellus Formation. McCave (1969, 1973) has studied the Portland Point Member of the Moscow Formation, and designated the Cooksburg Member as an eastern correlative of the Portland Point. Baird (1978; in press) has re-defined the Wanakah, Ledyard, and King Ferry Members of the Ludlowville Formation, has defined the Jacox Member of the Ludlowville; has transferred the Tichenor Limestone and Deep Run
Member from the Ludlowville to the Moscow Formation on the basis of the presence of a regional disconformity at the base of the Tichenor; has clarified the stratigraphic relationships among the Tichenor, Deep Run, Portland Point, and Kashong Members; and has located regional disconformities between the Portland Point and Kashong Members and between the Kashong and Windom Members.

The Tully Limestone of New York was studied by H. S. Williams (1890), who mistakenly placed it high in the Upper Devonian. Cooper and J. S. Williams (1935) considered the biostratigraphy of the Tully, which they divided into three members. Johnson and Friedman (1969) and Mc Cave (1969) discussed the clastic rocks which are shoreward facies of the Tully. Heckel (1973) revised the lithostratigraphy of the Tully and considered its correlatives elsewhere in eastern North America. As previously mentioned, Ziegler, Klapper, and Johnson (1976) have revised the conodont biostratigraphy of the varcus Zone, encompassing the Tully and the upper two formations of the Hamilton Group.

The Hamilton Group in Pennsylvania was studied by Willard and Cleaves (1933) and by Willard (1935a, 1935b). These studies were summarized and expanded by Willard, Swartz, and Cleaves (1939). More recently the quadrangle reports of the Pennsylvania Topographical and Geological Survey have expanded the lithostratigraphic knowledge of the Pennsylvania Hamilton, as the primarily
biostratigraphic schemes of earlier workers had met with limited success. Important among these reports are the works of Fletcher and Woodrow (1970) on the Milford and Port Jervis Quadrangles, Epstein, Sevon, and Glaeser (1974) on the Lehighton and Palmerton Quadrangles, and Faill and Wells (1974) on the Millerstown Quadrangle. Ellison (1965) described the faunas and stratigraphy of the Hamilton Group of central and southern Pennsylvania. Willard (1937) and Heckel (1969) have described the fauna and stratigraphy of the Tully correlative in Pennsylvania.

The classical study of the Maryland Devonian was undertaken by Prosser, Kindle, and Swartz (1913), while in West Virginia a similar work was produced by Woodward (1932). Little detailed stratigraphy was revealed in either of these studies. More recently, Dennison (1971), Dennison and Hasson (1976), and Hasson and Dennison (1974), have undertaken a detailed study of Hamilton and Tully lithostratigraphy from southern Pennsylvania through Maryland and West Virginia, revealing changes in facies both parallel and perpendicular to the Appalachian outcrop belt. Oliver and others (1967, 1969) have compiled a correlation chart for the Devonian of the Appalachian Basin.

Cooper and others (1942) and Sanford (1967) summarized the Hamilton Group of southwestern Ontario. Studies of individual formations in this area include Wright and Wright (1961) on the
Widder Formation, Wright and Wright (1963) on the Ipperwash Limestone, Mitchell (1967) on the Hungry Hollow Limestone, and Driscoll and Mitchell (1969), on the Arkona Formation. The fauna and stratigraphy of the Prout Limestone and Plum Brook Shale of northern Ohio were described by Stumm (1942). Kesling and Chilman (1975) have summarized much of the previously produced information about the Silica Formation of northwestern Ohio and southeastern Michigan.

Several books from the University of Michigan Museum of Paleontology have summarized knowledge concerning the outcropping Traverse Group of northern Michigan. Ehlers and Kesling (1970) discuss the strata in the area of Thunder Bay; Kesling, Segall, and Sorensen (1974) consider the rocks of Emmet and Charlevoix Counties; and Kesling, Johnson, and Sorensen (1976) review the rocks of the Afton-Onaway region. Sanford (1967) and Gardner (1974) have studied the subsurface Devonian of the Michigan Basin. The conodont biostratigraphy of the northern Lower Peninsula outcrop belt has been described by Butynck (1976). The Devonian stratigraphy of the James Bay region of Canada was studied by Sanford and Norris (1975).

The southern flank of the Michigan Basin is a region of stratigraphic controversy. Cooper (1941), Cooper and Warthin (1941), and Cooper and Phelan (1966), have described three formations in the area of Logansport, Indiana, which correlate biostratigraphically
with the outcrop areas of northern Michigan and New York. Shaver and others (1971), and Orr (1971), consider these rocks to be part of the Traverse Formation, which they correlate on the basis of conodonts and lithology with the sub-Squaw Bay part of the Traverse of northern Michigan and most of the Skaneateles and Ludlowville Formations of New York. A detailed study of this latter scheme shows that little has been changed from a biostratigraphic viewpoint, although these rocks are considered to be a single lithostratigraphic unit.

Strata near Fort Wayne, also referred to the Traverse Formation (Shaver and others, 1971; Doheny, Droste, and Shaver, 1975) are extensions of the Silica Formation and Ten Mile Creek Dolomite of northwestern Ohio.

Campbell (1942) described five formations of upper Middle Devonian age in southern Indiana. More recent reports (Collinson, 1967; Becker, 1974) have grouped these strata as the North Vernon Formation, while retaining three of the older units, the Speeds, Silver Creek, and Beechwood Limestones, as members. The Deputy and Swanville Limestones have been eliminated, regarded as facies of, respectively the Speeds and Beechwood Members. The Speeds Limestone has been suggested to be a facies of the Silver Creek Limestone, although faunal evidence suggests that they are of different ages. The lowest part of the New Albany Shale, which overlies the North Vernon Formation in southern Indiana, is Middle
Devonian (Lineback, 1970), perhaps correlative with the Tully Limestone of New York (Heckel, 1973). Conkin, Conkin, and Lipchinsky (1973) have studied the stratigraphy of the Middle Devonian Sellersburg Group and Boyle Group in central and eastern Kentucky, an area of deeper water sedimentation and frequent unconformities. Little work has been done on the Ragland Sandstone of Alabama, the Pegram Formation of Tennessee, or the Clifty Formation of northwestern Arkansas, since Cooper and others (1942).

The Devonian rocks of Indiana, Illinois, Missouri, and Iowa, are summarized by Collinson (1967). The North Vernon Formation of southern Indiana correlates with the Lingle Formation of Illinois and the St. Laurent Formation of eastern Missouri. Study of the faunas of these rocks show biostratigraphic units to be traceable among them. North (1969) subdivided the Lingle Formation into four members and showed that the outcropping limestones of the Lingle in southern Illinois are partly correlative to the black shales of the New Albany Group of Illinois terminology in the subsurface of the Illinois Basin. Fraunfelder and Baesemann (1972) have described the brachiopod fauna of the Lingle and St. Laurent Formations.

The brachiopod fauna of the Cedar Valley Formation was described in the works of Stainbrook (1938a, 1938b, 1940a, 1940b, 1941, 1942, 1943a, and 1943b). Fraunfelder (1967) and Schumacher (1976) have recently studied aspects of the paleoecology of the Cedar Valley.
Fossils from the Cedar Valley in Illinois and Missouri have been described by Cooper and Cloud (1938), by Cooper (1945) and by Fraunfelter (1974). Cooper (1967) correlated the megafauna of the Cedar Valley with fossils of the Tully Limestone in New York and the upper part of the Traverse Group of northern Michigan. As mentioned above, Ziegler, Klapper, and Johnson (1976) have considered the same correlation based on conodonts. Griesemer (1965) has described the brachiopod fauna of the Milwaukee Formation of Wisconsin and suggested biostratigraphic similarity with the Cedar Valley Formation in Iowa.

The biostratigraphic chart used in this study is based largely upon the works cited above, with such alterations as are necessary to conform to the ideas expressed in the section on Biostratigraphy.
METHODS OF STUDY

Prior to the present study, I undertook a Master's thesis on the Silica Formation of northwestern Ohio and southeastern Michigan. This work familiarized me with the taxonomy and autecology of the brachiopods of the late Middle Devonian of eastern North America. Subsequently, I reviewed the extensive literature on the Hamilton Group and Tully Formation and their correlatives. After becoming familiar with the geographic and stratigraphic span of these rocks, I assembled faunal lists based on the literature concerning these strata, discriminating the smallest possible units both in time and space. Although little data on the abundances of the brachiopods was available in the literature, a qualitative biofacies cum community scheme was constructed.

During the summers of 1975 and 1976, I visited the United States National Museum of Natural History in Washington, D.C. I examined the vast and well-described collections of late Middle Devonian fossils that have been assembled over the past 75 years by G. A. Cooper, H. S. Williams, Charles Butts, and others.

Data from upper Middle Devonian outcrops not represented in the collections in the National Museum were obtained in the field during the summer of 1977. Formations collected included the Lake Church and Milwaukee in Wisconsin, the Silica in northeastern Indiana, and the Mahantango in Pennsylvania and Maryland. In
August, 1977, I visited the Institute of Petroleum and Sedimentary Geology in Calgary, Alberta, at which time I examined the collections of A. W. Norris from the Murray Island and Williams Island Formations of the James Bay region of Ontario.

Counts were made of the articulate brachiopod genera present in each of the studied collections, while quantitative estimates were made of the relative abundances of other macrofauna present. Communi ties were established based on the patterns of brachiopod abundance, and placed within a framework relating them to the environments in which the animals lived. These communities were plotted on stratigraphic charts and paleogeographic maps to study their distribution through time and to determine the nature and variations of paleobiogeographic units. The community framework used to describe the associations of the brachiopod genera is based on that of Boucot (1975). The lithofacies in which the brachiopods occur were determined from inspection of hand samples. Lithofacies data for areas in which faunal samples are lacking were taken from published sources such as Rickard (1975), Dennison and Hasson (1976), and Hasson and Dennison (1974).

The community evolution data for the Lower Devonian is based on Boucot (1975); Boucot (1975) and Feldman (1978, unpublished Ph.D. dissertation) are the sources for pre-Hamilton Middle Devonian community evolution. Boucot (1975), Oliver (1976; 1977), and
Boucot and Gray (in press) have produced the paleobiogeographic framework that is utilized in this study.
The concept of a framework of communities and benthic assemblages that is used to organize the data in this study is discussed in detail by Boucot (1975). Briefly, communities are defined by recurring assemblages of fossil taxa which reflect similar environmental conditions. No interrelations among taxa are to be inferred from community assignments. Although it is highly probable that such interactions occurred, they cannot be determined from the data on hand. Benthic Assemblages are composed of groups of communities which occur in response to broadly similar environmental factors, the most important of which is distance from shore. Other factors of importance include depth of water, wave or current energy, restriction of circulation, presence of fine clastics in the water, amount of oxygen in the water, and grain size of the substrate.

The taxa considered in the definition of the communities are chiefly articulate brachiopods, which are commonly the most abundant macroscopic element of late Middle Devonian level bottom communities. Inarticulate brachiopods are largely neglected due to the poor understanding of their taxonomy. Marine invertebrates other than brachiopods are considered in less detail. This is partly due to the lack of recent taxonomic work on such groups as pelecypods and gastropods, partly to my field of specialization, and partly to the
nature of the available samples. A comparison with the paleoecology of other groups of abundant and well-studied invertebrates, such as corals or trilobites, would be of great interest. However, the relative abundances of all major groups of invertebrates, with the exception of microfossils, are considered, and attention is called to any instances in which they form significant parts of the fauna.

Only level-bottom communities are considered in this study. The reef environments of the Michigan Basin and other parts of the Midwest are complex and at present both poorly known and poorly exposed. Some suspected reefs are known only from the subsurface.

Few communities belonging to Benthic Assemblage 1 are described. In part this is due to a lack of articulate brachiopods in these rocks which represent the upper part of the intertidal zone. The Cupularostrum (Figs. 1, 2, 3), Subrensselandia (Figs. 1, 3, 5), and Rensselandia (Fig. 4) Communities extend into Benthic Assemblage 1 from Benthic Assemblage 2. The small number of communities belonging to Benthic Assemblage 1 may also be associated with a lack of exposure of the paleo-shoreline. Subsurface studies in the Michigan Basin (Gardner, 1974), for example, indicate a transition from limestone to dolomite near the western margin of the basin. This is the probable direction of the paleo-shoreline; as the dolomite is possibly of intratidal or supratidal origin; however, there are no surface exposures in this region.
The following descriptions of communities include relative abundances of those taxa which characterize the communities. These figures represent idealized samples. Most collections represent an ecoclinal gradient between two or more communities. For example, in the Montebello Sandstone of Pennsylvania, the Subrensselandia Community (Fig. 1; Table 9) grades into the Mediospirifer Community (Fig. 1; Table 4) as wave and current energy decreases. With a continued decline in energy, the Mediospirifer Community grades into the Tropidoleptus Community (Fig. 1; Table 5) and into the Devonchonetes Community (Fig. 1; Table 8). All of these communities grade, with increasing distance from shore, into the Mucrospirifer Community (Fig. 1; Table 2). With a decrease in the quantity of fine clastic sediment in the water, the Mucrospirifer Community grades into the Atrypid-Strophodontid Community (Fig. 1; Table 1). Both the Mucrospirifer Community and the Atrypid-Strophodontid Community grade with increasing distance from shore into the Ambocoelid Community (Fig. 1; Table 3). While collections assignable to only one community are not uncommon, they are not in the majority. Many of the assignments of collections given in the tables are indicative only of the community to which a particular collection is most closely related.

The descriptions of certain communities are based upon insufficient collections to permit a great degree of certainty in these
descriptions. Among communities known from few samples are the Rhyssochonetes Community (Fig. 2; Table 10b) of the Tully Limestone, the Rhipidothyris Communities of the Traverse Group (Fig. 3; Table 11c) and the Gilboa Formation (Fig. 2; Table 10a), the Longispina Community of the Traverse Group (Fig. 3; Table 11c), and the Chonetid Community of the Cedar Valley Limestone (Fig. 4; Table 12b). The Spinatrypa Community of the Tully Limestone (Fig. 2; Table 10a) is known from only 3 collections and these contain few specimens. The Subrensselandia (Figs. 1, 3, 5; Tables 9, 11c, 13), Rensselandia (Fig. 4; Table 12b), and Stringocephalus (Fig. 3; Table 11c) Communities are described from few collections. The majority of collections from the James Bay region of Ontario contain insufficient individuals to be of definitive value. Many collections from strata correlative with the Dundee and Rogers City Formations (the Leptaena-Schizophoria Assemblage Zone, defined below) contain too few individuals to be of great use. Also, the communities described from strata of the Leptaena-Schizophoria Assemblage Zone can only be considered as tentative until more is learned of the community paleoecology of the underlying Eifelian rocks. At present, the paleoecology of the Onondaga Formation outside of eastern New York, plus the Columbus, Detroit River, Jeffersonville, and Grand Tower Formations is poorly understood, if it has been studied at all.
Cupularostrum Community (Fig. 1; Table 6)

The Cupularostrum Community occurs in siltstone and sandstone units of the Appalachian Basin from New York south through Pennsylvania to Maryland. This community is also found in the Gilboa Formation (Fig. 2; Table 10a) and in the Traverse Group (Fig. 3; Table 11c). Frequently, it is a monospecific community and collections are always composed of more than 50% specimens of Cupularostrum. These animals lived in environments of relatively high energy, close to shore, most often in the lowest intertidal to highest subtidal environment of Benthic Assemblage 2, but also ranging shoreward into Benthic Assemblage 1. This pattern of occurrence is similar to that of the Lower Devonian and older Rhynchonellid Community of Boucot (1975).

Typical occurrences of the Cupularostrum Community are found in the Chaneysville Siltstone of Maryland and the Backbone Ridge Siltstone of Pennsylvania. Many exposures of the Mount Marion and Panther Mountain Formations in eastern New York also contain examples of this community.

Mediospirifer Community (Fig. 1; Table 4)

This community is characterized by large spiriferids such as
Mediospirifer, Spinocytia, and, in southern Indiana and adjacent areas, Orthospirifer. One or more of these genera makes up 50% or more of the population in collections of the Mediospirifer Community. Other brachiopods which occur commonly include Tropidoleptus and Mucrospirifer. Large pelecypods are frequently found, as is the homalonotid trilobite Dipleura dekayi. Plant remains are also commonly present.

The Mediospirifer Community is placed in the high energy, nearshore Benthic Assemblage 2 environment and is ecologically similar to the lower Devonian Hipparonyx Community (Boucot, 1975). It is commonly found in the siltstones and sandstones of the Montebello Member of central Pennsylvania, and the Panther Mountain Formation and Cooperstown Member of eastern New York. The Silver Creek Member of southern Indiana also contains examples of the Mediospirifer Community.

Subrensselandia Community (Fig. 1; Table 9)

The Subrensselandia Community extends from the very high energy Benthic Assemblage 2 environment shoreward into Benthic Assemblage 1. This community is known from only a few localities in the coarse orthoquartzite of the Montebello Sandstone in eastern Pennsylvania. Outside of the Appalachian Basin, this community occurs in the Traverse Group (Fig. 3; Table 11c) and in equivalents
Figure 1. Communities of the Hamilton Group of the Appalachian and Illinois Basins.
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of the Dundee and Rogers City Limestones (Fig. 5; Table 13). More than 50% of the specimens in these collections are Subrensselandia, while Mediospirifer may also be common. Plant remains frequently are found in collections from the Subrensselandia Community.

**Tropidoleptus Community** (Fig. 1; Table 5)

The Tropidoleptus Community is commonly found in medium to high energy, nearshore Benthic Assemblage 2 siltstones, sandstones, and limestones. Beside common occurrences in the Hamilton Group of the Appalachian Basin, this community is found in the Gilboa Formation (Fig. 2; Table 10a) and in the Speeds Limestone (Fig. 5; Table 13). Tropidoleptus accounts for at least 50% of the specimens present in collections, Mucrospirifer is always abundant, and Devonochonetes is frequently common. Pelecypods, conularids, Dipleura dekayi, and pelmatozoan columnals are also frequently found in the Tropidoleptus Community.

In Huntington County, Pennsylvania, the Tropidoleptus Community occurs commonly in the Crooked Creek Shale; in Perry County, it is found in the Sherman Ridge Member; whereas at Milford in northeastern Pennsylvania; this community is found in the Middle Sandstone Member. Many collections from the Panther Mountain Formation in eastern New York are included in the Tropidoleptus Community, whereas this community frequently characterizes the Kashong Shale.
in western New York. The Lingle Limestone of southern Illinois and the St. Laurent Limestone of eastern Missouri also contain examples of the Tropidoleptus Community.

**Devonochoenetes Community (Fig. 1; Table 8)**

This community is represented in collections of shale or siltstone which contain large specimens of *Devonochoenetes*, accompanied by the brachiopods *Mucrospirifer* and *Tropidoleptus*, along with *Dipleura dekayi*, conularids, and large pelecypods. *Devonochoenetes* makes up at least 40% of the brachiopod population of the Devonochoenetes Community. This community is found in the nearshore, low energy environments of Benthic Assemblage 2.

The *Devonochoenetes* Community occurs widely in the nearshore clastic rocks of Pennsylvania and New York, although it does not dominate any rock unit. Apparently, quiet water environments were not the rule in lowest intertidal to highest subtidal Benthic Assemblage 2 environment, and the development of such low energy environments required sufficient restriction of the sea, in local lagoons or basins, that only the Camarotoechia Community could survive. Other examples of the *Devonochoenetes* Community are found in the St. Helen's Island Breccia from Cote St. Paul near Montreal, Quebec and in the Lingle Limestone of southern Illinois. Closely related communities include the *Devonochoenetes* Community of the Traverse Group (Fig. 3;
Table 11c) and possibly the Chonetid Community of the Cedar Valley Limestone (Fig. 4; Table 12b).

**Mucrospirifer Community** (Fig. 1; Table 2)

This medium to low diversity, low energy Benthic Assemblage 3 community accounts for a larger number of collections than any other community in the Hamilton Group of the Appalachian Basin. Similar communities are found in the Gilboa Formation (Fig. 2; Table 10c), the Williams Island Formation (Fig. 4; Table 12b), and the equivalents of the Dundee and Rogers City Formations within the Leptaena-Schizophoria Assemblage Zone (Fig. 5; Table 13). The Mucrospirifer Community occurs at a distance from shore that corresponds to a range of depths including the depth of wavebase. The depth of wavebase marks the seaward edge of the upper surface of the Catskill clastic wedge, a surface equivalent to the upper surface of the "topset" beds of a classical delta or the undathem of Rich (1951). The previously mentioned communities of Benthic Assemblage 2 occur on the upper surface of this clastic wedge, the undathem; communities of Benthic Assemblage 3 occur from the most seaward part of the undathem, through the clinothem or slope, and on the most landward part of the fondathem or basin; and communities of Benthic Assemblages 4 and 5 occur on more distal parts of the fondathem (Fig. 21). The geometry of the margins of the late Middle Devonian
Appalachian, Michigan, and Illinois Basins and their relationship to community distribution are considered in depth in a later section of this study.

The **Mucrospirifer** Community is found at a distance from shore similar to that of the high diversity Atrypid-Strophodontid Community, but under conditions which are unfavorable to the wide variety of invertebrates commonly found in the Atrypid-Strophodontid Community. The environmental factor most responsible for this exclusion of benthic organisms is a plentiful supply of silt and mud. While suspended in the water column, this fine sediment interferes with the feeding and respiration of filter-feeding organisms. After the sediment settles, a substrate of soft mud, unsuitable for the attachment of many epifaunal benthic invertebrates, is produced.

While this community is designated the **Mucrospirifer** Community, **Mucrospirifer** may not be the most abundant brachiopod present. Small species of **Longispina** and **Devonochenetes** frequently constitute a majority of the fauna, while **Tropidoleptus**, larger species of **Devonochenetes**, "**Schuchertella,"** **Spinulicosta**, **Rhipidomella**, **Ambocoelia**, **Athyris**, **Pholidostrophia**, and a variety of other brachiopods locally are also common. The **Mucrospirifer** Community is distinguished from the communities of Benthic Assemblages 2 and 4 by a lack of dominance of the fauna by any of the brachiopod genera which characteristically dominate the communities of these benthic
assemblages. From the Atrypid-Strophodontid Community of Benthic Assemblage 3, the Mucrospirifer Community is distinguished by its lower diversity. However, most of the brachiopods known from the Atrypid-Strophodontid Community are found in at least one collection included in the Mucrospirifer Community.

Invertebrates other than brachiopods which occur in the Mucrospirifer Community include small clams, often present in great numbers. Gastropods, nautiloids, ammonoids, the trilobites Phacops and Greenops, tentaculitids, various corals, pelmatozoan debris, and bryozoans, including fenestrate forms, are common in this community.

The Mucrospirifer Community is typically well developed in the Chaneysville Siltstone and Upper Shale Members of southern Pennsylvania and Maryland and in the Sherman Ridge Member of central Pennsylvania. At Milford, Pennsylvania, it is found in the Upper Shale Member. Most siltstones and many shales in the Hamilton Group of New York are characterized by the Mucrospirifer Community. The Plum Brook Shale of north-central Ohio, the Arkona and Widder Formations of Ontario, the St. Laurent Limestone of eastern Missouri, and the Clifty Formation of Arkansas, also contain excellent examples of this community.
Atrypid-Strophodontid Community (Fig. 1; Table 1)

The Atrypid-Strophodontid Community has the highest diversity of any community in the Hamilton Group of the Appalachian Basin. As typically developed, 25 to 30 articulate brachiopod genera may be present in this low to medium energy, subtidal Benthic Assemblage 3 community. Abundant rugose and tabulate corals occur in the Atrypid-Strophodontid Community, along with bryozoans, gastropods, trilobites, and pelmatozoans.

The Atrypid-Strophodontid Community occurs at a distance from shore similar to the Mucrospirifer Community. In the northern Appalachian Basin the depth range of both of these communities includes wavebase, the depth at the outermost edge of the upper surface of the Catskill clastic wedge (the "topset" beds of a classical delta, the undathem of Rich (1951). The Atrypid-Strophodontid Community differs from the Mucrospirifer Community in its high diversity, which is correlated with reduced fine clastic sediment in the water column and as substrate. This reduction in fine clastics may be caused by transgression which drowns the former shoreline and allows deposition of clastics landward of the previous site, to a reduction in the clastic supply caused by reduced tectonism in the source area, to tectonic trapping of sediment (Heckel, 1973), or to increased wave or current energy which winnows the clastics from the depositional site.
This community is not named for its dominant brachiopods but for two groups of brachiopods which produce their greatest numbers in this environment. Terebratulid and pentamerid brachiopods are also found in greatest abundance in the Atrypid-Strophodontid Community. However, in many collections, the diversity is sufficiently great that no brachiopod genus makes up more than 10% of the sample. Many genera are virtually unknown outside of this community. Genera characteristic of this community include Schizophoria, Protodouvillina, Megastrophia, Fimbrispirifer, Elytha, Pentagonia, Parazyga, Charionella, Camarospira, Leptospira, Rhynchospirina, Callipleura, Atribonium, Cranaena, and Centronella.

In central and southern Pennsylvania, the Atrypid-Strophodontid Community is common in the Upper Shale and Sherman Ridge Members. The Centerfield Member of northeastern Pennsylvania is characterized by this community. It is found locally in the coarser clastic rocks of eastern New York, but is dominant in many of the limestones and calcareous shales in western New York, especially in the Tioughnioga Stage. In much of the Midwest, including Ohio, Michigan, and Indiana, this community is found in rocks correlative with the Centerfield Limestone of New York. This biostratigraphic unit, termed the Fimbrispirifer-Pentagonia Assemblage Zone, is considered further in the section on biostratigraphy.
The Ambocoeliid Community is found in the low energy, low diversity environment of Benthic Assemblages 4 to 5 in the Hamilton Group of the Appalachian Basin. It is closely related to the Hypothyridina-Ambocoeliid Community of the Tully Limestone (Fig. 2; Table 10b) and the Emanuella Communities of the Rogers City Formation (Fig. 5; Table 13) and the Little Rock Creek Limestone (Fig. 4; Table 12b). Ambocoelia, Emanuella, and Pustulatia are the brachiopods characteristic of this community. Only one of these genera is usually dominant, composing at least 40% of the brachiopod population. Mucrospirifer and small chonetids of the genera Longispina and Devonochonetes are also common. Other elements of the fauna include the trilobites Phacops and Greenops, small pelecypods, gastropods, and nautiloids. Corals or bryozoans are locally common. However, the diversity of the Ambocoeliid Community is always less than that of the Atrypid-Strophodontid Community of Benthic Assemblage 3.

The Ambocoeliid Community occurs in the uppermost beds of the Upper Shale and Sherman Ridge Members in Pennsylvania. In central New York, this community is found in the Cherry Valley Limestone and the Ambocoelia, Emanuella praeumbona (formerly "Ambocoelia" praeumbona), and Pustulatia (formerly Vitulina) Beds
of the Cooperstown and Windom Members. The Stafford Limestone and the Wanakah and Windom Shales offer typical examples of the Ambocoeliid Community in western New York. The fauna of the marcasite bed of the Ledyard Shale, described by Fisher (1951), is assigned to the Ambocoeliid Community. The deeper water facies of the Beechwood Limestone in southern Indiana and Kentucky, often associated with bone beds (Conkin, Conkin, and Lipchinsky, 1973), is also placed in this community.

**Truncalosia Community (Fig. 1; Table 9)**

Several genera of small-shelled brachiopods are characteristic of this low energy, low diversity Benthic Assemblage 5 community. *Truncalosia* is the most common of these, but small specimens of *Ambocoelia*, *Devonochoonetes*, and *Longispina* may also be common. At a few localities, mostly in the Ledyard Shale of western New York, hundreds of tiny specimens of *Tropidoleptus* dominate the fauna, while in the Millboro Shale of Virginia and West Virginia, tiny shells assigned to the inarticulate brachiopod genus *Schizobolus* occur in equally large numbers. Usually one of the above mentioned genera makes up at least 50% of a collection. *Styliolinids*, small pelecypods, ammonoids, and nautiloids also occur. The diversity of this community is restricted not only by the depth of the water under which these animals lived, but also by the substrate of fine mud which restricted
the settlement of many epifaunal benthic invertebrates.

The Truncalosia Community is found in the dark limestones and black shales of the Millboro and Marcellus Formations in the Virginias, Maryland, and southern Pennsylvania. In western New York, this community is concentrated in the Levanna and Ledyard Shales. The Truncalosia Community represents the fauna of the deepest regions of the Appalachian Basin.

**Camarotoechia Community** (Fig. 1; Table 7)

The Camarotoechia Community is found in dark gray to black shales representing environments of quiet water, restricted circulation, and possible anaerobic conditions, ranging from Benthic Assemblage 2 to Benthic Assemblage 5. This community occurs in the Hamilton Group and the Silica Formation (Fig. 3; Table 11c). Few organisms other than Camarotoechia (formerly included in Leiorhynchus; see Sartenaer, 1961) occur in this environment. Camarotoechia commonly accounts for more than 50% of the specimens in a collection. Small chonetids and Mucrospirifer are common, and small pelecypods and nautiloids also are found.

Examples of the Camarotoechia Community in a nearshore, Benthic Assemblage 2 environment are found in the Camarotoechia Bed (formerly "Leiorhynchus" Bed) of the Cooperstown Member and in the Panther Mountain Formation in eastern New York.
Deep water, Benthic Assemblage 5 examples occur in the Millboro and Marcellus Formations of the Virginias, the Marcellus Formation of Maryland and Pennsylvania, the Bakoven Shale of eastern New York, the Union Springs and Cardiff Shales of central New York, and the Oatka Creek and Levanna Shales of western New York. The Camarotoechia Community is also known from a black shale bed in the upper part of the Arkona Formation near Arkona, Ontario.

**Lagoonal Community** (Fig. 1)

This is not strictly a marine community, but it has been included in this study as it may represent brackish lagoonal or estuarine environments. It is represented by black shale lenses in the non-marine red beds of eastern New York. No brachiopods are found in these rocks. The fauna consists of impressions of brachiopods and ostracodes (Goldring, 1943; Chadwick, 1944).

**Pacificocoelia Community** (Fig. 1; Table 9)

This community is named for Pacificocoelia acutiplicata which makes up at least 50% of the specimens in collections assigned to this community. (Johnson, oral communication, considers Anoplotheca acutiplicata Kindle 1912 to be a Leptocoelina Johnson 1970b, not a Pacificocoelia Boucot 1975.) Other brachiopods found in this community, known only from the basal Union Springs Member
in New York, include Longispina and Ambocoelia, both commonly found also in the Benthic Assemblage 4 to 5 Ambocoeliid Community. Small pelecypods, gastropods, and styliolinids are also found in this community. The Pacificocoelia Community occurs in quiet water environments of Benthic Assemblages 4 and 5.

Brachiopod Communities of the Tully Limestone and Correlative Strata in the Appalachian Basin (Fig. 2)

Cupularostrum Community (Fig. 2; Table 10a)

This community is identical to the Cupularostrum Communities of the Hamilton Group (Fig. 1; Table 6) and of the Traverse Group (Fig. 3; Table 11c). It ranges from the high energy Benthic Assemblage 2 into the shallower Benthic Assemblage 1 intertidal environment. Consisting almost entirely of the genus Cupularostrum, this community is found in the Gilboa Formation of eastern New York.

Rhipidothyris Community (Fig. 2; Table 10a)

The Rhipidothyris Community is known only from two collections from the Gilboa Formation of eastern New York. A similar community is found in the Silica Formation (Fig. 3; Table 11c). Both New York collections contain no brachiopod genera other than Rhipidothyris, while at one locality, small pelecypods and tentaculitids are found. This is a high energy, low diversity, nearshore Benthic
Assemblage 2 community which occurs in an environment very similar to that of the Cupularostrum Community.

**Tropidoleptus Community (Fig. 2; Table 10a)**

The Tropidoleptus Community which is found in the Gilboa Formation of eastern New York is highly similar to the community of the same name which is found in the underlying Hamilton Group (Fig. 1; Table 5) and in the Speeds Limestone of southern Indiana (Fig. 5; Table 13). It is a high energy, medium diversity community, occurring in the nearshore environment of Benthic Assemblage 2.

**Orthospirifer Community (Fig. 2; Table 10c)**

This community is similar in nearly all respects to the Mediospirifer Community of the Hamilton Group (Fig. 1; Table 4). However, it is dominated by the genus Orthospirifer, which previously had been restricted to the area of the Michigan Basin and southern Indiana. This brachiopod migrated during the Taghanic onlap into the northern part of the Appalachian Basin and replaced Mediospirifer and Spinocyrtia in this community. The high energy, medium diversity Orthospirifer Community is found in the Benthic Assemblage 2 siltstones and sandstones of the Gilboa Formation in eastern New York.
Figure 2. Communities of the Tully Formation of the Appalachian Basin.
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- CUPULAROSTRUM
- RHIPIDOTHYRUS
- ORTHOSPIRIFER
- TROPIDOLEPTUS
- SPINATRYPAL
- HYPOTHRYONINULA-AMBOCHELITA
- MICROSPIRIFER
- RHYSOSPIRIFER
- RHYSOSPIRIFER
- ELYTHIA
- LEORHYNCHUS
**Mucrospirifer Community** (Fig. 2; Table 10c)

The *Mucrospirifer* Community is the most abundant community in the Gilboa Formation, the eastern clastic equivalent of the Tully Limestone. It is a low diversity Benthic Assemblage 3 community, occurring where a heavy influx of clastic sediment prohibited the development of the high diversity *Elytha* Community. As with the Hamilton *Mucrospirifer* Community (Fig. 1; Table 2) and the similar community in the Williams Island Formation (Fig. 4; Table 12b), this community is defined not on the presence of specific taxa, but on low diversity and an inability to be placed into the communities of Benthic Assemblages 2 and 4.

Common brachiopods of the *Mucrospirifer* Community include *Mucrospirifer, Hypothyridina, Ambocoelia, Emanuella, Echinocoelia, Spinatyrpa, and Rhyssochonetes*. However, none of these brachiopods dominate the fauna as they do in other communities. Small pelecypods are locally abundant. The *Mucrospirifer* Community occurs abundantly in the shales and siltstones of the Gilboa Formation in eastern and central New York.

**Elytha Community** (Fig. 2; Table 10a)

The *Elytha* Community has the highest diversity of any community occurring in the Tully Limestone. This Benthic Assemblage 3
community represents the optimum level bottom environment of the Taghanic Stage in the Appalachian Basin, in a manner similar to the Atrypid-Strophodontid Community (Fig. 1; Table 1) of the Hamilton. The high brachiopod diversity is accompanied by such low numbers of individuals that no genus makes up more than 10% of a collection. The diversity of invertebrates other than brachiopods is also very high.

Characteristic brachiopods of the Elytha Community include "Tylothyris," Spinatrypa, Pseudoatrypa, Elytha, Cupularostrum, Rhipidomella, Protodouvillina, Mesoleptostrophia junia, and Nervostrophia. Trilobites, pelecypods, gastropods, nautiloids, rugose and tabulate corals, and massive and fenestrate bryozoans are common in this community. The Elytha Community is characteristic of the lower part of the Upper Member of the Tully Limestone in western and central New York, including the upper Taughannock Falls and lower Moravia Beds of Heckel (1973). It is also known from a few localities in the Tully Member of central Pennsylvania.

Spinatrypa Community (Fig. 2; Table 10a)

The Spinatrypa Community is found only in the area of reef development near Borodino on the Skaneateles quadrangle in central New York. The single sample taken from a reefal mass is dominated by Spinatrypa, with Hypothyridina and Cupularostrum also common.
Corals and trilobites are also major elements of the fauna. Two samples from flank beds consist largely of pelmatozoan debris and corals; brachiopod remains are uncommon.

Other examples of reef-related communities are unknown in the Appalachian Basin. However, a similar community occurs in the Williams Island Formation of the James Bay region of Ontario and in the Cedar Valley Limestone of Iowa (Fig. 4; Table 12b).

**Rhyssochonetes Community (Fig. 2; Table 10b)**

Abundant specimens of *Rhyssochonetes aurora* characterize the *Rhyssochonetes* Community. Frequently, *Rhyssochonetes* composes more than 60% of a collection. This medium diversity, low energy Benthic Assemblage 4 community is found only at the base of the Lower Member of the Tully Limestone in central New York, where it overlies a submarine unconformity, representing an interval of non-deposition of terrigenous clastics. The rocks in which this community is found belong to the laminated muddy siltstone facies, in the Cuyler Bed of Heckel (1973). Heckel claims that these rocks represent a nearshore environment, perhaps intertidal. However, the presence of the Benthic Assemblage 4 *Hypothyridina-Ambocoeliid* Community in rocks to the west and in overlying rocks suggests that the *Rhyssochonetes* Community also lived in deeper, offshore waters. Additional evidence for the deeper water occurrence of the
Rhyssochonetes Community is furnished by Johnson (personal communication) who states that Rhyssochonetes occurs in deeper water environments in Middle Devonian rocks of western North America. The occurrence of Rhyssochonetes in Benthic Assemblage 4 is similar to the occurrence of small specimens of Devonochonetes and Longispina in the Benthic Assemblage 4 Ambocoeliid Community of the Hamilton Group (Fig. 1; Table 3).

Hypothyridina-Ambocoeliid Community (Fig. 2; Table 10b)

This community occurs in low energy Benthic Assemblage 4 to 5 environments in a manner similar to the Hamilton Ambocoeliid (Fig.1; Table 3) and Rogers City (Fig. 5; Table 13) and Little Rock Creek (Fig. 4; Table 12b) Emanuella Communities. It dominates most of the Lower Member of the Tully Limestone in western and central New York, as well as the Tully Member of Pennsylvania. This widespread deeper water community is typical of the effects of the Taghanic onlap on eastern North America.

Collections of the Hypothyridina-Ambocoeliid Community consist of at least 40% of specimens of Hypothyridina or of Emanuella or Echinocoelia or of some combination of these genera. Mucrospirifer, Rhyssochonetes, Spinatrypa, "Schuchertella," or Schizophoria may be locally abundant; however, the total diversity is always low, with perhaps four genera being common in a given collection. Trilobites,
gastropods, corals, or styliolinids may also be present.

Leiorhynchus Community (Fig. 2; Table 12b)

The Leiorhynchus Communities of the Taghanic are similar to the Camarotoechia Communities (Figs. 1, 3; Tables 7, 11b) of the earlier Middle Devonian with the exception of the replacement of Camarotoechia by the closely related genus Leiorhynchus. Leiorhynchus migrated into eastern North America during the Taghanic transgression; Leiorhynchus Communities are known in the Appalachian Basin and in correlatives of the Cedar Valley Formation in the Midwest (Fig. 4; Table 12b).

In eastern New York, the Leiorhynchus Community is best developed in the basal part of the Gilboa Formation, where it represents the nearshore effects of the Taghanic onlap. This community is typical of restricted, quiet water, possibly anaerobic environments ranging from Benthic Assemblage 2 to Benthic Assemblage 5.

Brachiopod Communities of the Sub-Taghanic Traverse
Group of the Michigan Basin (Fig. 3)

Cupularostrum Community (Fig. 3; Table 11c)

This community is known from a single collection in the Michigan Basin. The sample, which consists entirely of specimens of Cupularostrum, is from the basal Norway Point Formation,
disconformably overlying the Four Mile Dam Formation. The
Cupularostrum Community of the Traverse Group is similar to those
of the Appalachian Basin (Figs. 1, 2; Tables 6, 10a), ranging from
high energy Benthic Assemblage 2 into Benthic Assemblage 1.

Rhipidothyris Community (Fig. 3; Table 11c)

The Rhipidothyris Community is based on one sample from a
small, reef-like mass of Aulocystis found in Units 18A and 18B,
described by Kesling and Chilman (1975), from the Berkey Member
of the Silica Formation in northwestern Ohio. Within this reeval mass
are found small specimens of the brachiopods Rhipidothyris,
Cupularostrum, and Sphenophragmus, occurring in large numbers.
Pelecypods are also abundant. This community is placed in the high
energy Benthic Assemblage 2, similar to the occurrences of
Cupularostrum and Rhipidothyris in the Gilboa Formation (Fig. 2;
Table 10a).

Subrensselandia Community (Fig. 3; Table

This community, closely similar to the Subrensselandia
Communities of the Hamilton Group (Fig. 1; Table 9) and the Leptaena-
Brevispirifer Assemblage Zone (Fig. 5; Table 13), is characterized
by extremely low diversity, containing only one or two genera of
brachiopods. It ranges through the very high energy Benthic Assemblage 2 into Benthic Assemblage 1. The environment of the Subrensselandia Community is either very close to shore or in the upper part of a reef. As in the Appalachian Basin, the Subrensselandia Community is uncommon in the Michigan Basin. It is known only from the stromatoporoid-coralline limestone of the Miami Bend Limestone in northern Indiana. Massive tabulate corals, colonia rugose corals, massive stromatoporoids, large pelecypods, and large gastropods are also found in this community. The Subrensselandia Community is restricted to the shoaling southern flank of the Michigan Basin, where it is associated with the Stringocephalus Community (Fig. 3; Table 11c).

**Devonochonetes Community (Fig. 3; Table 11c)**

The Devonochonetes Community is characterized by large specimens of Devonochonetes and Longispina. Along with Mucrospirifer, these genera account for at least 35% of a typical collection. Pseudotrype, Pholidostrophia, and Strophodonta also are locally abundant; Strophodonta is often the most abundant genus in the Devonochonetes, Cyrtina-Atyris, Atrypid-Gypidulinid, and Longispina Communities of the Traverse Group. The Devonochonetes Community is placed in the low energy Benthic Assemblage 2, usually occurring in calcareous shales suggestive of a quiet water environment. It is closely related
Figure 3. Communities of the Sub-Taghanic Traverse Group of the Michigan Basin.
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to the *Devonochoonetes* Community of the Hamilton Group (Fig. 1; Table 8) and the Chonetid Community of the Cedar Valley Limestone (Fig. 4; Table 12b).

The *Devonochoonetes* Community is found in the uppermost beds of the Bell and Ferron Point Shales of northeastern Michigan. It is also characteristic of the Brint Road Member of the Silica Formation, in which it may be traced southeastward from Milan, Michigan, to Sylvania, Ohio, and to the area of Fort Wayne, Indiana.

**Atrypid-Strophodontid Community (Fig. 3; Table 1)**

The Atrypid-Strophodontid Community, typical of many localities and stratigraphic units in the Appalachian Basin (Fig. 1; Table occurs in the Traverse Group in the Four Mile Dam Formation of northeastern Michigan, the Logansport Limestone of northern Indiana, and the Ten Mile Creek Dolomite of northwestern Ohio. This community is an ecological homolog of the *Cyrtina-Athyris* Community (Fig. 3; Tables 11a, 11b), which dominates most collections from the Traverse Group. Both are characteristic of low energy Benthic Assemblage 3 environments in which large inputs of terrigenous clastics are lacking. Throughout much of the late Middle Devonian, the areas occupied by these two communities belonged to different paleobiogeographic units. However, during the basal Tioughnioga Stage, animals typical of the Appalachian Basin were
able to enter the Michigan Basin, resulting in a fauna containing elements previously endemic to the Appalachian Basin along with elements previously endemic to the Michigan Basin. A further discussion of the paleobiogeography of the late Middle Devonian of eastern North America is presented below.

**Cyrtina-Athyris Community (Fig. 3; Tables 11a, 11b)**

The **Cyrtina-Athyris** Community is the most common community represented in collections from the Traverse Group. The **Cyrtina-Athyris** Community is a highly diverse, medium to low energy Benthic Assemblage 3 community. It has the greatest diversity of any level bottom Traverse community, with the exception of the Atrypid-Strophodontid Community (Fig. 3; Table 1), the exceptional diversity of which is the result of a breakdown in provinciality. Among the brachiopods which are common in the **Cyrtina-Athyris** Community are *Strophodonta*, *Pseudoatrypa*, *Mucrospirifer*, *Orthospirifer*, *Cyrtina*, and *Athyris*. *Schizophoria* and *Helaspis* are common locally. Gastropods, trilobites, crinoids, bryozoans, and solitary and rugose corals are also frequently present. This community is found in rocks ranging from calcareous shale to bioclastic limestone.

Typical occurrences of the **Cyrtina-Athyris** Community are found in the Silica Formation at Waynedale and Woodburn, Indiana.
Similar occurrences in Alpena and Presque Isle Counties in north-eastern Michigan include the lower Bell and lower Ferron Point Shales, the Killians Member of the Genshaw Formation, and the Norway Point Formation. In Emmet and Charlevoix Counties in northwestern Michigan, this community occurs in the Gravel Point and Petoskey Formations.

**Stringocephalus Community** (Fig. 3; Table 11c)

The **Stringocephalus** Community occurs only in the Miami Bend Limestone of northern Indiana. This is the only occurrence of **Stringocephalus** known from eastern North America. This community is separated from the **Subrensisselandia** Community (Fig. 3; Table 11c) which occurs lower in the same formation, separated by an interval of 6 1/2 feet (Cooper and Phelan, 1966). The **Stringocephalus** Community is monospecific and is assigned to a high energy Benthic Assemblage 3 environment. The associated fauna of large pelecypods, large gastropods, massive stromatoporoids, colonial rugose corals and tabulate corals, with the corals and stromatoporoids largely not in growth position, but lying in a large spectrum of positions, indicates a high energy environment, possibly on the flank of a reef.
Atrypid-Gypidulinid Community (Fig. 3; Table 11c)

This is a high energy, medium diversity Benthic Assemblage 3 community. *Strophodonta* is usually the most abundant genus in collections assigned to this community, but this is true of most Traverse communities. A gypidulinid, usually *Pentamerella*, constitutes at least 10% of these collections, while robust specimens of *Pseudoatrypa* are generally common. As with the *Subrensselandia* and *Stringocephalus* Communities, the dominant brachiopods of the Atrypid-Gypidulinid Community are characterized by thick shells, indicative of a rough water environment. Similar communities are found in Cedar Valley (Fig. 4; Table 12b) and Rogers City (Fig. 5; Table 13) Limestones.

Other brachiopods are common to certain stratigraphic units. *"Sieberella" romingeri* (Imbrie) 1957 replaces *Pentamerella* as the characteristic gypidulinid in much of the Genshaw Formation of northeastern Michigan. Robust specimens of *Charionella*, *Cranaena*, and *Pentamerella*, along with small specimens of *Sieberella newtonensis* Imbrie 1957 characterize the fauna of the Newton Creek Limestone of northeastern Michigan. *Cranaena* is also common in the Charlevoix Limestone of northwestern Michigan. Typical examples of the Atrypid-Gypidulinid Community are found in the Rockport Quarry Limestone, in close association with the *Longispina* Community (Fig. 3; Table 16). The Atrypid-Gypidulinid Community is
commonly found in stromatoporoid-coralline limestones and may have been associated with small reefs.

**Longispina Community** (Fig. 3; Table 11c)

The **Longispina** Community is known only from the Rockport Quarry Limestone of northeastern Michigan. The four collections on which this community is based also contain the Atrypid-Gypidulinid Community (Fig. 3; Table 11c). The **Longispina** Community occurs as specimens of Longispina and Strophodonta in black shale which forms lenses in the massive stromatoporoid-coralline limestone of the Rockport Quarry Formation. These lenses represent bodies of water characterized by restricted circulation in low energy environments, perhaps lagoons surrounded by the high energy limestones containing the Benthic Assemblage 3 Atrypid-Gypidulinid Community which forms the bulk of the Rockport Quarry Formation.

**Camarotoechia Community** (Fig. 3; Table 11b)

The **Camarotoechia** Community in the Michigan Basin is known only from the Berkey Member of the Silica Formation in northwestern Ohio. **Camarotoechia** forms over 70% of these collections, with **Mucrospirifer** and **Strophodonta** forming most of the remainder of the samples. This community may represent a local restriction of
the epeiric sea in which poor circulation limited the fauna to Camarotoechia and other tolerant brachiopods. The Camarotoechia Community in the Silica Formation is assigned to Benthic Assemblage 2 or 3 on the basis of the communities which are stratigraphically adjacent to it. The Camarotoechia Community also occurs in the Hamilton Group of the Appalachian Basin (Fig. 1; Table 7).

Brachiopod Communities of the Cedar Valley Limestone and Correlative Strata Outside of the Appalachian Basin (Fig. 4)

Rensselandia Community (Fig. 4; Table 12b)

Collections dominated by Rensselandia are known from the profunda Bed of the Solon Limestone in eastern Iowa and from the part of the Cedar Valley Limestone in northern Missouri formerly termed the Ashland Limestone. Rensselandia makes up from 80% to 100% of these collections. The Rensselandia Community occurs in very high energy, nearshore Benthic Assemblage 2 environments, ranging shoreward into Benthic Assemblage 1, in a manner similar to the pre-Taghanic Subrensselandia Communities (Figs. 1, 3, 5; Tables 9, 11c, 13).

Chonetid Community (Fig. 4; Tables 12b)

More than 50% of the specimens in samples assigned to the Chonetid Community belong to chonetid genera. This is considered
to be a quiet water Benthic Assemblage 2 community, analogous to the Devonochonetes Communities of the Hamilton (Fig. 1; Table 8) and Traverse (Fig. 3; Table 11c). The Chonetid Community is not common. It is represented in two collections from the Cedar Valley Limestone of Iowa. The fauna of large chonetids and other brachiopods reported by Raasch (1935) from tunnel excavations and borings into the North Point Member of the Milwaukee Formation is also assigned to the Chonetid Community. This member has no surface exposures.

Pentamerella-Orthospirifer-Cranaena Community
(Fig. 4; Table 12b)

This community is in many ways similar to the Atrypid-Gypidulinid Community of the Traverse Group (Fig. 3; Table 11c). It is a medium diversity, high energy community, ranging through Benthic Assemblages 2 and 3. Frequently, it is found in stromatoporoid-coraline limestones. Characteristic brachiopods include Pentamerella, Orthospirifer, and Cranaena; one or more of these genera makes up at least 60% of a given collection. Pentamerella and Cranaena link this community to the Atrypid-Cypidulinid Community, while the presence of Orthospirifer suggests a similarity with the Mediospirifer (Fig. 1; Table 4) and Orthospirifer (Fig. 2; Table 10c) Communities which occupy high energy Benthic Assemblage 2
Figure 4. Communities of the Cedar Valley Formation and Correlative Strata Exclusive of the Appalachian Basin.
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environments in the Appalachian Basin.

The Pentamerella-Orthospirifer-Cranaena Community is found in the profunda Bed of the Solon Limestone and the Cranaena Bed of the Coralville Limestone in eastern Iowa. It also occurs in the "B Zone" of the Berthelet Member of the Milwaukee Formation of southeastern Wisconsin and the Potter Farm and Thunder Bay Formations of northeastern Michigan.

**Spiriferid-Atrypid Community** (Fig. 4; Table 12a)

The Spiriferid-Atrypid Community is the most common community of the Taghanic Stage outside the Appalachian Basin. It is characterized by the presence of one or more atrypid genera, including *Pseudoatrypa, Desquamatia (Independatrypa), D. (Neatrypa), and Spinatrypa*, often composing more than 30% of the fauna. Spiriferids such as *Orthospirifer* and "Tylothyris" make up another 20%. *Schizophoria, Strophodonta, Cyrtina, and Athyris* are also commonly found. The Spiriferid-Atrypid Community is closely related to the *Cyrtina-Athyris* Community of the Traverse Group (Fig. 3; Tables 11a, 11b) and is assigned to the low to medium energy, high diversity Benthic Assemblage 3 environment.

The Spiriferid-Atrypid Community occurs in the independensis Bed of the Solon Limestone, and in the Rapid Limestone, both of eastern Iowa, and most of the Cedar Valley Limestone of Missouri.
(formerly Callaway Limestone). In southeastern Wisconsin, it is characteristic of the "C Zone" or Lindwurm Member of the Milwaukee Formation. In northwestern Michigan, it is known from the Whiskey Creek Formation, while in northeastern Michigan the Spiriferid-Atypid Community is found in the Potter Farm Formation. Samples from the upper limestone of the Williams Island Formation of the James Bay region of Ontario appear to represent this community; however, they are of insufficient size to be certain of this.

**Mucrospirifer Community** (Fig. 4; Table 12b)

This community includes collections from the lower red shale of the Williams Island Formation of the mid-bay shoal of Hudson Bay, and the western shore of the bay, in northern Ontario. These collections are dominated by *Mucrospirifer*, with *Pseudoatrypa* and small chonetids also common. This *Mucrospirifer* Community is considered to be similar to the *Mucrospirifer* Communities of the Hamilton Group (Fig. 1; Table 2) and Gilboa Formation (Fig. 2; Table 10c), and is assigned to low diversity, low energy Benthic Assemblage 3.

**Emanuella Community** (Fig. 4; Table 12b)

Known only from the Little Rock Creek Limestone of northern Indiana, the *Emanuella* Community is characterized by the presence of the ambicoeliid *Emanuella* and a small chonetid. *Mucrospirifer*
is also found in this community. This is a low diversity, low energy Benthic Assemblage 4 to 5 community similar to the Ambocoeliid Community of the Tully Limestone (Fig. 2; Table 10b), and the Emanuella Community of the Rogers City Limestone (Fig. 5; Table 13).

**Leiorhynchus Community** (Fig. 4; Table 12b)

The **Leiorhynchus** Community is associated, as in the previous description from the Gilboa Formation (Fig. 2; Table 10b), with restricted environments of low energy, poor circulation, and possible anaerobic conditions. Two collections are assigned to this community; one from the Blocher Member of the New Albany Shale of southern Indiana, which is placed in Benthic Assemblage 4, and the other from the uppermost black shale beds of the Williams Island Formation, which may be in either Benthic Assemblage 3 or 4.

**Subrensselandia Community** (Fig. 5; Table 13)

This community is represented in two collections from eastern Missouri, one each from the Beauvais Sandstone and the St. Laurent Limestone. The occurrence of **Subrensselandia** in the upper Rogers City Limestone at Rogers City, Michigan, is reported by Ehlers and
Kesling (1970). The *Subrensselandia* Community of these late Eifelian rocks is similar in most respects to this community in the Traverse Group, although its occurrence in post-Eifelian rocks is partly in nearshore clastics rather than in shallow water carbonates. This community ranges from Benthic Assemblage 2 to Benthic Assemblage 1 in the very high energy intertidal to shallowest subtidal environment, similar to occurrences in the Hamilton (Fig. 1; Table 9) and Traverse Groups (Fig. 3; Table 11c).

**Tropidoleptus** Community (Fig. 5; Table 13)

The *Tropidoleptus* Community is represented by a single collection from the Speeds Limestone (formerly Deputy Limestone) of southern Indiana. This is a low diversity, relatively high energy Benthic Assemblage 2 community. *Tropidoleptus* makes up 47% of the sample and *Devonochonetes* makes up another 41%. This community is also found in the Hamilton Group (Fig. 1; Table 5) and the Gilboa Formation (Fig. 2; Table 10a).

**Mucrospirifer-Pholidostrophia** Community (Fig. 5; Table 13)

This community is also known only from those exposures of the Speeds Limestone that formerly were termed the Deputy Limestone in southern Indiana. While as many as 14 genera of brachiopods may be present in collections, *Mucrospirifer* and *Pholidostrophia*
Figure 5. Communities of the Dundee and Rogers City Formations and Correlative Strata of the Appalachian Basin.
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together account for 75% of the sample. This low diversity community is placed in the low energy Benthic Assemblage 3, although it may extend into Benthic Assemblage 2. The _Mucrospirifer-Pholidostrophia_ Community displays similarity to both the _Mucrospirifer_ Community of the Hamilton Group (Fig. 1; Table 2) and the _Devonochnetes_ Community of the Traverse Group (Fig. 3; Table 11c).

**Chonetid-Leptaena Community** (Fig. 5; Table 13)

The Chonetid-**Leptaena** Community is dominated by specimens of _Longispina_ and, especially, _Devonochnetes_, which constitute at least 4% of the collections. _Tylothyris, Leptaena, Schizophoria, Athyris, and Mediospirifer_ are locally fairly common, as are rugose corals, small pelecypods, trilobites, and pelmatozoan debris. This is a medium diversity, low energy, Benthic Assemblage 3 Community, in some ways similar to the _Mucrospirifer_ Community of the Hamilton Group (Fig. 1; Table 2).

Examples of the Chonetid-**Leptaena** Community are common in the lower part of the St. Laurent Limestone of eastern Missouri and the correlative Howardton Member of the Lingle Limestone of southern Illinois. A similar chonetid-dominated assemblage occurs in the lower part of the Lake Church Formation of eastern Wisconsin; samples, however, are insufficient to determine if it is identical to the community found in Illinois and Missouri.
Brevispirifer Community (Fig. 5; Table 13)

Brevispirifer characteristically constitutes at least 40% of collections assigned to the Brevispirifer Community. Strophodonta, Spinatrypa, Mediospirifer, and Spinulicosta are commonly found in this community, along with large and small pelecypods, Conocardium, gastropods, and trilobites. The medium diversity Benthic Assemblage 3 Brevispirifer Community is found in rocks which represent a low to medium energy environment.

The Dundee Limestone of Michigan and Ohio is dominated by the Brevispirifer Community. It is also known from the Speeds Limestone near Speeds in southern Indiana and from the St. Laurent Limestone in eastern Missouri.

Atrypid-Gypidulinid Community (Fig. 5; Table 13)

This is a high energy, medium diversity Benthic Assemblage 3 community, closely related to the Atrypid-Gypidulinid Community (Fig. 3; Table 11c) of the overlying Traverse Group. The dominant brachiopods include Spinatrypa, Desquamatia arctica (referred by Johnson, personal communication, to Variatrypa), Gypidula, and, locally, Athyris. These brachiopod genera make up from 50% to 90% of the fauna. Large gastropods, large pelecypods, and nautiloids are common, while much of the limestone which contains the Atrypid-Gypidulinid Community is made up of massive stromatoporoids and...
The Emanuella Community is known from the lower part of the Rogers City Limestone of northeastern Michigan. The ambocoellid Emanuella makes up between 74% and 91% of these collections, with much of the remainder of the fauna attributable to Desquamatia (Variatrypa of Johnson, personal communication), Spinatrypa, and other atrypids. By analogy with other ambocoeliid dominated communities (Figs. 1, 2; Tables 3, 10b), the Emanuella Community is placed in the low energy, low diversity Benthic Assemblages 4 to 5.

**Emanuella Community (Fig. 5; Table 13)**

The Emanuella Community is known from the lower part of the Rogers City Limestone of northeastern Michigan. The ambocoeliid Emanuella makes up between 74% and 91% of these collections, with much of the remainder of the fauna attributable to Desquamatia (Variatrypa of Johnson, personal communication), Spinatrypa, and other atrypids. By analogy with other ambocoeliid dominated communities (Figs. 1, 2; Tables 3, 10b), the Emanuella Community is placed in the low energy, low diversity Benthic Assemblages 4 to 5.

**Warrenella Community (Fig. 5; Table 13)**

This community occurs only in the Delaware Limestone of central Ohio. The fauna of the Warrenella Community is composed primarily of Warrenella, Leptaena, and small chonetids. On the basis of Warrenella Communities known from western North America (Boucot, 1975; Savage and Boucot, 1978), and considerations of the...
depositional pattern of the Appalachian Basin, the Warrenella Community is assigned to the low energy, low diversity Benthic Assemblages 4 and 5.
The articulate brachiopod communities of the late Middle Devonian (latest Eifelian through Givetian) of eastern North America are related both ecologically and genetically to older and younger communities. In most cases, an ecological similarity with respect to morphological type and environmental position is evident. In many instances, an ancestor-descendant relationship between communities may also be suggested (Fig. 6).

In studying the relationships between the communities of the late Middle Devonian and earlier or later communities, it is useful to first combine the communities of the late Middle Devonian into groups of related communities. The members of these Community Groups (see Boucot, 1975, p. 232, for definition) are commonly characterized by genetically related genera with similar environmental preferences. Six Community Groups are recognized in the late Middle Devonian of eastern North America. The remaining communities, while not placed in Community Groups, can also be related to communities which occur at earlier and later times (Fig. 6).

**Rensseldandiiid Community Group** (Fig. 6)

This Community Group includes the *Subrensselandia* (Figs. 1, 3, 5; Tables 9, 11c, 13) and *Rensselandia* (Fig. 4; Table 12b) Communities.
Both of the characteristic genera belong to the subfamily Rensselandiinae Cloud 1942 and both communities are characterized by low diversity and occurrence in very high energy Benthic Assemblage 1 and 2 environments in eastern North America. However, in the Givetian of Europe, rensselandiids occur in Benthic Assemblage 3, accompanied by Stringocephalus and related genera (Holzapfel, 1895; Torley, 1934). Therefore, the Stringocephalus Community (Fig. 3; Table 11c) is also assigned to the Rensselandiid Community Group, since Stringocephalus and the closely related genera which occur in this community outside eastern North America are placed, along with the rensselandiids, in the family Stringocephalidae King 1850. The low diversity Rensselandiid Community Group occurs in environments ranging from high energy Benthic Assemblage 1 to 3.

The Rensselandiid Community Group is an expansion of the Rensselandiid Community of Boucot (1975, p. 259). This change has been made in recognition of the three communities which are assigned to the Rensselandiid Community Group.

**Orthospirifer Community Group** (Figs. 6, 7)

The Orthospirifer Community Group includes those low to medium diversity, high energy Benthic Assemblage 2 communities
dominated by genera of large spiriferid brachiopods. A single

The Orthospirifer Community Group also includes the Orthospirifer Community of the Taghanic of the Appalachian Basin (Fig. 2; Table 11c) and the Pentamerella-Orthospirifer-Cranaena Community of the Iowa and Michigan Taghanic (Fig. 4; Table 12b). The Pentamerella-Orthospirifer-Cranaena Community is also included in the Atrypid-Gypiduliniid Community Group. This community, found in the Cedar Valley Limestone and correlative strata, is dominated by Orthospirifer, Cranaena, and Pentamerella, and represents a possible eocclinal mixture of the faunas of the Orthospirifer and Atrypid-Gypiduliniid Community Groups. However, the mixture of these faunas may simply reflect inadequate sampling of the Cedar Valley Limestone. Additional samples may permit the resolution of the Pentamerella-Orthospirifer-Cranaena Community into two communities, a Benthic Assemblage 2 community dominated by Orthospirifer and a Benthic Assemblage 3 community dominated by Cranaena and Pentamerella.

The Orthospirifer Community Group is ecologically analogous to the Hipparionyx Community of Boucot (1975); that is, both
communities occupy high energy Benthic Assemblage 2 environments and contain specimens of large spiriferid brachiopods. No genetic relationship is implied. Givetian to Frasnian communities assigned to this Community Group are included in the Nuculites-Palaeosolon Facies of the Genesee Group of New York by Thayer (1974). The Cypricardella and Bellerophon Communities of the Frasnian Sonyea Group of New York, described by Bown and others (1974), and the Cyrtospirifer-Cupularostrum Community of the Frasnian-Famennian Foreknobs Group of West Virginia, described by McGhee (1976) (McGhee described this community as the Cyrtospirifer-Camarotoechia Community, using 'Camarotoechia' for the genus described by Sartenaer, 1961, as Cupularostrum or a closely related Late Devonian rhynchonellid genus) are also included in the Orthospirifer Community Group.

The pelecypods for which the communities described by Thayer (1974) and Bowen and others (1974) are named are also found in the upper Middle Devonian, the greatest abundance of these pelecypods occurring in the Benthic Assemblage 2 Tropidoleptus, Mediospirifer, and Orthospirifer Communities. The Nuculites-Palaeosolon Facies of Thayer (1974) and the Cypricardella Community of Bown (1974) include three brachiopod-dominated communities descended from communities of the Middle Devonian. These Middle to Late Devonian communities, placed in Benthic Assemblage 2, include a high energy
Figure 8. Late Devonian Appalachian Basin Communities.

8A. Givetian to Frasnian Genesee Group of New York (Thayer, 1974).

8B. Frasnian Sonyea Group of New York (Bowen and others, 1974).

8C. Frasnian to Famennian Foreknobs Formation of Maryland and West Virginia (McGhee, 1976).
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Cupularostrum Community or a community dominated by closely related rhynchonellids, a high energy Orthospirifer Community, and a medium energy Tropidoleptus Community.

The Tropidoleptus Community and the communities assigned to the Orthospirifer and Devonochonetes Community Groups of the late Middle Devonian frequently contain abundant pelecypods. In some cases, the pelecypods make up a majority of the fauna. This is especially true in environments dominated by clay to silt-sized terrigenous clastics. However, the communities which I have described in this study are all based on their articulate brachiopod content. I do not know whether a series of communities based on pelecypods or other organisms would have boundaries coincident with those of brachiopod-based communities. Therefore, I will not attempt to describe precisely the development of late Middle Devonian brachiopod-based communities in terms of the communities of Thayer (1974), Bowen and others (1974), or McGhee (1976) which are not based on brachiopods.

Devonochoonetes Community Group (Figs. 6, 7)

Low energy, low diversity Benthic Assemblage 2 communities dominated by Devonochonetes and a low energy, low diversity Benthic Assemblage 2 community dominated by Longispina form the Devonochonetes Community Group. These two genera belong to
the family Chonetidae Bronn 1862, with Devonochonetes descended from Chonetes and Longispina descended from Protochonetes.

The Devonochonetes Community Group includes the Devonochonetes Communities of the Hamilton (Fig. 1; Table 8) and Traverse Groups (Fig. 3; Table 11c) and the Longispina Community of the Traverse Group (Fig. 3; Table 11c). The Benthic Assemblage 3 Longispina Community differs from the Benthic Assemblage 2 Devonochonetes Community of the Traverse Group in being dominated by Longispina rather than Devonochonetes and in occurring in black shale lenses interbedded with Benthic Assemblage 3 stromatoporoid-coralline limestones which represent lagoon-like areas of restricted circulation between organic reefs or banks. The Devonochonetes Community of the Traverse Group is found in calcareous shales and shaly limestones deposited under conditions of quiet water in depths characteristic of Benthic Assemblage 2.

The Chonetid Community of the Cedar Valley Limestone (Fig. 4; Table 12b) may be related to the Devonochonetes Community Group; however, it is not possible to determine from published studies the generic affinity of the chonetids which are found in this community. The Rhyssochonetes Community (Fig. 2; Table 10b) of the Tully Limestone is excluded from the Devonochonetes Community Group due to its occurrence in the deeper water Benthic Assemblage 4. The Mucrospirifer-Pholidostrophis Community of the Dundee-Rogers City
equivalents (**Leptaena-Schizophoria** Assemblage Zone) (Fig. 5; Table 13) resembles the communities of the **Devonochonetes** Community Group in that both occupy low energy Benthic Assemblage 2 environments and are characterized by low diversity. However, the Mucrospirifer-Pholidostrophia Community extends into Benthic Assemblage 3, few chonetids are present, and the fauna is closely related to that of the **Elytha** Community Group.

The **Devonochonetes** Community Group is a continuation of the Chonetid Community of Boucot (1975) which is dominated by Plebejochonetes or **Chonetes** sensu strictu, and occurs in the quiet water Benthic Assemblage 2 of the Early Devonian. The Early Devonian Chonetid Community may also be partly ancestral to the **Leptaena-Chonetid** Community of the **Leptaena-Schizophoria** Assemblage Zone (Fig. 5; Table 13) which contains abundant Devonochenetes. However, the **Leptaena-Chonetid** Community is also similar to the **Leptaena-Megakozlowskiella** Community of Feldman (1978). Both are medium diversity Benthic Assemblage 3 communities which are genetically related to the **Elytha** Community Group. The **Leptaena-Chonetid** Community may represent an eoclineal mixture of quiet water Benthic Assemblage 2 and 3 communities belonging to both the **Devonochonetes** and **Elytha** Community Groups.
The Elytha Community Group is divided into two major subgroups on the basis of diversity. The first subgroup, termed the Nucleospira Community Subgroup, includes medium to high diversity, relatively quiet water Benthic Assemblage 3 communities such as the Brevispirifer Community of the Leptaea-Schizophoria Assemblage Zone (Fig. 5; Table 13), the Atrypid-Strophodontid Community of the Hamilton Group (Fig. 1; Table 1), the Cyrtina-Athyris Community of the Traverse Group (Fig. 3; Tables 11a, 11b), the Spiriferid-Atrypid Community of the Cedar Valley Limestone (Fig. 4; Table 12a), and the Elytha Community of the Tully Limestone (Fig. 2; Table 10a). These communities represent the optimal environment for the largest number of articulate brachiopod genera.

The second subgroup, termed the Mucrospirifer Community Subgroup, includes the Mucrospirifer Communities of the Hamilton Group (Fig. 1; Table 2), the Gilboa Formation (Fig. 2; Table 10c), and the Williams Island Formation (Fig. 4; Table 12b), along with the Leptaea-Chonetid Community of the Leptaea-Schizophoria Assemblage Zone (Fig. 5; Table 13). The Mucrospirifer-Pholidostrophia Community belongs to the Mucrospirifer Community Subgroup, although it occupies a quiet water Benthic Assemblage 2 environment. The other communities of the Mucrospirifer
Community Subgroup are found in quiet water Benthic Assemblage 3 environments. The communities of the *Mucrospirifer* Community Subgroup are distinguished from those of the *Nucleospira* Community Subgroup by reduced diversity, due to the presence of an abundant supply of fine clastic sediments in the environments occupied by the *Mucrospirifer* Community Subgroup. This fine sediment of either terrigenous or biogenic origin, may have interfered with the filter-feeding processes of many brachiopods and also may have formed a substratum in which the larvae of many brachiopods had difficulty in attachment. The number of brachiopod taxa present in the *Mucrospirifer* Community Subgroup is thus reduced below the optimum level present in the *Nucleospira* Community Subgroup, although the numbers of individuals present in the *Mucrospirifer* Subgroup may be high. However, the presence of many genera common in the *Nucleospira* Community Subgroup in collections of the *Mucrospirifer* Community Subgroup provides a link between the two subgroups of the *Elytha* Community Group. The gradual nature of the division between the two community subgroups indicates that the subgroups are part of an ecoclineal spectrum ranging from low to high diversity.

The communities of the *Elytha* Community Group closely resemble and are descended from the *Amphigenia* Community of Boucot (1975), as many of the brachiopod genera which characterize the Emsian *Amphigenia* Community are found in the *Elytha* Community
Group of the late Middle Devonian. Feldman (1978) places his
Atrypa-Coelospira-Nucleospira, Atrypa-Megakozlowskiella, Lept-
taena-Megakozlowskiella, and Atrypa Communities in the Striispirifer
Community Group of Boucot (1975), and states that they are descended
from the Amphigenia Community of Boucot (1975). These Eifelian
(Onondaga Limestone) communities provide the link between the
Amphigenia Community of Boucot (1975) and the Elytha Community
Group. The Elytha Community Group is descended from the
Striispirifer Community Group of Boucot (1975). The name change
is in recognition of the major faunal and biogeographic change which
takes place in the Eastern Americas Realm between the Onondaga
Limestone and the Hamilton Group. The Onondaga brachiopod fauna
contains many taxa which were endemic to eastern North America
during the Early Devonian. At the end of Onondaga deposition, many
of these brachiopods, including Dalejina, Strophonella, Acrospirifer,
Megakozlowskiella, Coelospira, and Amphigenia, became extinct
(Fig. 7) and were replaced by migrants from outside the Eastern
Americas realm. Levenea and Pacificocoelia acutiplicata (Boucot,
1975; Boucot and Rehmer, 1977; Leptocoelina acutiplicata of Johnson,
1970, p. 121) became extinct shortly thereafter, during deposition
of the late Eifelian beds of the basal Marcellus Formation (Union
Springs Member in New York).

Feldman (1978) describes a gradient from high to low diversity
in his Atrypa-Coelospira-Nucleospira, Atrypa-Megakozlowskiella, Atrypa, and Leptaena-Megakozlowskiella Communities. This is similar to the ecoclineal gradient between the Nucleospira and Mucrospirifer Community Subgroups of the Elytha Community Group.

In the Givetian to Frasnian Genesee Group of New York, the Schizophoria-Strophomenid Facies of Thayer (1974) represents the Nucleospira Community Subgroup of the Elytha Community Group, while the Rhipidomella-Leiorhynchus Facies is a continuation of the Mucrospirifer Community Subgroup (Fig. 8). Similarly, the Productella Community of the Frasnian Sonyea Group (Bowen and others, 1974) is a representative of the Nucleospira Community Subgroup and the Rhipidomella Community of the same authors represents the Mucrospirifer Community Subgroup (Fig. 8). The Atrypa-Cypricardella Community and the Leptodesma-Tylothyris Community of McGhee (1976) (Fig. 8) are also representatives of the Elytha Community Group. However, due to the Frasnian-Famennian boundary and accompanying extinctions which occur in the upper part of the Foreknobs Formation of West Virginia from which these communities are described, and which may separate the Atrypa-Cypricardella Community (Frasnian) from the Leptodesma-Tylothyris Community (Famennian), I will not attempt to place these communities into the community subgroups which I have described above. It is doubtful that all of the Community Groups described in
this study will continue into the Famennian, as many of the dominant genera became extinct at the Frasnian-Famennian boundary.

Atrypid-Gypidulinid Community Group (Figs. 6, 7)

The communities in this Community Group characterize Benthic Assemblage 3 high energy carbonate environments, often associated with reefs, but also found in non-reefal shelf environments. These environments are characterized by hard bottoms of sand-size or larger carbonate grains or of firmly cemented carbonate rock, largely of biogenic origin. Wave and current action are sufficiently strong to remove all unconsolidated material in many instances. The characteristic brachiopods of these low to medium diversity communities are generally of spherical to ovoid shape, with thick, robust shells, often weighted in the beak to maintain an upright position in turbulent waters.

The Atrypid-Gypidulinid Community includes the Atrypid-Gypidulinid Communities of the Rogers City Limestone (Fig. 5; Table 13) and the Traverse Group (Fig. 3; Table 11c), as well as the Spinatrypa Community of the Tully Limestone (Fig. 2; Table 10a), and the Pentamerella-Orthospirifer-Cranaena Community of the Cedar Valley Limestone (Fig. 4; Table 12b). As mentioned above, the latter community contains elements of the Orthospirifer Community Group and the Atrypid-Gypidulinid Community Group and may
represent an ecoclinal mixture of these Community Groups. These two Community Groups favor similar environments with the exception that the Atrypid-Gypidiulinid Community Group is unknown in areas of terrigenous deposition. The absence of this Community Group may be associated with highly turbid water or lack of firm substrates; its absence in the Appalachian Basin may be related to the absence of reefs and other organic buildups in environments dominated by terrigenous clastics.

The Atrypid-Gypidulinid Community is ecologically similar to the Gypidulinidae Community Group of Boucot (1975) and may be descended from it. Both Community Groups are characterized by low diversity and occur in high energy Benthic Assemblage 3 environments. The Atrypid-Gypidulinid Community Group may have expanded its ecological range to include reef environments, which prior to the Eifelian had become extinct in the Michigan Basin. No communities described from the Late Devonian clastics of the Appalachian Basin are assigned to the Atrypid-Gypidulinid Community Group.

Ambocoeliid Community Group (Figs. 6, 7)

The Ambocoeliid Community Group is defined to include the Early Devonian Ambocoeliid Community of Boucot (1975) and the Middle and Late Devonian communities which are descended from it. The Ambocoeliid Community Group is descended from a deep water,
high diversity community of the *Dicoelosia-Skenidioides* Community Group of Boucot (1975) and is characterized by low diversity Benthic Assemblage 4 and 5 communities dominated usually by a single ambocoeliid genus, although two genera are present in the *Hypothyridina-Ambocoeliid* Community of the Tully Limestone (Fig. 2; Table 10b) and three genera are present in the Ambocoeliid Community of the Hamilton Group (Fig. 1; Table 3). Also assigned to the Ambocoeliid Community Group are the *Emanuella* Community of the Rogers City Limestone (Fig. 5; Table 13) and the *Emanuella* Community of the Little Rock Creek Limestone (Fig. 4; Table 12b).

The Givetian to Frasnian *Ambocoelia* Facies of the Genesee Group (Thayer, 1974) extends the Ambocoeliid Community Group into the Late Devonian. This Community Group is also represented in the *Ambocoelia-Chonetes* Community described by McGhee (1976) from the Frasnian-Famennian Foreknobs Formation of West Virginia.

**Evolutionary Relationships of Unassigned Communities**

The Benthic Assemblage 1 to 2, high energy, low diversity *Cupularostrum* Community (Figs. 1, 2, 3, 6; Tables 6, 10a, 11c) is identical to the Silurian-Devonian Rhynchonellid Community as described by Boucot (1975). Communities dominated by *Cupularostrum* or closely related rhynchonellids are known from the Late Devonian of the Appalachian Basin. Thayer (1974) includes the *Cupularostrum*
Community in the *Nuculites-Palaeosolon* Facies of the Givetian to Frasnian Genesee Group, while Bowen and others (1974) include it in the *Cypricardella* and *Bellerophon* Communities of the Frasnian Sonyea Group. As mentioned above, the pelecypods which characterize these post-Tully communities are found also in the Hamilton Group and the *Nuculites-Palaeosolon* Facies and the *Cypricardella* Community each contain equivalents of three Hamilton brachiopod-based communities. The *Bellerophon* Community contains *Productella*, *Mucrospirifer*, *Leiorhynchus*, and *Cupularostrum* or a similar rhynchonellid; it appears to incorporate elements of the Hamilton *Mucrospirifer* and *Cupularostrum* Communities. The *Cyrtospirifer-Cupularostrum* Community (described by McGhee, 1976) of the Frasnian-Famennian Foreknobs Formation of West Virginia incorporates elements of both the *Orthospirifer* Community Group and the *Cupularostrum* Community.

The *Tropidoleptus* Community (Figs. 1, 2, 5, 6; Tables 5, 10a, 13) is known from the Early Devonian of the Rhenish-Bohemian Region and the Early Devonian and/or Eifelian of the Malvinokaffric Realm (Boucot, 1975). This brachiopod migrated into the Eastern Americas Realm during the Eifelian (Isaacson and Perry, 1977), near the onset of deposition of the Hamilton Group. The *Tropidoleptus* Community is known from the *Leptaena-Schizophoria* Assemblage Zone in southern Indiana (Fig. 5; Table 13), the Hamilton Group (Fig. 1;
Table 5), and the Gilboa Formation (Fig. 2; Table 10a). Thayer (1974) includes the **Tropidoleptus** Community, along with the **Cupularostrum** Community and the **Orthospirifer** Community Group in the Nuculites-Palaeosolon Facies of the Givetian-Frasnian Genesee Group. Likewise, Bowen and others (1974) place the **Tropidoleptus** Community in their **Cypricardella** Community, described from the Frasnian Sonyea Group. The pelecypods for which these communities are designated are also present in the Benthic Assemblage 2 **Tropidoleptus** and **Cupularostrum** Communities and the **Orthospirifer** Community Group of the Middle Devonian. McGhee (1976) does not report **Tropidoleptus** from the Frasnian-Famennian Foreknobs Formation of West Virginia.

**Rhipidothyris** is regarded as a descendant of **Globithyris** (Cloud, 1942; Boucot, 1975) and the **Rhipidothyris** Communities of the Gilboa Formation (Fig. 2; Table 10a) and Traverse Group (Fig. 3; Table 11c) are regarded as both ecological analogs and genetic descendants of the Lower Devonian **Globithyris** Community of the Appohimchi Subprovince (Boucot, 1975). Both are low diversity, low energy Benthic Assemblage 2 communities. No related communities are known from the Late Devonian of the Appalachian Basin.

The **Truncalosia** Community is peculiar to the Appohimchi Subprovince of the late Middle Devonian. While the small size of the brachiopods in this community is a characteristic shared with
other Benthic Assemblage 5 communities, the extremely low diversity is unique to the Truncalosia Community. This low diversity is attributed to the abundance of mud, plus possible anaerobic conditions in the deepest parts of the Appalachian Basin. The Plumalina Facies described from the Givetian to Frasnian Genesee Group by Thayer (1974) contains a single brachiopod, Productella. This deep water Benthic Assemblage 4 or 5 community is similar to the Truncalosia Community of the Hamilton Group, although the dominant brachiopod genera are unrelated.

In the upper Middle Devonian of eastern North America, Warrenella is known only from the Delaware Limestone of central Ohio. However, it is common elsewhere, including the Givetian of western and arctic North America. Boucot (1975, p. 263) mentions a Warrenella-Rhynchonellid Community, also mentioned by Noble and Ferguson (1971) and Johnson (1971), that occurs in Benthic Assemblages 4 and 5 in western North America. This community is similar to the Warrenella Community of the Delaware Limestone in that both are characterized by low diversity and occupation of low energy Benthic 4 to 5 environments. Savage and Boucot (1978) describe an Eifelian Warrenella Community from the Kennett Formation in the Klamath Mountains of California. This is a low diversity community in which Warrenella comprises about 80% of the fauna. The Warrenella Community of Savage and Boucot (1978) occurs under
quiet water conditions, on soft bottoms. **Warrenella** ranges from lower Benthic Assemblage 3 to Benthic Assemblage 5, although the *Warrenella*-dominated communities are restricted to Benthic Assemblage 4 and perhaps 5. The Delaware Limestone *Warrenella* Community also contains the rhynchonellid **Camarotoechia** which is closely related to **Leiorhynchus** of the *Warrenella*-Rhynchonellid Community. *Warrenella* occurs in the Givetian to Frasnian Genesee Group of New York; Thayer (1974) places it in his Cladochonous Facies, in which it is the only brachiopod present. *Warrenella* has also been reported, as "Spirifer" laevis or "Reticularia" laevis from the Jordan River Formation of the northwestern Michigan Basin (Kesling and others, 1974), and from the Alto Formation of southern Illinois (Collinson, 1967).

A **Camarotoechia** Community characteristic of restricted environments has not been reported from strata older than the late Middle Devonian. However, similar communities are known from younger rocks. Thayer (1974) reports **Leiorhynchus**, a closely related rhynchonellid genus, from the Styliolina-Brachiopod Facies of the Genesee Group, in which it is the only brachiopod present.

The **Pacifococoelia** Community of Feldman (1978) (Johnson, oral communication, considers Pacificocoelia to be a Leptocoelina) is found in samples from the basal Marcellus (Union Springs Member in New York) Shale in the Appalachian Basin (Cleland, 1903; Table 9,
Samples 0944, 1463). This is the highest known occurrence of this low diversity Onondaga community. Although Feldman (1978) suggests that the low diversity of the Pacificocoelia Community indicates a nearshore position, the communities present in the adjacent strata, including the "Chonetes" Community (Feldman, 1978) and the Camarotoechia Community, suggest that the Marcellus Pacificocoelia Community should be assigned to Benthic Assemblage 4 or 5. The Pacificocoelia Community is placed in the Leptocoeliidae Community Group of Boucot (1975) and is descended from the Early Devonian Coelospira-Pacificocoelia Community of the Appohimchi Subprovince (Boucot, 1975, described as the Coelospira-Leptocoelia Community; Boucot and Rehmer, 1977, redefined as Coelospira-Pacificocoelia Community). Both communities occupied quiet water Bentic Assemblage 4 to 5.
BIOSTRATIGRAPHY

Figure 9 shows five biostratigraphic units based on brachiopods which I recognize in the upper Eifelian through Givetian rocks of eastern North America. These units are not related to the evolution of the brachiopods involved in their recognition; their boundaries are unrelated to the first or last appearances of genera or species. The upper, middle, and lower units are assemblage zones in the sense of Johnson and Niebuhr (1976), that is, assemblages of fauna and environment which coexisted over much of eastern North America for geologically significant intervals of time. The upper and lower boundaries of these assemblage zones represent the migrations of specific faunal elements into or out of the area of study. These assemblage zones result from changes in paleobiogeographic boundaries which allowed elements of previously separated faunas to exist.

The three assemblage zones are separated by units which are not designated as zones. These units do not contain insignificant thicknesses of strata nor do they represent minute intervals of time. However, the faunas of these two units consist of genera that have long ranges in the late Middle Devonian of eastern North America, are largely facies-controlled, and are of little value in regional correlation. *Rhipidomella, Tropidoleptus, Strophodonta, Protoleptostrophia, Pholidostrophia, "Schuchertella," Devonochonetes, Longispina,*
Spinulicosta, Truncalesia, Mucrospirifer, Mediospirifer, Spinocytia, Orthospirifer, Cyrtina, Athyris, Ambocoelia, Emanuella, Pseudoatrypa, Cupularostrum, and Camarotoechia are found within these units, but mark no useful biostratigraphic horizons. Correlation of these units, the lower of which is equivalent to the Skaneateles Formation and upper Marcellus Formation of New York, and the upper of which contains the Moscow and upper Ludlowville Formations, can be accomplished locally, and, in unusual cases, regionally, by tracing small scale changes in the positions of lithofacies and communities in response to epeirogenic and tectonic fluctuations of sea level. This model for correlation is discussed in the final section of this report.

**Leptaena-Schizophoria Assemblage Zone**

The oldest zone recognized in the late Middle Devonian of eastern North America is designated the Leptaena-Schizophoria Assemblage Zone. It ranges from the late Eifelian into the earliest Givetian, incorporating the lower part of the Cazenovia Stage of eastern North America. The base of this zone is designated as the top (top of the uppermost layer where multiple beds are present) of the Tioga Bentonite. The top of the zone is the uppermost occurrence of Schizophoria in the Hamilton Group of eastern New York. The lower part of this zone is characterized by brachiopods such as Leptaena, Schizophoria, and Brevispirifer, which occur in underlying
Eifelian age limestones. The rock units in the lower part of the Leptaena-Schizophoria Assemblage Zone include the Union Springs Shale and Bakoven Members of New York, the Dundee Limestone of Michigan and Ohio, the Speeds Limestone of southern Indiana, and the Howardton Member of the Lingle Formation of southern Illinois. The upper part of the Leptaena-Schizophoria Assemblage Zone, including the Stony Hollow and Cherry Valley Members of New York, the Purcell Member of the central Appalachians, and the Rogers City Limestone of Michigan, are characterized by a fauna containing several elements formerly endemic to the Old World Realm. These brachiopods include *Desquamatia arctica*, *Carinatrypa*, *Kayserella*, and a small *Pentamerella* similar to *P. winterei* from Nevada (Johnson, oral communication).

The Leptaena-Schizophoria Assemblage Zone is recognized in the Illinois and Appalachian Basins on the occurrence of *Leptaena* and *Schizophoria*. In New York, *Leptaena* and *Schizophoria* are known from the Stony Hollow Member, the Otsego Member, and the Mount Marion Formation. Other strata of this age in New York Pennsylvania, Maryland, and the Virginias are of a deeper water facies, representing Benthic Assemblage 4 or 5, which does not contain fossils characteristic of this zone. However, strata in these areas can be correlated lithologically with those of eastern New York, where the fauna characteristic of this zone is found.
Although *Schizophoria* disappears from the area of New York and Pennsylvania between the top of the *Leptaena-Schizophoria* Assemblage Zone and the base of the *Rhyssochonetes-Hypothyridina* Assemblage Zone, it remains in the Michigan Basin throughout the late Middle Devonian. In the Michigan Basin, and also in the Illinois Basin, *Brevispirifer* is used to recognize the *Leptaena-Schizophoria* Assemblage Zone. The Speeds Member of southern Indiana is assigned to the *Leptaena-Schizophoria* Assemblage Zone on the basis of the presence of *Leptaena, Schizophoria, and Brevispirifer*. In southern Illinois, the Howardton Member of the Lingle Formation is also assigned to this zone. *Leptaena* and *Schizophoria* are common in the Howardton and unknown above it, while *Brevispirifer* occurs in strata of the St. Laurent Formation in eastern Missouri which correlate with the Howardton.

The Delaware Limestone of Ohio contains *Leptaena* and is placed in the *Leptaena-Schizophoria* Assemblage Zone. *Warrenella* is found only in the Delaware in pre-Taghanic rocks of eastern North America and may also be of value in defining the *Leptaena-Schizophoria* Assemblage Zone.

The Rogers City Limestone which overlies the Dundee contains characteristic Old World Realm brachiopods such as *Carinatrypa* and *Desquamatia arctica* (considered by Johnson, oral communication, to be a *Variatrypa*). Old World Realm brachiopods, including *Kayserella,*
a small *Pentamerella* similar to *P. winterei* Johnson 1971 from Nevada (Johnson, oral communication), and a finely ribbed atrypid externally similar to *Desquamatia*, are also known from the Cherry Valley and Stony Hollow Members of New York, while *Desquamatia* and *Carinatrypa* are also found in the Lake Church Formation of Wisconsin and the Murray Island Formation of the James Bay region of Ontario. These occurrences of an Old World Realm fauna within the Eastern Americas Realm represent the effect of a sea level rise which produced major transgression over much of eastern North America and are time equivalent. Rock units which represent this transgression include the Cherry Valley, Purcell, and Stony Hollow Members of the Appalachian Basin and the Rogers City Limestone of the Michigan Basin. Other transgressions, such as that culminating in the Centerfield Limestone of the basal Tioughnioga, and the Taghanic onlap (Johnson, 1970), are also of use for correlation in the upper Middle Devonian of eastern North America; they are considered below.

At the upper boundary of the *Leptaena-Schizophoria* Assemblage Zone, *Leptaena* nearly disappears from eastern North America while *Brevispirifer* becomes extinct. *Schizophoria* becomes restricted to the Michigan Basin-Hudson Bay Lowland Subprovince at this time. Simultaneously, the Old World Realm genera disappeared from the Eastern Americas Realm, with the exception of *Undispirifer* and
Stringocephalus, which remained in the Michigan Basin-Hudson Bay Lowland Subprovince. Leptaena and Schizophoria continued to be present in the Old World Realm.

**Fimbrispirifer-Pentagonia Assemblage Zone**

The **Fimbrispirifer-Pentagonia** Assemblage Zone is the most widespread biochronologic unit prior to the Taghanic in the upper Middle Devonian of eastern North America. It occupies the base of the Tioughnioga Stage as recognized in eastern North America. In terms of conodont biostratigraphy, the **Fimbrispirifer-Pentagonia** Assemblage Zone occupies the lower part of the Lower varcus Zone (Ziegler, Klapper, and Johnson, 1976). The existence of this brachiopod zone was recognized by Cooper and Warthin (1942), who noted that a fauna closely related to that of the Onondaga Limestone recurs at several levels within the Hamilton Group. The Mottville, Stafford, Tichenor, and Portland Point Members contain elements of this fauna, but it is best developed in the Centerfield Member. This fauna is typical of the Atrypid-Strophodontid Community of Benthic Assemblage 3 and is composed largely of members of earlier Devonian Eastern Americas Realm stocks. Common elements of this fauna include the brachiopods Atribonium, Callipleura, Cryptonella, Centronella, Camarospira, Pentagonia, Parazyga, Leptospira, Fimbrispirifer, and Pustulatia.
The *Fimbrispirifer-Pentagonia* Assemblage Zone marks the basal Tioughnioga transgression which spread the conditions necessary for the development of this fauna over a wide area of eastern North America. This rise in sea level breached the barriers which had separated the Appohimchi and Michigan Basin-Hudson Bay Lowland Subprovinces and allowed this characteristically Appohimchi fauna to become established in the Michigan Basin. The *Fimbrispirifer-Pentagonia* Assemblage Zone is represented in the Michigan Basin by the Logansport, Four Mile Dam, Charlevoix, and uppermost Gravel Point Formations. The top of the *Fimbrispirifer-Pentagonia* Assemblage Zone is marked in the Michigan Basin by the disappearance of the characteristic fauna, although *Spinocyrtia*, which, in North America, is confined to the Appohimchi Subprovince, lingered on through the Norway Point Formation. On the southern flank of the Michigan Basin and on the margins of the Illinois Basin, strata above the basal Tioughnioga and below the Taghanic were not deposited or have been removed by erosion.

Other rock units included within the *Fimbrispirifer-Pentagonia* Assemblage Zone include the Hungry Hollow Limestone of Ontario, the Prout Limestone of north-central Ohio, the Ten Mile Creek Dolomite of northwestern Ohio and southeastern Michigan, the Beechwood Member of southern Indiana, the Pegram Limestone of Tennessee (Foerste, 1901; Cooper and Warthin, 1942), the Walnut...
Grove Member of the Lingle Limestone of southern Illinois, and the Clifty Formation of Arkansas. The *Fimbrispirifer-Pentagonia* Assemblage Zone can be traced from the Centerfield Limestone of western New York into the Stone Mill Limestone of central New York and into the Mahantango Formation of northeastern Pennsylvania (Epstein, Sevon, and Glaeser, 1974) and may be present in the Chaneysville Siltstone of south-central Pennsylvania (Ellison, 1965).

**Rhyssochonetes-Hypothyridina Assemblage Zone**

The *Rhyssochonetes-Hypothyridina* Assemblage Zone is defined to include strata in eastern North America of the same age as the Tully Limestone of New York, equal to much of the Taghanic Stage of Cooper and others (1942). These rocks contain a brachiopod fauna previously unknown to eastern North America, the characteristic genera of which migrated into the Eastern Americas Realm during the Taghanic rise of sea level and associated transgression. Of these brachiopods, *Rhyssochonetes, Mesoleptostrophia, Leptaena, Hypothyridina, Leiorhynchus, Meristella, and Productella*, are found throughout the Eastern Americas Realm, while *Desquamatia* and *Rensselandia* are known only from the Cedar Valley Limestone in Iowa, a part of the Michigan Basin-Hudson Bay Lowland Subprovince. *Schizophoria* is again found in the Appohimchi Subprovince after an absence which began at the termination of the *Leptaena-Schizophoria*
Assemblage Zone. The \textit{Rhyssochonetes-Hypothyridina} Assemblage Zone corresponds to the middle and upper part of the Middle \textit{varcus} Zone and the Upper \textit{varcus} Zone of Ziegler, Klapper, and Johnson (1976).

Rock units which fall within the \textit{Rhyssochonetes-Hypothyridina} Assemblage Zone include the Tully Limestone of central New York along with the correlative lower part of the Gilboa Formation of eastern New York. The various Tully "Members" recognized in Pennsylvania, Maryland, and the Virginias are also included in the \textit{Rhyssochonetes-Hypothyridina} Assemblage Zone. The lower part of the Solon Member of the Cedar Valley Limestone (\textit{independens} and \textit{profunda} Beds) is also placed in this zone. Although the diagnostic brachiopods are lacking in these units, the Little Rock Creek Limestone of northern Indiana, the Wapsipinicon Formation of Iowa, and the lower beds of the Blocher Shale of the New Albany Group in southern Indiana are placed in the \textit{Rhyssochonetes-Hypothyridina} Assemblage Zone on the basis of their relationships to other rock units, combined with the ecofacies model which is discussed in a later section of this report. The brachiopod fauna of the lower limestone and shale of the Williams Island Formation of the James Bay region of Ontario indicates that these strata belong to the \textit{Rhyssochonetes-Hypothyridina} Assemblage Zone. The Potter Farm,
Thunder Bay, and Whiskey Creek Formations of northern Michigan correlate with this zone on the basis of their conodont fauna.
PALEOBIOGEOGRAPHY

The articulate brachiopod paleobiogeography of the Early Devonian has been described by Boucot and Johnson (1967), Boucot, Johnson and Talent (1969), and Boucot (1975). During the Early Devonian and early Middle Devonian (Eifelian), eastern North America is assigned to the Appohimchi Subprovince of the Eastern Americas Realm (Boucot, 1975). The Early Devonian brachiopod fauna of the Appohimchi Subprovince is distinct, in that it contains 10% to 25% endemic genera, from the faunas of the Amazon-Colombian Subprovince of South America and the Nevadan Subprovince of western North America. Although all the area of eastern North America considered in this study is assigned to the Appohimchi Subprovince during the Early Devonian, the Eifelian faunas of the Midwest are too poorly known to determine whether only a single paleobiogeographic unit is present in the Eifelian.

The terminology for paleobiogeographic units used in this study follows the usage of Kauffman (1973). Realms contain 75% or more endemic genera, regions contain 50% to 75% endemics, provinces contain 25% to 50% endemics, and endemic centers contain 5% to 10% endemics. Boucot (1975, p. 266) discusses the advantages and disadvantages of this system of biogeographic classification, including the usefulness of not adhering rigidly to the numerical limits of Kauffman.
Figure 10 shows the ranges of articulate brachiopods in the Eastern Americas Realm at several intervals in the upper Middle Devonian. The faunas of the early Cazenovia are compared in the columns labeled "Leptaena-Schizophoria Assemblage Zone." Likewise, the late Cazenovia faunas of the Appalachian and Michigan Basins are compared in the columns labeled, respectively, "Lower Hamilton" and "Lower Traverse." The basal Tioughnioga faunas are compared in the columns labeled "Fimbrispirifer-Pentagonia Assemblage Zone." The "Upper Hamilton" column lists the upper Tioughnioga faunas of the Appalachian Basin, while the "Norway Point" column contains the upper Tioughnioga fauna of the Michigan Basin. The Taghanic faunas of the Michigan and Appalachian Basins are described under the heading "Rhyssochonetes-Hypothyridina Assemblage Zone." The column labeled "Intermediate" lists the fauna of the boundary region that separates the two subunits of the Eastern Americas Realm.

Figure 10 summarizes the data for the Middle Devonian Eastern Americas Realm presented in Tables 1 to 13. Data concerning the distribution of Early Devonian and Eifelian articulate brachiopods is taken from Johnson (1971b). Johnson (1971b) is also the source for information concerning the occurrences of late Middle Devonian brachiopods in the Old World Realm.
Mixture of Eastern Americas Realm and Old World Realm
Faunas in the Upper Middle Devonian
of Eastern North America

The Hamilton fauna has intrigued paleontologists for many years because it contains a mixture of North American and European lineages. In modern terminology, both earlier Devonian Eastern Americas Realm and earlier Devonian Old World Realm lineages are represented in the late Middle Devonian Eastern Americas Realm. Many of the earlier Devonian Eastern Americas Realm stocks died out in the Eifelian (upper Onondaga or post-Onondaga). Among genera that became extinct either during Onondaga deposition or at the base of the Hamilton Group are Levenea, Dalejina, Strophonella, Acrospirifer, Megakozlowskiella, Coleospira, Amphigenia, and Pacifico-coelia (Assigned by Johnson, oral communication, to Leptocoelina).

Many endemic earlier Devonian Eastern Americas Realm brachiopod lineages have representatives in the late Middle Devonian of eastern North America. Among these are Rhipidomella, Strophodonta, Protodouvillea, Protoleptostrophia, Megastrophia, Pholidostrophia, Fimbrispirifer, Elytha, Pentagonia, Parazyga, Leptospira, Pustulatia, Cupularostrum, Cranaena, Cryptonella, and Centronella.

Several brachiopod genera with earlier Devonian endemic Old World Realm antecedents are known in the lowest Hamilton beds and their equivalents elsewhere in eastern North America. These include
Tropidoleptus, Devonochonetes, Longispina, Paraspirifer, Spinastryga, and Athyris. Also present during the late Middle Devonian of eastern North America are representatives of earlier Devonian cosmopolitan stocks. Among these are Schizophoria, Leptaena, "Schuchertella," Gypidula, Pentamerella, Mucrospirifer, "Tylothyris," Mediospirifer, Spinocyrtia, Orthospirifer, Cyrtina, Nucleospira, Meristina, Ambocoelia, Emanuella, Rhynchospirina, and Spinulicosta.

Migrations of Old World Brachiopods into the Eastern Americas Realm During the Late Middle Devonian

Late Middle Devonian occurrences of otherwise endemic Old World Realm brachiopod genera in the Eastern Americas Realm are concentrated at two stratigraphic intervals. The earliest interval is approximately at the Eifelian-Givetian boundary. The latest Eifelian Rogers City Limestone of Michigan contains two atrypid genera, Carinatrypa and Desquamata (the latter genus, based on Atrypa arctica Warren, has been referred to Variatrypa by Johnson, oral communication). These genera also occur in the correlative Lake Church Formation of Wisconsin and the Murray Island Formation of the James Bay region of Ontario. A fine-ribbed atrypid externally similar to Desquamata and a small Pentamerella very similar to P. winterei Johnson 1966 from the Roberts Mountains in Nevada
(Johnson, 1970) occur in the Stony Hollow Member of New York. The Old World endemic *Kayserella* is also found in the Stony Hollow Member. *Warrenella*, an Old World endemic, is found in the Delaware Limestone of Ohio, a correlative of the Dundee Limestone which underlies the Rogers City. The Eifelian-Givetian boundary was a time of limited migration of Old World Realm genera into the Eastern Americas Realm. This migration characterizes the upper part of the *Leptaena-Schizophoria* Assemblage Zone, as discussed previously.

Rocks of Taghanic age in the Eastern Americas Realm are also characterized by the presence of former Old World Realm endemics (Johnson, 1970; 1971b). *Productella*, *Leiorhynchus*, *Hypothyridina*, and *Rhysochonetes* occur in the Cedar Valley Limestone of Iowa and Missouri and in the Tully Limestone and its equivalents in the Appalachian Basin. *Desquamatia* (*Independatrypa*), *D.* (*Neatrypa*), and *Anathyris* occur in the Cedar Valley. The presence of these genera in the Eastern Americas Realm is the basis for the *Rhysochonetes-Hypothyridina* Assemblage Zone which is defined above. The migrations of Old World endemics into the Eastern Americas Realm at the Eifelian-Givetian boundary and during the Taghanic are associated with major marine transgressions, associated with the Cherry Valley and Tully Limestone and correlative rocks, and related to sea-level rises, which are discussed below.
Stringocephalus and Undispirifer, both Old World endemics at earlier and later times, are found in the Traverse Group of Michigan during the early Givetian (Cazenovia). The former genus occurs in the Miami Bend Limestone and the latter genus in the Bell Shale. The presence of these genera indicates that a connection between the Michigan Basin and the Old World Realm persisted beyond the base of the Givetian. This will be considered in more detail in the next section.

**Provinciality Within the Eastern Americas Realm**

During the late Middle Devonian, the brachiopods of the Eastern Americas Realm form two paleobiogeographic subunits, each characterized by a group of restricted genera, including endemic genera as well as genera known from outside the Eastern Americas Realm. One paleobiogeographic unit, the Appohimchi, occurs within the Appalachian Basin from Montreal on the north, through New York, Pennsylvania, Maryland, the Virginias, Kentucky, Tennessee, southern Illinois, eastern Missouri, and northwestern Arkansas. The Appohimchi Subprovince or Province (see below for distinction), is a direct continuation of the Early Devonian Appohimchi Subprovince of Boucot (1975). The second unit, the Michigan Basin-Hudson Bay Lowland Subprovince (Oliver, 1976), extends from northern Missouri through Iowa, northwestern Illinois, eastern Wisconsin, northern
Indiana, Michigan, to the James Bay region of Ontario. Oliver (1976) bases the recognition of this paleobiogeographic unit on the presence of Old World Realm coral genera in the Michigan Basin and Hudson Bay Lowland areas during the Givetian, beginning with the Rogers City Limestone of Michigan and ending at the close of the Givetian.

Boucot (1975) defined the Appohimchi as a subprovince. However, during the late Middle Devonian, the status of the Appohimchi changes, as the percentage of endemic genera changes. I consider the Appohimchi of the Leptaena-Schizophoria Assemblage Zone to be a subprovince, although it contains only 9.1% endemics. During the late Cazenovia, 27.9% endemic genera make the Appohimchi a province. During the Fimbrispirifer-Pentagonia Assemblage Zone, endemism decreases to 14.3%, returning the Appohimchi to subprovince status. During the late Tioughnioga, the Appohimchi contains 28.6% endemics, and is a province. During the Taghanic, however, a decrease to 5.0% endemics returns the Appohimchi to subprovince status. The Michigan Basin-Hudson Bay Lowlands Subprovince remains at all times a subprovince, as genus level endemism never increases above 14.2%.

Figures 11 and 12 show the changing relationships between these two paleobiogeographic units. In the Leptaena-Schizophoria Assemblage Zone of the early Cazenovia (defined in the previous section of this report), near the Eifelian-Givetian boundary, 57.5% of the
articulate brachiopod genera of the Eastern Americas Realm are shared between the two subprovinces. 42.5% of the Appohimchi fauna is restricted to the subprovince, while 9.1% of the Appohimchi fauna is endemic. 22.6% of the fauna of the Michigan Basin-Hudson Bay Lowlands Subprovince is restricted to the subprovince; 3.2% of the fauna is endemic. During the late Cazenovia, the percentage of genera shared between the Appohimchi and the Michigan Basin-Hudson Bay Lowlands falls to 47.2%; 41.9% of the Appohimchi fauna is restricted to the province, 27.9% of the Appohimchi fauna is endemic; 28.6% of the Michigan Basin-Hudson Bay Lowlands fauna is restricted, while 14.2% of the fauna is endemic to the subprovince.

The brachiopod faunas of the early Cazenovia are not as restricted as those of the late Cazenovia. Many brachiopods that are restricted to the Appohimchi belong to lineages that were present in but not necessarily endemic to the Appohimchi during the Early Devonian. Among these are Protodouvillina, Elytha, Meristina, and Pacificocoelia. Paraspirifer, Spinocyrtia, and Tropidoleptus, restricted to the Appohimchi, migrated westward into the Eastern Americas Realm from the Old World Realm (Rhenish-Bohemian Region) during the Eifelian. Truncalosia appears in the Appohimchi during the early Cazenovia. Kayserella is present only in the Stony Hollow Member of eastern New York. This characteristic Old World genus migrated into the Appohimchi during the sea-level rise in the
upper part of the Leptaena-Schizophoria Assemblage Zone.

Among genera restricted to the Michigan Basin-Hudson Bay Lowland Subprovince during the early Cazenovia, *Brevispirifer*, found in Eifelian rocks of the Midwest, such as the Jeffersonville and Grand Tower Limestones, is absent from the correlative Onondaga Limestone of the Appalachian Basin. *Brevispirifer* is also known from Eifelian rocks in eastern Quebec, where it is associated with an Old World Realm brachiopod fauna (Boucot, 1975). If *Brevispirifer* is considered to be of Old World origin, the presence of this Old World brachiopod in the Midwest would suggest a division in the Eifelian age rocks similar to that which I have documented for later Middle Devonian rocks. *Orthospirifer* is endemic to the Michigan Basin-Hudson Bay Lowland Subprovince from its appearance in the late Eifelian. Only during the Taghanic does *Orthospirifer* migrate into the Appalachian Basin and displace the related genera *Spinocyrtia* and *Mediospirifer*. *Gypidula* is restricted to the Michigan Basin-Hudson Bay Lowlands Subprovince throughout the Eifelian and Givetian. As mentioned above, *Carinatrypa* and *Desquamatia*, both Old World endemics, are limited to the Michigan Basin-Hudson Bay Lowland Subprovince. These two genera are found in the Rogers City Limestone of Michigan, the Lake Church Formation of eastern Wisconsin, and the Murray Island Formation of the James Bay region of Ontario. *Warrenella*, another Old World endemic, is known in the
Eastern Americas Realm only from the late Eifelian Delaware Limestone of central Ohio. This is the boundary region of the Appohimchi Subprovince and the Michigan Basin-Hudson Bay Lowland Subprovince, as is discussed below. As the majority of Old World endemics known from the Eastern Americas Realm are restricted to the Michigan Basin-Hudson Bay Lowland Subprovince, Warrenella is considered to be restricted to this subprovince.

The increased provincialism of the late Cazenovia is due to an increase in the number of genera endemic to a single subprovince. Leptaena, which is common in both subprovinces during the early Cazenovia, disappears from the Eastern Americas Realm during the late Cazenovia and does not return until the Taghanic. Schizophoria, common to both subprovinces during the early Cazenovia, becomes restricted to the Michigan Basin-Hudson Bay Lowlands Subprovince during the late Cazenovia. Endemic genera, such as "Sieberella" romingeri (see discussion in section on community description), Helaspis, Devonalosia, Orthospirifer, and Atribonianum are unknown outside the Michigan Basin-Hudson Bay Lowland Subprovince. Genera which belong to endemic lineages in the Early Devonian Appohimchi Subprovince are unknown from the Michigan Basin-Hudson Bay Lowland Subprovince. These genera include Rhipidomella, Protodouvilleina, Megastrophia, Fimbrispirifer, Elytha, Leptospira, Pustulatia, and Centronella. Tropidoleptus and Paraspirifer, migrants from the
Rhenish-Bohemian region, do not reach beyond the boundary region between the Appohimchi Province and the Michigan Basin-Hudson Bay Lowland Subprovince. Cosmopolitan forms such as *Spinocyrtia* and *Mediospirifer* are restricted to the Appohimchi Province. *Undispirifer* and *Stringocephalus*, which migrated into the Michigan Basin-Hudson Bay Lowland Subprovince from the Old World Realm of western or arctic North America, did not enter the Appohimchi Province.

Oliver (1976) and Oliver and Pedder (in press) note similar migration patterns among rugose corals of the upper Middle Devonian of eastern North America. They find that the coral faunas of the Miami Bend and Rogers City Formations of the Michigan Basin-Hudson Bay Subprovince are composed largely of Old World endemics. This is true also of the brachiopod faunas of these formations. However, the environmentally restricted nature of the brachiopod fauna of the Miami Bend Formation makes correlation difficult. The stromatoporoid-coraline limestones of the Miami Bend contain only the very high energy, Benthic Assemblage 2 *Subrensselandia* Community and the high energy, Benthic Assemblage 3 *Stringocephalus* Community. Although the overall similarity of the invertebrate faunas led Cooper and Phelan (1966) to correlate the Miami Bend and the Rogers City, the brachiopod and molluscan faunas are indicative of similar high energy, shallow water environments, rather than chronological equivalence. Conodont data suggests that the Rogers
City is late Eifelian (Buitynck, 1976), while the Miami Bend is early Givetian (Orr, 1971).

Oliver (1976) and Oliver and Pedder (in press) also state that a mixture of Old World Realm and Eastern Americas Realm rugose corals is known from the Traverse Group of northern Michigan. However, whether corals of different paleobiogeographic affinities lived simultaneously in any given stratum and place is not stated. As only two Old World Realm brachiopod genera are known from the Traverse Group, the brachiopod data are too sparse for useful comparison. Undispirifer occurs in the Bell Shale with a large fauna of Eastern Americas Realm endemics, while Stringocephalus occurs in a high energy, Benthic Assemblage 3 environment in which few other brachiopods are likely to be found.

Oliver (1976) and Oliver and Pedder (in press) base their division of the Eastern Americas Realm into two provinces on the presence of Old World endemic rugose coral genera in the Michigan Basin-Hudson Bay Lowland Subprovince. These Old World endemics are lacking in the Appohimchi Province. The division of these provinces on the basis of brachiopods is not based on the presence of Old World endemics in the Michigan Basin-Hudson Bay Lowland Province, because such endemics do not make up a great part of the fauna. Rather, the differentiation of these provinces is based on the levels of endemism and restriction shown by their brachiopod faunas.
The basal Tioughnioga strata of the *Fimbrispirifer-Pentagonia* Assemblage Zone, such as the Centerfield Limestone of the Appalachian Basin and the Four Mile Dam Formation of northern Michigan, represent a brief interval of decreased provinciality in the Eastern Americas Realm. 62.5% of the articulate brachiopod genera of the Eastern Americas Realm are shared between the two subprovinces at this time. In the Appohimchi Subprovince, 14.3% of the brachiopods are restricted and 28.8% are endemic, while in the Michigan Basin-Hudson Bay Lowland Subprovince, 8.3% of the brachiopods are endemic and 16.7% are restricted to the subprovince.

The basal Tioughnioga fauna of the Michigan Basin-Hudson Bay Lowland Subprovince contains many brachiopod genera that had been restricted to the Appohimchi during the earlier Middle Devonian. Among Appohimchi Subprovince endemics found in the basal Tioughnioga of the Michigan Basin-Hudson Bay Lowland Subprovince (Four Mile Dam Formation, uppermost Gravel Point Formation, Logansport Limestone) are *Rhipidomella*, *Protodouvillina*, *Megastrophia*, *Elytha*, *Fimbrispirifer*, *Charionella*, *Parazyga*, *Leptospira*, and *Callipleura*. Only a single Michigan Basin-Hudson Bay Lowland Subprovince endemic, *Atribonium*, migrated into the Appohimchi Subprovince.

The cause of this decrease in endemism is thought to be a major transgression related to a rise in sea level and is considered in a later section of this study. This interval of decreased endemism
within the Eastern Americas Realm coincides with the widespread occurrence of the "Centerfield fauna" over much of eastern North America described by Cooper and Warthin (1942).

The fauna of the basal Tioughnioga Fimbrispirifer-Pentagonia Assemblage Zone is repeated at several other stratigraphic levels in the Hamilton Group of New York (Cooper and Warthin, 1942). Among the units which contain this fauna are the Stafford-Mottville Members, Otsego Member, Tichenor Limestone, and Portland Point Limestone. These occurrences of this fauna, described above as the Atrypid-Strophodontid Community, are limited to the Appalachian Basin. The typical elements of this fauna, including both Appohimchi endemics such as Protodouvillina, Megastrophe, Elytha, Fimbrispirifer, Charionella, Parazyga, Leptospira, and Callipleura, and cosmopolitan genera such as Pentamerella, Nucleospira, Meristina, and Rhynchospirina, required an environment lacking large influxes of terrigenous clastic sediments. When such conditions were present, the brachiopods of the Atrypid-Strophodontid thrived in the northern Appalachian Basin. The occurrences of the Atrypid-Strophodontid Community in the Appalachian Basin at stratigraphic levels other than the basal Tioughnioga are caused by local environmental factors and not to migrations among paleobiogeographic boundaries.

The brachiopod faunas of the few formations (Norway Point, Beebe School, Petoskey) known from the Michigan Basin-Hudson Bay
Lowland Subprovince during the late Tioughnioga show a similar level of endemism to those of the basal Tioughnioga. However, the percentage of shared genera in the Eastern Americas Realm decreases to 53.2% during the late Tioughnioga. This is largely due to an increase in the number of endemic genera to 28.6% in the Appohimchi Subprovince. Included among Appohimchi endemics are *Rhipidomella*, *Protodouvillina*, *Fimbrispirifer*, *Parazyga*, *Leptospira*, *Pustulatia*, *Callipleura*, and *Centronella*. Of genera restricted to the Appohimchi during the upper Cazenovia, only *Elytha* and *Spinocyrtia* are found in the upper Tioughnioga of the Michigan Basin-Hudson Bay Lowland Subprovince.

The level of provinciality between the Eastern Americas Realm and the Old World Realm declined markedly in the Taghanic (Johnson, 1970c, 1971b). This decrease in provinciality is associated with the previously mentioned migrations of Old World endemics into the Eastern Americas Realm during the Taghanic sea level rise. At the same time, several Eastern Americas Realm endemics, including *Charionella*, *Protodouvillina*, *Pholidostrophia*, *Cranaena*, and, possibly, *Tecnocyrtina*, migrated into the former Old World Realm areas.

Provincialism within the Eastern Americas Realm also declined greatly in the Taghanic. The percentage of brachiopod genera shared between the two subprovinces increased to 76.6% at this time.
Only 5.0% of the brachiopods of the Appohimchi are endemic and 10.0% restricted, while in the Michigan Basin-Hudson Bay Lowlands Subprovince, endemism and restriction remained nearly constant at 7.0% and 16.3%, respectively. The decline in Appohimchi endemics is due largely to the extinction of several restricted Appohimchi lineages including Pentagonia, Parazyga, Fimbrispirifer, Meristina, Nucleospira, and Callipleura. The only genera which are restricted to the Appohimchi during the Taghanic are Nervostrophia, Echinocelia, Pustulatia, and Septothyris.

Several Old World Realm genera which became established in the Michigan Basin-Hudson Bay Lowland in the Taghanic did not enter the Appohimchi. These genera include Rensselandia, Desquamatia (Independatrypa), D. (Neatrypa), Anathyris, and Eosyringothyris, although the origin of the last mentioned genus is uncertain. Meso-leptostrophia, Rhyssochonetes, Productella, Meristella, Hypothyridina, and Leiorhynchus are found in both subprovinces during the Taghanic. Orthospirifer migrated into the northern part of the Appohimchi (New York) at this time, occupying the ecological niche that had been occupied during the Cazenovia and Tioughnioga by Spinocyrtia and Mediospirifer.

Oliver (1976) and Oliver and Pedder (in press) state that the entire endemic rugose coral fauna of the Eastern Americas Realm became extinct at the end of the Givetian. This is not true of the endemic
brachiopods of the Eastern Americas Realm, several of which became cosmopolitan during the Frasnian. Among these cosmopolitan genera are Orthospirifer, Charionella, possibly Tecnocyrtina, Atribonium, and Cranaena. Tropidoleptus remained within the former area of the Eastern Americas Realm; it is found as far west as New Mexico, although its Givetian range extended possibly as far as Bolivia, South Africa, and north Africa.

Oliver (1976) and Oliver and Pedder (in press) note a high degree of affinity between the Givetian rugose corals of the Appohimchi Subprovince and those of Europe, as opposed to the affinity between Michigan Basin-Hudson Bay Lowland corals and corals of western and arctic North America. A similar affinity is seen between Appohimchi and European brachiopods. Among brachiopod genera listed by Johnson (1971b) as occurring in the Givetian of eastern North America and Europe, but absent in western or arctic North America are Athyris, Douvillina (Protodouvillina ? cf Harper and Boucot, 1978), Orthopleura, Kayserella, Mediospirifer, Paraspirifer, Sieberella, Spinocyrtia, and Strophodonta. Of these brachiopods, Protodouvillina, Kayserella, Mediospirifer, Paraspirifer, and Spinocyrtia are restricted, in North America to the Appohimchi. Along with the biogeographic history of earlier migrants such as Tropidoleptus, the distribution of Givetian brachiopods supports the existence of a marine connection between the eastern North America
and Europe. Such a connection is shown in Figure 13 which is taken from Oliver, 1976. The possible connections between the Eastern Americas Realm and arctic and western North America are indicated on this map.

Various pathways for migration between the Michigan Basin-Hudson Bay Lowland and arctic and western North America have also been suggested. The similarity of the faunas of the Rogers City, Lake Church, and Murray Island Formations with those of the Elk Point Group of the Williston Basin of Manitoba (Cooper and Phelan, 1966) suggests that the Old World endemich which arrived in the Michigan Basin-Hudson Bay Lowland Subprovince at approximately the Eifel-Givet boundary traveled via the Williston Basin.

The brachiopod fauna of the Horn Plateau Formation of the District of Mackenzie includes several genera with affinities to the Eastern Americas Realm (McLaren and Norris, 1964). These include *Pholidostrophia*, *Longispina*, *Ambocoelia*, and *Athyris*. *Pentamerella* and *Sieberella* from the Horn Plateau Formation which are very similar to Michigan Basin-Hudson Bay Lowland endemics, and the *Trematospira* reported from the Horn Plateau is probably the Appohimchi endemic *Leptospira*. Of the remaining brachiopods, *Schizophoria*, *Spinatrypa*, *Hypothyridina*, *Leiorhynchus*, *"Atrypa"*, *Leptaena* or *Leptagonia*, *Gypidula*, *Schuchertella*, *Spinulicosta*,
Emanuella, Cranaena, and Eleutherokomma or Mucrospirifer, are widely distributed in the Taghanic. Only Cymostrophia is unknown from Taghanic strata of the Eastern Americas Realm; only Cymostrophia, Hypothyridina, and Leiorhynchus are unknown from the pre-Taghanic Givetian of the Eastern Americas Realm. A migration route connecting arctic Canada and the Michigan Basin-Hudson Bay Lowland Subprovince during the Taghanic is suggested by the fauna of the Horn Plateau Formation.

Transition Zone Between the Appohimchi and Michigan Basin-Hudson Bay Lowland Subprovinces

A belt extending from Ontario in the north, through southeastern Michigan, northwestern, northern, and central Ohio, southern Indiana, and northern Kentucky, contains localities characterized by faunas transitional between the Appohimchi and Michigan Basin-Hudson Bay Lowland Subprovinces. The formations contained within this transitional zone include the Arkona, Hungry Hollow, Widder, and Ipperwash Formations, the Silica Formation and Ten Mile Creek Dolomite of southeastern Michigan and northwestern Ohio, the Prout Limestone and Plum Brook Shale of north-central Ohio, the Delaware Limestone of central Ohio, and the Speeds, Silver Creek, and Beechwood Members of southern Indiana and northern Kentucky.

The brachiopod fauna of these rocks includes genera that are
largely restricted to the Michigan Basin-Hudson Bay Subprovince, including *Schizophoria*, *Orthopleura*, *Devonalosia*, *Orthospirifer*, and *Atribonium*. However, brachiopods restricted to the Appohimchi are also frequently found. Some of these Appohimchi brachiopods, including *Protodouvillina*, *Elytha*, *Fimbrispirifer*, *Pustulatia*, *Meristina*, *Nucleospira*, *Pentagonia*, *Parazyga*, *Leptospira*, *Rhynchospirina*, *Callipleura*, and *Centronella* are found only in basal Tioughnioga rocks, equivalent to the Centerfield Member of New York, and are the result of the widespread migration of the Appohimchi fauna during the basal Tioughnioga. Other brachiopods restricted to the Appohimchi, such as *Rhipidomella*, *Tropidoleptus*, *Megastrophia*, and *Mediospirifer* are found through rocks of Cazenovia age within the transitional zone. Tioughnioga rocks younger than the Centerfield equivalents are unknown in the transitional zone, with the exception of the Widder and Ipperwash Formations in Ontario.

**Boundary Between the Appohimchi Subprovince and the Michigan Basin-Hudson Bay Lowland Subprovince**

In order to understand the migrations of brachiopods among paleobiogeographic units of the late Middle Devonian, it is first necessary to consider the nature of their boundaries. Figure 13 shows the distribution of land, sea, and faunas of the Appohimchi
and Michigan Basin-Hudson Bay Subprovinces during the late Middle Devonian. The boundary region, for times other than the three named assemblage zones, lies approximately at the western margin of the Appalachian Basin. Through this boundary region, Appohimchi and Michigan Basin-Hudson Bay Lowland genera occur together. Rocks of this boundary region include the Arkona, Hungry Hollow, Widder, and Ipperwash Formations of the Thedford, Ontario, area; the Plum Brook and Prout Formations of northern Ohio; and the Silica and Ten Mile Creek Formations of northwestern Ohio and southwestern Michigan. A few Michigan Basin-Hudson Bay Lowland Subprovince genera, such as Atribonium and Orthospirifer, are found in the Silver Creek and Beechwood Formations of southern Indiana.

The area occupied by the Michigan Basin-Hudson Bay Lowland Subprovince on Figure 13 is a broad, shallow (deepest fauna is Benthic Assemblage 3), carbonate platform, landlocked on three sides. Such a platform, located 10° to 20° from the equator and a probable site of poor marine circulation, would have been characterized by a water mass that was warm and slightly hypersaline in comparison to the remainder of the Eastern Americas Realm. Hypersaline conditions were present in the Michigan Basin during the Eifelian (Lucas evaporites) and on the Iowa platform during the Eifelian or Givetian (Wapsipinicon evaporites; Givetian age is suggested by the presence of Emanuella (Cooper and others, 1942) but
any age between Silurian and Taghanic is possible. The brachiopod genera that were restricted to the Michigan Basin-Hudson Bay Lowlands Subprovince were possibly tolerant of warmer conditions than were the brachiopods of the Appohimchi Subprovince.

The brachiopod genera restricted to the Appohimchi Subprovince may have been restricted during periods of lower sea level to the edge of the platform occupied by the Michigan Basin-Hudson Bay Lowland Subprovince by the higher temperature of the platform interior. Sea level rise would have provided an influx of water of lower temperature as well as changing the circulation on this platform to enable larvae of Appohimchi genera to reach its interior. This decrease in temperature and change of circulation of surface water would have enabled the Appohimchi fauna characteristic of the *Fimbrispirifer-Pentagonia* Assemblage Zone to migrate into the interior of the platform, where it occurs in the Four Mile Dam and Logansport Formations.

This hypothesis is consistent with the decrease in provinciality within the Eastern Americas Realm during the *Leptaena-Schizophoria* Assemblage Zone. The Old World Realm genera which migrated into the Eastern Americas Realm at this time are either widespread in the Old World Realm (*Desquamatia, Kayserella*) or restricted to western and arctic North America (*Carinatrypa, Pentamerella similar to *P. wintereri* Johnson, 1966). These genera may have had
Figure 13. Late Middle Devonian Paleobiogeography of North America.
OLD WORLD REALM

MICHIGAN BASIN-HUDSON BAY LOWLAND SUBPROVINCE

APPOMATTOX SUBPROVINCE

LAND

POSSIBLE CONNECTIONS BETWEEN OLD WORLD AND EASTERN AMERICAS REALMS

SHELF MARGINS OF EASTERN NORTH AMERICA
teleplanic larvae, able to travel long distances in marine currents, which allowed them to quickly migrate into the Eastern Americas Realm when favorable conditions for their migration became present. A fauna correlative with the *Leptaena-Schizophoria* Assemblage Zone is known from the Elk Point Group of the Williston Basin in Manitoba (Cooper and Phelan, 1968). The presence of *Desquamatia* and *Carinatrypa* in this fauna suggests that these Old World Realm genera migrated into the Eastern Americas Realm through the Williston Basin. The sea level rise of the *Leptaena-Schizophoria* Assemblage Zone may also have ended the earlier Eifelian evaporitic conditions within the Michigan Basin by improving circulation in this area.

The decrease in provincialism during the Taghanic is also consistent with a subprovincial boundary caused by differences in salinity and temperature. The sea level rise of the Taghanic may have improved circulation, raised the temperature, and reduced salinity on the Michigan Basin-Hudson Bay Lowland Platform, which may have been completely emergent during the low stand of sea level marked by the Kashong Member in New York. The Taghanic faunas of the Michigan Basin-Hudson Bay Lowland Subprovince are characterized by a decrease in provinciality from the faunas of the post-basal Tioughnioga strata of the same area.

The pattern of faunal migration between the Appohimchi Subprovince and the Michigan Basin-Hudson Bay Subprovince is explained
by the pattern of currents within the restricted basin occupied by these subprovinces in eastern North America. The hypothetical current entered the Appalachian Basin from the east, coming around the southern end of the Acadian landmass on the eastern side of the basin. The position of this and of the Acadian landmass, in northern Virginia, is based on the southernmost occurrence of coarse terrigenous clastics. One branch of this current flowed to the west from the southern end of this landmass, carrying the Appohimchi fauna from Pennsylvania, Maryland, or the Virginias to southern Indiana, the Illinois Basin, and the southern flank of the Ozark Dome. The other branch of this current flowed to the north, through Pennsylvania and New York, reaching at least as far north as Montreal. Pelagic larvae of Appohimchi Subprovince brachiopods were carried in this current to the northern end of the Appalachian Basin, where the current turned to the west, going at least as far north as the center of Hudson Bay (Sanford and Norris, 1975), and south and flowed southward along the western margin of the Appalachian Basin. This current pattern explains the presence of Appohimchi Subprovince genera along the western edge of the Appalachian Basin, while Michigan Basin-Hudson Bay Lowland genera are absent from the eastern margin. For example, during the *Fimbrispirifer-Pentagonia* Assemblage Zone, nine genera formerly restricted to the Appohimchi are found in the Michigan Basin-Hudson Bay Lowland Subprovince. These include
Rhipidomella, Protodouvillea, Megastrophia, Elytha, Fimbrispirifer, Charionella, Parazyga, Leptospira, and Callipleura. Only one genus previously restricted to the Michigan Basin-Hudson Bay Lowland Subprovince, Atribonium, migrated into the Appohimchi Subprovince at this time.

**Boundary Between the Eastern Americas Realm and the Old World Realm During the Late Middle Devonian**

Figure 14 is adapted from Oliver (1976; 1967). This reconstruction of the Middle Devonian world has been altered to better fit the available geologic data (Boucot, oral comm.). The Eastern Americas Realm in North America occupies a largely restricted basin. To the north and northeast, the limit of this basin has been removed by erosion from the Canadian shield. The boundary on the west and northwest follows the position of the transcontinental arch or continental backbone. This does not necessarily mean that this landmass was solely responsible for the position of the boundary. To the south and southwest, this basin was open to the ocean, while to the east and southeast, the basin was partially closed during the Middle Devonian by the Acadian highlands, extending as far south as Virignia. Eastern Americas Realm faunas are also known from the Amazon-Colombian Subprovince in South America during the Middle Devonian.
Figure 14 shows hypothetical patterns of Middle Devonian surface currents, based on adapting the circulation patterns of Recent oceans (Sverdrup and others, 1942) to the reconstructed Middle Devonian paleogeography. The Eastern Americas Realm in North America occupies a partly restricted, temperate area. The northwestern corner of this marine area, occupied by the Michigan Basin-Hudson Bay Lowland Subprovince, may have been warmer and slightly more saline than the Appohimchi Subprovince to the south and east. The area of the Michigan Basin-Hudson Bay Lowland Subprovince was a shallow, equatorial carbonate platform, probably characterized by poorer circulation than the remainder of the Eastern Americas Realm.

A current of warmer water from the North American section of the Eastern Americas Realm flowed to the southwest, along the continental margin, carrying the pelagic larvae of Eastern Americas Realm genera to northern and western South America. This warm current separated the Eastern Americas Realm in South America from the Malvinokaffric Realm to the south and east, which was characterized by cold water moving in the south circumpolar gyre. The return current from the Eastern Americas Realm area of South America would have carried cooler water to the Eastern Americas Realm area of North America, separating the Eastern Americas Realm fauna from the fauna of the Rhenish-Bohemian Region of the
Old Realm to the east. The Old World Realm was situated largely in tropical areas and may have been characterized by higher average temperatures than the Eastern Americas Realm (Boucot, 1975, p. 330-331).

Communication between the Eastern Americas Realm and the Old World Realm of western North-America was restricted by the landmass of the continental backbone and by the previously mentioned bodies of hypersaline water between the emergent area and areas of normal marine water (Boucot, 1975), in addition to any differences in the temperatures of the water masses on the opposite sides of the continental backbone. The hypothesis of the Michigan Basin-Hudson Bay Subprovince being characterized by warmer water than the Appohimchi Subprovince is supported by the concept of a temperature differential between the Old World Realm and the Eastern Americas Realm. The Michigan Basin-Hudson Bay Subprovince contains more Old World Realm genera of both brachiopods and corals (Oliver, 1977) than does the Appohimchi Subprovince. This would indicate that conditions in the Michigan Basin-Hudson Bay Lowland Subprovince was more hospitable, comparable to those in the Old World Realm, to Old World Realm genera than were conditions in the Appohimchi Subprovince. The cooler water of the Appohimchi Subprovince was the probable result of the return current from the cooler temperate regions of South America flowing into the Appohimchi Subprovince.
This current presumably came into contact with the south circumpolar current which characterized the Malvinokaffric Realm, possibly accounting for the Eastern Americas Realm ancestry of many Malvinokaffric genera (Boucot, 1975). The Malvinokaffric Realm, occupying the south polar region and surrounding areas, was probably colder than the temperate Eastern Americas Realm or the tropical Old World Realm (Boucot, 1975; Boucot and Grey, in press).

Sea level rise and associated transgression are suggested as causes for the transportation of formerly restricted genera of brachiopods across biogeographic boundaries. A rise in sea level would have flooded more of the shelf areas of eastern North America and improved circulation in this area, reducing temperature differentials with the Old World Realm. Inundation of the southern end of the Acadian landmass may have allowed the migration of Rhenish-Bohemian Region brachiopod genera into the Appalachian Basin on the prevailing current, while the temperature of the Appalachian Basin was raised by the increased inflow of water from the Old World Realm.

Similarly, sea level rise would have reduced or eliminated the bodies of hypersaline water along the continental backbone and perhaps breached this landmass as well. Evidence has been previously cited for connections between the Michigan Basin-Hudson Bay Lowland Subprovince and the Williston Basin or the Canadian arctic. The
former connection was probably present during the *Leptaena-Schizophoria* Assemblage Zone, while the latter connection existed during the *Rhyssochonetes-Hypothyridina* Assemblage Zone. It is noted, however, that with both connections open, current patterns would have favored transport of pelagic larvae from the Canadian arctic to the Eastern Americas Realm and from the Eastern Americas Realm to the Williston Basin.

The transgressions which are not associated with changes in biogeographic boundaries are thought to have been of insufficient magnitude to affect patterns of circulation of surface waters. These transgressions, including those responsible for the Stafford, Tichenor, and Menteth Limestones, did not cover sufficient former land areas or open formerly restricted paths of faunal communication to allow the pelagic larvae of brachiopods to migrate across biogeographic boundaries.
The brachiopod communities described in this model are, in many instances, intimately related to the lithofacies in which they occur. The rocks which contain the communities represent the environments in which these groups of invertebrates lived. This is clearly shown by Fig. 15 in which the communities are plotted on a correlation chart which indicates the lithologies of the late Middle Devonian rocks. The correspondence between brachiopod communities and clastic environments in the northern Appalachian Basin is paralleled by the correspondence between brachiopod communities and carbonate environments in the Illinois and Michigan Basins. In each case, for the majority of communities, specific communities are found in low and high energy nearshore rocks, in subtidal rocks, and in deep water rocks. The combined suites of communities (biofacies) and lithofacies which represent the environments in which the communities lived, are termed ecofacies.

Although the correlation between communities and lithofacies is widespread, I emphasize that this only reflects the correlation between communities and environments. There are many examples of communities that are not confined to particular lithofacies. Among these are the Camarotoechia Community which occurs in basinal black shales.
and in shales and siltstones formed in restricted shelf environments. The Ambocoelid Community occurs in both basinal dark shales and mudstones and in thin basinal limestones. The Mucrospirifer Community is found in calcareous shales, non-calcareous shales, siltstones and limestones. The Devonochonetes Community, Tropido leptus Community, Mediospirifer Community, and Mucros spirifer Community occur in clastic lithofacies in the Appalachian Basin and in carbonate lithofacies in the Illinois Basin.

The communities of a given ecofacies are more sensitive environmental indicators than are the rocks. A dark shale or mudstone may represent a basinal or a low energy shallow water environment. The presence of the Ambocoelid Community indicates a definite deep water environment, while the Devonochonetes Community indicates shallow, quiet water. Coarser and finer nearshore clastics, containing faunas of shallow water communities, may be transported from the shelf to basinal depths by slumps or turbidity currents. If indigenous deep water communities are present in the intervening autochthonous beds, the depth of final deposition of the allochthonous rocks may be separated from the depth of their origin.

The relationship of the ecofacies to distance from shore and water depth can be shown to great advantage by plotting the ecofacies on a transect representing a close approximation to a geologically instantaneous time. Such transects can be drawn using rock units
correlated through the zonal scheme described in the previous section of this report. The relative thicknesses of these rock units are plotted along a section extending across the axis of the depositional basin of the late Middle Devonian. The lower surface of the rock unit being plotted is taken as a datum in the deepest part of the basin. This datum is maintained as the rock unit is traced toward the margin of the basin, as long as the thickness of the rock unit remains uniform or increases toward the margin of the basin. When the thickness of the rock unit begins to decrease in the direction of the basin margin, the datum is changed to the upper surface of the rock unit. This technique avoids making unjustified assumptions concerning the topography of the surface upon which the rock unit was deposited; any changes in the thickness of the unit reflect only the conditions under which the unit was deposited.

Figure 16 shows such a transect, plotted for the Stony Hollow and Cherry Valley Members of New York and the Rogers City Limestone of Michigan, all of which are included in the upper part of the Leptaena-Fimbrispirifer Assemblage Zone. The decrease in the thickness of this suite of rocks westward from the Stony Hollow into the Cherry Valley Member indicates that the transition between these members is the position of the paleo-shelf edge. This shelf profile is similar to those described by Rich (1951), Van Siclen (1958), and Dietz (1952, 1963) (Fig. 17) as well as the Onondaga profiles of the
Figure 16. Depositional topography from eastern New York to western Michigan during the late Leptaena-Schizophoria Assemblage Zone.

Legend:

<table>
<thead>
<tr>
<th>Legend</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Stony Hollow Member (sandstone)</td>
</tr>
<tr>
<td>B</td>
<td>Cherry Valley Member (limestone)</td>
</tr>
<tr>
<td>C</td>
<td>Chittenango Member (black shale)</td>
</tr>
<tr>
<td>D</td>
<td>Otsego Member (sandstone)</td>
</tr>
<tr>
<td>E</td>
<td>Bridgewater Member (shale)</td>
</tr>
<tr>
<td>F</td>
<td>Cardiff Member (shale)</td>
</tr>
<tr>
<td>G</td>
<td>Solsville Member (sandstone)</td>
</tr>
<tr>
<td>H</td>
<td>Pecksport Member (shale)</td>
</tr>
<tr>
<td>I</td>
<td>Mottville Member (sandstone)</td>
</tr>
<tr>
<td>J</td>
<td>Stafford Member (limestone)</td>
</tr>
<tr>
<td>K</td>
<td>Oatka Creek Member (black shale)</td>
</tr>
<tr>
<td>L</td>
<td>&quot;Marcellus&quot; Formation (black shale)</td>
</tr>
<tr>
<td>M</td>
<td>Lower Arkona Member (limestone)</td>
</tr>
<tr>
<td>N</td>
<td>Rogers City Limestone</td>
</tr>
<tr>
<td>O</td>
<td>Bell Shale</td>
</tr>
<tr>
<td>P</td>
<td>Rockport Quarry Limestone</td>
</tr>
<tr>
<td>Q</td>
<td>Dundee Limestone</td>
</tr>
<tr>
<td>R</td>
<td>Union Springs Member (black shale)</td>
</tr>
<tr>
<td>S</td>
<td>Bakoven Member (shale)</td>
</tr>
</tbody>
</table>

Locations of generalized sections:

1. Northwestern Michigan
2. Northeastern Michigan
3. Thedford, Ontario
4. Erie, Pennsylvania
5. Lake Erie, Buffalo Quadrangle, N.Y.
6. Cazenovia Creek, Depew Quadrangle, N.Y.
7. Murder Creek, Batavia Quadrangle, N.Y.
8. East Bethany, Batavia Quadrangle, N.Y.
9. Genesee Quadrangle, Batavia Quadrangle, N.Y.
10. Canandaigua Lake, Canandaigua Quadrangle, N.Y.
11. Seneca Lake, Geneva Quadrangle, N.Y.
12. Cayuga Lake, Auburn Quadrangle, N.Y.
13. Skaneateles Lake, Skaneateles Quadrangle, N.Y.
14. Onondaga Valley, Tully Quadrangle, N.Y.
15. Cazenovia Quadrangle, N.Y.
16. Chenango Valley, Morrisville Quadrangle, N.Y.
17. Unadilla Valley, Hartwick and New Berlin Quadrangles, N.Y.
18. Susquehanna Valley, Cooperstown Quadrangle, N.Y.
20. Schoharie Valley, Schoharie Quadrangle, N.Y.
21. Berne and Durham Quadrangles, N.Y.
22. Coxsackie Quadrangle, N.Y.
23. Catskill Quadrangle, N.Y.

Sources of data include Baird, in press; Chadwick, 1944; Cooper, 1930; Cooper, 1933; Ehlers and Kesling, 1970; Goldring, 1935; Goldring, 1943; Kesling and others, 1974; Sanford, 1967; and Smith, 1935.
Appalachian Basin of Mesolella (1978). The Stony Hollow is composed of the undathem (shelf deposits) and clinothem (slope deposits) of Rich (1951); the Cherry Valley is the basinal fondothem of the same author. The underlying Bakoven and Union Springs Member exhibit a similar shelf profile and a similar division into undathem and clinothem (Bakoven) and fondothem (Union Springs). Similar profiles may be found in the members of the Marcellus Formation which overlie the Stony Hollow and Cherry Valley, although they are severely distorted by the great amount of subsidence which characterized the eastern margin of the Appalachian Basin during upper Marcellus deposition. However, by tracing the combined fluctuations of lithofacies and communities, the successive positions of shelf margin can be plotted throughout the upper Middle Devonian. Similar profiles along the western margin of the Appalachian Basin are difficult to plot in detail due to the wide separation of outcrops in Ontario, Ohio, and Michigan.

A similar profile may be constructed for other intervals in the upper Middle Devonian. Fig. 18 shows a transect constructed on the Mottville and Stafford Members of New York and Rockport Quarry Limestone of Michigan, which are correlated through the eustatic model which is discussed below. Fig. 18 shows a distinct shelf margin in the eastern side of the Appalachian Basin, approximately 95 miles west of the margin of the Stony Hollow-Cherry Valley profile. The western margin of the Appalachian Basin was near
Figure 17. Idealized Shelf to Basin Depositional Topography Profile. Adapted from Rich (1951).
Figure 18. Depositional Topography from eastern New York to western Michigan at the time of deposition of the Mottville Member.

Legend:

A  Stone Mill Member (limestone)
B  Centerfield Member (limestone)
C  Chenango Member (sandstone)
D  Butternut Member (shale)
E  Pompey Member (sandstone)
F  Delphi Station Member (shale)
G  Mottville Member (sandstone)
H  Levanna Member (black shale)
I  Stafford Member (limestone)
J  Lower Arkona Member (limestone)
K  Upper Arkona Member (shale)
L  Hungry Hollow Limestone
M  Rockport Quarry Limestone
N  Ferron Point Shale
O  Lower Member, Genshaw Formation ("Sieberella" Beds; limestone)
P  Killians Member, Genshaw Formation (limestone)
Q  Upper Member, Genshaw Formation (limestone)
R  Newton Creek Limestone
S  "Koehler" Limestone
T  Gravel Point Limestone
U  Alpena Limestone
V  Dock Street Clay Member, Four Mile Dam Formation (shale)
W  Upper Blue Bed, Gravel Point Limestone
X  Four Mile Dam Formation (limestone)
Y  Charlevoix Limestone

Location data as in Figure 16.
Figure 19. Depositional Topography from eastern New York to western Michigan during the *Fimbrispirifer-Pentagonia* Assemblage Zone.

<table>
<thead>
<tr>
<th>Legend</th>
<th>Description</th>
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<tbody>
<tr>
<td>A</td>
<td>Cooperstown Member (sandstone and shale)</td>
</tr>
<tr>
<td>B</td>
<td>Portland Point Member (limestone)</td>
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<tr>
<td>C</td>
<td>Cooksburg Member (sandstone)</td>
</tr>
<tr>
<td>D</td>
<td>Owasco Member (sandstone)</td>
</tr>
<tr>
<td>E</td>
<td>Spafford Member (sandstone and shale)</td>
</tr>
<tr>
<td>F</td>
<td>Ivy Point Member (sandstone and shale)</td>
</tr>
<tr>
<td>G</td>
<td>Otisco Member (containing coral beds) (sandstone and shale)</td>
</tr>
<tr>
<td>H</td>
<td>Panther Mountain Formation (sandstone)</td>
</tr>
<tr>
<td>I</td>
<td>Stone Mill Member (limestone)</td>
</tr>
<tr>
<td>J</td>
<td>Centerfield Member (limestone)</td>
</tr>
<tr>
<td>K</td>
<td>Ledyard Member (black shale)</td>
</tr>
<tr>
<td>L</td>
<td>Wanakah and Jacox Members (shale)</td>
</tr>
<tr>
<td>M</td>
<td>Tichenor Member (limestone)</td>
</tr>
<tr>
<td>N</td>
<td>Deep Run Member (shale)</td>
</tr>
<tr>
<td>O</td>
<td>Menteth Member (limestone)</td>
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<tr>
<td>Q</td>
<td>Wisdom Member (shale)</td>
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<tr>
<td>R</td>
<td>&quot;Pteropod&quot; Bed</td>
</tr>
<tr>
<td>S</td>
<td>Hungry Hollow Limestone</td>
</tr>
<tr>
<td>T</td>
<td>Widder Formation (shale) and Ipperwash Limestone</td>
</tr>
<tr>
<td>U</td>
<td>Dock Street Clay Member, Four Mile Dam Formation (shale)</td>
</tr>
<tr>
<td>V</td>
<td>Four Mile Dam Formation (limestone)</td>
</tr>
<tr>
<td>W</td>
<td>Norway Point Limestone</td>
</tr>
<tr>
<td>X</td>
<td>Upper Blue Bed, Gravel Point Limestone</td>
</tr>
<tr>
<td>Y</td>
<td>Charlevoix Limestone</td>
</tr>
<tr>
<td>Z</td>
<td>Petoskey Formation</td>
</tr>
</tbody>
</table>

Location data as in Figure 16.
Buffalo, New York, to the west of which, a carbonate platform extended into the Michigan Basin. Fig. 19 shows a similar shelf profile, constructed for the *Fimbrispirifer-Pentagonia* Assemblage Zone. Included on this transect, from east to west, are the Stone Mill and Centerfield Members of New York, the Hungry Hollow Limestone of Ontario, and the Four Mile Dam, Charlevoix, and uppermost Gravel Point Formations of Michigan. At this time, the western margin of the Appalachian Basin was located near Lake Huron.

Fig. 20 shows a sequence of shelf profiles on the western side of the Illinois Basin. Fig. 20A depicts a transect across the Illinois Basin, using the Tripp Limestone of southern Illinois and the Silver Creek Limestone of southern Indiana as a datum. The western shelf margin of the Illinois Basin is clearly visible, although the eastern margin is obscured by a lack of data points. Fig. 20B shows the changing positions of the shelf margin in the Howardton, Tripp, Misenheimer, and Walnut Grove Members of the Lingle Formation and the Alto Formation.

Comparison of these transects with the community-lithofacies data from Fig. 15 produces the idealized section of a late Middle Devonian shelf margin shown in Fig. 21. Communities of Benthic Assemblages 1 and 2 are found on the undathem of Rich (1951), in shelf environments more shallow than the depth of wave base, which marks the shelf edge. Communities assigned to Benthic Assemblage 3
Figure 20. Depositional Topography in the Illinois Basin during the late Middle Devonian.

Legend:
A Beechwood Member (limestone)
B Silver Creek Member (limestone)
C Speeds Member (limestone)
D Blocher Member (black shale)
E Sweetland Creek Member (shale)
F Blocher Member (black shale)
G Tripp Member (limestone)
H Howardton Member (limestone)
I Misenheimer Member (black shale)
J Walnut Grove Member (limestone)
K Alto Member (limestone and shale)

Locations of sections:
1. Ohio No. 1 Sawyer, Sec. 33, T. 2 S., R. 1 W., Washington County, Illinois
2. Magnolia No. 1 Jones, Sec. 10, T. 3 S., R. 2 E., Jefferson County, Illinois
3. Sun No. 1, Aydt, Sec. 1, T. 4 S., R. 4 E., Jefferson County, Illinois
4. Texas No. 1 Draper, Sec. 8, T. 3 S., R. 6 E., Wayne County, Illinois
5. Nation No. 2 McIntosh, Sec. 31, T. 3 S., R. 8 E., White County, Illinois
6. Taylor No. 1 Winter, Sec. 36, T. 4 S., R. 9 E., White County, Illinois
7. Speed Quarry, Louisville Cement Company, Speed, Indiana
8. Tunnel Mill section, along Muscatatuck River, west of Indiana Rte. 3, 0.3 miles south of jct. with Indiana Rte. 7, SW 1/4 Sec. 11, T. 6 N., R. 8 E., Jennings County, Indiana
9. Muscatatuck Group, type section, Big Camp Creek, NE 1/4 NE 1/4 SW 1/4 Sec. 13, T. 4 N., R. 8 E., Jefferson County, Indiana
10. Lambert No. 1 Hagler, Sec. 28, T. 10 S., R. 2 W., Jackson County, Illinois
11. Sturdevant No. 1 State Pond Land, Sec. 14, T. 12 S., R. 2 W., Union County, Illinois
12. McRauer No. 4 City of Jonesboro, Sec. 25, T. 12 S., R. 2 W., Union County, Illinois
13. Rigney No. 1 Hileman, Sec. 21, T. 13 S., R. 1 W., Union County, Illinois
14. Vaughn No. 1 Ragsdale, Sec. 18, T. 14 S., R. 1 E., Pulaski County, Illinois
Figure 21. Idealized Shelf to Basin Profile for the late Middle Devonian of the Appohimchi Subprovince.
BA 3

BA 4

A_5

SHELF

BASIN

SEA LEVEL

DEPTH OF WAVE BASE

BA 1
BA 2
BA 3
BA 4
BA 5

UNDATHEM

CLINOTHEM

FONDOTHEM
extend from slightly shoreward of the shelf break, near wave base, to slightly seaward of the base of the slope. Reefs which form on carbonate shelves occur at the shelf edge, or on the slope, or in equivalent depths on broad carbonate platforms. The bases of all reefs noted in this study occur in Benthic Assemblage 3, although reefs that grow from basinal depths are known from the Onondaga Limestone (Mesolella, 1978). Benthic Assemblages 4 and 5 are found on the fondothem, in the deeper parts of basins. The chain of communities along the shore to basin transect is an example of a catena (Krassilov, 1974), a group of contemporaneous communities arranged along a gradient reflecting a physical factor of the environment such as depth or temperature. The presence of a given community at an outcrop under study can be used to determine the position on the shelf profile of that outcrop in the absence of other data, provided the position of the community within a catena on a contemporaneous shelf profile is known.

**Regional Correlation through Local Changes of Sea Level**

The previously described assemblage zones which permit regional correlation of the upper Middle Devonian rocks of eastern North America are concluded to result from migrations of previously restricted brachiopod genera at times of transgression of the sea. Several lithofacies changes are produced during transgressions onto
the margins of the basins of eastern North America. Foremost among these factors is a shoreward shift in the position of the shelf margin, as determined from study of the depositional sequences of a given interval of time, using the method described by Vail and others (1977). Associated changes include shoreward shifts of lithofacies and community patterns, and the deposition of thin basinal (Benthic Assemblages 3 to 5) limestones, such as the Cherry Valley, Mottville, Centerfield, Tichenor, and Portland Point, in areas formerly characterized by the deposition of basinal clastics, such as the Oatka Creek and Levanna Members. This change from clastic to carbonate deposition resulted from a reduction in the supply of clastics during a transgression (McCave, 1969).

The Leptaena-Schizophoria Assemblage Zone and the Rhyssochonetes-Hypothyridina Assemblage Zone are the result of changes in sea level of either local or global extent which enabled brachiopods formerly restricted to the Old World Realm by current-controlled temperature differences to migrate into the Eastern Americas Realm. The exchange of surface water between the Old World Realm and the Eastern Americas Realm may have improved sufficiently during transgressive intervals to allow Old World Realm genera to migrate into the Eastern Americas Realm. The termination of the Leptaena-Schizophoria Assemblage Zone may reflect the cessation of exchange between these realms, with the subsequent lowering of the temperature
in the Eastern Americas Realm to a level unfavorable to the former Old World Realm genera. Among the brachiopod genera which migrate from the Old World Realm into the Eastern Americas Realm during the Leptaena-Schizophoria Assemblage Zone are Desquamatia (assigned to Variatrypa by Johnson, oral communication), Carinatrypa, Kayserella, and a Pentamerella similar to P. wintereri Johnson 1966 from Nevada. However, at the end of the Rhyssonetes-Hypothyridina Assemblage Zone, provincialism, both between the subprovinces of the Eastern Americas Realm, and between the Eastern Americas Realm and the Old World Realm, continued to decrease into the Frasnian (Johnson, 1970c). This decrease is probably due to improved circulation of surface water between the former realms during the Frasnian.

The Fimbrispirifer-Pentagonia Assemblage Zone is characterized by the outward spread of the Centerfield fauna (Cooper and Warthin, 1942) throughout most of the Middle Devonian outcrops of eastern North America. This fauna is composed largely of brachiopod genera that were restricted to the Appohimchi Subprovince during the earlier and later parts of the late Middle Devonian. This fauna includes both Appohimchi endemics such as Protodouvillina, Megastrophia, Elytha, Fimbrispirifer, Pentagonia, Charionella, Parazyga, Leptsopira, Pustulatia, Callipleura, Cranaena, Cryptonella, and Centronella, along with cosmopolitan genera such as Pentamerella,
Nucleospira, and Meristina; I have described this fauna as the Atrypid-Strophodontid Community.

The above-mentioned suite of fossils characterizes the limestone members of the Hamilton, as well as being present in several calcareous shale members. Meristina, Elytha, Fimbri spirifer, and Leptospira are known from the Otsego Member; Protodouvillea, Elytha, Meristina, Leptospira, Cranaena, and Cryptonella are known from the Stafford or Mottville; Pustulatia, Centronella, and Cryptonella are found in the Tichenor; and Megastrophia, Elytha, Fimbri spirifer, Nucleospira, Pustulatia, Cranaena, and Centronella are known from the Portland Point. These brachiopods occurred in an environment that was free from large inputs of fine clastic sediments. When such fine sediments are present, the Atrypid-Strophodontid Community was not present. However, in limestones and calcareous shales, including the rock units named above as well as the Eifelian age Onondaga Limestone, the brachiopods of this community, or one closely related to it such as the Elytha Community (Fig. 2) of the Upper Tully Member, were able to thrive.

The Fimbri spirifer-Pentagonia Assemblage Zone is characterized by the presence of brachiopods formerly restricted to the Appohimchi Subprovince spreading across the carbonate platform area of the Michigan Basin-Hudson Bay Lowland Subprovince. The restricted Appohimchi genera had occurred only along the eastern
margin of this platform. The basal Tioughnioga transgression probably changed the circulation on this platform, reducing the temperature of the epeiric sea and improving faunal communication with the Appohimchi Subprovince. With salinity and temperature reduced to a level similar to that of the Appalachian Basin, brachiopods formerly restricted to the Appohimchi Subprovince were able to live within the interior of this platform. When regression occurred communication of larvae from the Appohimchi Subprovince may have been prevented by current changes, and temperature on the platform may have risen to levels unfavorable for many of the brachiopods formerly restricted to the Appohimchi Subprovince, and these brachiopods disappeared from the Michigan Basin-Hudson Bay Lowland Subprovince. Brachiopods with wider tolerances were able to remain in the Michigan Basin-Hudson Bay Subprovince.

The two intervals between the named assemblage zones are not designated as biostratigraphic units since the faunas of these intervals contain no brachiopods which distinguish them as representing region-wide events. There are no major biogeographic fluctuations in the intervals represented by the upper Marcellus and Skaneateles Formations (the lower unnamed interval) or the upper Ludlowville and Moscow Formations (the upper unnamed interval). The boundaries of the Old World and Eastern Americas Realms remain constant during these intervals, as does the boundary between the Appohimchi
Subprovince and the Michigan Basin-Hudson Bay Subprovince. Transgressions, such as those represented by the Stafford, Tichenor, and Menteth Limestones, and the Ambocoelia umbonata, Emanuella praeumbona, Camarotoechia, and Pustulatia-Allanella Beds of the Windom Member, are of insufficient magnitude to alter circulation patterns to carry brachiopod larvae across biogeographic boundaries. The transgressions which occur during the three named assemblage zones are concluded to be of larger extent, in terms of inundating more land or of a possible higher rise of sea level, than are the transgressions within the unnamed intervals.

As the assemblage zones which form the framework for regional correlation within the upper Middle Devonian of eastern North America are in large part the result of probable fluctuations in sea level that produced transgressions and regressions over much of eastern North America, so lithostratigraphic correlation is possible through tracing the effects of these changes on lithologic successions. Figure 9 shows the basinward and shoreward fluctuations of the shelf margin in New York at intervals corresponding to the members of the Hamilton Group and Gilboa Formation in a composite section. Such shelf fluctuations could be observed along other parts of the Appalachian Basin margins if sufficient data were available; however, lithofacies data is sufficient to indicate these fluctuations.

Also shown is a curve representing the supply of terrigenous
clastic sediments entering the Appalachian Basin in New York during intervals corresponding to the aforementioned members of the Hamilton and Gilboa. This curve is based on estimates of the quantity of clastics deposited both on the shelf, often in restricted areas of severe subsidence and great thicknesses of sediment, and in the deeper basin. This clastic supply is though to reflect local tectonism in the Acadian highlands to the east of New York, as well as local subsidence of the shelf and basin. A curve plotted for southern Pennsylvania would show a lower influx of clastics in the Marcellus Formation, and a greater influx in the equivalents of the lower part of the Moscow Formation. Several intervals of increased clastic supply may coincide with periods of regression; similarly, clastic supply falls during transgression. However, this is not always the case. The regression of greatest magnitude, represented by the Kashong Member, occurs at a time of low clastic influx in New York, an exemption to regression coinciding with high sediment supply.

There is evidence for a general decline in the supply of terrigenous sediments to the area of New York during the late Middle Devonian. Cycles of transgression and regression in the Cazenovia Stage encompass more rock units than do those of the overlying Tioughnioga Stage. The lowest complete cycle includes the Cherry Valley, Chittenango, Bridgewater, Solsville, Pecksport, and Mottville Members. The Windom Member and the correlative
Cooperstown Member to the east, containing the highest complete cycles, contain two complete cycles. If these cycles represent comparable intervals of time, the difference in rock volume contained within the lowest and highest cycles reflects an overall decrease in clastic supply through the late Middle Devonian.

The columns labeled "Michigan Basin," "Southern Pennsylvania, Maryland, West Virginia," and "Illinois Basin" show suggested correlations of these areas with New York, based on a model of cyclic sea level fluctuations producing cyclic repetitions of sedimentary units. Dennison and Head (1975) discuss evidence for sea level fluctuations in the Appalachian Basin Silurian and Devonian and suggest correlations of rock units related to these fluctuations. I consider the following rock units to represent basin-wide changes of sea level. These correlations are in general agreement with correlations based on paleontologic or lithologic data.

Rises of sea level are concluded to be marked by the Stone Mill-Cherry Valley Members of New York, Purcell Limestones of Maryland and West Virginia, and Rogers City Limestone of Michigan; the Mottville and Stafford Members of New York and the Rockport Quarry Limestone of Michigan, the Centerfield and Stone Mill Members of New York, the Landes Limestone of Maryland and West Virginia, the Four Mile Dam Formation of Michigan, and the Beechwood and Walnut Grove Members of the Illinois Basin; the
Tichenor Limestone of New York and the Frame Shale of Maryland and West Virginia; the Portland Point and Cooksburg Members of New York and the Middle Shale of Maryland and West Virginia, and, as a long term trend, the Windom Member of New York and the Pokejoy Member and Upper Shale of Maryland and West Virginia.

Sea Level rises are concluded to be reflected in the Solsville Member of New York and the Bell Shale of Michigan; the Pompey Member of New York and the Ferron Point Shale of Michigan; the Wanakah and Ledyard Members of New York, the Norway Point Limestone of Michigan, and the Chaneysville Siltstone of Maryland and West Virginia; the Deep Run Member of New York and the Lower Siltstone of Maryland and West Virginia; and the Kashong Member of New York and the Clearville Siltstone of Maryland and West Virginia.

A variety of factors may be responsible for local, as well as global, changes in sea level. Isotacy may produce regional sea level changes in response to sediment deposited in a basin or eroded from an emergent area. Sediment influx may fill a basin and displace the water previously present. Local tectonism may raise or lower parts of a basin. The latter mechanism has been used by Heckel (1973) to explain the deposition of the Tully Limestone in New York. Local tectonism is probably responsible for the differences in the patterns of subsidence and influx of terrigenous sediment observed along the
eastern margin of the Appalachian Basin in rocks deposited during the late Middle Devonian.

Regional epeirogeny, perhaps related to the regional uplift of the Acadian landmass to the east of the Appalachian Basin, may be responsible for certain sea level changes affecting eastern North America during the late Middle Devonian. Although regional downwarp in the Appalachian Basin can be traced back to Late Silurian and Early Devonian time (Mesolella, 1978), Dennison and Head (1975) cite regional evidence for a sudden deeping of the Appalachian Basin following deposition of the Tioga Bentonite, and corresponding to the lowest black shale beds of the Marcellus Formation. This data agrees with the conclusion of Boucot (1968, p. 93) who correlated the onset of the Acadian Orogeny with the lithofacies change between the Onondaga Limestone of Eifelian age and the overlying late Eifelian through Givetian terrigenous clastics of the Hamilton Group. Boucot (1968; 1975) bases his assignment of the Acadian Orogeny to the mid-Middle Devonian on the presence of fossiliferous marine rocks of Eifelian age in the northern Appalachians. These rocks, including the Mountain House Wharf Limestone, the Famine Limestone, and the Touladi Limestone, all from the eastern townships of Quebec, have undergone deformation which Boucot (1968) attributes to the Acadian Orogeny. The later Middle Devonian and Upper Devonian rocks of the northern Appalachians are of non-marine origin and do
not show the effects of Acadian deformation. The sea level fluctuations of the late Middle Devonian may reflect continued smaller pulsations of the Acadian Orogeny.

**Summary: The Late Middle Devonian of Eastern North America**

Dennison and Head (1975) cite evidence for an increase in water depth in the Appalachian Basin immediately following the deposition of the Tioga Bentonite, and coincident with possible downwarp of the basin simultaneously with the uplift of the Acadian highlands to the east (Map 1). The basinal black Marcellus Shales (Benthic Assemblage 5: *Truncalosia* and *Camarotoechia* Communities) overlie shallow water pre-Tioga sediments at several localities. Only in eastern New York is the slope and eastern shelf of the Appalachian Basin visible at this time, represented by the Bakoven Member and the Cornwall Shale and Bellvale Formation of the Green Pond outlier (Benthic Assemblages 2 and 3). To the west in New York are found basinal (Benthic Assemblage 5; *Truncalosia* and *Camarotoechia* Communities) rocks of the Union Springs Shale, which grade stratigraphically downward and westward into the basinal (Benthic Assemblage 4 and 5 faunas) limestone of the Seneca Member of the Onondaga Limestone. To the west, near the western flank of the Appalachian Basin in Ohio, the Delaware Limestone represents deposits ranging
from shelf to basin (Benthic Assemblage 4 and 5 faunas). The correlative Dundee Limestone, lower Lake Church Formation, and lower Murray Island Formation of the broad carbonate platform which stretched from the Michigan Basin to the James Bay region of Ontario, represent deposition in deeper water (Benthic Assemblage 3 faunas) than the underlying evaporites of the Detroit River Group.

In the Illinois Basin, correlative rocks of the lower Leptaena-Schizophoria Assemblage Zone represent a continuation of pre-Tioga carbonate deposition. The Howardton, lower St. Laurent, and Speeds Limestones formed a carbonate sheet which stretched from the margins (Benthic Assemblage 2 and 3 faunas) of the Illinois Basin into its center. The fauna of the lower Leptaena-Schizophoria Assemblage Zone contains several brachiopods which are remnants of the earlier Middle Devonian faunas of eastern North America. Among these are Levenea, Pacificocoelia, Leptaena, Schizophoria, and Brevispirifer.

A major transgression characterizes the upper Leptaena-Schizophoria Assemblage Zone (Map 2). This transgression reduced the quantity of terrigenous clastic sediment entering the Appalachian Basin by shoreward migration of the shelf margin and alluviation of coastal valleys in the Acadian landmass to the east of the Appalachian Basin (McCave, 1969). Thus, the margin at the transition between the Stony Hollow Member (shelf and slope, Benthic Assemblages 2
and 3 faunas) and the Cherry Valley Member (basin, Benthic Assemblages 4 and 5 faunas) in New York retreated shoreward by approximately 35 miles. To the south, in southern Pennsylvania, Maryland, and the Virginia, the basinal limestone is termed the Purcell. A carbonate platform continued to extend across the Michigan Basin and into northern Ontario, recognized in the Rogers City, upper Lake Church, and upper Murray Island Formations. This rise in sea level coincides with the entrance of formerly endemic brachiopods of the Old World Realm into the Eastern Americas Realm. Among Old World Realm brachiopods that entered the Eastern Americas Realm are Desquamatia, Carinatrypa, Kayserella, and a Pentamerella similar to P. wintereri Johnson 1966.

Regression marked the termination of the Leptaena-Schizophoria Assemblage Zone (Map 3). As regression progressed, the clastic wedge on the eastern margin of the Appalachian Basin prograded into the basin. The greatest extent of this progradation is represented by the Solsville Member in New York (Benthic Assemblages 2 and 3 faunas). Most of this terrigenous sediment remained in the shelf area, which subsided severely. In the basin, the Oatka Creek Shale (Benthic Assemblage 5 faunas) of New York and the upper Marcellus Shale of the Appalachian Basin to the south were deposited. The distal edge of this clastic wedge is seen in the Bell Shale (Benthic Assemblage 3 faunas) of Michigan. As regression continued, communication
with the Old World Realm was no longer maintained, and the majority of Old World Realm genera disappeared from the Eastern American Realm. Provinciability between the Appohimchi Province and the Michigan Basin-Hudson Bay Lowland Subprovince increased to its highest level.

A transgression of lesser magnitude than that of the late *Leptaena-Schizophoria* Assemblage Zone ended the spread of the Marcellus clastic wedge. This transgression is represented in the basinal Stafford Limestone (Benthic Assemblages 3 to 5 faunas) and the equivalent slope and shelf deposits of the Mottville Member (Benthic Assemblages 2 and 3 faunas) in New York. The termination of the clastic influx from the Acadian highlands across the Appalachian Basin to the Michigan Basin carbonate platform is seen in the Rockport Quarry Limestone (Benthic Assemblage 3 faunas) and the basal beds of the Brint Road Member of the Silica Formation (Benthic Assemblage 2 fauna). In the Ontario subsurface, correlative rocks constitute the limestone of the lower Arkona Formation. However, this transgression was insufficient to affect the paleobiogeographic boundaries within the Eastern Americas Realm or between the Eastern Americas Realm and the Old World Realm.

The post-Mottville *Skaneateles* Formation of New York (Map 4) was characterized by regression and progradation of the eastern shelf margin. This progradation reached its maximum extent during
deposition of the Pompey Member (Benthic Assemblages 2 and 3 faunas) of New York, after which the shelf edge migrated eastward in response to the next cycle of transgression. The same progradation is seen in the lower part of the Montebello Member of central Pennsylvania. The locus of maximum subsidence shifted from the shelf area in New York to the shelf area in central Pennsylvania. The basinal reaches of this clastic wedge form the Levanna Member of New York (Benthic Assemblages 4 to 5 faunas), the Fisher Ridge Shale (Benthic Assemblage 5 fauna) of central Pennsylvania, the Gander Run Shale (Benthic Assemblage 5) of southern Pennsylvania, Maryland, and West Virginia, the Plum Brook Shale (Benthic Assemblage 3 fauna) of Ohio, and the upper shales of the Arkona Formation (Benthic Assemblage 3 fauna) of Ontario. Carbonate platform conditions, typified by the Genshaw and Alpena Formations (Benthic Assemblage 3 faunas) characterized the Michigan Basin, although the distal part of the Appalachian clastic wedge is seen in the Ferron Point Shale (Benthic Assemblages 2 and 3 faunas). The Silica Formation (Benthic Assemblages 2 and 3 faunas) and the Miami Bend Limestone (Benthic Assemblage 3 fauna) represent shallow, quiet water, and shallow, high energy conditions, respectively, along the southern margin of the Michigan Basin.

To the south of the Michigan Basin, the Wabash Platform (Droste and others, 1975) separated the epeiric seas of the Michigan Basin
from those of the Illinois and Appalachian Basins. The Wabash Platform was the site of either subaerial erosion or supratidal deposition throughout the late Middle Devonian. The Tripp and Silver Creek Limestone (Benthic Assemblages 2 and 3) were deposited on the western and eastern flanks of the Illinois Basin, while the Blocher Shale (probable Benthic Assemblage 4 or 5 faunas) was deposited in the deeper parts of this basin. The upper part of the St. Laurent Limestone in Missouri (Benthic Assemblages 2 and 3 faunas), equivalent to the Tripp Member of Illinois, lapped onto the eastern flank of the Ozark Dome.

The transgression that began during the deposition of the upper Skaneateles Formation of New York culminated in the basal Tioughnioga (Map 5). This transgression allowed brachiopods formerly restricted to the Appohimchi Subprovince to migrate into the Michigan Basin-Hudson Bay Lowland Subprovince, possibly by lowering temperature within the Michigan Basin-Hudson Bay Lowland Subprovince to a level similar to that of the more temperate Appohimchi Subprovince. The spread of the Appohimchi Subprovince fauna characterizes the Fimbrispirifer-Pentagonia Assemblage Zone.

During the basal Tioughnioga, the shelf margin in New York prograded basinward from its most shoreward position, which was at the western margin of the Chenango Member of the Skaneateles Formation. This progradation was largely in response to the
production of biogenic carbonate debris. Throughout eastern North America, the basal Tioughnioga transgression produced the widest distribution of rocks in the pre-Taghanic late Middle Devonian. Basal Tioughnioga rocks in New York include the Stone Mill and Centerfield Limestones (Benthic Assemblage 3 fauna). The Centerfield is traceable into northwestern Pennsylvania. In southern Pennsylvania, Maryland, and West Virginia, faunal evidence suggests that the Chaneysville Siltstone (Benthic Assemblages 2 and 3 faunas) belongs in the basal Tioughnioga. The Landes Limestone of Maryland and West Virginia is a basinal equivalent of the Centerfield.

The deepest parts of the Appalachian Basin were starved in respect to terrigenous sediment at this time, resulting in the deposition of thin black shales, such as the so-called Pteropod Bed of Erie County, New York, a black shaly limestone containing a fauna of styliolinids (Cooper, 1930). The western regions of the Appalachian Basin were the site of deposition of thin beds of limestone, such as the Hungry Hollow Limestone (Benthic Assemblage 3 fauna) of Ontario and the Prout Limestone (Benthic Assemblage 3 fauna) of Ohio. These basinal limestones frequently contain evidence of submarine disconformity, such as the bone beds and Ambocoelia coquinas in the Beechwood Limestone (Benthic Assemblage 4 or 5 fauna) in Kentucky.

Carbonate platform conditions continued to dominate the Michigan Basin, producing the Four Mile Dam Formation, the
Charlevoix Limestone, the upper Gravel Point Formation, the Ten Mile Creek Dolomite, and the Logansport Limestone (all Benthic Assemblage 3 faunas). The eastern margin of the Illinois Basin was the site of deposition of the Beechwood Limestone (Benthic Assemblage 3 fauna) in southern Indiana, while the Walnut Grove Limestone (Benthic Assemblages 2 and 3 faunas) was deposited on the western flank and the Sweetland Creek Shale was deposited in the basin center. The only late Middle Devonian deposit on the southern flank of the Ozark Dome, the Clifty Formation of northwestern Arkansas (Benthic Assemblage 2 fauna) is also of basal Tioughnioga age.

Following the basal Tioughnioga (Map 6), regression recurred and the rate of clastic influx increased. The area of the Hamilton outcrop belt in New York received comparatively little terrigenous sediment at this time as the major locus of deposition and subsidence is represented by the Montebello Member (Benthic Assemblages 2 and 3 faunas) of central Pennsylvania. Basinal clastics of this age constitute the Ledyard, Wanakah, and Jacox Members of New York (Baird, in press), the Crooked Creek Shale of central Pennsylvania, and the Widder Formation of Ontario (Benthic Assemblages 3 to 5 faunas). The Chaneysville Siltstone (Benthic Assemblage 2 and 3 faunas) of southern Pennsylvania, Maryland, and West Virginia represents a clastic wedge of this age. The Michigan Basin continued to be an area of platform carbonates, typified by the Norway Point and
Petoskey Formations (Benthic Assemblages 2 and 3 faunas).

Although the shelf margin in Pennsylvania, Maryland, and West Virginia prograded markedly, the shelf margin in New York remained near the position it had occupied during the basal Tioughnioga. Two coral beds developed at this margin (Oliver, 1951). This suggests that the rate of terrigenous clastic influx was not great in New York.

The Tichenor Limestone and the equivalent basal bed of the Portland Point Limestone overlie a regional paraconformity on the Ludlowville Formation (Baird, in press) in New York. These rocks, containing Benthic Assemblage 3 faunas, mark a regional transgression. In southern Pennsylvania, Maryland, and West Virginia, this transgression is indicated by the Frame Shale (Benthic Assemblage 3 fauna). Although the record of sedimentation of the upper Hamilton in West Virginia and Maryland is relatively complete, in New York, the Moscow Formation contains several major disconformities. These breaks in the sedimentary record reflect the low volume of terrigenous clastics that entered the Appalachian Basin at this time.

The Tichenor is overlain by the Deep Run Member. The Deep Run (Benthic Assemblages 3 and 4 faunas) represents the progradation of shelf margin following the post-Tichenor regression. In Maryland, southern Pennsylvania, and West Virginia, this regression is related to the Lower Siltstone (Benthic Assemblage 3 fauna). The next
transgressive cycle produced the Menteth Limestone and upper Portland Port Member (Benthic Assemblage 3 fauna) of New York and the Middle Shale of southern Pennsylvania, Maryland, and Virginia. Regression followed; the shelf margin migrated from the former upper Portland Point shelf edge in eastern New York to a position approximately 300 miles to the west, forming the shelf edge of the Kashong Member (Benthic Assemblage 2; Tropidoleptus Community) (Map 8). This is the most westerly shelf margin established during Hamilton deposition. At the same time, the Clearville Siltstone (Benthic Assemblage 3 fauna) of southern Pennsylvania, Maryland, and West Virginia was deposited. This differs from the model of Dennison and Head (1975) who correlate the Clearville with the sub-Tichenor Wanakah Member of New York.

Evidence for a submarine disconformity between the Kashong and Windom Members (Baird, 1978; Baird, in press) attests to the rapidity of the basal Windom transgression and the reduced sediment influx at this time (Map 8). This transgression is represented by the Pokejoy Limestone and Upper Shale Members of southern Pennsylvania, Maryland, and West Virginia. Two additional cycles of transgression and regression may be observed in the Windom and Cooperstown Members of New York. The lower cycle includes the Ambocoelia umbonata Bed (Benthic Assemblage 4, Ambocoeliid Community; transgression), the Strophodonta-Coralline Bed (Benthic
Assemblage 3, Atrypid-Stropholontid Community; regression), and the **Emanuella praeumbona** Bed (Benthic Assemblage 4, Ambocoeliid Community; transgression). (These beds, and additional beds mentioned below are described by Cleland (1903) and Cooper (1930), who termed them faunal zones, although not in the modern usage of the term zone. They are the smallest recognizable biostratigraphic units of the Windom.) The upper cycle is made up of the **E. praeumbona** and **Camarotoechia** Beds (Benthic Assemblages 4 and 5, Ambocoeliid and **Camarotoechia** Communities; transgression), the **Spiriferid-Atrypid** Bed and the **Cystodyctia** Beds (Benthic Assemblage 3, Atrypid-Strophodontid Community; regression), and the **Pustulatia-Allanaria** Bed (Benthic Assemblage 4, Ambocoeliid Community; regression). The final transgression continued into the Taghanic onlap of Johnson (1970c).

The greatest eastward retreat of the late Middle Devonian shelf is seen in the Gilboa Formation (Map 9). The Lower Tully Member is composed entirely of basinal deposits containing faunas of Benthic Assemblages 4 and 5. An anticline which formed a topographic high separated the site of Lower Tully deposition from the shelf and terrigenous clastics (Heckal, 1973). In southern Pennsylvania, Maryland, and West Virginia, where tectonic activity did not interrupt sedimentation, the height of the Taghanic onlap is represented by deep water limestone (Benthic Assemblage 4 and 5 faunas)
correlative with the Tully of New York. The Upper Tully Member of New York (Benthic Assemblage 3 fauna) was deposited in an area temporarily kept free of terrigenous clastics by the development of a hypothetical downfaulted basin to the east (Heckel, 1973). When this downdropped basin filled, the terrigenous clastics of the Genesee Group overwhelmed the site of Tully deposition.

The Taghanic onlap inundated several formerly subaerial areas of the Midwest. For example, the carbonate platform of the Michigan Basin may have been drained of marine water during the regression represented by the Kashong Member of New York. The epeiric sea transgressed this platform during the Taghanic, depositing the Potter Farm, Thunder Bay, Little Rock Creek, and Whiskey Creek Formations (Benthic Assemblages 2 and 3 faunas). The sea extended at least as far north as James Bay, another probable area of former subaerial erosion, where the Williams Island Formation was deposited. To the west, this transgression covered formerly subaerial regions of southeastern Wisconsin, where it is recognized in the Milwaukee Formation (Benthic Assemblages 2 and 3 faunas). Shallow water sediments, including a portion of the dolomite and evaporites of the Wapsipinicon Formation of Iowa, were followed by the normal marine limestones of the Cedar Valley Formation (Benthic Assemblages 2 and 3 faunas) which reached into western Illinois, northern Missouri, and southern Minnesota. To the south, the transgression spread
basinal black shales of the Blocher Formation (Benthic Assemblage 4 or 5 fauna) over the former shelf area of southern Indiana; similarly, the Sweetland Creek Shale spread across the former shelf areas of southern Illinois, on the western side of the Illinois Basin.

Many former Old World Realm brachiopod genera migrated into the Eastern Americas Realm during the Taghanic, while several genera formerly restricted to the Eastern Americas Realm migrated into the Old World Realm. This decrease in provincialism is partly attributed to the continental backbone being inundated in one or more places by the transgressing sea, and partly to the improvement in circulation and termination of hypersaline conditions on the Michigan Basin-Hudson Bay Lowland platform that resulted from an increase in the depth of the water in the epeiric seas of eastern North America.
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APPENDIX
APPENDIX 1

Locations of Collections Arranged By Community

The numbers by which the collections are listed in Appendix 1 are also used to reference the collections in Appendix 2. Appendix 1 lists the locations of the collections arranged by community. The thirteen tables of Appendix 2 list the faunas of the collections, also arranged by community.

Atypid-Strophodontid Community

0002 Tichenor Limestone, Eighteen Mile Creek, Buffalo Quadrangle, N.Y., coralline and crinoidal hash limestone

0003 Tichenor Limestone, north branch of Smoke Creek, just east of Berg Road bridge, southeast of Buffalo, Buffalo Quadrangle, N.Y., gray bioclastic limestone

0009 Tichenor Limestone, Buffalo Quadrangle, N.Y., gray fragmental limestone

0033 Centerfield Limestone, bed of Buffalo Creek, below dam at Blossom, Erie County, Depew Quadrangle, N.Y., gray calcareous shale

0025, 0026 Wanakah Shale, Cazenovia Creek, west of bridge at Spring Brook, Depew Quadrangle, N.Y., gray shale

0027, 0028 Wanakah Shale, Trilobite Beds, west of bridge, Cazenovia Creek, Spring Brook, Depew Quadrangle, N.Y., gray shale

0021, 0022, 0023, 0024 Tichenor Limestone, east of bridge, Cazenovia Creek, Spring Brook, Depew Quadrangle, N.Y., light gray calcareous shale and bioclastic limestone

0015 Kashong Shale, branch of Cayuga Creek, east of road, 1.6 miles southeast of West Alden, Depew Quadrangle, N.Y., gray shale

0047, 0048, 0049 Centerfield Limestone, 2 miles northwest of Darien on Crooked Creek, and 0.8 miles southeast of Darien Station in field north of road, Attica Quadrangle, N.Y., gray shale and limestone

0046 Tichenor Limestone, shale 1 foot above limestone bed, Bowen Brook, Alexander, Attica Quadrangle, N.Y., dark gray shale

0067 Centerfield Limestone, Murder Creek, near Losee School, north of Darien, Batavia Quadrangle, N.Y., gray shale and limestone

0070 Centerfield Limestone, branch of Tonawanda Creek, 3 miles west of East Bethany, Batavia Quadrangle, N.Y., gray limestone

0066 Lower Wanakah Shale, Pleurodictyum Bed, Murder Creek, 3/4 mile north-northwest of Darien, Batavia Quadrangle, N.Y., gray shale

0060 Tichenor Limestone, 1 1/2 miles southeast of East Bethany, Batavia Quadrangle, N.Y., gray shale

0064 Tichenor Limestone, shale beds 5 feet below limestone, cut on east side of road, 3.8 miles northwest of Pavilion, Batavia Quadrangle, N.Y., gray shale

0065 Tichenor Limestone, Murder Creek, Darien, Batavia Quadrangle, N.Y., gray shale

0058 Menteth Limestone, 1 1/2 miles southeast of East Bethany, Batavia Quadrangle, N.Y., coarse gray bioclastic limestone
Kashong Shale, Griegsville, 1 mile southeast of intersection of Pavilion and Lancaster Roads, Livingston County, Batavia Quadrangle, N.Y., gray shale

Kashong Shale, Walker Road, north side, 2 miles northeast of Darien, Batavia Quadrangle, N.Y., dark gray shale

Upper Windom Shale, branch of White Creek, 1 1/2 miles southeast of East Bethany, Batavia Quadrangle, N.Y., gray shale

Tichenor Limestone, Wheeler Gully or Jacox Run, 2 1/2 miles north-northeast of Geneseo, Caledonia Quadrangle, N.Y., gray shale and bioclastic limestone

Deep Run Shale, Wheeler Gully or Jacox Run, 2 1/2 miles north-northeast of Geneseo, Caledonia Quadrangle, N.Y., gray shale

Menteth Limestone, Wheeler Gully or Jacox Run, 2 1/2 miles north-northeast of Geneseo, Caledonia Quadrangle, N.Y., gray crinoidal limestone

Menteth Limestone, Hills Gulch, 1 1/4 mile northwest of Linwood and 5 miles south of Leroy, Caledonia Quadrangle, N.Y., gray crinoidal limestone

Windom Shale, _Mucrospirifer consobrinus_ Bed, Little Beards Creek, Leicester, Caledonia Quadrangle, N.Y., gray shale

Windom Shale, _Mucrospirifer consobrinus_ Bed, Fall Brook, 2 miles south-southwest of Geneseo, Caledonia Quadrangle, N.Y., gray shale

Windom Shale, coral bed just above "Ambocoelia praeumbona" Bed, Fall Brook, 2 miles south-southwest of Geneseo, Caledonia Quadrangle, N.Y., gray shale

Windom Shale, "_Atypa spinosa_" Bed, Fall Brook, 1 1/2 miles south-southwest of Geneseo, Caledonia Quadrangle, N.Y., gray shale

Centerfield Limestone, Shaffer Creek, 0.9-1 mile north-northwest of Centerfield, Canandaigua Quadrangle, N.Y., gray limestone and shale

Tichenor Limestone, lower calcareous shale, Tichenor Point Ravine, Canandaigua Lake, N.Y., dark gray shale

Tichenor Limestone, lower calcareous shale, Fall Brook, Canandaigua Quadrangle, N.Y., dark gray shale

Basal Deep Run Shale, Tichenor Point, east side Canandaigua Lake, Canandaigua Quadrangle, N.Y., gray to brown and gray coralline limestone

Basal Deep Run Shale, Gage Creek, east side Canandaigua Lake, 1/4 mile south of Cottage City, Canandaigua Quadrangle, N.Y., dark gray shale

Deep Run Shale, Deep Run, Cottage City, east side Canandaigua Lake, Canandaigua Quadrangle, N.Y., dark gray shale
Menteth Limestone, Gage Creek, east side Canandaigua Lake, 1/4 mile south of Cottage City, Canandaigua Quadrangle, N.Y., dark, fine-grained limestone

Portland Port Limestone, Centronella Beds, Menteth Glen, west side Canandaigua Lake, Canandaigua Quadrangle, N.Y., gray shale and mudstone

Centerfield Limestone, Wilson Creek, north of Bellona, west side of Seneca Lake, Geneva Quadrangle, N.Y., dark fine-grained to crinoidal limestone and gray mudstone

Centerfield Limestone, Big Hollow Creek, west side Cayuga Lake, 3 1/2 miles north-northeast of Ovid, Ovid Quadrangle, N.Y., dark gray siltstone and limestone

Tichenor Limestone, Kashong Creek, Seneca Lake, Geneva Quadrangle, N.Y., gray limestone and mudstone

Portland Point Limestone, Kashong Creek, Bellona, west side Seneca Lake, Geneva Quadrangle, N.Y., gray shale and mudstone

Windom Shale, "Spirifer"-"Atrypa" Bed, Kashong Creek, Bellona, west side Seneca Lake, Geneva Quadrangle, N.Y., gray mudstone

Centerfield Limestone, Moonshine Falls, Paines Creek, 2 1/4 miles northwest of Black Rock, near Aurora and Cayuga Lake, Auburn Quadrangle, N.Y., dark gray siltstone, mudstone, and limestone

Centerfield Limestone, 1023 paces up Big Hollow Creek from Cayuga Lake, west side Cayuga Lake, 3 1/2 miles north-northeast of Ovid, Ovid Quadrangle, N.Y., gray shale and siltstone

Centerfield Limestone, Deans Creek, 1 mile north of Aurora, Auburn Quadrangle, N.Y., dark gray shale

Portland Point Limestone, falls 1230 paces up Bloomer Creek from shore of Cayuga Lake, Auburn Quadrangle, N.Y., dark gray bioclastic limestone and mudstone

Upper Windom Shale, "Spirifer"-"Atrypa" Bed, just under falls, Bloomer Creek, Cayuga Lake, Auburn Quadrangle, N.Y., dark gray siltstone

Windom Shale, "Atrypa" spinosa Bed, Bloomer Creek, Cayuga Lake, Auburn Quadrangle, N.Y., gray shale and siltstone

Windom Shale, "Spirifer"-"Atrypa" Bed, King Ferry, Clearview, east side Cayuga Lake, N.Y., gray shale and mudstone

Windom Shale, Strophodonta-Coralline Bed, Shurger Glen, 2 miles south of Ludlowville, Cayuga Lake, Auburn Quadrangle, N.Y., gray crinoidal mudstone

Windom Shale, Upper Transition Beds, Shurger Glen, 2 miles south of Ludlowville, Cayuga Lake, Auburn Quadrangle, N.Y., dark gray to black shale and siltstone
Windom Shale, Sheldrake Creek, Sheldrake, west side Cayuga Lake, Auburn Quadrangle, N.Y., dark gray to black shale

Centerfield Limestone, Hall's Landing Ravine, 1 mile southeast of Ten Mile Point, east side Skaneateles Lake, Skaneateles Quadrangle, N.Y., gray to brown siltstone

Centerfield Limestone, Ensenore Glen, 3 miles east-northeast of Scipio, west side Owasco Lake, Skaneateles Quadrangle, N.Y., dark gray siltstone

Centerfield Limestone, New Gulf Road, 1/2 mile north-northwest of Marietta, Skaneateles Quadrangle, N.Y., dark gray siltstone and limestone

Centerfield Limestone, Harlands Gulf, 0.9 miles north-northwest of Marietta, Skaneateles Quadrangle, N.Y., gray siltstone

King Ferry Member?, Harlands Gulf, 0.9 mile north-northwest of Marietta, N.Y., light gray shale and siltstone

Portland Point Limestone, Barber Point Ravine, east side Skaneateles Lake, Skaneateles Quadrangle, N.Y., gray crinoidal limestone

Portland Point Limestone, Hall's Landing Ravine, 2 1/2 miles northwest of Spafford Landing, east side Skaneateles Lake, Skaneateles Quadrangle, N.Y., gray crinoidal limestone

Cooperstown Member, Strophodonta-Coralline Bed, Barber Point Ravine, east side Skaneateles Lake, Skaneateles Quadrangle, N.Y., dark gray siltstone

Cooperstown Member, Strophodonta-Coralline Bed, Hall's Landing Ravine, 2 1/2 miles northwest of Spafford Landing, east side Skaneateles Lake, Skaneateles Quadrangle, N.Y., dark gray siltstone

Mottville Member, Bear Mountain Ravine, west of Tully Valley, Tully Quadrangle, N.Y., gray sandy siltstone above limestone of Lower Mottville

Lower Mottville Member, Bear Mountain Ravine, west of Tully Valley, Tully Quadrangle, N.Y., dark gray bioclastic silty limestone and dark gray siltstone

Mottville Member, ravine 1/4 mile northeast of Tully Valley, Tully Quadrangle, N.Y., gray siltstone

Basal Delphi Station Member, shale 5 feet above Mottville Limestone, Bear Mountain Ravine, west of Tully Valley, Tully Quadrangle, N.Y., dark gray siltstone

Centerfield Limestone, falls in Bucktail Ravine, Spafford Valley, Tully Quadrangle, N.Y., dark gray siltstone and gray medium to fine grained limestone

Centerfield Limestone, Fellows Falls, 3 miles northwest of Tully, and 1 mile east of Vesper, Tully Quadrangle, N.Y., dark gray siltstone, silty shale, and bioclastic limestone
Otisco Member, *Pholidostrophia* Bed, Bucktail Ravine, Spafford Valley, Tully Quadrangle, N.Y., dark gray to brown silty shale and sandy siltstone

Otisco Member, *Pholidostrophia* Bed, 118 feet above coral bed, Fellows Falls Ravine, 1 mile east of Vesper, Tully Quadrangle, N.Y., dark gray siltstone

Upper Otisco Member, Fellows Falls Ravine, 1 mile east of Vesper, Tully Quadrangle, N.Y., dark gray siltstone

Spafford Member, Fellows Falls Ravine, 1 mile east of Vesper, Tully Quadrangle, N.Y., gray siltstone

Spafford Member?, Bucktail Ravine, Spafford Valley, Tully Quadrangle, N.Y., gray to brown silty mudstone

Portland Point Limestone, Bucktail Ravine, Spafford Valley, Tully Quadrangle, N.Y., dark gray siltstone and gray bioclastic limestone

Portland Point Limestone, Fellows Falls Ravine, 3/4 mile east of Vesper, Tully Quadrangle, N.Y., gray bioclastic limestone

Cooperstown Member, *Sirophodonta* -Coralline Bed, Bucktail Ravine, Spafford Valley, Tully Quadrangle, N.Y., dark gray siltstone

Mottville Member, Pratts Falls, 5 miles south of Manlius, Cazenovia Quadrangle, N.Y., gray silty shale and massive siltstone

Mottville Member, ravine on east side of Limestone Valley, Cazenovia Quadrangle, N.Y., dark gray siltstone

Mottville Member, above massive layer, tunnel 2 miles northwest of Cazenovia, Cazenovia Quadrangle, N.Y., dark gray siltstone

Mottville Member, massive layer, both sides of tunnel on west side of Cazenovia Lake, 2 miles northwest of Cazenovia, Cazenovia Quadrangle, N.Y., dark gray fine bioclastic limestone

Delphi Station Member, Delphi Falls, 1 mile southeast of Delphi, Cazenovia Quadrangle, N.Y., dark gray siltstone with lower black fissile shale

Lower Delphi Station Member, Pratts Falls, 5 miles south of Manlius, Cazenovia Quadrangle, N.Y., gray siltstone and shale

Delphi Station Member, Oran-Cazenovia Highway, 2 miles northwest of Cazenovia and 3-3 1/4 miles southeast of Oran, Cazenovia Quadrangle, N.Y., dark gray to brown siltstone and sandy siltstone

Upper Delphi Station Member, U.S. Rte. 20, 1 1/2 to 1 1/4 miles east of Pompey Center, and 1 1/2 miles west of Cazenovia, at top of hill, Cazenovia Quadrangle, N.Y., gray to brown siltstone
0464, 0465  Delphi Station Member, U.S. Rte. 20, 1 1/4 miles east of Pompey Center, Cazenovia Quadrangle, N.Y., dark gray siltstone

0466  Lower Delphi Station Member, U.S. Rte. 20, 1 1/2 miles east of Pompey Center, Cazenovia Quadrangle, N.Y., dark gray siltstone

0472, 0473, 0474  Delphi Station Member, on road, 3-3 1/2 miles southeast of Oran, Cazenovia Quadrangle, N.Y., dark gray siltstone

0440  Pompey Member, uppermost, Delphi Falls, 1 mile southeast of Delphi, Cazenovia Quadrangle, N.Y., fine gray sandstone

0441, 0442  Upper Pompey Member, top of second falls at Delphi Falls, 1 mile southeast of Delphi, Cazenovia Quadrangle, N.Y., massive, hard, gray sandstone

0447  Upper Pompey Member, Pratts Falls, 5 miles south of Manlius, Cazenovia Quadrangle, N.Y., massive gray sandstone

0427  Centerfield Limestone, ravine in north face of Arab Hill, Cazenovia Quadrangle, N.Y., dark gray siltstone

0433  Centerfield Limestone, below Otisco coral bed, just east of bridge, in first low cascade on Limestone Creek, 1/4 mile north of New Woodstock, Cazenovia Quadrangle, N.Y., thin-bedded dark gray siltstone

0434  Centerfield Limestone, glen 1 1/4 miles north-northeast of Nelson, Cazenovia Quadrangle, N.Y., gray sandy siltstone

0435, 0436  Centerfield Limestone, Stockham Hill Ravine, west of highway, 3/4-1 mile southeast of Delphi, Cazenovia Quadrangle, N.Y., dark gray to brown siltstone and gray fine bioclastic limestone

0432  Otisco Member, coral bed, 1/4 mile north of New Woodstock, Cazenovia Quadrangle, N.Y., dark gray siltstone

0418  Otisco Member, Pholidostrophia Bed, I.H. Hunt's Ravine, 1 mile southeast of New Woodstock, N.Y., massive gray siltstone

0431  Panther Mountain Fm., ravine on east side Deruyter Reservoir, Cazenovia Quadrangle, N.Y., gray siltstone

0428, 0429, 0430  Panther Mountain Fm., ravine 1/2 mile south of north end of Deruyter Reservoir, on east side of reservoir, Cazenovia Quadrangle, N.Y., dark gray siltstone

0412  Portland Point Limestone, ravine 1 1/4 miles south-southwest of Fabius, Cazenovia Quadrangle, N.Y., gray bioclastic limestone

0415  Portland Point Limestone, I.H. Hunt's Ravine, 1 mile southeast of New Woodstock, Cazenovia Quadrangle, N.Y., dark gray massive siltstone
0424, 0425  Portland Point Limestone, Arab Hill Ravine, north end of Deuyter Reservoir, Cazenovia Quadrangle, N.Y., dark gray massive, bioclastic limestone

0605  Delphi Station Member, Bembexia Bed, on road 1 1/2 miles northeast of Eaton, Morrisville Quadrangle, N.Y., dark gray to black sandy siltstone

0606  Basal Delphi Station Member, Pholidops Bed, intersection of Eaton and Hamilton Roads, 1.35 miles northeast of Eaton, Morrisville Quadrangle, N.Y., dark gray sandy siltstone

0637, 0638  Delphi Station Member, northeast of Hamilton, Morrisville Quadrangle, N.Y., dark gray sandy siltstone

0667  Delphi Station Member, vicinity of Hamilton, Morrisville Quadrangle, N.Y., dark gray sandy siltstone

0488  Stone Mill Limestone, glen on east side of road at southeast end of Bradley Brook Reservoir, Morrisville Quadrangle, N.Y., gray fine to coarse crinoidal limestone with thin-bedded gray siltstone above

0583  Stone Mill Limestone, Stone Mill Brook and adjacent West Shore Railroad cut, 1 1/4 miles northwest of Earlville, Morrisville Quadrangle, N.Y., dark gray sandy siltstone

0584  Stone Mill Limestone, Red Gate Stock Farm, 4 miles south of Hamilton, Morrisville Quadrangle, N.Y., dark gray sandy shale

0585, 0586  Stone Mill Limestone, Red Gate Stock Farm, 2 miles north of Earlville, Morrisville Quadrangle, N.Y., dark gray siltstone

0594, 0595  Stone Mill Limestone, along outlet stream at southwest end of Kingsley Brook Reservoir, 2 1/4 miles due west of Randalsville, Morrisville Quadrangle, N.Y., dark gray sandy siltstone

0596  Stone Mill Limestone, roadside 1 mile south of Randalsville, Morrisville Quadrangle, N.Y., dark gray sandy siltstone

0597  Stone Mill Limestone, Pattersons Glen, top of falls, 1/2 mile east-southeast of Randalsville, Morrisville Quadrangle, N.Y., gray fine bioclastic limestone

0644  Stone Mill Limestone, 1680 feet in branch of Oneida Creek, 3.3 miles south-southwest of Peterboro, Morrisville Quadrangle, N.Y., dark gray fine bioclastic limestone

0570, 0571  Panther Mountain Fm., Pholidotosphila Bed, ravine 0.7 miles east of Erieville, Morrisville Quadrangle, N.Y., dark gray fine bioclastic limestone
Portland Point Limestone, 3/4 mile south of road intersection at southwest end of Hatch Lake, Morrisville Quadrangle, N.Y., dark gray sandstone and siltstone

Portland Point Limestone, Strouds Ravine, 1/4 mile south-southwest of Lebanon, Morrisville Quadrangle, N.Y., light gray fine bioclastic limestone

Portland Point Limestone, Blairs Ravine, Morrisville Quadrangle, N.Y., dark gray fine bioclastic limestone

Portland Point Limestone, ravine 1/2 mile south-southwest of Lebanon, Morrisville Quadrangle, N.Y., dark gray sandy siltstone and fine fragmental limestone

Cooperstown Member, Schuchertella Beds, Moores Glen, 1 1/4-1 1/2 miles northeast of Georgetown, Morrisville Quadrangle, N.Y., dark gray siltstone

Cooperstown Member, Werner's Quarry, 1 1/4 miles northeast of Georgetown, Morrisville Quadrangle, N.Y., dark gray siltstone

Cooperstown Member, Pustularia-"Spirifer" tullius Bed, Moores Glen, 1 1/4-1 1/2 miles northeast of Georgetown, Morrisville Quadrangle, N.Y., dark gray siltstone

Cooperstown Member, "Spirifer"-"Atypa" Bed, West Brook, west side of New Berlin, Unadilla Valley, N.Y., dark gray sandy siltstone

Panther Mountain Fm., road leading to Bear Gulch Pond from Richmondville, 3 miles south of Richmondville, Richmondville Quadrangle, N.Y., fine gray sandstone and siltstone

Panther Mountain Fm., Tobias Wayman Gully at head of Panther Creek, 3 miles south of Summit, Richmondville Quadrangle, N.Y., gray siltstone and fine sandstone

Otsego Member, along Schoharie River, 1 mile north-northeast of Middleburg, Schoharie Quadrangle, N.Y., dark gray to brown fine sandstone

Basal Otsego Member, Meristella Bed, ravine 2 1/2 miles southeast of Schoharie, Schoharie Quadrangle, N.Y., dark gray sandy siltstone

Upper Mount Marion Fm., 1 1/2 miles northeast of Rensselaerville, Berne Quadrangle, N.Y., gray coarse siltstone

Upper Mount Marion Fm., Schizophoria Bed, 1/2 mile west of Westerlo, Berne Quadrangle, N.Y., dark gray siltstone

Upper Mount Marion Formation, Schizophoria Bed, roadside section 1 1/2 miles south of Westerlo, Berne Quadrangle, N.Y., dark gray coarse siltstone

Upper Mount Marion Fm., 1 mile south of Westerlo, Berne Quadrangle, N.Y., dark gray coarse siltstone

Lower Mount Marion Fm., basal Otsego equivalent, Meristella Bed, roadside section 1 1/4 miles southwest of East Berne, Berne Quadrangle, N.Y., coarse gray siltstone
0952 Mount Marion Fm., **Schizophoria** Bed, hill 1 3/4 miles south-southwest of Coeymans Hollow, Coxsackie Quadrangle, N.Y., gray fine sandstone

0963 Stony Hollow Member, massive bed, 2 miles south of Mount Marion, Catskill Quadrangle, N.Y., massive coarse gray siltstone

0964 Stony Hollow Member, massive bed, 1/2 mile west of Weber Bridge on N.Y. Rte. 23A, west of Catskill, Catskill Quadrangle, N.Y., massive coarse gray siltstone

0978 Stony Hollow Member, massive bed, 1 1/4 miles north of west edge of Kingston, Rosendale Quadrangle, N.Y., fine gray sandstone

0979 Stony Hollow Member, massive bed, railroad cut 2 miles southeast of Stony Hollow, Rosendale Quadrangle, N.Y., coarse dark gray siltstone

0970, 0971 Mount Marion Fm., **Schizophoria** Bed, cut on new road 5 miles northwest of Kingston, Rosendale Quadrangle, N.Y., coarse brown siltstone and fine sandstone

0972 Mount Marion Fm., **Schizophoria** Bed, between old road and new road, just northeast of Bristol Church, west of Stony Hollow, Rosendale Quadrangle, N.Y., gray siltstone

1124 Centerfield Member, coral bed, 3 1/4 miles north-northwest of junction of U.S. Rte. 290 and Pa. Rte. 191, road cut on west side of Pa. Rte. 191, East Stroudsburg, Pa., dark gray siltstone

1125 Centerfield Member, cut along Stroudsburg-Spragueville highway, just south of home of E. Bonyorge, Pa., dark gray siltstone

1127, 1128 Centerfield Member, north side of highway, 6 miles east of Lehighton, Pa., dark gray mudstone and siltstone

1160 Sherman Ridge Member, **Pustulatia** Bed, 2 miles northwest of Northumberland, Pa., gray siltstone

1145 Upper Shale Member, just above railroad bridge over Juniata River, 1 mile north of Mapleton, Huntington Quadrangle, Pa., dark gray siltstone

1154, 1155 Upper Shale Member, Eichelburgertown, Pa., dark gray siltstone

1151 Upper Shale Member, river bank 1/8 mile southeast of Reese, Pa., dark gray fine siltstone

1149, 1150 Upper Shale Member, shale pit, South Altoona Brickworks, Altoona, Pa., dark gray siltstone

1153 Upper Shale Member, limestone lense, cut on U.S. Rte. 22, Southfield, Pa., small concretions of fine-grained dark gray limestone

1589 Centerfield Member, west of Berwick, Pa., fine calcareous siltstone and mudstone

1590 Centerfield Member, cut on west side of U.S. Rte. 11 near Beachhaven, Pa., fine calcareous siltstone and mudstone
1592 Centerfield Member, roadcut in Lehighton, Pa., fine calcareous siltstone and mudstone
1188 Montebello Sandstone, north quarry, east side Susquehanna River, north of Rockville, Pa.
   (Ellison Section 1, Unit 3), gray sandy shale
1189 Montebello Sandstone, north quarry, east side Susquehanna River, north of Rockville, Pa.
   (Ellison Section 1, Unit 3), gray sandy shale
1192 Montebello Sandstone, north quarry, east side Susquehanna River, north of Rockville, Pa.
   (Ellison Section 1, Unit 9), fine gray sandstone
1209 Sherman Ridge Member, cut on Pa. Rte. 850, west of Dromgold, Pa. (Ellison Section 3,
   Unit 1), light green-gray silty shale and siltstone
1210 Sherman Ridge Member, cut on Pa. Rte. 850, west of Dromgold, Pa. (Ellison Section 3,
   Unit 1), light green-gray silty shale and siltstone
1211 Sherman Ridge Member, cut on Pa. Rte. 850, west of Dromgold, Pa. (Ellison Section 3,
   Unit 1), light green-gray silty shale and siltstone
1224 Sherman Ridge Member, pit on south flank of Mahanoy Ridge, south of New Bloomfield,
   Pa. (Ellison Section 5, Unit 1), gray silty claystone
1225 Sherman Ridge Member, pit on south flank of Mahanoy Ridge, south of New Bloomfield,
   Pa. (Ellison Section 5, Unit 1), gray silty claystone
1226 Sherman Ridge Member, pit on south flank of Mahanoy Ridge, south of New Bloomfield,
   Pa. (Ellison Section 5, Unit 1), gray silty claystone
1227 Sherman Ridge Member, pit on south flank of Mahanoy Ridge, south of New Bloomfield,
   Pa. (Ellison Section 5, Unit 1), gray silty claystone
1238 Sherman Ridge Member, pit on south flank of Mahanoy Ridge, south of New Bloomfield,
   Pa. (Ellison Section 5, Unit 2), green-gray argillaceous siltstone
1247 Sherman Ridge Member, cuts on U.S. Rte. 22 parallel to Juniata River at Amity Hall, Pa.
   (Ellison Section 6, Unit 1), dark gray-green shale
1248 Sherman Ridge Member, cuts on U.S. Rte. 22 parallel to Juniata River at Amity Hall, Pa.
   (Ellison Section 6, Unit 1), dark gray-green shale
1249 Sherman Ridge Member, cuts on U.S. Rte. 22 parallel to Juniata River at Amity Hall, Pa.
   (Ellison Section 6, Unit 1), dark gray-green shale
1250 Sherman Ridge Member, cuts on U.S. Rte. 22 parallel to Juniata River at Amity Hall, Pa.
   (Ellison Section 6, Unit 1), dark gray-green shale
1251 Sherman Ridge Member, cuts on U.S. Rte. 22 parallel to Juniata River at Amity Hall, Pa.
   (Ellison Section 6, Unit 1), dark gray-green shale
1252 Sherman Ridge Member, cuts on U.S. Rte. 22 parallel to Juniata River at Amity Hall, Pa.
   (Ellison Section 6, Unit 3), dark gray-green shale
Sherman Ridge Member, cuts on U.S. Rte. 22 parallel to Juniata River at Amity Hall, Pa. (Ellison Section 6, Unit 3), gray fine to medium grained sandstone and dark gray siltstone

Sherman Ridge Member, cuts on U.S. Rte. 22 parallel to Juniata River at Amity Hall, Pa. (Ellison Section 6, Unit 60, dark gray shaly siltstone

Sherman Ridge Member, stream cut and road cut on U.S. Rte. 15, near nose of Half Falls Mountain, at Girty's Notch, Pa. (Ellison Section 7, Unit 1), gray silty shale

Sherman Ridge Member, stream cut and road cut on U.S. Rte. 15, near nose of Half Falls Mountain, at Girty's Notch, Pa. (Ellison Section 7, Unit 1), gray silty shale

Sherman Ridge Member, stream cut and road cut on U.S. Rte. 15, near nose of Half Falls Mountain, at Girty's Notch, Pa. (Ellison Section 7, Unit 1), gray silty shale

Sherman Ridge Member, stream cut and road cut on U.S. Rte. 15, near nose of Half Falls Mountain, at Girty's Notch, Pa. (Ellison Section 7, Unit 1), gray silty shale

Sherman Ridge Member, stream cut and road cut on U.S. Rte. 22, near nose of Half Falls Mountain, at Girty's Notch, Pa. (Ellison Section 7, Unit 1), gray silty shale

Sherman Ridge Member, stream cut and road cut on U.S. Rte. 15, near nose of Half Falls Mountain, at Girty's Notch, Pa. (Ellison Section 7, Unit 1), gray silty shale

Upper Shale Member, cut on northwest side of U.S. Rte. 522, 0.1-0.5 miles south of Websters Mills, Pa. (Ellison Section 10, Unit 1), olive-gray shale

Frame Shale, cut on northwest side of U.S. Rte. 522, 0.1-0.5 miles south of Websters Mills, Pa. (Ellison Section 10, Unit 5), gray silty shale

Frame Shale, cut on northwest side of U.S. Rte. 522, 0.1-0.1 miles south of Websters Mills, Pa. (Ellison Section 10, Unit 5), gray silty shale

Chaneysville Siltstone, roadcuts at Chaneysville, Pa. (Ellison Section 11, Unit 7), dark gray shaly siltstone

Upper Shale Member, shale pit and dirt road parallel to Elk Lick Creek, Pa. (Ellison Section 12, Unit 1), gray silty claystone

Upper Shale Member, shale pit and dirt road parallel to Elk Lick Creek, Pa. (Ellison Section 12, Unit 2), gray calcareous siltstone

Upper Shale Member, cuts on Pa. Turnpike west of interchange at Bedford, Pa. (Ellison Section 14, Unit 1), gray silty shale

Clearville Siltstone, cuts on Pa. Turnpike west of interchange at Bedford, Pa. (Ellison Section 14, Unit 2), green-gray micaceous siltstone
1383  Frame Shale, borrow pit and cuts on Pa. Rte. 56 at Fishertown, Pa. (Ellison Section 15, Unit 4), gray silty calcareous mudstone
1384  Chaneysville Siltstone, cuts on Pa. Rte. 56 at Fishertown, Pa. (Ellison Section 15, Unit 5), gray calcareous shaly siltstone
1385  Chaneysville Siltstone, cuts on Pa. Rte. 56 at Fishertown, Pa. (Ellison Section 15, Unit 6), gray silty shale
1389  Upper Shale Member, cuts along U.S. Rte. 22 on southwestern side of the Juniata River, opposite Huntington, Pa. (Ellison Section 16, Unit 1), gray silty mudstone
1390  Upper Shale Member, cuts along U.S. Rte. 22 on southwestern side of the Juniata River, opposite Huntington, Pa. (Ellison Section 16, Unit 1), gray silty mudstone
1391  Upper Shale Member, cuts along U.S. Rte. 22 on southwestern side of the Juniata River, opposite Huntington, Pa. (Ellison Section 16, Unit 1), gray silty mudstone with light gray limestone lenses
1392  Upper Shale Member, cuts along U.S. Rte. 22 on southwestern side of the Juniata River, opposite Huntington, Pa. (Ellison Section 16, Unit 1), gray silty mudstone
1393  Upper Shale Member, cuts along U.S. Rte. 22 on southwestern side of the Juniata River, opposite Huntington, Pa. (Ellison Section 16, Unit 1), gray silty mudstone
1394  Upper Shale Member, cuts along U.S. Rte. 22 on southwestern side of the Juniata River, opposite Huntington, Pa. (Ellison Section 16, Unit 1), gray silty mudstone
1401  Donation Siltstone, cuts along U.S. Rte. 22 on southwestern side of the Juniata River, opposite Huntington, Pa. (Ellison Section 16, Unit 5), gray shaly siltstone
1402  Donation Siltstone, cuts along U.S. Rte. 22 on southwestern side of the Juniata River, opposite Huntington, Pa. (Ellison Section 16, Unit 5), gray shaly claystone
1403  Donation Siltstone, cuts along U.S. Rte. 22 on southwestern side of the Juniata River, opposite Huntington, Pa. (Ellison Section 16, Unit 5), gray shaly claystone
1404  Donation Siltstone, cuts along U.S. Rte. 22 on southwestern side of the Juniata River, opposite Huntington, Pa. (Ellison Section 16, Unit 5), gray shaly claystone
1417  Donation Siltstone, dirt road at Martin Gap, Miller Township, Huntington County, Pa. (Ellison Section 17, Unit 1), gray silty mudstone
1418  Donation Siltstone, dirt road at Martin Gap, Miller Township, Huntington County, Pa. (Ellison Section 17, Unit 1), gray silty mudstone
1429  Upper Shale Member, cuts along U.S. Rte. 220 south of Newry, Pa. (Ellison Section 18, Unit 1), green-gray silty claystone
1450  Mahantango Fm., road 2 miles east of Liberty Furnace, Woodstock quadrangle, Va., dark gray massive siltstone
Mahantango Fm., 3/4 mile northeast of summit of Deer Head, 1 mile southwest of Cabin Hill, Woodstock Quadrangle, Va., gray siltstone

Beechwood Limestone ("Swanville"), Graves Quarry, north corner lot 34, Clark Grant, near Watson, Ind., light gray coarse bioclastic limestone

Beechwood Limestone ("Swanville"), 50 feet east of Ind. Rte. 3, 8 miles south of east-west road from Commissary, Ind., light gray coarse bioclastic limestone

Beechwood Limestone, abandoned Gheens Quarry, lot 48, Clark Grant, Cementville, Clark County, Ind., crackouts from limestone

Logansport Limestone, Pipe Creek Falls, near Peru, Indiana, crackouts from light gray to white coarse bioclastic limestone

Praut Limestone, tributary to Pipe Creek, 1/4 mile east of Bloomingville, on Ridge Road, D. M. Love Farm, Ohio, fossils poorly preserved

Ten Mile Creek Dolomite, Ten Mile Creek, 3 miles southwest of Sylvania, Ohio, fossils poorly preserved

Hungry Hollow Limestone, Hungry Hollow, 2 miles northeast of Arkona, Ontario, gray massive crinoidal and coralline limestone

Hungry Hollow Limestone, Number 4 Hill, 2 1/2 miles north of Arkona, Ontario, gray coralline limestone

Hungry Hollow Limestone, Tile Yard, Thedford, Ontario, gray coralline limestone

Hungry Hollow Limestone, Bruce Thompson's farm, 4.1 mile north of Arkona, Ontario, gray limestone

Four Mile Dam Limestone, Dock Street Clay Member, abandoned Thunder Bay Quarry, NE 1/4 14-T. 31N-R. 8 E., Alpena, Michigan (Cooper No. 40F), gray calcareous shale

Four Mile Dam Limestone, beds above Dock Street Clay Member, abandoned Thunder Bay Quarry, NE 1/4 14 T. 31 N., R. 8 E., Alpena, Michigan (Cooper No. 40G), dark gray bioclastic limestone

Four Mile Dam Limestone, reef at Four Mile Dam on Thunder Bay River, SW 1/4 SE 1/4 7, T. 31 N., R. 8 E., Alpena County, Michigan (Cooper No. 41), crackouts from light gray to white coarse bioclastic limestone
Mucrospirifer Community

0012  Wanakah Shale, just below "Strophalosia" Bed, Buffalo Quadrangle, N.Y., gray shale
0008  Windom Shale, Buffalo Quadrangle, N.Y., gray shale
0040  Uppermost Windom Shale, Murder Creek, south of Darien, Attica Quadrangle, N.Y., gray shale
0068  Lower Wanakah Shale, Pleurodictyum Bed, 3 miles west of East Bethany on D.L.& W. Railroad Tracks, Batavia Quadrangle, N.Y., gray shale
0059  Deep Run Shale, roadside 1 1/2 miles southeast of East Bethany, Batavia Quadrangle, N.Y., gray shale
0088, 0089  Kashong Shale, Wheeler Gully or Jacox Run, north branch, 2 1/2 miles north-northeast of Geneseo, Caledonia Quadrangle, N.Y., gray shale
0144  Wanakah Shale, Deep Run, Canandaigua Quadrangle, N.Y., gray shale
0117  Uppermost Kashong Shale, Gage Creek, east side Canandaigua Lake, Canandaigua Quadrangle, N.Y., gray shale
0118  Kashong Shale, upper concretionary bed, Gage Creek, east side Canandaigua Lake, Canandaigua Quadrangle, N.Y., dark gray limestone with clams in concretions
0119  Kashong Shale, Gage Creek, east side Canandaigua Lake, Canandaigua Quadrangle, N.Y., gray shale
0132  Uppermost Kashong Shale, sandy bed, Menteth Glen, west side Canandaigua Lake, Canandaigua Quadrangle, N.Y., dark gray to black shale
0134  Kashong Shale, Megastrophia concava Bed, Menteth Point Ravine, Canandaigua Lake, Canandaigua Quadrangle, N.Y., dark gray shale
0145  Kashong Shale, Tichenor Glen, Canandaigua Lake, Canandaigua Quadrangle, N.Y., dark gray to black mudstone
0122  Windom Shale, "Spirifer"-"Atypa" Bed, Menteth Glen, west side Canandaigua Lake, Canandaigua Quadrangle, N.Y., gray shale
0130  Windom Shale, "Spirifer"-"Atypa" Bed, 1314 paces above falls, Menteth Point Ravine, Canandaigua Lake, Canandaigua Quadrangle, N.Y., gray shale
0115  Windom Shale, Strophodonta-Coralline Bed, Gage Creek east side Canandaigua Lake, Canandaigua Quadrangle, N.Y., dark gray shale
0184, 0185  King Ferry Member, Pleurodictyum Bed, Kashong Creek, Bellona, west side Seneca Lake, Geneva Quadrangle, N.Y., gray mudstone
0179  Deep Run Shale, Kashong Creek, Bellona, west side Seneca Lake, Geneva Quadrangle, N.Y., dark gray shale
Deep Run Shale, Deep Run, east side Canandaigua Lake, Geneva Quadrangle, N.Y., dark gray to black mudstone

Kashong Shale, above high falls, Kashong Creek, Bellona, west side Seneca Lake, Geneva Quadrangle, N.Y., gray mudstone and shale

King Ferry Member, Shurger Glen, Cayuga Lake, Auburn Quadrangle, N.Y., black to dark gray mudstone

King Ferry Member, below falls, Bloomer Creek, 1230 paces from shore of Cayuga Lake, Auburn Quadrangle, N.Y., gray siltstone

Upper King Ferry Member, King Ferry, Clearview, east side Cayuga Lake, Auburn Quadrangle, N.Y., gray shale and siltstone

King Ferry Member, Sheldrake Creek, west side Cayuga Lake, Auburn Quadrangle, N.Y., gray siltstone

King Ferry Member, Paines Creek, 1 1/4 miles north of Black Rock, Cayuga Lake, Auburn Quadrangle, N.Y., gray shale

Kashong Shale, King Ferry, Clearview, east side Cayuga Lake, Auburn Quadrangle, N.Y., gray shale

Windom Shale, _Cystodictya_ Bed, Shurger Glen, Cayuga Lake, Auburn Quadrangle, N.Y., gray shale and limestone

Mottville Member, ravine 2 miles south-southeast of Marcellus, Skaneateles Quadrangle, N.Y., gray siltstone

Pompey Member, _Nyassa_ Bed, 868 feet on New Gulf Road section, 3/4 mile north-northwest of Marietta, Skaneateles Quadrangle, N.Y., dark gray siltstone

Upper Otisco Member, _Pholidostrophia_ Bed, brink of first falls, Threemile Point Ravine, Skaneateles Quadrangle, N.Y., dark gray siltstone

Upper Otisco Shale, _Pholidostrophia_ Bed and shale directly above _Pholidostrophia_ Bed, Barber Point Ravine, east side Skaneateles Lake, Skaneateles Quadrangle, N.Y., dark gray to black silty shale

Otisco Member, coral bed, 11 feet above lake level, Barber Point Ravine, east side Skaneateles Lake, Skaneateles Quadrangle, N.Y., dark gray siltstone

Upper Otisco Member, _Pholidostrophia_ Bed, Hall's Landing Ravine, Skaneateles Lake, Skaneateles Quadrangle, N.Y., dark gray siltstone

Otisco Member, 103-162 feet above Centerfield, Hall's Landing Ravine, east side Skaneateles Lake, Skaneateles Quadrangle, N.Y., dark gray siltstone

Otisco Member, coral bed, 32-37 feet above Centerfield, Hall's Landing Ravine, east side Skaneateles Lake, Skaneateles Quadrangle, N.Y., dark gray siltstone
Otisco Member, Glen 1 1/2 miles south-southeast of Borodino, Skaneateles Quadrangle, N.Y., dark gray siltstone

Otisco Member, 278 paces above first falls, Ensenore Glen, Skaneateles Quadrangle, N.Y., dark to black silty mudstone

Otisco Member, Fallbrook Ravine, west side Skaneateles Lake, Skaneateles Quadrangle, N.Y., dark gray to brown siltstone

Otisco Member, top of third falls, Threemile Point Ravine, west side Skaneateles Lake, Skaneateles Quadrangle, N.Y., dark gray massive siltstone

Spafford Member, Barber Point Ravine, east side Skaneateles Lake, Skaneateles Quadrangle, N.Y., dark gray siltstone

Spafford Member, Hall's Landing Ravine, east side Skaneateles Lake, Skaneateles Quadrangle, N.Y., dark gray siltstone

Spafford Member, Glen 1 1/2 miles south-southeast of Borodino, Skaneateles Quadrangle, N.Y., dark gray siltstone

Spafford Member, Strophodonta demissa Bed, Ensenore Glen, Skaneateles Quadrangle, N.Y., gray siltstone

Spafford Member, Glen 0.9 miles northwest of Tenmile Point, east side Skaneateles Lake, Skaneateles Quadrangle, N.Y., dark gray siltstone

Ivy Point Member, base of second falls, Threemile Point Ravine, west side Skaneateles Lake, Skaneateles Quadrangle, N.Y., dark gray siltstone

Ivy Point Member, Barber Point Ravine, east side Skaneateles Lake, Skaneateles Quadrangle, N.Y., dark gray to black siltstone

Ivy Point Member, base of first falls, Hall's Landing Ravine, 2 1/2 miles northwest of Spafford Landing, east side Skaneateles Lake, Skaneateles Quadrangle, N.Y., dark gray silt shale

Ivy Point Member, above base of second falls, Ensenore Glen, Owasco Lake, 3 miles east-northeast of Scipio, Skaneateles Quadrangle, N.Y., dark gray siltstone and silty shale

Owasco Member, just below Portland Point, Ensenore Glen, Owasco Lake, 3 miles east-northeast of Scipio, Skaneateles Quadrangle, N.Y., dark gray silty shale

Cooperstown Member, Pholadella Bed, Three Mile Point Ravine, west side Skaneateles Lake, Skaneateles Quadrangle, N.Y., dark gray siltstone and silty shale

Cooperstown Member, 50 feet above Pholadella Bed, Threemile Point Ravine, west side Skaneateles Lake, Skaneateles Quadrangle, N.Y., dark gray siltstone
Cooperstown Member, Spinocyrtia marcyi Bed, Barber Point Ravine, east side Skaneateles Lake, Skaneateles Quadrangle, N.Y., dark gray to black siltstone

Cooperstown Member, Modiella pygmaea Bed, Barber Point Ravine, east side Skaneateles Lake, Skaneateles Quadrangle, N.Y., dark gray siltstone

Delphi Station Member, high falls, Bear Mountain Ravine, west of Tully Valley, Tully Quadrangle, N.Y., black to dark gray silty shale and siltstone

Pompey Member, 53-60 feet above high falls, Bear Mountain Ravine, west of Tully Valley, Tully Quadrangle, N.Y., dark gray siltstone

Lower Pompey Member, 44-50 feet above high falls, Bear Mountain Ravine, west of Tully Valley, Tully Quadrangle, N.Y., dark gray siltstone

Pompey Member, 211-233 feet above Mottville, Bear Mountain Ravine, west of Tully Valley, Tully Quadrangle, N.Y., dark gray massive siltstone

Pompey Member, ravine 1/4 mile northeast of Tully Valley, Tully Quadrangle, N.Y., dark gray siltstone

Cooperstown Member, Spinocyrtia marcyi Bed, Bucktail Ravine, Spafford Valley, Tully Quadrangle, N.Y., dark gray siltstone

Upper Cardiff Member, ravine on east side of Limestone Creek Valley, northwest of Cobb Hill, 2 miles west of Rippleton, Cazenovia Quadrangle, N.Y., dark gray siltstone

Cardiff Member, Paraspirifer Bed, ravine on east side of Limestone Creek Valley, just west of railroad tunnel, northwest of Cazenovia, Cazenovia Quadrangle, N.Y., dark gray siltstone

Cardiff Member, Knights Falls, 1/2 mile east of Delphi, Cazenovia Quadrangle, N.Y., dark gray siltstone

Cardiff Member, Knights Falls, 1/2 mile east of Delphi, Cazenovia Quadrangle, N.Y., dark gray siltstone

Upper Cardiff Member, roadcut, 2.3 miles southeast of Oran, Cazenovia Quadrangle, N.Y., dark gray siltstone

Panther Mountain Fm., ravine in north face of Arab Hill, Cazenovia Quadrangle, N.Y., dark gray siltstone

Panther Mountain, ravine 1 1/4 mile south-southwest of Fabius, Cazenovia Quadrangle, N.Y., dark gray siltstone

Panther Mountain Fm., ravine 1/2 mile south of north end of east side of Dennyer Reservoir, Cazenovia Quadrangle, N.Y., dark gray siltstone

Cooperstown Member, Pholadella Bed, I. H. Hunt's Ravine, Cazenovia Quadrangle, N.Y., dark gray siltstone
0422, 0423  Cooperstown Member, Pholadella Bed, ravine in north face of Arab Hill, Cazenovia Quadrangle, N.Y., dark gray silty shale

0403, 0404  Cooperstown Member, ravine 1/4 mile south of Keeney, Cazenovia Quadrangle, N.Y., gray massive siltstone

0406, 0407  Cooperstown Member, ravine 1/4 mile south of Keeney, Cazenovia Quadrangle, N.Y., dark gray massive siltstone

0408, 0409  Cooperstown Member, Clark's Ravine, 1/4 mile north of Keeney, Cazenovia Quadrangle, N.Y., dark gray siltstone

0486  Panther Mountain Fm., second ravine east of Strouds, Morrisville Quadrangle, N.Y., dark gray silty sandstone

0487  Panther Mountain Fm., 2.7 miles south-southeast of Hamilton, on road to Poolville, Morrisville Quadrangle, N.Y., dark gray sandy siltstone

0512  Panther Mountain Fm., Blairs Ravine, Morrisville Quadrangle, N.Y., dark gray sandy siltstone and fine fragmental limestone

0524  Panther Mountain Fm., ravine 0.6 miles east-southeast of Lebanon, Morrisville Quadrangle, N.Y., dark gray fine bioclastic limestone and gray siltstone

0525  Panther Mountain Fm., Beach Quarry, 2 1/4 miles southeast of Lebanon, Morrisville Quadrangle, N.Y., dark gray to tan sandy siltstone

0526  Panther Mountain Fm., below dam on Stone Mill Brook, 1 1/2 miles west-northwest of Lebanon, Morrisville Quadrangle, N.Y., dark gray sandy siltstone

0562  Panther Mountain Fm., Georgetown, Morrisville Quadrangle, N.Y., dark gray siltstone

0563  Panther Mountain Fm., branch of Otselic Creek, 3/4 mile northwest of Georgetown Station, Morrisville Quadrangle, N.Y., dark gray sandy siltstone

0565, 0566  Panther Mountain Fm., roadside on east side Erieville Reservoir, 3/4-1 mile northwest of Erieville, Morrisville Quadrangle, N.Y., dark gray sandy siltstone

0567, 0568, 0569  Panther Mountain Fm., ravine 0.7 miles east of Erieville, Morrisville Quadrangle, N.Y., dark gray siltstone and dark gray fine fragmental limestone

0572  Panther Mountain Fm., below Pholidostrophia Bed, glen 0.7 miles east of Erieville, Morrisville Quadrangle, N.Y., dark gray siltstone

0573, 0574  Panther Mountain Fm., ravine 0.7 miles east of Erieville, Morrisville Quadrangle, N.Y., dark gray siltstone

0575  Panther Mountain Fm., Strophodonta Bed, Burton's Ravine, Erieville, Morrisville Quadrangle, N.Y., dark gray siltstone

0578, 0579  Panther Mountain Fm., Hamilton's Ravine, Erieville, Morrisville Quadrangle, N.Y., dark gray siltstone
Panther Mountain Fm., Beecher's Quarry and above, 1 mile west-southwest of Earlville, Morrisville Quadrangle, N.Y., dark gray sandy siltstone

Panther Mountain Fm., 5 miles west-southwest of Morrisville, Morrisville Quadrangle, N.Y., dark gray siltstone

Panther Mountain Formation, Hamilton's Ravine, Erieville, Morrisville Quadrangle, N.Y., dark gray sandy siltstone

Cooperstown Member, shale pit 1 mile east-southeast of Lebanon Center, Morrisville Quadrangle, N.Y., dark gray siltstone

Cooperstown Member, Days Quarry and Strouds Ravine, 1465-1475 feet, 1/2 mile south-southwest of Lebanon, Morrisville Quadrangle, N.Y., dark gray siltstone

Cooperstown Member, 5-32 feet above Portland Point, Days Quarry and Strouds Ravine, 1/2 mile south of Lebanon, Morrisville Quadrangle, N.Y., dark gray siltstone

Cooperstown Member, Ambocoelia Bed, 1530-1035 feet in Blairs Ravine, Morrisville Quadrangle, N.Y., dark gray sandy siltstone

Cooperstown Member, 1470-1486 feet in Blairs Ravine, Morrisville Quadrangle, N.Y., dark gray siltstone

Cooperstown Member, south ravine tributary to Stone Mill Brook, 1 1/4 miles west-northwest of Lebanon, Morrisville Quadrangle, N.Y., dark gray siltstone

Cooperstown Member, South Lebanon Brook 5/8-1 3/4 miles west-southwest of South Lebanon, Morrisville Quadrangle, N.Y., dark gray siltstone

Cooperstown Member, Ambocoelia Bed, Stone Mill Brook, north of Lebanon, Morrisville Quadrangle, N.Y., dark gray to brown siltstone

Cooperstown Member, small quarry on Georgetown-Lebanon line, 2 3/4 miles due west of Lebanon, Morrisville Quadrangle, N.Y., gray sandy siltstone

Cooperstown Member, Moores Gully, 1 1/4 mile north-northeast of Georgetown, Morrisville Quadrangle, N.Y., dark gray siltstone

Cooperstown Member, Nuculana Bed, 1535-1546 feet in Moores Gully, 1 1/4 mile north-northeast of Georgetown, Morrisville Quadrangle, N.Y., dark gray siltstone

Cooperstown Member, 1509-1519 feet in Moores Gully, 1 1/4 mile north-northwest of Georgetown, Morrisville Quadrangle, N.Y., dark gray siltstone

Cooperstown Member, top of hill 1 1/2 to 1 1/4 miles northwest of Georgetown Station, Morrisville Quadrangle, N.Y., dark gray siltstone

Cooperstown Member, along road 1 mile west-northwest of Earlville, Morrisville Quadrangle, N.Y., dark gray sandy siltstone
0499, 0500  Cooperstown Member, *Pustulatia*-*Spirifer* *tullius* Bed, 1676-1698 feet in Blairs Ravine, Morrisville Quadrangle, N.Y., dark gray siltstone

0501  Cooperstown Member, 1584-1589 feet in Blairs Ravine, Morrisville Quadrangle, N.Y., dark gray siltstone

0503, 0504  Cooperstown Member, 1541-1549 feet in Blairs Ravine, Morrisville Quadrangle, N.Y., dark gray siltstone

0507, 0508, 0509  Cooperstown Member, *Pustulatia*-*Spirifer* *tullius* Bed, 1624 feet in glen 3/8-1/2 mile northwest of Georgetown, Morrisville Quadrangle, N.Y., dark gray siltstone

0510  Cooperstown Member, 1594-1609 feet in glen 3/8 mile northwest of Georgetown, Morrisville Quadrangle, N.Y., dark gray siltstone

0527, 0528, 0529, 0530  Cooperstown Member, *Pustulatia*-*Spirifer* *tullius* Bed, 1624 feet in glen 3/8-1/2 mile northwest of Georgetown, Morrisville Quadrangle, N.Y., dark gray siltstone

0531, 0532, 0533, 0534, 0535  Cooperstown Member, 1594-1609 feet in glen 3/8 mile northwest of Georgetown, Morrisville Quadrangle, N.Y., dark gray siltstone

0536, 0537  Cooperstown Member, *Spirifer*-*Atrypa* Bed, coral bed, glen 3/8 mile northwest of Georgetown, Morrisville Quadrangle, N.Y., dark gray siltstone

0544, 0545  Cooperstown Member, 1583-1595 feet in Moores Gully, 1 1/4 miles north-northeast of Georgetown, Morrisville Quadrangle, N.Y., dark gray siltstone

0711, 0712  Panther Mountain Fm., *Carr Brook*, 2.4 miles south of West Edmeston, Unadilla Valley, N.Y., gray siltstone and brown fine-grained sandstone

0713  Panther Mountain Fm., glen 3/4 miles south-southwest of West Edmeston, Unadilla Valley, N.Y., gray siltstone

0715, 0716  Delphi Station Member, glen 1 1/4 miles south-southeast of Leonardsville, Unadilla Valley, N.Y., dark gray siltstone

0730, 0731, 0732  Delphi Station Member, second brook south of Bridgewater, Unadilla Valley, N.Y., dark gray to black fine-grained siltstone

0743  Bridgewater Member, at 1377 feet on road up Markham Mountain, 1/2 mile east of Unadilla Forks, Unadilla Valley, N.Y., brown fine-grained sandstone

0744  Bridgewater Member, 1 1/2 miles south-southeast of Unadilla Forks, Unadilla Valley, N.Y., gray siltstone

0746  Bridgewater Member, 0.8 miles west-southwest of Bridgewater, Unadilla Valley, N.Y., dark gray siltstone

0751, 0752, 0753  Delphi Station Member, Button Falls Creek, 1 1/2 miles southwest of Leonardsville, Unadilla Valley, N.Y., dark gray sandy siltstone

0754  Bridgewater Member, vicinity of Bridgewater, Unadilla Valley, N.Y., dark gray siltstone and brown fine-grained sandstone

0755  Bridgewater Member, 1 mile north of West Windfield, Unadilla Valley, N.Y., dark gray siltstone and brown fine-grained sandstone

0769  Bridgewater Member, vicinity of Bridgewater, Unadilla Valley, N.Y., dark gray siltstone

0770, 0771, 0772  Bridgewater Member, second brook south of Bridgewater, Unadilla Valley, N.Y., dark gray to black fine-grained siltstone

0773  Bridgewater Member, vicinity of Bridgewater, Unadilla Valley, N.Y., dark gray siltstone

0774  Bridgewater Member, 1 mile north of West Windfield, Unadilla Valley, N.Y., dark gray sandy siltstone

0775, 0776, 0777  Delphi Station Member, glen 1 1/4 miles south-southeast of Leonardsville, Unadilla Valley, N.Y., dark gray siltstone

0778, 0779  Delphi Station Member, *Button Falls Creek*, 1 1/2 miles southwest of Leonardsville, Unadilla Valley, N.Y., dark gray sandy siltstone
0727, 0728  Panther Mountain Fm., Palmers Glen, 1 1/4 miles north of West Edmeston, Unadilla Valley, N.Y., dark to brown sandy siltstone and light gray fine-grained sandstone

0695  Panther Mountain Fm., roadside 2 miles north-northwest of Sherburne, Unadilla Valley, N.Y., dark gray sandy siltstone

0696, 0697  Cooperstown Member, first 11 feet above top of Rexford Falls on Mad Brook, 1 3/8 miles east of Sherburne, Unadilla Valley, N.Y., dark gray sandy siltstone

0688, 0689, 0690  Cooperstown Member, opposite bridge, 1 1/2 miles north-northeast of New Berlin, Unadilla Valley, N.Y., dark gray sandy siltstone

0684, 0685, 0686, 0687  Cooperstown Member, Shatrel Brook, 2 1/2 miles north-northeast of New Berlin, Unadilla Valley, N.Y., dark gray sandy siltstone

0707  Cooperstown Member, glen 1 mile north-northeast of South Edmeston, Unadilla Valley, N.Y., dark gray siltstone, contains much fossil hash that cannot be identified

0834, 0835  Otsego Member, **Athyris Bed**, the "Dugway," east side Otsego Lake, 4.8 miles south of Springfield Center, Cooperstown Quadrangle, N.Y., gray sandy siltstone

0836  Otsego Member, Fivemile Point Ravine, Cooperstown Quadrangle, N.Y., dark gray siltstone

0785  Portland Point Limestone, Hinman Hollow, 1 mile west-northwest of Milford, Cooperstown Quadrangle, N.Y., dark gray bioclastic limestone

0786  Portland Point Limestone, Moss Pond outlet, 3 miles north of Milford, Cooperstown Quadrangle, N.Y., dark gray bioclastic limestone

0779  Cooperstown Member, 2.4 miles south of Milford, Cooperstown Quadrangle, N.Y., gray siltstone

0809  Cooperstown Member, ravine 1 mile south-southwest of Westville, Cooperstown Quadrangle, N.Y., gray fine-grained sandstone

0806  Cooperstown Member, **"Atrypa" bed**, cuts on road 1 3/4 miles north-northeast of Portlandville, Cooperstown Quadrangle, N.Y., dark gray coarse siltstone

0846  Portland Point Limestone, tributary from south at head of Panther Creek, 3 1/2 miles east of Summit, Richmondville Quadrangle, N.Y., gray fine-grained sandstone

0857  Panther Mountain Fm., Stephen Goodfellow Quarry, 1/2-3/4 miles west-southwest of West Fulton, Schoharie Quadrangle, N.Y., dark gray sandy siltstone

0861, 0862  Panther Mountain Fm., section along stream and road up Moheganter Hill, Schoharie Quadrangle, N.Y., dark gray to brown fine-grained sandstone and dark gray to black siltstone

0865  Panther Mountain Fm., 2 miles southeast of Mineral Springs, Schoharie Quadrangle, N.Y., gray fine-grained sandstone
Panther Mountain Fm., road 2 1/2 miles south of Schoharie, on Hartmann's Hill, Schoharie Quadrangle, N.Y., gray fine-grained sandstone

Panther Mountain Fm., Keyser Hill at Breakabeen, Schoharie Quadrangle, N.Y., dark gray siltstone

Panther Mountain Fm., Shew Hollow, 2 1/2 miles east-southeast of Ruth, Gilboa Quadrangle, N.Y., gray medium-grained sandstone

Panther Mountain Fm., west side of river, 1/2 mile northwest of Breakabeen, Gilboa Quadrangle, N.Y., dark gray coarse massive siltstone

Panther Mountain Fm., road section 1 1/2 miles west-northwest of North Blenheim, Gilboa Quadrangle, N.Y., dark gray siltstone

Panther Mountain Fm., section along Gilboa-North Blenheim road, from junction of Jefferson Road south to Minekill, Gilboa Quadrangle, N.Y., gray siltstone

Panther Mountain Fm., section on hill opposite ravine 3/4 miles southeast of North Blenheim, Gilboa Quadrangle, N.Y., brown to gray, fine to medium grained sandstone

Panther Mountain Fm., bed of Schoharie River, 1/4 mile east of North Blenheim, Gilboa Quadrangle, N.Y., gray medium-grained sandstone

Cooperstown Member, ravine 1 mile south of North Blenheim, Gilboa Quadrangle, N.Y., gray fine-grained sandstone and dark gray coarse siltstone

Uppermost Mount Marion Fm., Rensselaerville Falls, 1/4 mile west of Rensselaerville, Berne Quadrangle, N.Y., gray fine-grained sandstone

Basal Mount Marion Fm., 2-2 1/2 miles south-southwest of East Berne, Berne Quadrangle, N.Y., gray fine-grained sandstone

Mount Marion Fm., 1 mile northwest of Lawson Lake, Coxsackie Quadrangle, N.Y., dark gray coarse siltstone

Mount Marion Fm., 2 miles northeast of Grapeville, Coxsackie Quadrangle, N.Y., brown fine-grained sandstone

Mount Marion Fm., quarry at Dormansville, Coxsackie Quadrangle, N.Y., dark gray to brown fine-grained sandstone

Mount Marion Fm., Paraspirifer Bed, 0.1 mile northeast of Great Falls of Catskill Creek, Catskill Quadrangle, N.Y., gray fine-grained sandstone

Mount Marion Fm., cut 3/4 miles southeast of Asbury, Catskill Quadrangle, N.Y., dark gray coarse siltstone

Mount Marion Fm., starfish bed, 320 feet up in Mount Marion, Catskill Quadrangle, N.Y., dark gray coarse siltstone
0961  Mount Marion Fm., cliff on the Platskill, 1 mile west of Mount Marion, Catskill Quadrangle, N.Y., dark gray to black siltstone

0973  Mount Marion Fm., just below Schizoporia Bed, 1.5 miles southeast of West Hurley, Rosendale Quadrangle, N.Y., gray fine-grained sandstone

0975  Mount Marion Fm., coral bed (equivalent to base of Otsego), base of Hallihan Hill, northwest of Kingston, Rosendale Quadrangle, N.Y., dark gray siltstone

0976  Mount Marion Fm., 1 1/2 miles southeast of Copla, Rosendale Quadrangle, N.Y., dark brown siltstone

0977  Mount Marion Fm., 2 1/2 miles due west of Stony Hollow, Rosendale Quadrangle, N.Y., dark gray siltstone

0981  "Moscow" Fm., 1/4 mile northwest of West Brookville, Ellenville Quadrangle, N.Y., dark gray medium-grained sandstone

0999  Mahantango Fm., 1 mile west-northwest of Huguenot, Port Jervis Quadrangle, N.Y., gray to tan fine-grained sandstone

0995  Portland Point Limestone, 1 3/4 miles northwest of Port Jervis, Port Jervis Quadrangle, N.Y., dark gray siltstone

0997  Portland Point Limestone, Centronella bed, Elks Charles Bros Memorial Park, 0.15 mile from park entrance, 90 feet above entrance, Port Jervis, Port Jervis Quadrangle, N.Y., dark gray fine-grained siltstone to coarse-grained sandstone

0998  "Moscow" Fm., 1 3/4 miles northwest of Port Jervis, Port Jervis Quadrangle, N.Y., dark gray to brown siltstone

0989  "Moscow" Fm., 390 feet above road, slope above Pustulatia Bed, 1 3/4 miles northwest of Port Jervis, Port Jervis Quadrangle, N.Y., gray fine-grained sandstone

0990  "Moscow" Fm., Rhipidomella Bed, shore of Delaware River, 2 miles northwest of Port Jervis, Port Jervis Quadrangle, N.Y., gray fine-grained sandstone

0991  "Moscow" Fm., Rhipidomella Bed, cliffs on N.Y. Rte. 97 1/2 mile northwest of Port Jervis, Port Jervis Quadrangle, N.Y., gray fine-grained sandstone

1581  Sherman Ridge Member, shale pit at Seven Stars, Millerstown Quadrangle, Pa., fine-grained brown mudstone

1586  Upper Mudstone Member, cuts on road along Raymondskill, west of Milford, Pa., brown mudstone and shale

1228  Sherman Ridge Member, pit on south flank of Mahanoy Ridge, south of New Bloomfield, Pa. (Ellison Section 5, Unit 1), gray silty claystone

1231  Sherman Ridge Member, pit on south flank of Mahanoy Ridge, south of New Bloomfield, Pa. (Ellison Section 5, Unit 2), gray-green argillaceous siltstone
Sherman Ridge Member, pit on south flank of Mahanoy Ridge, south of New Bloomfield, Pa. (Ellison Section 5, Unit 2), gray-green argillaceous siltstone

Sherman Ridge Member, pit on south flank of Mahanoy Ridge, south of New Bloomfield, Pa. (Ellison Section 5, Unit 2), gray-green argillaceous siltstone

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Sherman Ridge Member, pit on south flank of Mahanoy Ridge, south of New Bloomfield, Pa. (Ellison Section 5, Unit 2), gray-green argillaceous siltstone

Sherman Ridge Member, pit on south flank of Mahanoy Ridge, south of New Bloomfield, Pa. (Ellison Section 5, Unit 3), gray siltstone

Sherman Ridge Member, pit on south flank of Mahanoy Ridge, south of New Bloomfield, Pa. (Ellison Section 5, Unit 3), gray siltstone

Sherman Ridge Member, pit on south flank of Mahanoy Ridge, south of New Bloomfield, Pa. (Ellison Section 5, Unit 3), gray siltstone

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Sherman Ridge Member, pit on south flank of Mahanoy Ridge, south of New Bloomfield, Pa. (Ellison Section 5, Unit 3), gray siltstone

Sherman Ridge Member, pit on south flank of Mahanoy Ridge, south of New Bloomfield, Pa. (Ellison Section 5, Unit 3), gray siltstone

Sherman Ridge Member, cuts on U.S. Rte. 22 parallel to the Juniata River at Amity Hall, Pa. (Ellison Section 6, Unit 3), dark green-gray shale

Sherman Ridge Member, cuts on U.S. Rte. 22 parallel to the Juniata River at Amity Hall, Pa. (Ellison Section 6, Unit 3), dark green-gray shale

Sherman Ridge Member, cuts on U.S. Rte. 22 parallel to the Juniata River at Amity Hall, Pa. (Ellison Section 6, Unit 3), dark green-gray shale

Sherman Ridge Member, stream cut and road cut on U.S. Rte. 15, near nose of Half Falls Mountain, at Girty's Notch, Pa. (Ellison Section 7, Unit 6), gray silty shale

Sherman Ridge Member, stream cut and road cut on U.S. Rte. 15, near nose of Half Falls Mountain, at Girty's Notch, Pa. (Ellison Section 7, Unit 6), gray silty shale

Sherman Ridge Member, stream cut and road cut on U.S. Rte. 15, near nose of Half Falls Mountain, at Girty's Notch, Pa. (Ellison Section 7, Unit 6), gray silty shale

Sherman Ridge Member, stream cut and road cut on U.S. Rte. 15, near nose of Half Falls Mountain, at Girty's Notch, Pa. (Ellison Section 7, Unit 6), gray silty shale

Sherman Ridge Member, stream cut and road cut on U.S. Rte. 15, near nose of Half Falls Mountain, at Girty's Notch, Pa. (Ellison Section 7, Unit 6), gray silty shale

Sherman Ridge Member, east bank of North Branch Nahantango Creek and cuts on Pa. Rte. 104 (Ellison Section 9, Unit 1), gray shale

Frame Shale, cut on northwest side of U.S. Rte. 522, 0.1-0.5 mile south of Websters Mills, Pa. (Ellison Section 10, Unit 5), gray silty shale

Chaneysville Siltstone, cut on northwest side of U.S. Rte. 522, 0.1-0.5 mile south of Websters Mills, Pa. (Ellison Section 10, Unit 6), dark gray shaly siltstone

Chaneysville Siltstone, cut on northwest side of U.S. Rte. 522, 0.1-0.5 mile south of Websters Mills, Pa. (Ellison Section 10, Unit 6), dark gray shaly siltstone

Chaneysville Siltstone, cut on northwest side of U.S. Rte. 522, 0.1-0.5 mile south of Websters Mills, Pa. (Ellison Section 10, Unit 6), dark gray shaly siltstone

Chaneysville Siltstone, cut on northwest side of U.S. Rte. 522, 0.1-0.5 mile south of Websters Mills, Pa. (Ellison Section 10, Unit 6), gray silty shale and mudstone

Chaneysville Siltstone, cut on northwest side of U.S. Rte. 522, 0.1-0.5 mile south of Websters Mills, Pa. (Ellison Section 10, Unit 6), gray silty shale and mudstone
Chaneysville Siltstone, cut on northwest side of U.S. Rte. 522, 0.1-0.5 mile south of Websters Mills, Pa. (Ellison Section 10, Unit 6), gray silty shale and mudstone

Chaneysville Siltstone, cut on northwest side of U.S. Rte. 522, 0.1-0.5 mile south of Websters Mills, Pa. (Ellison Section 10, Unit 6), gray silty mudstone and shale

Chaneysville Siltstone, cut on northwest side of U.S. Rte. 522, 0.1-0.5 mile south of Websters Mills, Pa. (Ellison Section 10, Unit 6), gray silty shale and mudstone

Chaneysville Siltstone, cut on northwest side of U.S. Rte. 522, 0.1-0.5 mile south of Websters Mills, Pa. (Ellison Section 10, Unit 6), gray silty mudstone and shale

Chaneysville Siltstone, cut on northwest side of U.S. Rte. 522, 0.1-0.5 mile south of Websters Mills, Pa. (Ellison Section 10, Unit 6), gray silty mudstone and shale

Chaneysville Siltstone, cut on northwest side of U.S. Rte. 522, 0.1-0.5 mile south of Websters Mills, Pa. (Ellison Section 10, Unit 6), gray silty mudstone and shale

Chaneysville Siltstone, cut on northwest side of U.S. Rte. 522, 0.1-0.5 mile south of Websters Mills, Pa. (Ellison Section 10, Unit 6), gray silty mudstone and shale

Chaneysville Siltstone, cut on northwest side of U.S. Rte. 522, 0.1-0.5 mile south of Websters Mills, Pa. (Ellison Section 10, Unit 6), gray silty shale and mudstone

Chaneysville Siltstone, cut on northwest side of U.S. Rte. 522, 0.1-0.5 mile south of Websters Mills, Pa. (Ellison Section 10, Unit 6), gray silty mudstone and shale

Chaneysville Siltstone, cut on northwest side of U.S. Rte. 522, 0.1-0.5 mile south of Websters Mills, Pa. (Ellison Section 10, Unit 6), gray silty mudstone and shale

Chaneysville Siltstone, cut on northwest side of U.S. Rte. 522, 0.1-0.5 mile south of Websters Mills, Pa. (Ellison Section 10, Unit 6), gray silty shale and mudstone

Chaneysville Siltstone, cut on northwest side of U.S. Rte. 522, 0.1-0.5 mile south of Websters Mills, Pa. (Ellison Section 10, Unit 6), gray silty mudstone and shale

Chaneysville Siltstone, cut on northwest side of U.S. Rte. 522, 0.1-0.5 mile south of Websters Mills, Pa. (Ellison Section 10, Unit 6), gray silty shale and mudstone

Chaneysville Siltstone, roadcuts at Chaneysville, Pa. (Ellison Section 11, Unit 5), gray shaly siltstone

Chaneysville Siltstone, roadcuts at Chaneysville, Pa. (Ellison Section 11, Unit 7), olive-gray shaly siltstone

Chaneysville Siltstone, roadcuts at Chaneysville, Pa. (Ellison Section 11, Unit 5), olive-gray shaly siltstone

Chaneysville Siltstone, roadcuts at Chaneysville, Pa. (Ellison Section 11, Unit 7), olive-gray shaly siltstone

Frame and Chaneysville Members (undivided), cuts on Pa. Turnpike at Everett, Pa. (Ellison Section 13, Unit 1), gray silty mudstone
Frame and Chaneysville Members (undivided), cuts on Pa. Turnpike at Everett, Pa.
(Ellison Section 13, Unit 1), gray silty mudstone

Frame and Chaneysville Members (undivided), cuts on Pa. Turnpike at Everett, Pa.
(Ellison Section 13, Unit 1), gray silty mudstone

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(Ellison Section 13, Unit 1), gray silty mudstone

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(Ellison Section 13, Unit 1), gray silty mudstone

Frame and Chaneysville Members (undivided), cuts on Pa. Turnpike at Everett, Pa.
(Ellison Section 13, Unit 1), gray silty mudstone

Frame and Chaneysville Members (undivided), cuts on Pa. Turnpike at Everett, Pa.
(Ellison Section 13, Unit 1), gray silty mudstone

Upper Shale Member, cuts on Pa. Turnpike west of interchange at Bedford, Pa. (Ellison Section 14, Unit 1), gray silty shale

Upper Shale Member, cuts on Pa. Turnpike west of interchange at Bedford, Pa. (Ellison Section 14, Unit 1), gray silty shale

Upper Shale Member, cuts on Pa. Turnpike west of interchange at Bedford, Pa. (Ellison Section 14, Unit 1), gray silty shale

Upper Shale Member, cuts on Pa. Turnpike west of interchange at Bedford, Pa. (Ellison Section 14, Unit 1), gray silty shale

Upper Shale Member, cuts on Pa. Turnpike west of interchange at Bedford, Pa. (Ellison Section 14, Unit 1), gray silty shale

Frame Shale, borrow pit and cuts on Pa. Rte. 56 at Fishertown, Pa. (Ellison Section 15, Unit 4), gray silty calcareous mudstone

Chaneysville Siltstone, cuts on Pa. Rte. 56 at Fishertown, Pa. (Ellison Section 15, Unit 6), olive-gray silty shale

Upper Shale Member, cuts along U.S. Rte. 22 on southwestern side of the Juniata River, opposite Huntington, Pa. (Ellison Section 16, Unit 1), gray silty mudstone
Upper Shale Member, cuts along U.S. Rte. 22 on southwestern side of the Juniata River, opposite Huntington, Pa. (Ellison Section 16, Unit 1), gray silty mudstone

Upper Shale Member, cuts along U.S. Rte. 22 on southwestern side of the Juniata River, opposite Huntington, Pa. (Ellison Section 16, Unit 1), gray silty mudstone

Donation Siltstone, cuts along U.S. Rte. 22 on southwestern side of the Juniata River, opposite Huntington, Pa. (Ellison Section 16, Unit 5), gray shaly siltstone

Gander Run Shale, cuts along U.S. Rte. 22 on southwestern side of the Juniata River, opposite Huntington, Pa. (Ellison Section 16, Unit 10), gray calcareous siltstone

Crooked Creek Shale, borrow pit and dirt road at Martin Gap, Miller Township, Huntington County, Pa. (Ellison Section 17, Unit 3), gray silty calcareous mudstone

Crooked Creek Shale, borrow pit and dirt road at Martin Gap, Miller Township, Huntington County, Pa. (Ellison Section 17, Unit 3), gray silty calcareous mudstone

Upper Shale Member, cuts along U.S. Rte. 220 south of Newry, Pa. (Ellison Section 18, Unit 1), green-gray silty claystone

Upper Shale Member, cuts along U.S. Rte. 220 south of Newry, Pa. (Ellison Section 18, Unit 1), green-gray silty claystone

Upper Shale Member, cuts along U.S. Rte. 220 south of Newry, Pa. (Ellison Section 18, Unit 1), green-gray silty mudstone

Upper Shale Member, cuts along U.S. Rte. 220 south of Newry, Pa. (Ellison Section 18, Unit 1), green-gray silty mudstone

Upper Shale Member, cuts along U.S. Rte. 220 south of Newry, Pa. (Ellison Section 18, Unit 1), green-gray silty mudstone

Upper Shale Member, cuts along U.S. Rte. 220 south of Newry, Pa. (Ellison Section 18, Unit 1), green-gray silty mudstone

Upper Shale Member, cuts along U.S. Rte. 220 south of Newry, Pa. (Ellison Section 18, Unit 1), green-gray silty mudstone

Upper Mahantango Fm., 1500 feet west of Chambersville, U.S. Rte. 50, 5-6 miles west of Winchester, Va., gray siltstone

Upper Mahantango Fm., cut on U.S. Rte. 50, 500 feet west of Gore, Capon Bridge Quadrangle, Va., dark gray siltstone

Mahantango Fm., Passage Creek or Fort Valle, 1/2 mile northwest of Dietrich or Fort Cross Roads, Luray Quadrangle, Va., dark gray massive siltstone
Uppermost Mahantango Fm., U.S. Rte. 50, 600 feet northwest of Gore, Capon Bridge Quadrangle, Va., light gray coarse fragmental limestone

Mahantango Fm., Capon Springs, W. Va., sandstone slabs

Mahantango Fm., 0.2 mile north of North River on U.S. Rte. 50, W. Va., siltstone slabs

Frame Shale, cuts along road west of Wolfe Mills, Md., gray to brown shale

Clearville Siltstone, cuts along road west of Wolfe Mills, Md., gray to brown silty shale

Clearville Siltstone and Upper Shale Members, cuts along road west of Wolfe Mills, Md., gray to brown silty shale and claystone

Mahantango Fm., just east of Back Creek Bridge, west of Hedgeville, W. Va., dark gray silty mudstone

Gander Run Shale, cut on northwest side of U.S. Rte. 522, 0.1-0.5 mile south of Websters Mills, Pa. (Ellison Section 10, Unit 8), olive-gray silty shale

Montebello Sandstone, Pennsylvania Railroad cut, Millerstown, Pa. (Ellison Section 8, Unit 5), dark gray siltstone and fine sandstone

St. Laurent Limestone, 2 3/4 miles S 10 E of center of St. Marys, Perry Co., Mo., dark gray bioclastic limestone

St. Laurent Limestone, St. Laurent Creek, Perry Co., Mo., gray fine-grained limestone

St. Laurent Limestone, St. Laurent Creek, Perry Co., Mo., gray bioclastic limestone

St. Laurent Limestone, uppermost ledge on south slope of hill, 1 1/4 miles west of crossing of Little Saline Creek, and road south of Ozora, Little Saline Valley, Ste. Genevieve Co., Mo., gray sandy limestone

St. Laurent Limestone, fault block 1 1/2 miles north-northeast of Independence School, Ste. Genevieve Co., Mo., white orthoquartzite, with red-stained fossil casts

St. Laurent Limestone, gully 0.4 mile east of Ridge School, NE corner SW 1/4 NE 1/4 3-T. 34 N., R. 13 E., Altenburg Quadrangle, Mo., dark gray fine-grained limestone with some chert

St. Laurent Limestone, south of Ridge School, SW 1/4 NW 1/4 3-T. 34 N., R. 13 E., Altenburg Quadrangle, Mo., light gray muddy limestone

Clifty Fm., Devil's Gap, 600 feet southeast of Sheep Cave, SW 1/4 NE 1/4 19-T. 19 N., R. 27 W., War Eagle 7 1/2 minute Quadrangle, Arkansas, white orthoquartzite

Clifty Fm., SW 1/4 17-T. 19 N., R. 27 W., Eureka Springs Quadrangle, Arkansas, gray limestone containing much quartz sand

Arkona Shale, Hungry Hollow, 2 miles northeast of Arkona, Ontario, dark gray shale
Arkona Shale, banks of Ausable River, 1/2-1 mile east of Hungry Hollow, 2 miles northeast of Arkona, Ontario, dark gray shale

Arkona Shale, Rock Glen, 1 mile northeast of Arkona, Ontario, dark gray shale

Arkona Shale, Number 4 Hill, 2 1/2 miles north of Arkona, Ontario, dark gray shale

Arkona Shale, Ausable River at Lot 8, 3 1/4 miles north-northeast of Arkona, Ontario, dark gray shale

Arkona Shale, Ausable River at Lot 8, 3 1/4 miles north-northeast of Arkona, Ontario, dark gray shale

Arkona Shale, Rock Glen, 1 mile northeast of Arkona, Ontario, gray shale

Arkona Shale, Number 4 Hill, 2 1/2 miles north of Arkona, Ontario, gray shale

Arkona Shale, Ausable River at Lot 8, 3 1/4 miles north-northeast of Arkona, Ontario, gray shale

Arkona Shale, Ausable River at Lot 8, 3 1/4 miles north-northeast of Arkona, Ontario, gray shale

Arkona Shale, roadside 1 1/4 miles east-southeast of Thedford, Ontario, at entrance to Carl Nutt's place, gray shale

Arkona Shale, Kings Hwy. 82, 1 mile east of Thedford, Ontario, gray shale

Arkona Shale, overhead bridge of Canadian National Railroad, east of Thedford, Ontario, gray shale

Arkona Shale, Jim Bell's Quarry, 1 mile east of railroad station at Thedford, Ontario, gray shale

Arkona Shale, behind Laird's barn, 1/2 mile north and 1 mile west of Thedford, Ontario, gray shale

Arkona Shale, Commander Charles Findley's place, 4-5 miles north of Thedford, Ontario, gray shale

Arkona Shale, Kings Highway 82, 1 1/4 miles west and 1 mile north of Thedford, Ontario, gray shale

Arkona Shale, Kings Highway 82, 1/2 mile north of Laird's place, 2 1/4 miles by road from Thedford, Ontario, gray shale

Arkona Shale, hill and road near Port Franks, 6 miles northwest of Thedford, Ontario, gray shale

Lower Ipperwash Limestone, Lake Huron beach at Stony Point, north of Ravenswood, Ontario, gray limestone

Upper Ipperwash, Limestone, Silica Point on Lake Huron, near Ravenswood, Ontario, thin-bedded gray crinoidal limestone
Plum Brook Shale, branch of Pipe Creek, Bloomingville, and Plum Brook, 2 1/2 miles north-northeast of Prout Station, Ohio, dark gray shale

Windom Shale, *Strophodonta*-Coralline Bed, Menteth Point Ravine, Canandaigua Lake, Canandaigua Quadrangle, N.Y., dark gray shale

Panther Mountain Fm., 1.3 miles east of West Edmeston, Unadilla Valley, N.Y., dark gray sandy siltstone

Solsville Member, tributary to Shellrock Brook, 2 3/4 miles due west of Roseboom, Cooperstown Quadrangle, N.Y., dark gray to brown fine-grained sandstone

Panther Mountain Fm., on road leading west from main road, 1 1/2 miles north of Cooperstown, Cooperstown Quadrangle, N.Y., gray sandstone

Portland Point Limestone, ravine 2 miles southwest of Potter Hollow, Durham Quadrangle, N.Y., gray sandstone

Sellersburg Limestone, Silver Creek Member, cut on Baynes Street, Louisville, Ky., silicified fossils and slabs of gray limestone

Backbone Ridge Siltstone, cuts along U.S. Rte. 22 on southwestern side of the Juniata River, opposite Huntington, Pa. (Ellison Section 16, Unit 9), dark gray to red shaly calcareous siltstone

Crooked Creek Shale, cuts along U.S. Rte. 22 on southwestern side of the Juniata River, opposite Huntington, Pa. (Ellison Section 16, Unit 7), gray silty shale

Frame Shale or Clearville Siltstone Member, roadcuts at Chambersville, Pa. (Ellison Section 11, Unit 2), olive-gray siltstone
Ambocoellid Community

0014  Levanna Shale, Buffalo Quadrangle, N.Y., dark gray shale

0004  Lower Wanakah Shale, *Pleurodictyum* Bed, Smokes Creek, Windom, Erie County, Buffalo Quadrangle, N.Y., gray shale

0005  Lower Wanakah Shale, *Pleurodictyum* Bed, quarry at Bayview, Buffalo Quadrangle, N.Y., light gray shale

0006  Lower Wanakah Shale, *Pleurodictyum* Bed, quarry 2 miles east of Athol Springs, Buffalo Quadrangle, N.Y., light gray shale

0001  Uppermost Windom Shale, south of Eighteen Mile Creek, Lake Erie, Buffalo Quadrangle, N.Y., dark gray mudstone

0007  Upper Windom Shale, Buffalo Quadrangle, N.Y., gray shale

0032  Ledyard Shale, bridge on Cazenovia Creek just east of Ebenezer, Depew Quadrangle, N.Y., dark gray shale

0029, 0030  Wanakah Shale, *Pleurodictyum* Bed, bridge on Cazenovia Creek, Spring Brook, Depew Quadrangle, N.Y., light gray shale and dark gray mudstone

0031  Basal Wanakah Shale, "*Strophalosis*" Bed, Cazenovia Creek, west of Spring Brook, Depew Quadrangle, N.Y., dark gray shale

0017, 0018, 0019  Lower Windom Shale, Cazenovia Creek, Spring Brook, Depew Quadrangle, N.Y., light gray shale

0042  Wanakah Shale, concretionary bed 1 foot above "*Strophalosis*" Bed, Murder Creek, Attica Quadrangle, N.Y., dark gray mudstone

0072  Stafford Limestone, blocks in a stone wall 2 miles north of Canada, Batavia Quadrangle, N.Y., dark gray to black fine-grained limestone

0073  Lower Stafford Limestone, road corner 2 miles north of Canada, Batavia Quadrangle, N.Y., dark gray fine-grained muddy micritic limestone

0061  Wanakah Shale, *Ambocoelia nana* Bed, White Creek, 1 mile southeast of East Bethany, Batavia Quadrangle, N.Y., gray mudstone and siltstone

0062, 0063  Lower Wanakah Shale, *Pleurodictyum* Bed, White Creek, 1 1/2 miles east to southeast of East Bethany, Batavia Quadrangle, N.Y., dark gray shale

0054  Windom Shale, *Ambocoelia* Bed, White Creek, 1 1/2 miles southeast of East Bethany, Batavia Quadrangle, N.Y., dark gray shale

0106  Stafford Limestone?, Stafford, Caledonia Quadrangle, Stafford, N.Y., brown to tan mudstone and siltstone

0107, 0108, 0109  Stafford Limestone, in Oatka Creek below Main Street Bridge, Leroy, Caledonia Quadrangle, N.Y., dark gray fine-grained limestone with gray shale and mudstone
Wanakah Shale, *sabalate* Bed, Wheeler Gully or Jacox Run, 2 1/2 miles north-northeast of Geneseo, Caledonia Quadrangle, N.Y., dark gray shale and mudstone

Wanakah Shale, Jacox Run, Genesee Valley, Caledonia Quadrangle, N.Y., dark gray shale

Basal Wanakah Shale, Jacox Run or Wheeler Gully, Genesee Valley, Caledonia Quadrangle, N.Y., dark gray mudstone and shale

Windom Shale, *Ambocoelia* Bed, Fall Brook, 1 1/2 miles south-southwest of Geneseo, Caledonia Quadrangle, N.Y., light gray shale

Basal Windom Shale, calcareous bed, Fall Brook, 1 1/2 miles south-southwest of Geneseo, Caledonia Quadrangle, N.Y., brown to gray mudstone

Basal Windom Shale, Wheeler Gully or Jacox Run, 2 1/2 miles north-northeast of Geneseo, Caledonia Quadrangle, N.Y., gray shale

Windom Shale, "*Ambocoelia* *praeumbona* Bed, Fall Brook, 2 miles south-southwest of Geneseo, Caledonia Quadrangle, N.Y., gray to black shale

Upper Oatka Creek Shale, Flint Creek, 2 miles south of Phelps, Canandaigua Quadrangle, N.Y., brown to dark gray mudstone

Oatka Creek Shale, Flint Creek, above Phelps, Canandaigua Quadrangle, N.Y., thin-bedded black shale

Stafford Limestone, Flint Creek, above Phelps, Canandaigua Quadrangle, N.Y., dark gray to black limestone

Upper Wanakah Shale, base of falls, Fall Creek, 3 1/2 miles east-southeast of Canandaigua, Canandaigua Quadrangle, N.Y., gray shale and mudstone

Wanakah Shale, *Ambocoelia* Beds, above Trilobite Beds, Fall Brook, Canandaigua Quadrangle, N.Y., gray shale

Wanakah Shale, Upper Trilobite Bed, Fall Brook, 3 1/2 miles east-southeast of Canandaigua, Canandaigua Quadrangle, N.Y., dark gray shale

Windom Shale, *Ambocoelia* Bed, Gage Creek, east side of Canandaigua Lake, 1/4 mile south of Cottage City, Canandaigua Quadrangle, N.Y., dark gray shale and mudstone

Windom Shale, 100 paces above falls, Menteth Point Ravine, Canandaigua Lake, Canandaigua Quadrangle, N.Y., dark gray shale

Windom Shale, "*Ambocoelia* *praeumbona* Bed, Gage Creek, Canandaigua Lake, Canandaigua Quadrangle, N.Y., dark gray to black thin-bedded shale

Windom Shale, "*Ambocoelia* *praeumbona* Bed, Menteth Point Ravine, Canandaigua Lake, Canandaigua Quadrangle, N.Y., gray to black shale
0194 Mottville Member, Kendig Creek, 3 miles southwest of Waterloo, Geneva Quadrangle, N.Y., dark gray to black massive mudstone

0189, 0191, 0192 Levanna Shale, Wilson Creek, west side Seneca Lake, north of Bellona, Geneva Quadrangle, N.Y., black shale

0190 Levanna Shale, calcareous bed at 1990 paces from shore of Seneca Lake on Wilson Creek, west side Seneca Lake, north of Bellona, Geneva Quadrangle, N.Y., black shale and mudstone

0186 Ledyard Shale, Wilson Creek, west side of Seneca Lake, north of Bellona, Geneva Quadrangle, N.Y., black shale and mudstone

0181, 0182, 0183 King Ferry Member, above base of large falls, Kashong Creek, Seneca Lake, Geneva Quadrangle, N.Y., dark gray to black shale and mudstone

0173 Lower Windom Shale, Ambocoelia Bed, Kashong Creek, Bellona, Seneca Lake, Geneva Quadrangle, N.Y., dark gray mudstone

0172 Windom Shale, Kashong Creek, falls just below Bellona, Geneva Quadrangle, N.Y., dark gray shale

0171 Windom Shale, "Ambocoelia" praeumbona Bed, Kashong Creek, Bellona, Seneca Lake, Geneva Quadrangle, N.Y., dark gray to brown thin-bedded shale

0169 Windom Shale, Pustularia- "Spirifer" tullius Bed, just beneath Tully, Kashong Creek, Bellona, Geneva Quadrangle, N.Y., thin-bedded black shale

0244 Cherry Valley Limestone, Woods Quarry, Union Springs, Auburn Quadrangle, N.Y., dark gray limestone

0238 Mottville Member, Criss Creek, east side of road, 1 1/4 mile north-northeast of Levanna, Cayuga, Auburn Quadrangle, N.Y., dark gray to black shale and siltstone

0201, 0202, 0203 Windom Shale, Ambocoelia Beds, Shurger Glen, Cayuga Lake, Auburn Quadrangle, N.Y., dark gray siltstone, mudstone, and shale

0209, 0210 Windom Shale, Ambocoelia Beds, Bloomer Creek, Cayuga Lake, Auburn Quadrangle, N.Y., dark gray shale and siltstone

0211 Lower Windom Shale, Bloomer Creek, Cayuga Lake, Auburn Quadrangle, N.Y., dark gray shale and siltstone

0216 Windom Shale, Ambocoelia Bed, King Ferry, Clearview, east side Cayuga Lake, Auburn Quadrangle, N.Y., dark gray shale

0199 Windom Shale, "Ambocoelia" praeumbonata Bed, Shurger Glen, 2 miles south of Ludlowville, Cayuga Lake, Auburn Quadrangle, N.Y., dark gray to black shale

0196 Windom Shale, upper 2 feet, just below Tully, Groves Creek, 1 1/2 mile northwest of Sheldrake, Cayuga Lake, Auburn Quadrangle, N.Y., black shale
0335  Mottville Member, 1/2 mile south of Mottville on Skaneateles Creek, Skaneateles Quadrangle, N.Y., dark gray siltstone

0337  Mottville, Jacknife Run, 1 mile south-southeast of Marcelus, Skaneateles Quadrangle, N.Y.,
      dark gray siltstone

0316  Delphi Station Member, hard bed at 391 feet in Clintonsville Ravine, Marietta, Skaneateles Quadrangle, N.Y.,
      dark gray siltstone

0328  Delphi Station Member, 888-893 feet in Harland’s Gulf, Marietta, Skaneateles Quadrangle, N.Y.,
      dark gray siltstone

0332, 0333  Delphi Station Member, 81 feet above Mottville, ravine 2 1/4 miles southeast of
            Marcelus, Skaneateles Quadrangle, N.Y., black shale

0336  Delphi Station Member, just above Mottville, Jacknife Ravine, 1 mile south-southeast of
            Marcelus, Skaneateles Quadrangle, N.Y., dark gray siltstone

0311  Pompey Member, 925-930 feet in Clintonville Ravine, Marietta, Skaneateles Quadrangle,
      N.Y., dark gray siltstone

0323, 0324, 0325  Upper Pompey Member, 954-968 feet in Harland’s Gulf, 0.9 miles north-
                  northwest of Marietta, Skaneateles Quadrangle, N.Y., dark gray siltstone

0326, 0327  Pompey Member, 926-932 feet in Harland’s Gulf, 0.9 miles north-northwest of
            Marietta, Skaneateles Quadrangle, N.Y., gray to black siltstone

0294, 0295  Upper Butternut Member, lower 10 feet exposed behind Ensenor Glen House, Ensenor
            Glen, west side Owasco Lake, Skaneateles Quadrangle, N.Y., dark gray to black siltstone

0308, 0309, 0310  Butternut Member, Clintonsville Ravine, 2 1/4 miles north-northwest of
                   Marietta, Skaneateles Quadrangle, N.Y., dark gray siltstone

0259  Cooperstown member, Ambocoelia Bed, Barber Point Ravine, east side of Skaneateles Lake,
      Skaneateles Quadrangle, N.Y., dark gray siltstone

0245  Cooperstown Member, "Ambocoelia" praebona Bed, Threemile Point Ravine, west side
       Skaneateles Lake, Skaneateles Quadrangle, N.Y., dark gray siltstone

0255, 0256  Cooperstown Member, "Ambocoelia" praebona Bed, Barber Point Ravine, east side
            Skaneateles Lake, Skaneateles Quadrangle, N.Y., dark gray siltstone and siltstone, much fossil
            hash

0399  Cherry Valley Limestone, roadside 3 miles east of Jamesville, Tully Quadrangle, N.Y.,
      dark gray fine-grained limestone

0360  Butternut Member, just below Centerfield, Bucktail Ravine, Spafford Valley, Tully
      Quadrangle, N.Y., dark gray to brown sandy siltstone

0350, 0351  Cooperstown Member, Ambocoelia Bed, Bucktail Ravine, Spafford Valley, Tully
            Quadrangle, N.Y., gray siltly mudstone
Cooperstown Member, "Ambocoelia" praeumbona Bed, Tinkers Falls, 1 1/2 miles north-northeast of Truxton, Cortland Quadrangle, N.Y., dark gray sandy siltstone

Cooperstown Member, just below "A." praeumbona Bed, Tinkers Falls, 1 1/2 miles north-northeast of Truxton, Cortland Quadrangle, N.Y., black siltstone

Cooperstown Member, Pustulatia-"Spirifer" tullius Bed, just below Tully, Tinkers Falls, 1 1/2 mile north-northeast of Truxton, Cortland Quadrangle, N.Y., dark gray silty shale

Cooperstown Member, Pustulatia-"Spirifer" tullius Bed, just below Tully, Bucktail Ravine, Spafford Valley, Tully Quadrangle, N.Y., brown siltstone

Cherry Valley Limestone, 1/2 mile north of Chittango Falls, Cazenovia Quadrangle, N.Y., dark, fine-grained limestone

Cooperstown Member, Ambocoelia Bed, 1494 feet in Arab Hill Ravine, north end of west side of Denuyter Reservoir, Cazenovia Quadrangle, N.Y., dark gray siltstone

Cooperstown Member, Schuchertella Bed, 1484-1489 feet in Arab Hill Ravine, north end of west side of Denuyter Reservoir, Cazenovia Quadrangle, N.Y., dark gray siltstone

Cooperstown Member, "Ambocoelia" praeumbona Bed, ravine 1/4 mile south of Keeney, Cazenovia Quadrangle, N.Y., dark gray sandy siltstone

Cooperstown Member, "Ambocoelia" praeumbona Bed, on road 2 1/4 miles south-southwest of Fabius, Cazenovia Quadrangle, N.Y., brown sandy siltstone

Cooperstown Member, "Ambocoelia" praeumbona Bed, Arab Hill Ravine, north end of west side of Denuyter Reservoir, Cazenovia Quadrangle, N.Y., dark gray massive siltstone

Cooperstown Member, Pustulatia-"Spirifer" tullius Bed, ravine 1/4 mile south of Keeney, Cazenovia Quadrangle, N.Y., dark gray fissile siltstone

Cherry Valley Limestone, 1/2 mile above Stockbridge Falls on Oneida Creek, 2 miles southwest of Munnsville, Morrisville Quadrangle, N.Y., dark gray to black fine-grained limestone

Cardiff Member, glen 2 3/4 miles north-northwest of Morrisville, Morrisville Quadrangle, N.Y., dark gray to brown siltstone

Pecksport Member, Woods Ravine, near Solsville, Morrisville Quadrangle, N.Y., dark gray siltstone

Pecksport Member, 1288-1336 feet in Livermores Glen, 1 1/4 miles northeast of Pecksport, Morrisville Quadrangle, N.Y., dark gray massive siltstone

Pecksport Member, 1347-1352 feet in Livermores Glen, 1 1/4 miles northeast of Pecksport, Morrisville Quadrangle, N.Y., gray to brown sandy siltstone
Pecksport Member, glen just south of northeast end of Lake Moraine, 3 1/4 miles northeast of Hamilton, Morrisville Quadrangle, N.Y., dark gray sandy siltstone and sandstone

Butternut Member, Pustulatia Bed, south of Madison, Morrisville Quadrangle, N.Y., dark gray siltstone

Butternut Member, lower Pattersons Glen, 1/2 mile east-southeast of Randallsville, Morrisville Quadrangle, N.Y., dark gray siltstone

Butternut Member, roadside 1.2 mile northeast of Eaton, Morrisville Quadrangle, N.Y., dark gray siltstone

Lower Butternut Member, Pustulatia Bed, Livermores Glen, 1 1/4 miles northeast of Pecksport, Morrisville Quadrangle, Morrisville Quadrangle, N.Y., dark gray sandy siltstone

Lower Butternut Member, above Pustulatia Bed, Livermores Glen, 1 1/4 miles northeast of Pecksport, Morrisville Quadrangle, N.Y., massive gray siltstone

Butternut Member, Dart Glen, 1 mile south of Hamilton National Bank, Hamilton, Morrisville Quadrangle, N.Y., dark gray sandy siltstone

Butternut Member, Oneida Creek, 2.7 to 3 miles south-southwest of Peterboro, Morrisville Quadrangle, N.Y., dark gray siltstone

Butternut Member, near top of hill on U.S. Rte. 20, 1.3 miles east-northeast of Morrisville, Morrisville Quadrangle, N.Y., dark gray siltstone

Butternut Member, branch of Electric Light Stream, 2.7 to 1.4 miles west-southwest of Morrisville, Morrisville Quadrangle, N.Y., dark gray to brown sandy siltstone

Cooperstown Member, Ambocoelia Bed, 1487-1505 feet in Moore's (Trass) Gully, 1 1/2 miles north-northeast of Georgetown, Morrisville Quadrangle, N.Y., dark gray siltstone

Cooperstown Member, near base, bottom to 1487 feet in Moores (Trass) Gully, 1 1/2 miles north-northeast of Georgetown, Morrisville Quadrangle, N.Y., dark gray siltstone

Cooperstown Member, "Ambocoelia" praeumbona Bed, Blairs Ravine, Morrisville Quadrangle, N.Y., dark gray sandy siltstone

Cooperstown Member, "Ambocoelia" praeumbona Bed, glen 3/8 mile northwest of Georgetown, Morrisville Quadrangle, N.Y., dark gray siltstone

Cooperstown Member, Pustulatia- "Spirifer" tullius Bed, just below Tully, 2 1/4 miles northwest of Upperville, on Pleasant Creek, Norwich Quadrangle, N.Y., dark gray siltstone

Panther Mountain Fm., 2 1/2 miles east-northeast of Brookfield, Sangerfield Quadrangle, N.Y., dark gray to brown sandy siltstone
0698 Lower Cooperstown Member, Mad Brook, 750 paces upstream from bridge, 3/4 mile east of Sherburne, Unadilla Valley, N.Y., dark gray sandy siltstone

0699, 0700 Lower Cooperstown Member, Mad Brook, 1317-1517 paces east of bridge 3/4 mile east of Sherburne, Unadilla Valley, N.Y., dark gray sandy siltstone

0692 Cooperstown Member, "Ambocoelia" pueumbona Bed, West Brook, west edge of New Berlin, Unadilla Valley, N.Y., dark gray siltstone

0678 Cooperstown Member, Pustulatia Bed, 2 miles due north of Stetsonville, Unadilla Valley, N.Y., brown sandy siltstone

0679 Cooperstown Member, Pustulatia Bed, ravine 1 3/4 miles east-northeast of Pittsfield, Unadilla Valley, N.Y., gray silty shale

0680 Cooperstown Member, Pustulatia Bed, roadside 3/4 mile west of Columbus, Unadilla Valley, N.Y., gray to brown siltstone

0788 Basal Portland Point Limestone, Moss Point outlet, 3 miles north of Milford, Cooperstown Quadrangle, N.Y., light gray coarse bioclastic limestone

0992 Portland Point Member, Elks Charles Brox Memorial Park, intersection of power lines and Skyline Drive, Port Jervis, Port Jervis Quadrangle, N.Y., fine to medium gray sandstone

0993 Portland Point Member, 125 paces below entrance to transient camp, Elks Charles Brox Memorial Park, Port Jervis, Port Jervis Quadrangle, N.Y., gray siltstone

1570 Marcellus Fm., Oldtown, Md., coquina of tiny shells in black limestone

1475 Millboro Shale, Purcell Member, Hayter Gap, Ablington Quadrangle, Va., black shale

1476 Millboro Shale, Purcell Member, road 1/2 mile north of village of Hayter Gap, 40 feet above Onondaga, Ablington Quadrangle, Va., black shale and mudstone, marcasite present

1135 Sherman Ridge Member, Pustulatia Bed, Pennsylvania Railroad cut below Marysville, Pa., gray to green siltstone and mudstone

1143 Sherman Ridge Member, Pustulatia Bed, junction of U.S. Rte. 15 and Pa. Rte. 225, north of Harrisburg, Pa., dark gray shale and mudstone

1133 Sherman Ridge Member, 1 mile southeast of Danville, Pa., dark gray mudstone and shale

1134 Sherman Ridge Member, 1/2 mile southeast of New Bloomfield, Pa., green to gray mudstone

1159 Sherman Ridge Member, Pustulatia Bed, 2 miles northwest of Northumberland, Pa., on U.S. Rte. 15, dark gray mudstone

1157 Upper Shale Member, Pustulatia Bed, east side Juniata River, opposite Losh Run, Pa., dark gray mudstone

1190 Montebeullo Sandstone, north quarry, east side Susquehanna River, north of Rockville, Pa. (Ellison Section 1, Unit 3), gray sandy shale
Sherman Ridge Member, stream cut and road cut on U.S. Rte. 15, near nose of Half Falls Mountain, at Girty's Notch, Pa. (Ellison Section 7, Unit 1), gray silty shale

Sherman Ridge Member, stream cut and road cut on U.S. Rte. 15, near nose of Half Falls Mountain, at Girty's Notch, Pa. (Ellison Section 7, Unit 1), gray silty shale

Sherman Ridge Member, east bank of North Branch Mahantango Creek and cuts on Pa. Rte. 104 (Ellison Section 9, Unit 1), gray shale

Crooked Creek Shale, cuts along U.S. Rte. 22 on southwestern side of the Juniata River, opposite Huntington, Pa. (Ellison Section 16, Unit 7), gray silty shale.

Beechwood Limestone, old interurban track, lot 50, Clark Grant, Watson, Ind., silicified fossils.

Beechwood Limestone, west corner of lot 36, T 1 N R. 7 E., Clark Grant, near Watson, Ind., silicified fossils.
Mediospirifer Community

0278  Cooperstown Member, "Spirifer" tullius Bed, glen 2 1/2 miles east of Borodino, Skaneateles Quadrangle, N.Y., dark gray silty shale

0670, 0671  Cardiff Member, quarry beside road, 3 miles north of Morrisville, Morrisville Quadrangle, N.Y., dark gray sandy siltstone

0611, 0612, 0613  Solsville Member, bottom of falls, Woods Ravine, 1 3/4 miles west-northwest of Solsville, Morrisville Quadrangle, N.Y., dark gray sandy siltstone

0616  Solsville Member, cut on U.S. Rte. 20 just east of Pine Woods, Morrisville Quadrangle, N.Y., dark gray sandy siltstone

0617, 0618, 0619  Solsville Member, ledge 1/4 mile north-northeast of Solsville, Morrisville Quadrangle, N.Y., brown sandstone

0639, 0640  Mottville Member, west side of Madison Reservoir, at north end, 3 1/4 miles northeast of Hamilton, Morrisville Quadrangle, N.Y., massive dark gray fine silty limestone, and brown sandy siltstone

0668, 0669  Mottville Member, glen 2 3/4 miles north-northwest of Morrisville, Morrisville Quadrangle, N.Y., dark gray massive siltstone

0767  Solsville Member, cut on U.S. Rte. 20, 3 miles west-northwest of Bridgewater, Sangerfiled Quadrangle, Unadilla Valley, N.Y., gray sandstone

0768  Solsville Member, hill 1 1/4 miles north-northwest of Bridgewater, Unadilla Valley, N.Y., light gray silty sandstone

0701  Panther Mountain Fm., glen 1 mile north-northeast of South Edmeston, Unadilla Valley, N.Y., dark gray sandy siltstone

0714  Panther Mountain Fm., glen 1 1/4 miles south of West Edmeston, Unadilla Valley, N.Y., dark gray sandy siltstone

0735  Panther Mountain Fm., brook 3.6 miles south of West Edmeston, Unadilla Valley, N.Y., dark gray siltstone

0691  Cooperstown Member, Pustulatia-"Spirifer" tullius Bed, West Brook, west side of New Berlin, Unadilla Valley, N.Y., gray sandy siltstone

0694  Cooperstown Member, Pustulatia-"Spirifer" tullius Bed, Greens Gulf, west side Unadilla Valley, 1 1/2 miles south-southwest of New Berlin, N.Y., gray fine-grained sandstone

0803  Panther Mountain Fm., ravine on north side of Cherry Valley, 1 mile north of Middlefield, Cooperstown Quadrangle, N.Y., fine gray silty sandstone

0823  Panther Mountain Fm., basal Delphi Station equivalent, first west road south of Leatherstocking Falls, 1 1/4 miles north of Cooperstown, Cooperstown Quadrangle, N.Y., dark gray siltstone
Panther Mountain Fm., The Jams, 1 mile north-northeast of Milford, Cooperstown Quadrangle, N.Y., dark gray siltstone

Portland Point Limestone, The Jams, 1 mile east-northeast of Milford, Cooperstown Quadrangle, N.Y., dark gray fine-grained limestone

Cooperstown Member, The Jams, 1 mile north-northeast of Milford, Cooperstown Quadrangle, N.Y., dark gray sandy siltstone

Cooperstown Member, Pantheria-"Spirifer" tullius Bed, Woods Ravine, 2 miles northeast of Portlandville, Cooperstown Quadrangle, N.Y., gray sandstone and siltstone

Cooperstown Member, "Spirifer" tullius Bed, 16 feet below "storm-roller" bed, Strong's Ravine, 3 miles southwest of Westville, Cooperstown Quadrangle, N.Y., brown sandstone

Cooperstown Member, Pustulatia Bed?, on road 1 1/2 miles northwest of Westville, Cooperstown Quadrangle, N.Y., dark gray fine-grained sandstone

Cooperstown Member, Pustulatia Bed, ravine just south of Schenevus, Cooperstown Quadrangle, N.Y., gray fine-grained sandstone

Cooperstown Member, Pustulatia Bed, ravine 3 miles northwest of Worcester, Cooperstown Quadrangle, N.Y., gray sandy siltstone

Portland Point Limestone, head of Bear Gulch, 3 miles south-southwest of Richmondville, Richmondville Quadrangle, N.Y., gray fine fragmental limestone

Cooperstown Member, ravine 2 miles west-northwest of South Worcester, Richmondville Quadrangle, N.Y., gray fine-grained sandstone

Cooperstown Member, ravine 2 miles east-northeast of South Worcester, Richmondville Quadrangle, N.Y., dark gray sandstone

Cooperstown Member, 2 1/2 miles east of Summit, Richmondville Quadrangle, N.Y., gray sandstone

Panther Mountain Fm., cuts along road from Fultonham to West Fultonham, Schoharie Quadrangle, N.Y., gray fine-grained sandstone

Panther Mountain Fm., cuts on road 1 mile due south of West Fulton, Schoharie Quadrangle, N.Y., dark gray sandy siltstone

Panther Mountain Fm., ravine just west and north of Ruth, Gilboa Quadrangle, N.Y., gray sandstone

Panther Mountain Fm., cliffs 2 miles south-southwest of Breakabeen, Gilboa Quadrangle, N.Y., dark gray coarse siltstone

Panther Mountain Fm., cuts on road 3 1/4 miles south-southeast of Gilboa, Gilboa Quadrangle, N.Y., green-gray medium sandstone
0890, 0891 Panther Mountain Fm., N.Y. Rte. 30, 2 miles northwest of Gilboa, Gilboa Quadrangle, N.Y., gray sandstone

0903, 0904, 0905 Panther Mountain Fm., Minekill Falls, 2 1/2-3 miles south-southwest of North Blenheim, Gilboa Quadrangle, N.Y., gray siltstone and sandstone

0915 Panther Mountain Fm., ravine 1 3/4 miles north-northeast of North Blenheim, Gilboa Quadrangle, N.Y., dark gray siltstone

0921 Portland Point Limestone, 1 3/4 miles west-northwest of Durham, Durham Quadrangle, N.Y., interbedded black silty shale with brackish water fauna of ostracodes and phyllopods and gray sandstone

0918 Cooperstown Member, Potter Hollow, Durham Quadrangle, N.Y., dark gray coarse siltstone

0919 Basal Cooperstown Member, ravine 2 miles southwest of Potter Hollow, Durham Quadrangle, N.Y., gray thin-bedded silty shale

0947 Mount Marion Fm., bed of creek at Alcove, Coxsackie Quadrangle, N.Y., dark gray to brown fine sandstone

0948 Mount Marion Fm., 2 1/2 miles west-northwest of Limestone, Coxsackie Quadrangle, N.Y., gray sandstone

0960 Lower Mount Marion Fm., 1 1/2 miles west of Mount Marion Station, Catskill Quadrangle, N.Y., brown sandstone

0962 Mount Marion Fm., coral bed equivalent to basal Otsego, .75 mile west of Mount Marion, Catskill Quadrangle, N.Y., dark gray to black siltstone

0967 Mount Marion Fm., cut on Plattekill, 1 1/2 miles north-northeast of Dutch Settlement, Kaaterskill Quadrangle, N.Y., dark gray to black siltstone

0983 "Hamilton," 1 3/4 miles north-northwest of Huguenot, Ellenville Quadrangle, N.Y., dark gray coarse siltstone

0986 "Hamilton," at 470 feet on southeast slope of hill just north of Laurenkill, 1 1/2 miles south-southwest of Ellenville, Ellenville Quadrangle, N.Y., dark gray siltstone

1000 Marcellus Fm.?, starfish bed, along road to Point Peter, Elks Charles Brox Memorial Park, Port Jervis, Port Jervis Quadrangle, N.Y., brown fine-grained sandstone

1001 Marcellus Fm.?, big spirifer bed, 1 3/4 miles northwest of Port Jervis, Port Jervis Quadrangle, N.Y., gray to brown fine-grained sandstone

1140 Montebello Sandstone, along railroad 300 yards north of quarry, Marysville, Perry County, Pa., white orthoquartzite

1136 Montebello Sandstone, 1/2-3/4 mile west-northwest of Dromgold, on Sherman Creek, Perry County, Pa., gray to white orthoquartzite
Montebello Sandstone, cut on Pa. Rte. 850, 1 mile west-northwest of Dromgold, Perry Co., Pa., white orthoquartzite

Sherman Ridge Member, 2 miles northwest of Northumberland, on U.S. Rte. 15, Pa., green thin-bedded shale

Sherman Ridge Member, cuts on U.S. Rte. 22 at Amity Hall, Pa., highly tectonized mudstone

Sherman Ridge Member, shale pit at Ickesburg, Perry County, Pa., gray to brown siltstone

Montebello Sandstone, cut on west side of U.S. Rte. 15 at Marysville, Pa., gray massive orthoquartzite

Montebello Sandstone, cut on Pa. Rte. 850, 1 mile west of Dromgold, Pa., white orthoquartzite

Montebello Sandstone, north quarry, east side Susquehanna River, north of Rockville, Pa. (Ellison Section 1, Unit 1), gray siltstone and fine sandstone

Montebello Sandstone, north quarry, east side Susquehanna River, north of Rockville, Pa. (Ellison Section 1, Unit 1), gray sandstone

Montebello Sandstone, north quarry, east side Susquehanna River, north of Rockville, Pa. (Ellison Section 1, Unit 2), gray silty sandstone

Montebello Sandstone, north quarry, east side Susquehanna River, north of Rockville, Pa. (Ellison Section 1, Unit 3), gray sandy shale

Montebello Sandstone, middle quarry, east side Susquehanna River, north of Rockville, Pa. (Ellison Section 1, Unit 15), gray fine-grained sandstone

Montebello Sandstone, middle quarry, east side Susquehanna River, north of Rockville, Pa. (Ellison Section 1, Unit 15), gray fine-grained silty sandstone

Montebello Sandstone, railroad cut in Little Mountain, south of Marysville, Pa. (Ellison Section 2, Unit 2), light gray sandstone

Montebello Sandstone, railroad and U.S. Rte. 15 cuts in Little Mountain, south of Marysville, Pa. (Ellison Section 2, Unit 9), gray sandstone

Montebello Sandstone, railroad and U.S. Rte. 15 cuts in Little Mountain, south of Marysville, Pa. (Ellison Section 2, Unit 10), gray silty sandstone

Montebello Sandstone, railroad and U.S. Rte. 15 cuts in Little Mountain, south of Marysville, Pa. (Ellison Section 2, Unit 11), gray sandstone
1203 Montebello Sandstone, railroad and U.S. Rte. 15 cuts in Little Mountain, south of Marysville, Pa. (Ellison Section 2, Unit 11), gray sandstone

1204 Montebello Sandstone, railroad and U.S. Rte. 15 cuts in Little Mountain, south of Marysville, Pa. (Ellison Section 2, Unit 11), gray sandstone

1205 Montebello Sandstone, railroad and U.S. Rte. 15 cuts in Little Mountain, south of Marysville, Pa. (Ellison Section 2, Unit 11), gray very coarse sandstone

1207 Montebello Sandstone, railroad and U.S. Rte. 15 cuts in Little Mountain, south of Marysville, Pa. (Ellison Section 2, Unit 14), gray sandstone

1208 Montebello Sandstone, railroad and U.S. Rte. 15 cuts in Little Mountain, south of Marysville, Pa. (Ellison Section 2, Unit 14), gray sandstone

1214 Montebello Sandstone, cuts on Pa. Rte. 850 west of Dromgold, Pa. (Ellison Section 3, Unit 11), gray cross-bedded sandstone and conglomerate

1215 Montebello Sandstone, cuts on Pa. Rte. 850 west of Dromgold, Pa. (Ellison Section 3, Unit 11), gray fine-grained sandstone

1217 Montebello Sandstone, cuts on Pa. Rte. 850 west of Dromgold, Pa. (Ellison Section 3, Unit 13), green-gray shaly fine-grained sandstone

1219 Montebello Sandstone, cuts on Pa. Rte. 850 parallel to Sherman Creek, Pa. (Ellison Section 4, Unit 7), gray sandstone

1220 Montebello Sandstone, cuts on Pa. Rte. 850 parallel to Sherman Creek, Pa. (Ellison Section 4, Unit 11), green-gray siltstone

1237 Sherman Ridge Member, pit on south flank of Mahanoy Ridge, south of New Bloomfield, Pa. (Ellison Section 5, Unit 2), green-gray argillaceous siltstone

1246 Sherman Ridge Member, cuts on U.S. Rte. 22 parallel to the Juniata River at Amity Hall, Pa. (Ellison Section 6, Unit 1), dark green-gray shale

1260 Montebello Sandstone, cuts on U.S. Rte. 22 parallel to the Juniata River at Amity Hall, Pa. (Ellison Section 6, Unit 13), gray sandstone

1275 Montebello Sandstone, stream cut and road cut on U.S. Rte. 15, near nose of Half Falls Mountain, at Girty's Notch, Pa. (Ellison Section 7, Unit 11), dark green-gray shaly siltstone

1276 Montebello Sandstone, stream cut and road cut on U.S. Rte. 15, near nose of Half Falls Mountain, at Girty's Notch, Pa. (Ellison Section 7, Unit 11), green-gray fine-grained sandstone

1277 Montebello Sandstone, Pennsylvania Railroad cut, Millerstown, Pa. (Ellison Section 8, Unit 3), green-gray fine-grained sandstone
Montebello Sandstone, Pennsylvania Railroad cut at Millerstown, Pa. (Ellison Section 8, Unit 3), green-gray fine-grained sandstone

Montebello Sandstone, Pennsylvania Railroad cut at Millerstown, Pa. (Ellison Section 8, Unit 3), green-gray fine-grained sandstone

Montebello Sandstone, Pennsylvania Railroad cut at Millerstown, Pa. (Ellison Section 8, Unit 3), green-gray fine-grained sandstone

Montebello Sandstone, Pennsylvania Railroad cut at Millerstown, Pa. (Ellison Section 8, Unit 3), green-gray fine-grained sandstone

Montebello Sandstone, Pennsylvania Railroad cut at Millerstown, Pa. (Ellison Section 8, Unit 7), dark gray sandstone

Montebello Sandstone, Pennsylvania Railroad cut at Millerstown, Pa. (Ellison Section 8, Unit 7), dark gray sandstone

Montebello Sandstone, Pennsylvania Railroad cut at Millerstown, Pa. (Ellison Section 8, Unit 7), dark gray very fine grained sandstone

Montebello Sandstone, Pennsylvania Railroad cut at Millerstown, Pa. (Ellison Section 8, Unit 7), dark gray very fine grained sandstone

Montebello Sandstone, Pennsylvania Railroad cut at Millerstown, Pa. (Ellison Section 8, Unit 7), gray fine-grained argillaceous sandstone

Montebello Sandstone, Pennsylvania Railroad cut at Millerstown, Pa. (Ellison Section 8, Unit 7), gray fine-grained argillaceous sandstone

Montebello Sandstone, Pennsylvania Railroad cut at Millerstown, Pa. (Ellison Section 8, Unit 8), dark gray sandstone

Montebello Sandstone, Pennsylvania Railroad cut at Millerstown, Pa. (Ellison Section 8, Unit 9), dark gray sandstone

Montebello Sandstone, Pennsylvania Railroad cut at Millerstown, Pa. (Ellison Section 8, Unit 9), dark gray sandstone

Montebello Sandstone, Pennsylvania Railroad cut at Millerstown, Pa. (Ellison Section 8, Unit 9), green-gray sandstone

Montebello Sandstone, Pennsylvania Railroad cut at Millerstown, Pa. (Ellison Section 8, Unit 9), green-gray sandstone

Upper Shale Member, cut on northwest side of U.S. Rte. 522, 0.1-0.5 mile south of Websters Mills, Pa. (Ellison Section 10, Unit 2), green-gray fine-grained sandstone

Chaneysville Siltstone, roadcuts at Chaneysville, Pa. (Ellison Section 11, Unit 7), dark olive-gray shaly siltstone

Frame Shale, shale pit and dirt road parallel to Elk Lick Creek, Pa. (Ellison Section 12, Unit 3), silty claystone, siltstone, and fine-grained sandstone, very poorly exposed

Frame and Chaneysville Members (undivided), cuts on Pa. Turnpike at Everett, Pa. (Ellison Section 13, Unit 1), gray silty mudstone

Frame and Chaneysville Members (undivided), cuts on Pa. Turnpike at Everett, Pa. (Ellison Section 13, Unit 1), gray silty mudstone
Frame and Chaneysville Members (undivided), cuts on Pa. Turnpike at Everett, Pa. (Ellison Section 13, Unit 2), dark green-gray siltstone

Upper Shale Member, cuts on Pa. Turnpike west of interchange at Bedford, Pa. (Ellison Section 14, Unit 3), gray shale

Crooked Creek Shale, cuts on U.S. Rte. 22 on southwestern side of the Juniata River, opposite Huntington, Pa. (Ellison Section 16, Unit 8), gray silty mudstone

Crooked Creek Shale, cuts on U.S. Rte. 22 on southwestern side of the Juniata River, opposite Huntington, Pa. (Ellison Section 16, Unit 8), gray silty mudstone

Backbone Ridge Siltstone, cuts along U.S. Rte. 22 on southwestern side of the Juniata River, opposite Huntington, Pa. (Ellison Section 16, Unit 9), dark gray to red calcareous shaly siltstone

Upper Mahantango Fm., 100 yards from beginning of exposure, just west of Hedgeville, W. Va., brown sandstone containing *Mediospirifer* coquina

Silver Creek Limestone, 6 1/2 miles north of Falls of the Ohio, Sellersburg, Clark County, Ind., gray bioclastic limestone

Silver Creek Limestone, Golf Course, N 1/4, lot 51, Clark Grant, Watson, Ind., silicified fossils in gray limestone

Silver Creek Limestone, W. sec 51, Utica Township, Clark Grant, Clark County, Ind., silicified fossils in gray limestone

Silver Creek Limestone, area of Watson, Charlestown, and Sellersburg, Ind., silicified fossils in gray limestone

Upper Ipperwash Limestone, 0.9 mile north and 0.55 mile northeast of Ravenswood, in field, Ontario, gray limestone

St. Helen's Breccia, St. Helen's Island, Montreal, Quebec, Williams, 1908, sample 252.1, gray siltstone

Cooperstown Member, along road 1 1/2-1 3/4 miles east-southeast of Summit, Richmond-ville Quadrangle, N.Y., gray fine-grained sandstone
Tropidoleptus Community

0041 Kashong Shale, Murder Creek, south of Darien, Attica Quadrangle, N.Y., gray shale
0045 Kashong Shale, Bowen Brook, 1 3/4 miles northwest of Alexander, Attica Quadrangle, N.Y.,
dark gray shale
0051 Kashong Shale, Mulcahey Farm, 1.4 miles southwest of East Bethany, west of east branch
of Black Creek, Batavia Quadrangle, N.Y., dark gray shale
0055, 0056, 0057 Kashong Shale, Tile Factory and branch of White Creek, 1 1/2 mile southeast
of East Bethany, Batavia Quadrangle, N.Y., gray shale
0133, 0135, 0136, 0137 Kashong Shale, Menteth Point Ravine, west side Canandaigua Lake,
Canandaigua Quadrangle, N.Y., dark gray shale
0138 Lower Kashong Shale, Menteth Point Ravine, west side Canandaigua Lake, Canandaigua
Quadrangle, N.Y., dark gray to black shale
0165 Kashong Shale, west side Canandaigua Lake, Canandaigua Quadrangle, N.Y., gray shale
0204 Lower Kashong Shale, Orthnosta Bed, Shurger Glen, Cayuga Lake, Auburn Quadrangle,
N.Y., dark gray to black mudstone and siltstone
0304, 0305 Lower Otisco Shale, New Gulf Road, 1/2-3/4 mile north-northwest of Marietta,
Skaneateles Quadrangle, N.Y., dark gray to black siltstone
0361 Lower Cooperstown Member, Pholadella Bed, west of highway, Fellows Falls Ravine, 3/4
mile east of Vesper, Tully Quadrangle, N.Y., gray silty shale
0628, 0629, 0630 Chenango Sandstone, Colgate University Quarry, Hamilton, Morrisville Quad-
rangle, N.Y., massive dark gray to brown sandy siltstone and fine-grained sandstone
0497, 0498 Panther Mountain Fm., Strouds Ravine and Day's Quarry, 1 1/4 mile southeast of
Lebanon, Morrisville Quadrangle, N.Y., dark gray to brown sandy siltstone
0599, 0600 Panther Mountain Fm., road cut 3.2 miles west-southwest of West Eaton, Morrisville
Quadrangle, N.Y., dark gray to brown sandy siltstone
0539 Cooperstown Member, 1486 feet in glen 3/8 mile northwest of Georgetown, Morrisville
Quadrangle, N.Y., dark gray sandy siltstone
0506, 0507 Cooperstown Member, 1508-1520 feet in Blairs Ravine, Morrisville Quadrangle, N.Y.,
dark gray siltstone
0801, 0802, 0803 Panther Mountain Fm., ravine on north side of Cherry Valley, 1 mile north of
Middlefield, Cooperstown Quadrangle, N.Y., gray fine-grained silty sandstone
0814 Panther Mountain Fm., Hubbards Falls, on southeast edge of Middlefield, Cooperstown
Quadrangle, N.Y., dark gray siltstone
0815 Panther Mountain Fm., ravine on south edge of Middlefield, Cooperstown Quadrangle, N.Y.,
dark gray sandy siltstone
0817 Panther Mountain Fm., ravine 1 1/4 miles northwest of Middlefield, Cooperstown Quadrangle, N.Y., dark gray siltstone

0796, 0797 Panther Mountain Fm., ravine on south side of Cherry Valley, 1 1/4 miles northeast of Middlefield, Cooperstown Quadrangle, N.Y., gray fine-grained sandstone

0775, 0776, 0777, 0778 Cooperstown Member, along road to Crumhorn Lake, 1 3/4 miles southeast of Milford, Cooperstown Quadrangle, N.Y., coarse dark gray siltstone

0856 Mottville Member, Paraspirifer Bed, road section south of Richmondville, Richmondville Quadrangle, N.Y., brown fine-grained sandstone

0866, 0867 Panther Mountain Fm., The Hell Hole, 1 1/2 miles southeast of Mineral Springs, Schoharie Quadrangle, N.Y., dark gray silty sandstone

0871 Panther Mountain Fm., on the Kayser Kill, east-southeast of Breakabeen, Schoharie Quadrangle, N.Y., dark gray sandy siltstone

0897, 0898 Panther Mountain Fm., road section 1-2 miles west-southwest of North Blenheim, Gilboa Quadrangle, N.Y., gray sandstone

0878 Portland Point Limestone, Mill Creek Road, 1 mile west of North Blenheim, Gilboa Quadrangle, N.Y., dark gray coarse siltstone with conglomerate beds

0879 Portland Point Limestone, ravine 1 mile south of North Blenheim, Gilboa Quadrangle, N.Y., dark gray coarse siltstone with conglomerate beds

0880 Portland Point Limestone, glen 3/4 mile south-southeast of North Blenheim, Gilboa Quadrangle, N.Y., dark gray coarse siltstone with conglomerate beds

0996 Portland Point Limestone, Pustulatia Bed, 63 feet above river in bluff opposite Sparrow Bush, Port Jervis Quadrangle, N.Y., dark gray coarse siltstone

1585 Mahantango Fm., Middle Silstone Member, cuts on road along Raymondskill, west of Milford, Pa., gray to brown siltstone

1578 Sherman Ridge Member, shale pit at Dalmatia, on Pa. Rte. 147, Northumberland County, Pa., gray to brown silty mudstone

1579 Sherman Ridge Member, shale pit at Shadle, on Pa. Rte. 104, Snyder County, Pa., gray to brown silty mudstone

1594 Sherman Ridge Member, cut on road west of Millville, on Pa. Rte. 254, Columbia County, Pa., gray to brown mudstone and shale

1197 Montebello Sandstone, railroad cut in Little Mountain, south of main intersection in Marysville, Pa. (Ellison Section 2, Unit 1), gray sandstone and siltstone

1212 Sherman Ridge Member, cuts on Pa. Rte. 850 west of Dromgold, Pa. (Ellison Section 3, Unit 1), green-gray silty shale and siltstone
Sherman Ridge Member, cuts on Pa. Rte. 850 west of Dromgold, Pa. (Ellison Section 3, Unit 1), green-gray silty shale and siltstone

Sherman Ridge Member, pit on south flank of Mahanoy Ridge, south of New Bloomfield, Pa. (Ellison Section 5, Unit 1), gray silty claystone

Sherman Ridge Member, pit on south flank of Mahanoy Ridge, south of New Bloomfield, Pa. (Ellison Section 5, Unit 2), green-gray argillaceous siltstone

Sherman Ridge Member, pit on south flank of Mahanoy Ridge, south of New Bloomfield, Pa. (Ellison Section 5, Unit 2), green-gray argillaceous siltstone

Sherman Ridge Member, pit on south flank of Mahanoy Ridge, south of New Bloomfield, Pa. (Ellison Section 5, Unit 2), green-gray argillaceous siltstone

Sherman Ridge Member, pit on south flank of Mahanoy Ridge, south of New Bloomfield, Pa. (Ellison Section 5, Unit 3), gray mudstone

Montebello Sandstone, pit on south flank of Mahanoy Ridge, south of New Bloomfield, Pa. (Ellison Section 5, Unit 4), gray argillaceous siltstone

Sherman Ridge Member, cuts on U.S. Rte. 22 parallel to the Juniata River at Amity Hall, Pa. (Ellison Section 6, Unit 3), dark green-gray shale

Montebello Sandstone, cuts on U.S. Rte. 22 parallel to the Juniata River at Amity Hall, Pa. (Ellison Section 6, Unit 12), interbedded dark green-gray sandy shale, siltstone, and fine-grained sandstone

Montebello Sandstone, Pennsylvania Railroad cut, Millerstown, Pa. (Ellison Section 8, Unit 5), dark gray siltstone and sandstone

Montebello Sandstone, Pennsylvania Railroad cut, Millerstown, Pa. (Ellison Section 8, Unit 6), dark gray shaly siltstone

Montebello Sandstone, Pennsylvania Railroad cut, Millerstown, Pa. (Ellison Section 8, Unit 9), gray-green sandstone

Sherman Ridge Member, east bank of North Branch Mahantango Creek and cuts on Pa. Rte. 104 (Ellison Section 9, Unit 1), dark gray shale

Sherman Ridge Member, east bank of North Branch Mahantango Creek and cuts on Pa. Rte. 104 (Ellison Section 9, Unit 1), dark gray shale

Sherman Ridge Member, east bank of North Branch Mahantango Creek and cuts on Pa. Rte. 104 (Ellison Section 9, Unit 1), dark gray shale

Sherman Ridge Member, east bank of North Branch Mahantango Creek and cuts on Pa. Rte. 104 (Ellison Section 9, Unit 1), dark gray shale

Sherman Ridge Member, east bank of North Branch Mahantango Creek and cuts on Pa. Rte. 104 (Ellison Section 9, Unit 1), dark gray shale

Sherman Ridge Member, east bank of North Branch Mahantango Creek and cuts on Pa. Rte. 104 (Ellison Section 9, Unit 1), dark gray shale

Upper Shale Member, cuts on northwest side of U.S. Rte. 522, 0.1-0.5 mile south of Websters Mills, Pa. (Ellison Section 10, Unit 3), gray shaly siltstone and sandstone
Frame Shale, cuts on northwest side of U.S. Rte. 522, 0.1-0.5 mile south of Websters Mills, Pa. (Ellison Section 10, Unit 5), olive-gray silty shale

Frame Shale, cuts on northwest side of U.S. Rte. 522, 0.1-0.5 mile south of Websters Mills, Pa. (Ellison Section 10, Unit 6), gray silty mudstone and shale

Frame Shale, cuts on northwest side of U.S. Rte. 522, 0.1-0.5 mile south of Websters Mills, Pa. (Ellison Section 10, Unit 6), gray silty mudstone and shale

Chaneyville Siltstone, cuts on northwest side of U.S. Rte. 522, 0.1-0.5 mile south of Websters Mills, Pa. (Ellison Section 10, Unit 6), gray silty mudstone and shale

Chaneyville Siltstone, cuts on northwest side of U.S. Rte. 522, 0.1-0.5 mile south of Websters Mills, Pa. (Ellison Section 10, Unit 6), gray silty mudstone and shale

Chaneysville Siltstone, roadcuts at Chaneysville, Pa. (Ellison Section 11, Unit 7), dark olive-gray shaly siltstone

Frame and Chaneyville Members (undivided), cuts on Pa. Turnpike at Everett, Pa. (Ellison Section 13, Unit 1), gray silty mudstone

Frame and Chaneyville Members (undivided), cuts on Pa. Turnpike at Everett, Pa. (Ellison Section 13, Unit 1), gray silty mudstone

Frame and Chaneyville Members (undivided), cuts on Pa. Turnpike at Everett, Pa. (Ellison Section 13, Unit 1), gray silty mudstone

Frame and Chaneyville Members (undivided), cuts on Pa. Turnpike at Everett, Pa. (Ellison Section 13, Unit 2), dark green-gray siltstone

Clearville Siltstone, cuts on Pa. Turnpike west of interchange at Bedford, Pa. (Ellison Section 14, Unit 1), gray silty shale

Clearville Siltstone, cuts on Pa. Turnpike west of interchange at Bedford, Pa. (Ellison Section 14, Unit 1), gray silty shale

Frame Shale, borrow pit and cuts on Pa. Rte. 56 at Fishertown, Pa. (Ellison Section 15, Unit 4), gray silty calcareous mudstone

Upper Shale Member, cuts along U.S. Rte. 22 on southwestern side of the Juniata River, opposite Huntington Pa. (Ellison Section 16, Unit 3), green-gray silty claystone and siltstone

Crooked Creek Shale, cuts along U.S. Rte 22 on southwestern side of the Juniata River, opposite Huntington, Pa. (Ellison Section 16, Unit 8), gray silty mudstone

Crooked Creek Shale, borrow pit and dirt road at Martin Gap, Miller Township, Huntington County, Pa. (Ellison Section 17, Unit 3), gray silty calcareous mudstone
Frame Shale or Clearville Siltstone, cuts along U.S. Rte. 220 south of Newry, Pa. (Ellison Section 18, Unit 2), gray interbedded siltstone and silty shale and mudstone

Frame Shale or Clearville Siltstone, cuts along U.S. Rte. 220 south of Newry, Pa. (Ellison Section 18, Unit 2), gray interbedded siltstone and silty shale and mudstone

Mahantango Fm., old quarry on Williams Road, on north side of Cumberland, Md., brown siltstone slabs

Mahantango Fm., roadcuts 8.8 miles west of Martinsburg and 5.5 miles east of Berkeley Springs, on W. Va. Rte. 9, W. Va., brown siltstone

Lingle Limestone, Postulatia Bed, Clear Creek, 1 1/4 miles southwest of Mountain Glen, Ill., light gray coarse bioclastic limestone

Lingle Limestone, Devils Bakeoven, north of Grand Tower, Ill., gray fine bioclastic limestone

Lingle Limestone, 1 1/4 miles west-southwest of Lingle School, in bluff facing Lingle Creek, 27 feet above creek, NW 1/4 SW 1/4 Sec. 26, T. 13 S., R. 2 W., Jonesboro Quadrangle, Ill., dark gray bioclastic limestone

Lingle Limestone, 1 1/4 mile west-southwest of Lingle School, in bluff facing Lingle Creek, 27 feet above creek, NW 1/4 SW 1/4 Sec. 26, T. 13 S., R. 2 W., Jonesboro Quadrangle, Ill., silicified fossils

Lingle Limestone, SW 26, 13 S., R. 2 W., Union County, Ill., light gray coarse bioclastic limestone

St. Laurent Limestone, hill 1/4 mile west of junction of Little Saline Creek and road south of Ozora, Mo., white orthoquartzite with minor chert

St. Laurent Limestone, beds with scattered corals and Tropidoleptus, ridge 1/2 mile southwest of Wittenburg, Altenburg Quadrangle, Mo., dark gray bioclastic limestone
**Cupularostrum Community**

0607, 0608  Mottville Member, roadside 1 1/2 miles northeast of Eaton, Morrisville Quadrangle, N.Y., massive dark gray fine-grained limestone

0641, 0642  Mottville Member, glen and old canal 1/2-1 1/4 miles north of Hamilton, Morrisville Quadrangle, N.Y., massive dark gray limy siltstone

0665  Pompey Member, Electric Light Stream, 1.6 miles west-southwest of Morrisville, Morrisville Quadrangle, N.Y., dark gray sandy siltstone

0632  Pompey Member, 2 miles northwest of Hamilton, Morrisville Quadrangle, N.Y., gray siltstone

0664  Upper Pompey Member, Electric Light Stream, 2 miles southwest of Morrisville, Morrisville Quadrangle, N.Y., gray silty sandstone

0587  Chenango Sandstone, Red Gate Stock Farm, 2 miles north of Earlville, Morrisville Quadrangle, N.Y., dark gray siltstone

0601  Chenango Sandstone, 1.35 miles south-southwest of Eaton, Morrisville Quadrangle, N.Y., dark gray siltstone

0564  Panther Mountain Fm., roadcut 1 3/4 miles northeast of Georgetown station, Morrisville Quadrangle, N.Y., brown sandy siltstone

0576, 0577  Panther Mountain Fm., 1575-1578 feet in Hamilton's Ravine, Erleville, Morrisville Quadrangle, N.Y., dark gray siltstone

0580, 0581  Panther Mountain Fm., Beecher's Quarry, 1 mile west-southwest of Earlville, Morrisville Quadrangle, N.Y., dark gray sandy siltstone

0593  Panther Mountain Fm., first glen from south into Kingsley Brook, 1 mile west of Randallsville, Morrisville Quadrangle, N.Y., dark gray sandy siltstone and brown sandstone

0759  Solsville Member, Button Falls, 1 1/2 miles southwest of Leonardsville, Unadilla Valley, N.Y., light gray fine-grained sandstone

0762  Solsville Member, 1.7 miles northeast of Brookfield, Unadilla Valley, N.Y., massive dark gray sandy siltstone

0708  Mottville Member, glen 1 1/4 miles south of West Edmeston, Unadilla Valley, N.Y., gray sandstone

0754, 0755, 0756, 0757, 0758  Mottville Member, Button Falls Creek, 1 1/2 miles southwest of Leonardsville, Unadilla Valley, N.Y., gray fine bioclastic limestone and gray sandy siltstone

0740, 0741  Delphi Station Member, 2-2 3/4 miles southeast of Unadilla Forks, Unadilla Valley, N.Y., dark gray silty sandstone
0723, 0724, 0725, 0726  Butternut Member, Palmers Glen, 1 1/4-1 1/2 miles north of West Edmeston, Unadilla Valley, N.Y., dark gray silty sandstone, common pelmatozoan stems, crinoids and blastoids

0710  Panther Mountain Fm., 70 feet above second falls in Goulds Glen, 0.8 miles southwest of West Edmeston, Unadilla Valley, N.Y., dark gray sandy siltstone

0718  Panther Mountain Fm., glen 1 1/4 miles southeast of Leonardsville, Unadilla Valley, N.Y., brown fine-grained sandstone

0719, 0722, 0745  Panther Mountain Fm., road 2.6 miles south-southeast of Leonardsville, Unadilla Valley, N.Y., gray silty sandstone

0720, 0721  Panther Mountain Fm., base of section 2 1/4 miles southeast of Leonardsville, Unadilla Valley, N.Y., gray to brown silty sandstone

0730, 0731, 0732, 0733, 0734  Panther Mountain Fm., brook, 3.6 miles south of West Edmeston, Unadilla Valley, N.Y., dark gray sandy siltstone

0737, 0738, 0739  Panther Mountain Fm., 2 3/4 miles southeast of Unadilla Forks, Unadilla Valley, N.Y., gray silty sandstone

0746, 0747, 0748  Panther Mountain Fm., 1 1/2 miles west-northwest of Leonardsville, Unadilla Valley, N.Y., brown fine-grained sandstone

0749, 0750  Panther Mountain Fm., Button Falls Creek, 1 1/2 miles southwest of Leonardsville, Unadilla Valley, N.Y., dark gray silty sandstone

0761  Panther Mountain Fm., 1 mile northeast of Brookfield, Unadilla Valley, N.Y., gray siltstone and sandstone

0763  Panther Mountain Fm., 2 1/2 miles west-southwest of Bridgewater, Unadilla Valley, N.Y., gray to brown sandy siltstone

0703, 0704, 0705, 0706  Panther Mountain Fm., glen 1 mile north-northeast of South Edmeston, Unadilla Valley, N.Y., dark gray siltstone

0709  Panther Mountain, 2.4 miles south of West Edmeston, Unadilla Valley, N.Y., dark gray sandy siltstone

0822  Solsville Member, east side Otsego Lake, 2 1/2 miles north-northeast of Cooperstown, Cooperstown Quadrangle, N.Y., gray fine-grained sandstone

0825  Solsville Member, first ravine north of Leatherstocking Falls, 2 miles north of Cooperstown, west side of Otsego Lake, Cooperstown Quadrangle, N.Y., gray sandstone

0831  Solsville Member, road section 1 mile north of Cooperstown, Cooperstown Quadrangle, N.Y., brown sandy siltstone

0824  Lower Pecksport Member, Leatherstocking Falls, 1 1/2 miles north of Cooperstown, Cooperstown Quadrangle, N.Y., dark gray sandy siltstone
Pecksport Member, Fenimore Farms, 1 mile north of Cooperstown, Cooperstown Quadrangle, N.Y., gray sandy siltstone

Panther Mountain Fm., loose float 1 mile south of Pleasant Valley, Cooperstown Quadrangle, N.Y., gray fine-grained sandstone

Panther Mountain Fm., loose float, 1 mile northeast of Middlefield, Cooperstown Quadrangle, N.Y., gray sandstone

Panther Mountain Fm., road 2 1/2 miles northeast of Middlefield Center, Cooperstown Quadrangle, N.Y., gray fine-grained sandstone

Panther Mountain Fm., top of hill, 1 1/2 miles northwest of Cooperstown, Cooperstown Quadrangle, N.Y., dark gray coarse siltstone

Panther Mountain Fm., 1 mile east-northeast of Bowerstown, Cooperstown Quadrangle, N.Y., gray sandstone

Panther Mountain Fm., 3 miles south-southwest of Middlefield, Cooperstown Quadrangle, N.Y., gray sandstone

Panther Mountain Fm., road section 1 3/4 miles north-northwest of Summit, Richmondville Quadrangle, N.Y., gray siltstone

Panther Mountain Fm., along road to Lutheranville, at junction with highway, 1 mile south-southwest of Richmondville, Richmondville Quadrangle, N.Y., gray siltstone

Basal Panther Mountain Fm., equivalent to upper Marcellus, loose float at junction of Panther Creek and N.Y. Rte. 30, 2 miles south-southwest of Fultonham, Schoharie Quadrangle, N.Y., dark gray siltstone

Panther Mountain Fm., road cut 0.3-0.5 mile north of Franklinton, Schoharie Quadrangle, N.Y., gray to brown siltstone and sandstone

Panther Mountain Fm., ravine 1 1/4 miles southwest of Breakabeen, Schoharie Quadrangle, N.Y., gray sandy siltstone

Panther Mountain Fm., roadcut 2 1/2 miles south-southeast of Breakabeen, Schoharie Quadrangle, N.Y., brown sandstone

Panther Mountain Fm., on road south of Keyser Kill, 1 mile southeast of Breakabeen, Schoharie Quadrangle, N.Y., gray sandstone

Panther Mountain Fm., on the Manorkill, 1/2 mile east of West Conesville, Gilboa Quadrangle, N.Y., dark gray siltstone

Panther Mountain Fm., cliff between Breakabeen and North Blenheim, 2 miles south-southwest of Breakabeen, Gilboa Quadrangle, N.Y., dark gray siltstone

Panther Mountain Fm., 1 1/2 miles east-northeast of Breakabeen, Gilboa Quadrangle, N.Y., dark gray sandstone
0892 Panther Mountain Fm., on the Manorkill, 1 1/2 miles southeast of Gilboa, Gilboa Quadrangle, N.Y., gray sandstone

0895, 0896, 0901, 0902 Panther Mountain Fm., cuts on N.Y. Rte. 30, 3/4-1 mile southwest of North Blenheim, Gilboa Quadrangle, N.Y., dark gray siltstone and sandstone

0911 Panther Mountain Fm., 2 1/2 miles northeast of North Blenheim, Gilboa Quadrangle, N.Y., dark gray siltstone

0912, 0913 Panther Mountain Fm., hill 3 miles northeast of North Blenheim, Gilboa Quadrangle, N.Y., dark gray siltstone

0916, 0917 Panther Mountain Fm., Granby Hill Ravine, 1 1/2 miles north of North Blenheim, Gilboa Quadrangle, N.Y., gray to brown sandstone

0936 Lower Mount Marion Fm., quarry at top of section, 2 1/2 miles south-southwest of East Berne, Berne Quadrangle, N.Y., dark gray siltstone

0949 Mount Marion Fm., 1/2 mile west of Leeds on N.Y. Rte. 23, Coxsackie Quadrangle, N.Y., brown sandstone

0954 Mount Marion Fm., 1/4 mile west of Great Falls of the Catskill, north-northwest of Ascutney, Catskill Quadrangle, N.Y., gray sandstone and pebble conglomerate

0974 Mount Marion Fm., at 370 feet on Halihan Hill, northwest of Kingston, Rosendale Quadrangle, N.Y., gray sandstone

0982, 0987 Mahantango Fm., Napanoch Falls, Napanoch, Ellenville Quadrangle, N.Y., dark gray siltstone

0985 Mount Marion Fm., railroad cut between Summit and Phillipsport, Ellenville Quadrangle, N.Y., massive dark gray sandstone

0984 Mahantango Fm., 1 mile west-northwest of Spring Glen, Ellenville Quadrangle, N.Y., gray siltstone and sandstone

0998 "Moscow" Fm., 1 3/4 miles northwest of Port Jervis, Port Jervis Quadrangle, N.Y., dark gray to brown siltstone

1138 Montebello Sandstone, opposite Pennsylvania Railroad Bridge on west side of Susquehanna River, below Marysville, Pa., gray sandstone

1599 Chaneysville Siltstone Member, cuts on road west of Wolfe Mills, Md., brown fine-grained siltstone

1184 Montebello Sandstone, north quarry at Little Mountain Gap, on east side of Susquehanna River, north of Rockville, Pa. (Ellison Section 1, Unit 1), gray siltstone and sandstone

1200 Montebello Sandstone, highway and railroad cuts in Little Mountain, south of Marysville, Pa. (Ellison Section 2, Unit 9), gray silty sandstone
1412  Backbone Ridge Siltstone, roadcuts on U.S. Rte. 22 on southwestern side of the Juniata River, opposite Huntington, Pa. (Ellison Section 16, Unit 9), dark gray shaly calcareous siltstone

1414  Gander Run Shale, roadcuts on U.S. Rte. 22 on southwestern side of the Juniata River, opposite Huntington, Pa. (Ellison Section 16, Unit 10), gray calcareous siltstone

1422  Backbone Ridge Siltstone, borrow pit and dirt road at Martin Gap, Miller Township, Huntington County, Pa. (Ellison Section 17, Unit 4), dark gray mudstone and siltstone

1423  Backbone Ridge Siltstone, borrow pit and dirt road at Martin Gap, Miller Township, Huntington County, Pa. (Ellison Section 17, Unit 4), dark gray mudstone and siltstone

1424  Backbone Ridge Siltstone, borrow pit and dirt road at Martin Gap, Miller Township, Huntington County, Pa. (Ellison Section 17, Unit 4), dark gray mudstone and siltstone

1544C  St. Laurent Limestone, St. Laurent Creek near St. Marys, Perry County, Mo., gray limestone
Camarotoechia Community

0037, 0038  Stafford Limestone, below dam on Cayuga Creek, Como Park, Lancaster, Depew Quadrangle, N.Y., dark gray fine-grained limestone

0034, 0035, 0036  Levanna Shale, Cazenovia Creek, near Blossom, Depew Quadrangle, N.Y., dark gray shale

0074  Uppermost Oatka Creek Shale, Ashantee, Batavia Quadrangle, N.Y., black fissile shale

0075  Lower Oatka Creek Shale, Ashantee, Batavia Quadrangle, N.Y., brown to black shale

0069  Upper Ledyard Shale, branch of Tonawanda Creek, 3 miles west of East Bethany, Batavia Quadrangle, gray shale

0110  Oatka Creek Shale, just north of bridge over Oatka Creek, Main Street, Leroy, Caledonia Quadrangle, N.Y., black shale

0099  Wanakah Shale, above Pleurodictyum Bed, Wheeler Gully or Jacox Run, Caledonia Quadrangle, N.Y., dark gray shale

0085  Ledyard Shale, lowest exposure in Fall Brook, 3 miles east-southeast of Canandaigua Lake, Caledonia Quadrangle, N.Y., dark gray to black thin-bedded shale

0163, 0164  Oatka Creek Shale, Mud Creek, 5 1/2 miles northwest of Canandaigua, Canandaigua Quadrangle, N.Y., black shale and mudstone

0158  Levanna Shale, just below Centerfield on Shaffer Creek, 3/4 mile north-northwest of Centerfield, Canandaigua Quadrangle, N.Y., dark gray to black shale

0129  Windom Shale, "Ambocoelia" praeumbona Bed, Menteth Glen, Canandaigua Lake, Canandaigua Quadrangle, N.Y., black thin-bedded shale

0111-0112  Uppermost Windom Shale, just below Tully on Gage Creek, 1 mile east-southeast of Cottage City, east side of Canandaigua Lake, Canandaigua Quadrangle, N.Y., dark gray to black thin-bedded shale

0239, 0240, 0241, 0242, 0243  Oatka Creek Shale, between Lehigh Railroad and Cayuga Lake shore highway bridge in Criss Creek, 1 1/4 miles north-northeast of Levanna, Auburn Quadrangle, N.Y., black shale

0231  Uppermost Levanna Shale, first 5 feet of Moonshine Falls, Paines Creek, 2 1/4 miles northwest of Black Rock, Cayuga Lake, Auburn Quadrangle, N.Y., black shale

0234, 0235, 0236, 0237  Levanna Shale, 1465-2080 paces upstream from shore highway, Deans Creek, on Cayuga Lake, 1 mile north of Aurora, Auburn Quadrangle, N.Y., black shale and siltstone

0220  Windom Shale, Camarotoechia Bed, Sheldrake Creek, Sheldrake, west side of Cayuga Lake, Auburn Quadrangle, N.Y., dark gray siltstone
0329, 0330, 0331. Delphi Station Member, 872-888 feet in Harlands Gulf, 0.9 mile north-northwest of Marietta, Skaneateles Quadrangle, N.Y., dark gray to black shale and siltstone.

0312, 0313, 0314, 0315. Pompey Member, 866-925 feet in Clintonsville Ravine, 2 1/4 miles north-northwest of Marietta, Skaneateles Quadrangle, N.Y., dark gray to black shale.

0321, 0322. Butternut Member, 964-1040 feet in Harlands Gulf, 0.9 miles north-northwest of Marietta, Skaneateles Quadrangle, N.Y., dark gray to black shale.

0318. Ledyard Shale, 1148-1153 feet in Harlands Gulf, 0.9 mile north-northwest of Marietta, Skaneateles Quadrangle, N.Y., dark gray siltstone.

0385, 0386, 0387, 0388. Cardiff Member, Bear Mountain Ravine, west of Tully Valley, Tully Quadrangle, N.Y., dark gray to black shale and siltstone.

0400. Cardiff Member, just below Mottville, ravine 1/4 mile northeast of Tully Valley, Tully Quadrangle, N.Y., dark gray siltstone.

0379. Delphi Station Member, 108 feet above Mottville, Bear Mountain Ravine, west of Tully Valley, Tully Quadrangle, N.Y., dark gray siltstone.

0393, 0394. Delphi Station Member, ravine 1/4 mile northeast of Tully Valley, Tully Quadrangle, N.Y., dark gray siltstone.

0392. Lower Pompey Member, ravine 1/4 mile northeast of Tully Valley, Tully Quadrangle, N.Y., black silty shale.

0389. Butternut Member, The Cascades, Conklin's Gulf, 1 mile west-southwest of Berwyn, Tully Quadrangle, N.Y., dark gray siltstone.

0367. Upper Otisco Member, shale above coral bed 60 feet above Centerfield, Fellows Falls Ravine, 1 mile east of Vesper, Tully Quadrangle, N.Y., black silty shale.

0476. Cardiff Member, railroad cut 2 1/2 miles southeast of Oran, Cazenovia Quadrangle, N.Y., dark gray silty shale.

0480. Cardiff Member, at 950 feet in glen on east side of Limestone Creek Valley, just north of railroad tunnel, northwest of Cazenovia, Cazenovia Quadrangle, N.Y., black siltstone.

0437. Butternut Member, Stockham Hill Ravine, 1/2 mile southwest of Delphi, Cazenovia Quadrangle, N.Y., gray to brown sandy siltstone.

0438. Upper Butternut Member, ravine 2 miles due south of Delphi, Cazenovia Quadrangle, N.Y., dark gray siltstone.

0439. Basal Butternut Member, shale above upper falls at Delphi Falls, Cazenovia Quadrangle, N.Y., black fissile silty shale.

0417. Spafford Member, behind I. H. Hunt's house, 0.9 mile southeast of New Woodstock, Cazenovia Quadrangle, N.Y., gray siltstone.
0402 Cooperstown Member, *Camarotoechia* Bed, ravine 1/4 mile south of Keeney, Cazenovia Quadrangle, N.Y., black fissile siltstone

0410 Cooperstown Member, *Camarotoechia* Bed, on road 1 mile southeast of Tinselor Hill, Cazenovia Quadrangle, N.Y., brown siltstone

0655 Union Springs Shale, Oneida Creek, 2 miles southeast of Mumsville, Morrisville Quadrangle, N.Y., black fissile shale

0614, 0615 Cardiff Member, woods Ravine, 1 3/4 miles north-northwest of Solsville, Morrisville Quadrangle, N.Y., dark gray siltstone

0676, 0677, 0678 Cardiff Member, just above railroad crossing, glen 1/2 mile north of Morrisville Station, Morrisville Quadrangle, N.Y., dark gray sandy siltstone

0620 Bridgewater Member, glen 1.3 miles northwest of Solsville, Morrisville Quadrangle, N.Y., dark gray to black siltly fissile shale

0621 Pecksport Member, 1255 feet in Livermores Glen, 1 1/4 miles northeast of Pecksport, Morrisville Quadrangle, N.Y., dark gray siltstone

0515, 0516 Cooperstown Member, *Camarotoechia* Bed, glen 1 mile northwest of Lebanon, Morrisville Quadrangle, N.Y., dark gray siltstone

0531, 0532 Cooperstown Member, *Camarotoechia* Bed, glen 1/4 mile northwest of Georgetown, Morrisville Quadrangle, N.Y., dark gray siltstone

0560 Cooperstown Member, *Camarotoechia* Bed, glen 1 mile west-northwest of Georgetown Station, Morrisville Quadrangle, N.Y., dark gray siltstone

0557 Cooperstown Member, *Camarotoechia* Bed, Werners Glen, 1 mile northeast of Georgetown, Morrisville Quadrangle, N.Y., dark gray siltstone

0764, 0765 Pecksport Member, glen 2 1/2 miles west-northwest of Bridgewater, Unadilla Valley, N.Y., dark gray to brown silty sandstone

0742 Pecksport Member, Markham Mountain, 3/4 mile east-northeast of Unadilla Forks, Unadilla Valley, N.Y., gray to brown fine-grained sandstone

0766 Solsville Member, Reilly Quarry, 5 miles northwest of Bridgewater, just south of U.S. Rte. 20, Unadilla Valley, N.Y., gray to brown fine-grained sandstone

0717 Pompey Member, glen 1 1/4 miles south-southeast of Leonardsville, Unadilla Valley, N.Y., black fine-grained siltstone

0681, 0682, 0683 Cooperstown Member, *Camarotoechia* Bed, vicinity of Perrytown, Unadilla Valley, N.Y., dark gray siltstone

0837 Chittenango Shale, Trout Brook, 2 miles southwest of Springfield Center, Cooperstown Quadrangle, N.Y., black coarse fissile shale
Solsville Member, just above Otsego, the Dugway, east side Otsego Lake, Cooperstown Quadrangle, N.Y., soft black shale

Panther Mountain Fm., 0.3 mile south-southwest of Fivemile Point, Cooperstown Quadrangle, N.Y., gray sandy siltstone

Cooperstown Member, Camarotoechia Bed, east side Otsego Lake, below Clarke Quarry, Cooperstown, Cooperstown Quadrangle, N.Y., dark gray siltstone

Panther Mountain Fm., road section 3/4 mile south-southwest of Richmondville, Richmondville Quadrangle, N.Y., dark gray siltstone

Bakoven Shale, Pinnacle Hill, Berne Quadrangle, N.Y., dark gray silty shale

Bakoven Shale, below Stony Hollow, falls of Onesquethaw Creek, 2 1/2 miles northwest of Clarks ville, Albany Quadrangle, N.Y., dark gray to black massive mudstone

Marcellus Shale, bluff on Scott Street, Stroudsburg, Pa., black shale

Marcellus Shale, west side Lehigh River, 500 yards east of Eagle Hotel, Bowmanstown, Pa., black shale

Marcellus Shale, Pennsylvania Railroad cut, short distance south of Bellwood, Pa., black shale

Marcellus Shale, 2 1/2 miles south of Reese, at head of Robinson Run, Hollidaysburg Quadrangle, Pa., black shale

Gander Run Shale, cuts on Pa. Turnpike west of interchange at Bedford, Pa. (Ellison Section p4, Unit 5), gray silty and argillaceous shale

Gander Run Shale, cuts along U.S. Rte. 22 on southwestern side of the Juniata River, opposite Huntington, Pa. (Ellison Section 16, Unit 10), gray silty calcareous siltstone

Marcellus Shale, cuts along U.S. Rte. 22 on southwestern side of the Juniata River, opposite Huntington, Pa. (Ellison Section 16, Unit 1), black fissile shale

Crooked Creek Shale, cuts along U.S. Rte. 22 on southwestern side of the Juniata River, opposite Huntington, Pa. (Ellison Section 16, Unit 7), gray silty shale

Gander Run Shale, borrow pit and dirt road at Martin Gap, Miller Township, Huntington County, Pa. (Ellison Section 17, Unit 5), dark gray silty mudstone

Gander Run Shale, borrow pit and dirt road at Martin Gap, Miller Township, Huntington County, Pa. (Ellison Section 17, Unit 5), dark gray silty mudstone

Basal Marcellus Shale, 1/2 mile south of Hayfield, Middletown Quadrangle, Va., dark gray silty shale

Upper Marcellus Shale, bank of creek 1500 feet southeast of Hayfield, Middletown Quadrangle, Va., dark gray shale with thin limestone beds
Marcellus Shale, 1/4 mile northeast of Gainesboro, Va., tan shale and siltstone

Marcellus Shale, bluff just north of Rock Creek, 1 mile northeast of Gainesboro, Va., black thin-bedded shale

Marcellus Shale, fields 1 mile northeast of Gainesboro, Va., tan thin-bedded siltstone

Marcellus Shale, on forest road to Rockland, W. Va., 2 miles northeast of Liberty Furnace, Woodstock Quadrangle, Va., dark gray shale

Millboro Shale, slope west of Cow Pasture River, Stanlyton Quadrangle, Va., black shale

Millboro Shale, road on Hughes Creek, 1/4 mile north of mouth of creek, 12 miles north of Covington, Natural Bridge Quadrangle, Va., black shale

Millboro Shale, along railroad 400 yards below station, Hot Springs, Va., black shale

Millboro Shale, cut on Va. Rte. 311, 1 mile west of Newcastle, Lewisburg Quadrangle, Va., gray to tan silty mudstone

Millboro Shale, first bridge on Craigs Creek, 2 1/2 miles south of Mercantile, Christiansburg Quadrangle, Va., tan silty shale

Millboro Shale, Lee Highway bridge on Plum Creek, 3 miles east of Radford, Dublin Quadrangle, Va., tan shale

Millboro Shale, 12 miles south of Radford at intersection of road from Radford with Old Rock Road which crosses river at Ingle's Ferry, Dublin Quadrangle, Va., black shale

Millboro Shale, road on northwest side of New River, 1 mile northeast of Nannus, Dublin Quadrangle, Va., black shale

Millboro Shale, just above Onondaga, northwest slope of Draper Mountain along Lee Highway, south of Pulaski, Va., black shale

Millboro Shale, Poletown, 2 miles east-southeast of Max Meadows, Max Meadows Quadrangle, Va., black shale

Millboro Shale, on road over Walker Mountain via Stony Front, Pocahontas Quadrangle, Va., black shale

Millboro Shale, along railroad, just west of station, Bells Valley, Va., black shale

Millboro Shale, road 2.7 miles south of Paint Bank, Va., tan shale

Millboro Shale, Rte. 55 1 mile northwest of Star Tannery, Va., black mudstone

Millboro Shale, Howards Creek, Greenbriar County, W. Va., black shale

Millboro Shale, just above Onondaga, 1/2 mile south of Watterlee, W. Va., black shale

Arkona Shale, Hungry Hollow, 2 1/2 miles northeast of Arkona, Ontario, black fissile shale

8 inches below encrinal limestone bed of Hungry Hollow Fm.
Devonochonetes Community

0225 King Ferry Member, Pleurodictyum Bed, tributary to Paines Creek, 1 1/4 miles north of Black Rock, Cayuga Lake, Auburn Quadrangle, N.Y., gray shale and siltstone

0651 Cardiff Member, glen 1.9 miles south of Peterboro, Morrisville Quadrangle, N.Y., dark gray sandy siltstone

0520 Cooperstown Member, glen on Cooperstown-Lebanon line, 2 miles west-northwest of Lebanon, Morrisville Quadrangle, N.Y., dark gray sandy siltstone

0820 Solsville Member, roadcut 2 1/2 miles east of Middlefield Center, Cooperstown Quadrangle, N.Y., brown sandstone

0830 Pecksport Member, road section on road to west, 1 1/4 miles north of Cooperstown, Cooperstown Quadrangle, N.Y., gray sandstone

0790 Panther Mountain Fm., roadcut 1 mile northeast of Milford, Cooperstown Quadrangle, N.Y., gray siltstone and sandstone, much fossil hash

0828 Panther Mountain Fm., just south of Fenimore Farms, 1 mile north of Cooperstown, Cooperstown Quadrangle, N.Y., gray silty sandstone

0782 Cooperstown Member, Moss Pond outlet, 3 miles north of Milford, Cooperstown Quadrangle, N.Y., dark gray sandy siltstone

0873 Panther Mountain Fm., along road across Keyser Kill, 1 mile east-southeast of Breakabeen, Schoharie Quadrangle, N.Y., gray sandstone

0922 Portland Point Limestone, ledge 1 mile south-southwest of Durham, Durham Quadrangle, N.Y., gray sandstone with conglomerate beds

0950, 0951 Mount Marion Fm., 1 mile southwest of Alcove Reservoir on Alcove-Newry road, Coxsackie Quadrangle, N.Y., gray sandstone
0955, 0956, 0957. Mount Marion Fm., Catskill Creek at Great Falls, Catskill Quadrangle, N.Y.,
gray sandstone

0994. Mahantango Fm., roadcut 1 1/4 miles northwest of Huguenot, Port Jervis Quadrangle, N.Y.,
gray sandstone

1162. Sherman Ridge Member, cut on U.S. Rte. 15, 2 miles northwest of Northumberland, Pa.,
gray siltstone

1129. Mahantango Fm., shale pit on south side of Pa. Rte. 61 at Deer Lake, Pa., dark gray
siltstone

1584. Fisher Ridge Member, cut on southwest side of road 0.3 miles south of Pa. Rte. 17 at
Donally Mills, Pa., brown sandstone

1587. Mahantango Fm., shale pit on south side of Pa. Rte. 61 at Deer Lake, Pa., dark gray
fine-grained siltstone

1218. Montebello Sandstone, cuts on Pa. Rte. 850 along Sherman Creek, Pa. (Ellison Section 4,
Unit 2), gray silty shale

1241. Sherman Ridge Member, pit on south flank of Mahanoy Ridge, south of New Bloomfield, Pa.
(Ellison Section 5, Unit 3), gray siltstone

1253. Sherman Ridge Member, cuts on U.S. Rte. 22 parallel to the Juniata River at Amity Hall,
Pa. (Ellison Section 6, Unit 3), dark green-gray shale

1274. Montebello Sandstone, stream cut and road cut on U.S. Rte. 15, near nose of Half Falls
Mountain, at Girty's Notch, Pa. (Ellison Section 7, Unit 11), dark green-gray shaly siltstone

1283. Montebello Sandstone, Pennsylvania Railroad cut at Millerstown, Pa. (Ellison Section 8,
Unit 6), dark gray shaly siltstone

1301. Sherman Ridge Member, east bank of North Branch Mahantango Creek and cuts on Pa. 105
(Ellison Section 9, Unit 1), gray shale

1304. Montebello Sandstone, stream cut and road cut on U.S. Rte. 15, near nose of Half Falls
Mountain, at Girty's Notch, Pa. (Ellison Section 7, Unit 11), dark green-gray shaly siltstone

1283. Montebello Sandstone, Pennsylvania Railroad cut at Millerstown, Pa. (Ellison Section 8,
Unit 6), dark gray shaly siltstone

1301. Sherman Ridge Member, east bank of North Branch Mahantango Creek and cuts on Pa. 105
(Ellison Section 9, Unit 1), gray shale

1304. Montebello Sandstone, east bank of North Branch Mahantango Creek and cuts on Pa. Rte.
104 (Ellison Section 9, Unit 9), gray sandstone

(Ellison Section 13, Unit 1), gray silty mudstone
Basal Mahantango Fm., north side of road, 100 yards northwest of spring in old village, 1/2 mile north of Post Office, Chambersville, Va., dark gray mudstone and shale.

Lingle Limestone, bluff facing Clear Creek, 1 1/4 miles southwest of Mountain Glen, NE 1/4 34, 11 S., R. 2 W., Alto Pass Quadrangle, Ill., light gray coarse bioclastic limestone.

Lingle Limestone, Devils Bakeoven, north of Grand Tower, Ill., light gray coarse bioclastic limestone.

St. Helen's Breccia, Cote St. Paul, near Montreal, Quebec, gray siltstone.
Truncalosia Community

0011 Wanakah Shale, *Strophalosia* Bed, Buffalo Quadrangle, N.Y., dark gray shale

0039 Stafford Limestone, Plumbottom Creek, Lancaster, Depew Quadrangle, N.Y., dark gray fine-grained limestone

0044 Ledyard Shale, small *Tropidoleptus* bed, below small bridge over Murder Creek, 1/2 mile north of Darien, Attica Quadrangle, N.Y., dark gray shale

0043 Wanakah Shale, *Strophalosia* Bed, under bridge over Murder Creek, 1/2 mile north of Darien, Attica Quadrangle, N.Y., dark gray shale

0071 Wanakah Shale, *Strophalosia* Bed, along D.L. and W. Railroad tracks, 3 miles west of East Bethany, Batavia Quadrangle, N.Y., gray mudstone

0105 Levanna Shale, small *Tropidoleptus* Bed, 1440 paces from railroad, Wheeler Gully or Jacox Run, 2 1/2 miles north-northeast of Geneseo, Caledonia Quadrangle, N.Y., dark gray to black shale

0102 Wanakah Shale, *Strophalosia* Bed, 1458 paces from railroad in Wheeler Gully or Jacox Run, 2 1/2 miles north-northeast of Geneseo, Caledonia Quadrangle, N.Y., dark gray shale

0159, 0160, 0161 Levanna Shale, Shaffer Creek, near junction with Mud Creek, 5 1/4 miles northwest of Canandaigua, Canandaigua Quadrangle, N.Y., dark gray to black shale

0162 Levanna Shale, railroad cut 1/2 mile southeast of Padelford, Canandaigua Quadrangle, N.Y., dark gray to black shale

0153 Ledyard Shale, small *Tropidoleptus* Bed, just below Wanakah, Fall Brook, Canandaigua Quadrangle, N.Y., dark gray to black shale

0152 Wanakah Shale, *Strophalosia* Bed, Fall Brook 3 miles east-southeast of Canandaigua Quadrangle, N.Y., dark gray mudstone

0226 Ledyard Shale, small *Tropidoleptus* Bed, Paines Creek, 2 1/4 miles northwest of Black Rock, Cayuga Lake, Auburn Quadrangle, N.Y., dark gray to black shale

0338, 0339 Cardiff Member, Jacknife Ravine, 1 mile south-southeast of Marcellus, Skaneateles Quadrangle, N.Y., black shale and siltstone

0371 Butternut Member, 65-70 feet above base of lower falls, Fellows Falls Ravine, 1 mile east of Vesper, Tully Quadrangle, N.Y., dark gray siltstone

0650 Basal Pompey Member, Oneida Creek, 2.7 miles south of Peterboro, Morrisville Quadrangle, N.Y., dark gray to black shaly siltstone

0602 Basal Butternut, road cut 1.2 miles northeast of Eaton, Morrisville Quadrangle, N.Y., dark gray siltstone

0925 Panther Mountain Fm., 3 miles northwest of South Western, Durham Quadrangle, N.Y., dark gray sandstone
Stony Hollow Member, Falls of the Onesquethaw, 2 1/2 miles northwest of Clarksville, Albany Quadrangle, N.Y., dark gray fine-grained sandstone

Marcellus Shale, cut on King Street, north edge of Stroudsburg, Pa., black mudstone and shale

Marcellus Shale, near reformatory 1/2 mile east of Huntington, Pa., black carbonaceous shale

Marcellus Shale, 1 mile south of Milesburg Station, Central City, Bellefonte Quadrangle, Pa., black shale and tan shale and mudstone

Marcellus Shale, east side of knoll 1/2 mile south of railroad station at Central City, Bellefonte Quadrangle, Pa., black shale and tan mudstone

Millboro Shale, 3 miles north of Big Run, 1 mile north of Millboro Springs, Monterey Quadrangle, Va., black shale

Millboro Shale, Big Run, 1 mile north of Millboro Springs, Monterey Quadrangle, Va., black shale

Millboro Shale, road to Eagle Rock 2 miles northeast of Newcastle, Lewisburg Quadrangle, Va., black shale

Basal Millboro Shale, near base of southeast slope of Catawba Mountain, on road to Bekner Gap, Christiansburg Quadrangle, Va., black shale

Millboro Shale, old quarry, just east of road at northeast end of Queen's Knob, 3 1/2 miles northwest of Wytheville, Wytheville Quadrangle, Va., black shale and tan to gray mudstone

Millboro Shale, cut on U.S. Rte. 21, 1/2 mile south of Hicksville and 5 miles north of Bland, Pocahontas Quadrangle, Va., black shale

Millboro Shale, below goniatite bed, Hayter Gap, Ablingdon Quadrangle, Va., black shale

Millboro Shale, Poor Valley road, 2 1/2 miles southwest of town of Hayter Gap, Ablingdon Quadrangle, Va., black shale and mudstone

Millboro Shale, Poor Valley road, 1/2 mile northwest of junction with U.S. Rte. 19, back of house just north of road, Ablingdon Quadrangle, Va., black shale

Millboro Shale, side hollow of Cleghorn Valley, west of junction of Elk and Walker Creeks, 1 mile southeast of Shannon Gap in Walker Mountain, Ablingdon Quadrangle, Va., black shale

Millboro Shale, southeast slope of Clinch Mountain, 1/2 mile west-northwest of Hiltons, Bristol Quadrangle, Va., black shale

Millboro Shale, Dry Run Creek, near White Sulphur Springs, W. Va., black shale

Millboro Shale, northwest base of Clinch Mountain, on highway to Cumberland Gap, 11 miles northwest of Morristown Tenn., black shale
**Subrensselandia Community**

1130  Montebello Sandstone, cut in Swope Mountain, on Pa. Rte. 645, 0.7 mile of junction with Pa. Rte. 443, 1 1/2 miles south of Pine Grove, Schuylkill County, Pa., white orthoquartzite

1131  Montebello Sandstone, Swope Mountain, just west of Pa. Rte. 501, 0.6 miles S90W of junction of Pa. Rte. 501 and Pa. Rte. 895, 1.5 miles south-southeast of Pine Grove, Schuylkill County, Pa., white orthoquartzite

1132  Montebello Sandstone, at junction of Pa. Rte. 501 and side road, 0.56 mile due south of junction of Pa. Rte. 501 and Pa. Rte. 895, 1.5 mile south-southeast of Pine Grove, Schuylkill County, Pa., white orthoquartzite

1139  Montebello Sandstone, summit of Little Mountain near Marysville, Perry County, Pa., white orthoquartzite

1137  Montebello Sandstone, 1 1/2 miles north of Shermandale, Pa., in road cut, gray sandstone

1142  Montebello Sandstone, on Pa. Rte. 850 at Camp Carson Long, on Sherman Creek, 0.5 miles west-northwest of Dromgold, Pa., gray sandstone

1206  Montebello Sandstone, railroad and highway cuts in Little Mountain, south of Marysville, Pa. (Ellison Section 2, Unit 11), gray sandstone

1216  Montebello Sandstone, cuts on Pa. Rte. 850 west of Dromgold, Pa. (Ellison Section 3, Unit 11), gray fine-grained sandstone
Pacificocoelia Community

0944 Bakoven Shale, Pacificocoelia Bed at base, Onesquethaw Creek, 2 1/2 miles northwest of Clarksville, Albany Quadrangle, New York, massive black mudstone.

1463 Millboro Fm., north fork of Roanoke River, 1/2 mile northeast of Fagg, Christianburg Quadrangle, Virginia, black shale.
Elytha Community

1004  Tully Limestone, Upper Member, Chamberlain's Quarry, 1 1/2 miles north of Ovid, Ovid Quadrangle, N.Y., dark gray fine bioclastic limestone and micrite

1006  Tully Limestone, Upper Member, falls of Kashong Creek at Bellona, west side Seneca Lake, Geneva Quadrangle, N.Y., dark gray fine bioclastic limestone

1018  Tully Limestone, Upper Member, Tinkers Falls, 3 miles south-southeast of Apulia Station, Tully Quadrangle, N.Y., dark gray micritic limestone

1024  Tully Limestone, Upper Member, Tinselor Hill, 2 1/2 miles northwest of Erieville, Cazenovia Quadrangle, N.Y., dark gray micritic limestone

1027  Tully Limestone, Upper Member, Arab Hill, north end of west side of Deruyter Reservoir, 5 miles north of Deruyter, Cazenovia Quadrangle, N.Y., gray micritic limestone

1032, 1033  Tully Limestone, Upper Member, Muller Creek, 2 1/2 miles north-northwest of Otselic, Cazenovia Quadrangle, N.Y., gray micritic limestone

1037  Tully Limestone, Upper Member, Werners Glen, 1 mile northeast of Georgetown, Morrisville Quadrangle, N.Y., dark gray massive micritic limestone

1038  Tully Limestone, Upper Member, Werners Glen, 1 mile northeast of Georgetown, Morrisville Quadrangle, N.Y., gray siltstone

1040  Tully Limestone, Upper Member, upper beds, 1 mile northwest of Georgetown, Morrisville Quadrangle, N.Y., dark gray coarse limy siltstone

1041  Tully Limestone, Upper Member, middle beds, 1 mile northwest of Georgetown, Morrisville Quadrangle, N.Y., gray micritic limestone

1042  Tully Limestone, Upper Member, lower beds, 1 mile northwest of Georgetown, Morrisville Quadrangle, N.Y., dark gray limy siltstone

1044  Tully Limestone, Upper Member, 1/2 mile south-southwest of South Lebanon, Morrisville Quadrangle, N.Y., dark gray fine-grained limestone

1045  Tully Limestone, Upper Member, first tributary from north into Nigger Hollow, on south slope of Hunts Mountain, 1 1/2 miles south of Sherburne, New Berlin Quadrangle, N.Y., dark gray siltstone
Tully Limestone, Upper Member, West Brook, 3 miles south of Sherburne, New Berlin Quadrangle, N.Y., dark gray micritic limestone

Tully Limestone, Upper Member, lower beds, West Brook, 3 miles south of Sherburne, New Berlin Quadrangle, N.Y., dark gray limy siltstone

Tully Limestone, Upper Member, ravine 1 1/2 miles southwest of Columbus, New Berlin Quadrangle, N.Y., dark gray siltstone

Tully Limestone, Upper Member, ravine 1 mile west of Perrytown, New Berlin Quadrangle, N.Y., gray siltstone

Tully Limestone, Upper Member, ravine just southwest of Perrytown, New Berlin Quadrangle, N.Y., dark gray siltstone

Tully Limestone, Upper Member, Greens Gulf, 1 1/2 miles south-southwest of New Berlin, New Berlin Quadrangle, N.Y., gray siltstone

Tully Limestone, Upper Member, lower beds, Greens Gulf, 1 1/2 miles south-southwest of New Berlin, New Berlin Quadrangle, N.Y., gray siltstone

Tully Limestone, Upper Member, 1476-1481 feet in first south tributary to Stony Creek, 1 1/2 miles south of New Lisbon, Hartwick Quadrangle, N.Y., dark gray siltstone

Tully Limestone, Upper Member, 1482-1488 feet in branch of first south tributary to Stony Creek, 1 1/2 miles south of New Lisbon, Hartwick Quadrangle, N.Y., dark gray siltstone

Tully Limestone, Upper Member, upper beds, branch of first south tributary to Stony Creek, 1 1/2 miles east of New Lisbon, Hartwick Quadrangle, N.Y., dark gray siltstone

Tully Limestone, Upper Member, ravine 1 mile northeast of Laurens, Hartwick Quadrangle, N.Y., dark gray crinoidal limestone and siltstone

Tully Limestone, Upper Member, 1294 feet in ravine on west side of valley, 2 1/2 miles northeast of Morris, Hartwick Quadrangle, N.Y., dark gray siltstone

Tully Member, roadcut on U.S. Rte. 22 parallel to the Juniata River at Amity Hall, Pa. (Ellison Section 6, Unit 2), gray calcareous shale

Tully Member, large borrow pit on south flank of Mahanoy Ridge south of New Bloomfield, Pa. (Ellison Section 5, Unit 2), gray silty claystone

Tully Member, 1/2 mile southeast of New Bloomfield, Pa., highly weathered green-gray mudstone

Tully Member, U.S. Rte. 22, halfway between Losh Run and Halfway, Pa., dark gray mudstone

Tully Member, at bridge at which Pa. Rte. 54 crosses the Susquehanna River, east of Jersey Shore, Pa., dark gray fine-grained limestone
1170 Tully Member, 0.3 mile north of Pennsylvania Railroad bridge at Little Mountain, 3/4 mile south of Marysville, Pa., green-gray shale

1176, 1177 Tully Member, 3.7 miles north of Summit, Pa., green-gray shale and mudstone

1178, 1179 Tully Member, Curtin, Pa., dark gray mudstone and shale and gray fine-grained limestone
Spinatypa Community

1010 Tully Limestone, Upper Member, southern lenticle in quarry 1 1/2 miles southeast of Borodino, Skaneateles Quadrangle, N.Y., gray bioclastic limestone

1009 Tully Limestone, Upper Member, quarry on east side of road, 1 1/2 miles southeast of Borodino, Skaneateles Quadrangle, N.Y., gray crinoidal limestone, flank beds

1011 Tully Limestone, Upper Member, quarry 1 1/2 miles southeast of Borodino, Skaneateles Quadrangle, N.Y., gray crinoidal limestone, flank beds
Tropidoleptus Community

1118  Gilboa Fm., road 1 mile due west of Conesville, Gilboa Quadrangle, N.Y., gray sandstone

1119  Gilboa Fm., cut on N.Y. Rte. 30, 2 miles northeast of Grand Gorge, Gilboa Quadrangle, N.Y., gray sandstone
<table>
<thead>
<tr>
<th>Location</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gilboa Fm., 1650 feet on hill on east side of Schoharie River, 1 1/2 miles north of Gilboa, Gilboa Quadrangle, N.Y.</td>
<td>gray fine-grained sandstone</td>
</tr>
<tr>
<td>Gilboa Fm., Hardenburg Falls, 3 3/4 miles south of Gilboa, Gilboa Quadrangle, N.Y.</td>
<td>dark gray siltstone</td>
</tr>
<tr>
<td>Tully Member, at junction Pa. Rte. 191 and Pa. Rte. 447, 4 miles northwest of Stroudsburg, Pa.</td>
<td>dark gray siltstone</td>
</tr>
</tbody>
</table>
Rhipidothyris Community

1111  Gilboa Fm., cut on road 3 1/2-4 miles east of Ruth, Gilboa Quadrangle, N.Y., gray fine-grained sandstone (may be uppermost Hamilton)

1114  Gilboa Fm., cut on the Manorkill, 1/2 mile east of West Conesville, Gilboa Quadrangle, N.Y., green-gray shale and siltstone
Hypothyridina-Ambocoelid Community

1002, 1003  Tully Limestone, Lower Member, Gage Creek, 2 3/4 miles north-northeast of Rushville, east side Canandaigua Lake, Canandaigua Quadrangle, N.Y., gray micritic and bioclastic limestone

1005  Tully Limestone, Lower Member, Groves Creek, 1 1/2 miles north of Ovid Center, Ovid Quadrangle, N.Y., dark gray fine bioclastic limestone

1007  Tully Limestone, Lower Member, falls of Kashong Creek, Bellona, west side Seneca Lake, Geneva Quadrangle, N.Y., dark gray coarse bioclastic limestone

1008  Tully Limestone, Lower Member, town quarry in Scipio, Auburn Quadrangle, N.Y., gray micritic limestone

1022  Tully Limestone, Lower Member, Junes Quarry and Ravine, 1 mile east-northeast of Tully, Tully Quadrangle, N.Y., gray fine-grained limestone

1021  Tully Limestone, Lower Member, Junes Quarry and Ravine, 1 mile east-northeast of Tully, Tully Quadrangle, N.Y., gray fine-grained limestone

1020  Tully Limestone, Lower Member, Hypothyridina Bed, Junes Quarry, 1 mile east-northeast of Tully, Tully Quadrangle, N.Y., dark gray micritic limestone

1015  Tully Limestone, Lower Member, Tinkers Falls, 3 miles south-southeast of Apulia Station, Tully Quadrangle, N.Y., gray fine-grained limestone

1014  Tully Limestone, Lower Member, Emanuella Bed, Tinkers Falls, 3 miles south-southeast of Apulia Station, Tully Quadrangle, N.Y., gray fine-grained limestone

1012  Tully Limestone, Lower Member, Carrs Quarry, Onondaga County, Tully Quadrangle, N.Y., dark gray fine bioclastic limestone

1034  Tully Limestone, Lower Member, 2 miles north of Otselic, Cazenovia Quadrangle, N.Y., dark gray fine bioclastic limestone

1035  Tully Limestone, Lower Member, Muller Creek, 2 1/2 miles north-northwest of Otselic, Cazenovia Quadrangle, N.Y., dark gray fine bioclastic limestone

1036  Tully Limestone, Lower Member, Muller Brook, northwest corner of Norwich Quadrangle, N.Y., gray fine bioclastic limestone

1049  Tully Limestone, basal oolite, 3 miles south of Sherburne, New Berlin Quadrangle, N.Y., dark gray oolitic limestone


1165  Tully Member, bank of Little Fishing Creek, 1 1/2 miles northwest of Bloomsburg, Pa., dark gray shale
Tully Member, *Echinocoeilia* Bed, Reading Railroad cut 1/2 mile northwest of Auburn, Pa., dark gray massive siltstone

Tully Member, 1/2 mile northwest of Eyers Grove, Hughesville Quadrangle, Pa., gray siltstone

Tully Member, *Echinocoeilia* Bed, 0.3 miles north of Pennsylvania Railroad bridge, 3/4 mile south of Marysville, in Little Mountain, Pa., tan siltstone

Tully Member, cuts on Pa. Rte. 5 in Perry County, Pa., gray mudstone

Tully Member, pit on south flank of Mahanoy Ridge, Pa. (Ellison Section 5, Unit 3), deeply weathered dark yellow-brown highly clayey siltstone

Tully Member, 1/2 mile southeast of New Bloomfield, Pa., highly weathered gray mudstone

Tully Member, roadcuts on U.S. Rte. 22 on southwestern side of the Juniata River, opposite Huntington, Pa. (Ellison Section 16, Unit 2), gray silty shale

Tully Member, exposure on east side of the Juniata River, opposite Losh Run, Pa., dark gray siltstone

Tully Member, opposite north end of bridge over Susquehanna River, on north side of the river, Lockhaven, Pa., dark gray silty shale

Tully Member, cuts on U.S. Rte. 220, 0.8 miles south of Newry, Bald Eagle Valley, Pa. (Ellison Section 18, Unit 1), gray shaly limestone

Tully Member, cuts on Pa. Turnpike west of interchange at Bedford, Pa. (Ellison Section 14, Unit 2), gray calcareous shale

Tully Member, cuts on Pa. Turnpike west of interchange at Bedford, Pa. (Ellison Section 14, Unit 2), gray calcareous shale
Rhyssochonetes Community

1016, 1017  Tully Limestone, Lower Member, Tinkers Falls, 3 miles south-southeast of Apulia Station, Tully Quadrangle, N.Y., dark gray fine bioclastic limestone

1023  Tully Limestone, Lower Member, lower beds, Junes Quarry and Ravine, 1 mile east-northeast of Tully, Tully Quadrangle, N.Y., gray coarse bioclastic limestone

1025  Tully Limestone, Lower Member, 2 1/2 miles south-southwest of Fabius, Cazenovia Quadrangle, N.Y., dark gray limestone

1026  Tully Limestone, Lower Member, Spicers Gulf, Cuyler, Cazenovia Quadrangle, N.Y., light gray fine bioclastic limestone

1028  Tully Limestone, Lower Member, east branch Tioughnioga River, 3 miles northwest of Deruyter, Cazenovia Quadrangle, N.Y., gray limestone

1031  Tully Limestone, Lower Member, 1 1/2 miles northwest of Deruyter, Cazenovia Quadrangle, N.Y., gray fine bioclastic limestone

1051  Tully Limestone, Basal Upper Member, West Brook 3 miles south of Sherburne, New Berlin Quadrangle, N.Y., dark gray fine-grained limestone
Leiorhynchus Community

1058, 1059  Lower Gilboa Fm., 1405-1427 feet in ravine 1 3/4 miles east-northeast of Pittsfield,
            New Berlin Quadrangle, N.Y., dark gray siltstone and fine-grained sandstone

1071, 1072  Lower Gilboa Fm., roadside quarry, 1.1 miles east-northeast of New Lisbon,
            Hartwick Quadrangle, N.Y., gray fine-grained sandstone

1084, 1085  Tully Limestone, Upper Member, ravine 1 mile north-northwest of Stetsonville,
            Hartwick Quadrangle, N.Y., dark gray siltstone

1097  Gilboa Fm., Camarotoechia bed at base of section, Woods Ravine, 1 mile east of
       Portlandville, Cooperstown Quadrangle, N.Y., dark gray sandy siltstone

1108  Gilboa Fm., 0.7 miles south-southwest of Summit, Richmondville Quadrangle, N.Y.,
       dark gray siltstone
**Mucrospirifer Community**

1039  Gilboa Fm., Werners Glen, 1 mile northeast of Georgetown, Morrisville Quadrangle, N.Y.,
dark gray fine bioclastic limestone

1043  Gilboa Fm., 1 mile northwest of Georgetown, Morrisville Quadrangle, N.Y., gray fine
bioclastic limestone

1057  Gilboa Fm., ravine 3/4 mile south-southeast of Pittsfield, New Berlin Quadrangle, N.Y.,
gray fine-grained sandstone

1070  Gilboa Fm., first Hypothyridina bed, roadside quarry 1.1 miles east-northeast of New Lisbon,
Hartwick Quadrangle, N.Y., gray siltstone

1069  Gilboa Fm., just above first Hypothyridina bed, first south tributary to Stony Creek,
Hartwick Quadrangle, N.Y., gray sandy siltstone

1067, 1068  Gilboa Fm., second Hypothyridina bed, first south tributary to Stony Creek,
Hartwick Quadrangle, N.Y., dark gray siltstone

1066  Gilboa Fm., just above second Hypothyridina bed, first south tributary to Stony Creek,
1 1/2 miles east of New Lisbon, Hartwick Quadrangle, N.Y., gray siltstone

1065  Gilboa Fm., third Hypothyridina bed, first south tributary to Stony Creek, 1 1/2 miles east
of New Lisbon, Hartwick Quadrangle, N.Y., dark gray sandy siltstone

1064  Gilboa Fm., 1455 feet in first south tributary to Stony Creek, Hartwick Quadrangle, N.Y.,
gray siltstone

1078  Gilboa Fm., near base, Houghtalings Glen, 1 1/2 miles northeast of Laurens, Hartwick
Quadrangle, N.Y., gray fine-grained sandstone

1076, 1077  Gilboa Fm., 5-6 feet above base, Houghtalings Glen, 1 1/2 miles northeast of Laurens,
Hartwick Quadrangle, N.Y., dark gray siltstone

1074  Gilboa Fm., 43-48 feet above base, Houghtalings Glen, 1 1/2 miles northeast of Laurens,
Hartwick Quadrangle, N.Y., dark gray siltstone

1073  Gilboa Fm., 73 feet above base, Houghtalings Glen, 1 1/2 miles northeast of Laurens,
Hartwick Quadrangle, N.Y., brown fine-grained sandstone

1081, 1082  Gilboa Fm., Echinocoelia bed, ravine 1 mile east of Laurens, Hartwick Quadrangle,
N.Y., dark gray sandy siltstone

1083  Gilboa Fm., 16 feet above Echinocoelia bed, ravine 5 miles northeast of Laurens, Hartwick
Quadrangle, N.Y., dark gray siltstone

1103  Gilboa Fm., 1569 feet in ravine just south of Schenevus, Cooperstown Quadrangle, N.Y.,
dark gray siltstone

1102  Gilboa Fm., 2 feet below Hypothyridina bed, ravine just south of Schenevus, Cooperstown
Quadrangle, N.Y., gray fine-grained sandstone
Gilboa Fm., *Hypothyridina* bed, 1609 feet in ravine just south of Schenevus, Cooperstown Quadrangle, N.Y., dark gray sandy siltstone

Gilboa Fm., Crandalls, east side of Goodyear Lake, 1 1/4 miles southwest of Portlandville, Cooperstown Quadrangle, N.Y., gray fine-grained sandstone

Gilboa Fm., "storm-roller" bed at 1838-1852 feet in Strong Ravine, 3 miles southwest of Westville, Cooperstown Quadrangle, N.Y., gray fine-grained sandstone

Gilboa Fm., 21-27 feet above "storm-roller" bed, Strong Ravine, 3 miles southwest of Westville, Cooperstown Quadrangle, N.Y., dark gray siltstone

Gilboa Fm., Strong Ravine, 3 miles southwest of Westville, Cooperstown Quadrangle, N.Y., gray fine-grained sandstone

Gilboa Fm., on road at head of Strong Ravine, 3 miles southwest of Westville, Cooperstown Quadrangle, N.Y., gray fine-grained sandstone

Gilboa Fm., Woods Ravine, 1 mile east of Portlandville, Cooperstown Quadrangle, N.Y., gray fine-grained sandstone

Gilboa Fm., *Hypothyridina* bed at 1530 feet in woods Ravine, 1 mile east of Portlandville, Cooperstown Quadrangle, N.Y., dark gray sandstone

Gilboa Fm., 20 feet below *Hypothyridina* bed, ravine 3/4 mile southwest of Chaseville, Cooperstown Quadrangle, N.Y., gray siltstone

Gilboa Fm., ravine 3/4 mile southwest of Chaseville, Cooperstown Quadrangle, N.Y., gray fine-grained sandstone

Gilboa Fm., west side Goodyear Lake, 1 1/2 miles south of Milford Center, Cooperstown Quadrangle, N.Y., gray siltstone

Gilboa Fm., 4 feet above upper *Hypothyridina* bed, west side of Goodyear Lake, 1 1/2 miles south of Milford Center, Cooperstown Quadrangle, N.Y., gray siltstone

Gilboa Fm., Summit Hill, 1 mile north-northeast of Summit, Richmondville Quadrangle, N.Y., dark gray siltstone

Gilboa Fm., 0.7 miles west of Baldwin Road, 2 1/2 miles south-southwest of Summit, Richmondville Quadrangle, N.Y., gray siltstone

Gilboa Member, 1885-1900 feet in ravine 2 3/4 miles east of South Worcester, Richmondville Quadrangle, N.Y., gray fine-grained sandstone

Gilboa Fm., 1843-1848 feet in ravine 2 3/4 miles east of South Worcester, Richmondville Quadrangle, N.Y., gray fine-grained sandstone
Orthospirifer Community

1104 Gilboa Fm., near base, "storm-roller" bed, 40-45 feet above Pustulatia Bed of Moscow, ravine just south of Schenevus, Cooperstown Quadrangle, N.Y., gray fine-grained sandstone

1100 Gilboa Fm., 8 feet above Hypothyridina bed in ravine just south of Schenevus, Cooperstown Quadrangle, N.Y., dark gray siltstone

1112 Gilboa Fm., quarry in Stevens Mountain, p.8 mile east of Gilboa, Gilboa Quadrangle, N.Y., dark gray siltstone and fine-grained sandstone

1115, 1116 Gilboa Fm., road section at intake building on Schoharie Reservoir, 3 miles south of Gilboa, Gilboa Quadrangle, N.Y., dark gray sandstone with conglomerate beds

1120 Gilboa Fm., 1/2 mile west of North Blenheim, Gilboa Quadrangle, N.Y., gray fine-grained sandstone

1121 Gilboa Fm., 1616 feet in ravine 3/4 mile southeast of North Blenheim, Gilboa Quadrangle, N.Y., gray fine-grained sandstone
**Cyrtina-Athyris Community**

1799, 1800, 1801  **Lower Bell Shale**, channels in Rogers City Limestone, Michigan Limestone and Chemical Co. Quarry, SE 1/2 23, T. 35 N. R. 5 E., Rogers City, Presque Isle County, Mich.  (Cooper Nos. 31C, 31G), gray calcareous shale

1802, 1803, 1804, 1805, 1806  **Upper Bell Shale**, dumps along railroad at Michigan Limestone and Chemical Co. Quarry, SE 1/4, 23 T. 35 N. R. 5 E., Rogers City, Presque Isle County, Mich.  (Cooper Nos. 31H, 31I), gray calcareous shale

1812, 1813, 1814, 1815, 1816  **Basal Rockport Quarry Limestone**, Rockport Quarry, NW 1/4 6, T. 32 N., R. 9 E., Alpena County, Mich.  (Cooper No. 38B), gray calcareous shale, fossils appear weathered, possibly reworked from Bell Shale

1817  **Rockport Quarry Limestone**, cut on U.S. Rte. 23, 5.25 miles south of road to Posen, on west side Grand Lake, Presque Isle County, Mich.  (Cooper No. 28F), dark gray shale

1829  **Ferron Point Shale**, cut on U.S. Rte. 23, 1.75 miles east of D&M Railroad crossing, E. 16, T. 36 N., R. 6 E., southeast of Rogers City, Presque Isle County, Mich.  (Cooper No. 30C), gray calcareous shale

1830, 1831, 1832, 1833, 1834, 1835, 1836  **Ferron Point Shale**, west wall of Rockport Quarry, NW 1/4 6, T. 32 N., R. 9 E., Alpena County, Mich.  (Cooper No. 38E), gray calcareous shale

1837, 1838, 1839  **Ferron Point Shale**, Rockport Quarry, NW 1/4 6, T. 32 N., R. 9 E., Alpena County, Mich.  (Cooper No. 38F), gray calcareous shale

1840, 1841  **Ferron Point Shale**, sinkhole in Adams Point Quarry, 21, T. 35 N. R. 6 E., Presque Isle County, Mich.  (Cooper No. 38G), gray calcareous shale

1842, 1843, 1844, 1845  **Ferron Point Shale**, Onaway Limestone Quarry, south end of Black Lake, NW1/4 SW 1/4 sec. 7, T. 35 N., R. 2 E., Presque Isle County, Mich.  (Cooper No. 29A), gray calcareous shale

1846  **Ferron Point Shale**, shale thrown out of basement of house, NW 1/4 sec. 26, T. 35 N., R. 1 E., Cheboygan County, Mich.  (Cooper No. 29C), gray calcareous shale

1847, 1848, 1849, 1850  **Ferron Point Shale**, upper beds, Rockport Quarry, NW 1/4 Sec. 6, T. 32 N., R. 9 E., Alpena County, Mich.  (Cooper No. 38C), gray calcareous shale

1858, 1859  **Lower Genshaw Fm.**, road ditch on center north line Sec. 30, T. 35 N., R. 1 W., 2 1/4 miles north-northeast of Afton, Cheboygan County, Mich.  (Cooper No. 25A), gray limestone

1860, 1861  **Lower Genshaw Fm.**, top of hill near center Sec. 34, T. 35 N., R. 1 E., 1.5 miles north of U.S. Rte. 23 in Tower, Cheboygan County, Mich.  (Cooper No. 28D), gray limestone
Lower Genshaw Fm., cut on U.S. Rte. 23, 1/4 mile east of bridge over Rainy River at Tower, SE 1/4 SE 1/4 Sec. 26, T. 35 N., R. 2 E., Cheboygan County, Mich. (Cooper No. 28E), gray limestone

Lower Genshaw Fm., quarry at El Cajon Beach, NW 1/4 NE 1/4 Sec. 10, T. 31 N., R. 9 E., Alpena County, Mich. (Cooper No. 49), gray limestone

Lower Genshaw Fm., 1/2 mile south of Genshaw School, on section line 1/2 mile south of NW corner Sec. 19, T. 32 N., R. 9 E., Alpena County, Mich. (Cooper No. 51 C), gray limestone

Lower Genshaw Fm., cut on French Road, 1/4 mile south of NE corner Sec. 8, T. 32 N., R. 8 E., Alpena County, Mich. (Cooper No. 52A), gray limestone

Lower Genshaw Fm., just below Killians, cut on French Road, 1/2 mile south of NE corner Section 8, T. 32 N., R. 8 E., Alpena County, Mich. (Cooper No. 52C), gray limestone

Lower Genshaw Fm., roadside ditch at south end Long Lake, NE 1/4 Sec. 22, T. 32 N., R. 8 E., 6.5 miles north of Alpena, Alpena County, Mich. (Cooper No. 52H), gray limestone

Lower Genshaw Fm., ditch along Long Lake Road, NE 1/4 NE 1/4 Sec. 22, T. 32 N., R. 8 E., Alpena County, Mich. (Cooper No. 52H'), gray limestone

Lower Genshaw Fm., just upstream from bridge over Long Lake Creek, SW 1/4 NW 1/4 Sec. 23, T. 32 N., R. 8 E., Alpena County, Mich. (Cooper No. 521A), gray limestone

Lower Genshaw Fm., sink in west wall of Rockport Quarry, NW 1/4 Sec. 6, T. 32 N., R. 9 E., Alpena County, Mich. (Cooper No. 52M), gray limestone

Lower Genshaw Fm., new road at south end of Long Lake, 0.4 mile north of junction with U.S. Rte. 23, SE 1/4 NE 1/4 Sec. 22, T. 32 N., R. 8 E., Alpena County, Mich. (Cooper No. 52T), gray limestone

Genshaw Fm., Killians Member, cut on U.S. Rte. 23, 1 1/4 miles west of Tower, north line section 9, T. 34 N., R. 1 E., Cheboygan County, Mich. (Cooper No. 28A), gray limestone

Genshaw Fm., Killians Member, cut on west side U.S. 23 at south line of Posen, SE 1/4 NE 1/4 Sec. 16, T. 32 N., R. 6 E., Posen Township, Presque Isle County, Mich. (Cooper No. 33F), gray limestone

Genshaw Fm., Killians Member, 1/2 mile south of NE corner Sec. 25, T. 32 N., R. 9 E., on Wessel Road, Alpena County, Mich. (Cooper No. 50), gray limestone

Genshaw Fm., Killians Member, cuts on both sides of Presque Isle County Road 640, 0.2-0.3 mile north of Alpena County line, SW 1/4 Sec. 32, T. 33 N., R. 6 E., Mich. (Cooper No. 97), gray limestone
1909, 1910, 1911  Genshaw Fm., Killians Member, Cyrtina bed, Presque Isle County Road 634, 1/4 mile north of Alpena County line, SE 1/4 Sec. 31, T. 33 N., R. 8 E., Mich. (Cooper No. 82), gray limestone

1912  Genshaw Fm., basal Killians Member, Presque Isle County Road 634, 50 yards south of Alpena County line, Mich. (Cooper No. 98), gray limestone

1913, 1914, 1915  Genshaw Fm., lower Killians Member, Presque Isle County Road 634, 100 yards north of Alpena County line, E 1/2 Sec. 31, T. 33 N., R. 8 E., Mich. (Cooper No. 82), gray limestone

1916, 1917  Genshaw Fm., Killians Member, Presque Isle County Road 634, 1 mile west of Leroy, NE 1/4 Sec. 36, T. 33 N., R. 7 E., Mich. (Cooper No. 116), gray limestone

1918, 1919  Genshaw Fm., Killians Member, junction of French and Long Lake Roads, NE 1/4 NE 1/4 Sec. 8, T. 32 N., R. 8 E., Alpena County, Mich. (Cooper No. 52N), gray limestone

1921  Genshaw Fm., Killians Member, cellar in SW 1/4 SE 1/4 Sec. 3, T. 33 N., R. 6 E., Posen Township, Presque Isle County, Mich. (Cooper No. 33), gray limestone

1922, 1923  Genshaw Fm., Killians Member, 1 mile north and 0.75 mile west of Posen, middle of south line of SW 1/4 Sec. 4, T. 33 N., R. 6 E., Presque Isle County, Mich. (Cooper No. 33B), black limestone

1924  Genshaw Fm., Killians Member, bend of Presque Isle County Road 634, SW 1/4 NW 1/4, Sec. 32, T. 33 N., R. 8 E., Presque Isle County, Mich. (Cooper No. 82), black limestone

1925  Genshaw Fm., Killians Member, SW 1/4 NE 1/4, Sec. 36, T. 33 N., R. 7 E., just southwest of Leroy, Presque Isle County, Mich. (Cooper No. 116), black limestone

1926, 1927  Upper Genshaw Fm., Athyris bed, NW corner Sec. 4, T. 33 N., R. 6 E., 1 mile west and two miles north of Posen, Presque Isle County, Mich. (Cooper No. 33A), gray limestone

1928  Upper Genshaw Fm., Athyris bed, 1 mile north and 1 mile west of Posen, NE corner Sec. 8, T. 33 N., R. 6 E., Presque Isle County, Mich. (Cooper No. 33A), gray limestone

1929  Upper Genshaw Fm., SE 1/4 Sec. 26, T. 32 N., R. 8 E., Alpena County, Mich. (Cooper No. 52P), gray limestone

1931  Alpena Limestone, lower limestone, Huron Portland Cement Co. Quarry, SW 1/4, Sec. 13, T. 31 N., R. 8 E., Alpena County, Mich. (Cooper No. 40C), gray limestone

1932, 1933, 1934, 1935, 1936  Alpena Limestone, middle shale, roadcuts 1/4 mile east of NW corner Sec. 8, T. 33 N., R. 6 E., 1 mile north and 2 miles west of Posen, Presque Isle County, Mich. (Cooper No. 33G), gray calcareous shale

1937, 1938  Alpena Limestone, middle shale, Huron Portland Cement Co. Quarry, SW 1/4 Sec. 13, T. 31 N., R. 8 E., Alpena County, Mich. (Cooper No. 40C), gray calcareous shale
1940, 1941  Alpena Limestone, upper reefal limestone, Huron Portland Cement Co. Quarry, SW 1/4 Sec. 13, T. 31 N., R. 8 W., Alpena County, Mich. (Cooper No. 40D), gray limestone

1950, 1951, 1952  Norway Point Fm., south bank of Thunder Bay River, 3/4 mile downstream from Four Mile Dam, S center Sec. 31, T. 8 N., R. 7 E., Alpena County, Mich. (Cooper No. 46), gray limestone

1953, 1954  Gravel Point Fm., shore of Lake Michigan, 2-2 1/2 miles west of Charlevoix, at Gravel Point, NW 1/4 Sec. 28, NE 1/4 Sec. 29, T. 34 N., R. 8 W., Charlevoix County, Mich. (Cooper No. 8), gray limestone


1964, 1965, 1966  Gravel Point Fm., lower blue shale, Bell Quarry, 2.3 miles east of Bayshore, NW 1/4 Sec. 9, T. 34 N., R. 6 W., Emmet County, Mich. (Cooper No. 14E), gray calcareous shale

1967, 1968, 1969  Gravel Point Fm., upper blue shale, Charlevoix Rock Products Co. Quarry, SE 1/4 Sec. 29, T. 34 N., R. 8 W., 2 miles west of Charlevoix, Charlevoix County, Mich. (Cooper No. 9B), gray calcareous shale

1970, 1971, 1972, 1973  Gravel Point Fm., upper blue shale, Bell Quarry, 2.3 miles east of Bayshore, NW 1/4 NE 1/4 Sec. 9, T. 35 N., R. 6 W., Emmet County, Mich. (Cooper No. 14E'), gray calcareous shale


1978  Gravel Point Fm., upper blue shale, Antrim Lime Co. Quarry, SE 1/4 Sec. 1, T. 34 N., R. 6 W., near Petoskey, Emmet County, Mich. (Cooper No. 17), gray calcareous shale

1979-1980  Gravel Point Fm., upper blue shale, Bayview, on lake shore east of Petoskey, opposite Pennsylvania Railroad Station, NE 1/4 Sec. 32, T. 35 N., R. 5 W., Emmet County, Mich. (Cooper No. 18A), gray calcareous shale

1984  Beebe School Fm., grounds of Beebe School, Sec. 14, T. 34 N., R. 2 W., Cheboygan County, Mich. (Cooper No. 22A), gray limestone

1994, 1995  Petoskey Fm., upper beds in quarry at Mud Lake (Kegonic Quarry), 1 1/2 miles northeast of Bayview, NW 1/4 Sec. 34, T. 35 N., R. 5 W., Emmet County, Mich. (Cooper No. 21), gray limestone

1996  Gravel Point Fm., upper blue shale, north line section 8, T. 34 N., R. 6 W., 0.3 mile east of north-south line between sections 5 and 6, 3 miles east of Bayshore, Emmet County, Mich. (Cooper No. 7K), gray calcareous shale

1998  Silica Fm., May Stone Co. Quarry, near Woodburn, NE 1/4 Sec. 23, T. 31 N., R. 14 E., Ind., gray micrite and fine bioclastic limestone

2000  Silica Fm., Midwest Aggregate Co. Quarry, 3 miles west of Waynedale, Sec. 36, T. 30 N., R. 11 E., southwest of Fort Wayne, Ind., light gray bioclastic limestone

1877, 1878, 1879  Lower Genshaw Fm., Alpena Portland Cement Co. shale pit, SE 1/4 Sec. 18, T. 32 N., R. 9 E., Alpena County, Mich. (Cooper No. 51B), gray limestone

1943, 1944, 1945  Lower Norway Point Fm., south bank of Thunder Bay River at Four Mile Dam, center S 31, T. 8 N., R. 7 F., Alpena County, Mich. (Cooper No. 46A), gray limestone overlying reef in Four Mile Dam Limestone
Camarotoechia Community

1658  Silica Fm., Berkey Member, Medusa Portland Cement Co. Quarry, NE 1/4 SE 1/4 Sec. 7, T. 45, R. 6 E., 2.5 miles southwest of Sylvania, Ohio, gray calcareous shale

1659  Silica Fm., Berkey Member, bank of Ten Mile Creek, 3 miles southwest of Sylvania, Ohio, gray calcareous shale

1664  Drift Boulder, Locklin Gravel Pit, Northville, Mich., gray calcareous shale
Arypid-Gypidulinid Community

1818, 1821 Rockport Quarry Limestone, cut on U.S. Rte. 23, 5 mile southeast of junction with
Posen Road, west side of Grand Lake, NE ¼ NW ¼ Sec. 24, T. 34 N., R. 6 E., Presque Isle County, Mich. (Cooper Nos. 28G, 30E), gray to black limestone

1819, 1820 Rockport Quarry Limestone, cut on U.S. Rte. 23, just southwest of Grand Island, west side of Grand Lake, SE ¼ SW ¼ Sec. 31, T. 34 N., R. 8 E., Presque Isle County, Mich. (Cooper No. 28H), dark gray to black limestone

1822, 1823, 1824 Rockport Quarry Limestone, dumps at Michigan Limestone and Chemical Co. Quarry, SE ¼, Sec. 23, T. 25 N., R. 5 E., Rogers City, Presque Isle County, Mich. (Cooper No. 31I), gray limestone

1825, 1826, 1827 Rockport Quarry Limestone, Rockport Quarry, SW ¼ Sec. 6, T. 32 N., R. 9 E., Alpena County, Mich. (Cooper Nos. 38C, 38D), gray to black limestone

1828 Rockport Quarry Limestone, cut on U.S. Rte. 23, 4.45 miles east of D.&M. Railroad, Presque Isle County, Mich. (Cooper No. 80B), black limestone

1863 Lower Genshaw Fm., bank of Rainy River, near center of south line, Sec. 26, T. 35 N., R. 2 E., Presque Isle County, Mich. (Cooper No. 29D), gray limestone

1864 Lower Genshaw Fm., NE ¼ NE ¼ Sec. 12, T. 33 N., R. 6 E., Presque Isle County, Mich. (Cooper No. 30D), gray limestone

1865, 1866 Lower Genshaw Fm., SE 1/4 28 and NE 1/4 Sec. 33, T. 34 N., R. 6 E., 3 miles north of Posen on Mich. Rte. 65, Presque Isle County, Mich. (Cooper No. 33), gray limestone

1867 Lower Genshaw Fm., cut on north-south road, SW 1/4 NW 1/4 Sec. 9, T. 34 N., R. 5 E., Belknap Township, Presque Isle County, Mich. (Cooper No. 33), gray limestone

1868 Lower Genshaw Fm., NW 1/4 NW 1/4 Sec. 12, T. 33 N., R. 6 E., 2 miles east of U.S. Rte. 23, 1 mile north of Posen, Presque Isle County, Mich. (Cooper No. 33D), gray limestone

1869, 1870, 1871, 1872, 1873 Lower Genshaw Fm., Rabiteau Farm, Preswue Isle County Road 405, east side of road, NW 1/4 NW 1/4 Sec. 35, T. 33 N., R. 8 E., 0.8 miles north of Alpena County line, Mich. (Cooper No. 38H), gray limestone

1885 Lower Genshaw Fm., 1/2 mile south of NE 1/4 Sec. 8, T. 32 N., R. 8 E., cut on French Road, Alpena County, Mich. (Cooper No. 52B), gray limestone

1901 Lower Genshaw Fm., bed of Swan Creek and cut on U.S. Rte. 23, 0.1 mile to east of creek, center N 1/2 NW 1/4 Sec. 17, T. 34 N., R. 6 E., just east of railroad, Presque Isle County, Mich. (Cooper No. 77), gray limestone
1902  Lower Genshaw Fm., cut on U.S. Rte. 23, 2.6 miles north of Alpena County line, NE 1/4 Sec. 29, T. 8 N., R. 33 E., northeast corner of Long Lake, Presque Isle County, Mich.  (Cooper No. 520), gray limestone

1906  Genshaw Fm., Killians Member, cut on Presque Isle County Road 451 5 miles south of Rogers City, 3 miles west and 1.5 miles north of Hegensville, at SE 1/4 NE 1/4 Sec. 8, T. 34 N., R. 5 E., Mich.  (Cooper No. 33H), gray limestone

1920  Genshaw Fm., Killians Member, below dam on Black River, 1/4 mile east of railroad station at Tower, NW 1/4 SW 1/4 Sec. 3, T. 33 N., R. 1 E., Cheboygan County, Mich.  (Cooper No. 28), gray limestone

1930  Alpena Limestone, lower limestone, cut on west side of Long Lake Road, SE 1/4 NE 1/4 Sec. 27, T. 32 N., R. 8 E., 0.6 mile north of Town Hall School, 5 miles north of Alpena, Alpena County, Mich.  (Cooper No. 52J), gray limestone

1939  Alpena Limestone, middle shale, quarry 1 1/2 miles west of Bolton, SE 1/4 SW 1/4 Sec. 5, T. 32 N., R. 7 E., Alpena County, Mich.  (Cooper No. 52L), gray calcareous shale

1946, 1947, 1948, 1949  Lower Norway Point Fm., Norway Point Dam (Seven Mile Dam), south side of Thunder Bay River, NE 1/4 Sec. 12, T. 31 N., R. 7 E., Alpena County, Mich.  (Cooper Nos. 47A, 47C), gray limestone

1962-1963  Gravel Point Fm., lower blue shale, Petoskey Portland Cement Co. Quarry, 2 miles west of Petoskey, on lake shore, SW 1/4 Sec. 42, T. 34 N., R. 6 W., Emmet County, Mich.  (Cooper No. 14G), gray calcareous shale

1981  Charlevoix Limestone, quarry of Charlevoix Rock Products Co. (No. 1 Quarry), 1 mile west of Charlevoix, near center SE 1/4 Sec. 28, T. 34 N., R. 8 W., Charlevoix County, Mich.  (Cooper No. 9), light gray limestone

1982  Charlevoix Limestone, Curtis Quarry and shore of Lake Michigan, Bayshore, Sec. 6, T. 34 N., R. 6 W., Emmet County, Mich.  (Cooper No. 13B), light gray limestone

1983  Charlevoix Limestone, Northern Line Co. Quarry, just north of Pennsylvania Railroad Station, Bayshore, NE 1/4 Sec. 32, T. 35 N., R. 5 W., Emmet County, Mich.  (Cooper No. 18), light gray limestone

1992, 1993  Petoskey Limestone, road cut at junction Mich. Rte. 131 and U.S. Rte. 31, at Mud Lake, 1 mile east-northeast of Bayview, NW 1/4 NW 1/4 Sec. 34, T. 35 N., R. 5 W., Emmet County, Mich.  (Cooper No. 21A), gray limestone
Longispina Community

1818, 1821  Rockport Quarry Limestone, black shale lenses, cut on U.S. Rte. 23, 5 miles southeast of junction with Posen Road, west side of Grand Lake, NE 1/4 NW 1/4 Sec. 24, T. 34 N., R. 6 E., Presque Isle County, Mich. (Cooper Nos. 28G, 30E), black shale lenses

1822, 1823, 1824  Rockport Quarry Limestone, black shale lenses, dumps at Michigan Limestone and Chemical Co. Quarry, SE 1/4 Sec. 23, T. 25 N., R. 5 E., Rogers City, Presque Isle County, Mich. (Cooper No. 31I), black shale lenses

1825, 1826, 1827  Rockport Quarry Limestone, black shale lenses, Rockport Quarry, SW 1/4 Sec. 6, T. 32 N., R. 9 E., Alpena County, Mich. (Cooper Nos. 38C, 38D), black shale lenses

1828  Rockport Quarry Limestone, black shale lenses, cut on U.S. Rte. 23, 4.45 miles east of D. & M. Railroad, Presque Isle County, Mich. (Cooper No. 80B), black shale lenses
Devonochoonetes Community

1807, 1808, 1809, 1810, 1811 Bell Shale, upper 12 feet, Rockport Quarry, NW 1/4 Sec. 6, T. 32 N., R. 9 E., Alpena County, Mich. (Cooper No. 38A), gray calcareous shale

1851, 1852, 1853, 1854, 1855, 1856, 1857 Upper Ferron Point Shale, Alpena Portland Cement Co. shale pits, SE 1/4 Sec. 18, T. 32 N., R. 9 E., Alpena County, Mich. (Cooper Nos. 51, 51A), gray calcareous shale

1904 Genshaw Fm., Killians Member, center of N line NW 1/4 Sec. 7, T. 33 N., R. 7 E., Krakow Township, Presque Isle County, Mich. (Cooper No. 33C), gray limestone

1997 Silica Fm., Brint Road Member?, Martin-Marietta Quarry, Milan, Mich., gray calcareous shale

1999 Silica Fm., May Stone Co., Ardmore Quarry, 2 1/2 miles west of Waynedale, NW 1/4 Sec. 29, T. 30 N., R. 12 E., southwest of Fort Wayne, Ind., gray-tan bioclastic limestone

1667, 1668, 1669, 1670, 1671, 1672 Silica Fm., blue limestone at base of Brint Road Member, NE 1/4 SE 1/4 Sec. 7, T. 9 S., R. 6 E., Medusa Portland Cement Co. Quarry, 2 1/2 miles southwest of Sylvania, Ohio, gray bioclastic limestone

1673, 1674, 1675, 1676, 1677, 1678 Silica Fm., Brint Road Member, Protoleptostrophia bed, Medusa Portland Cement Co. Quarry, NE 1/4 SE 1/4 Sec. 7, T. 9 S., R. 6 E., 2 1/2 miles southwest of Sylvania, Ohio, gray calcareous shale

1679, 1680, 1681, 1682, 1683, 1684 Silica Fm., Brint Road Member, Paraspirifer bed, Medusa Portland Cement Co. Quarry, NE 1/4 SE 1/4 Sec. 7, T. 9 S., R. 6 E., 2 1/2 miles southwest of Sylvania, Ohio, gray calcareous shale

1685, 1686, 1687 Silica Fm., Brint Road Member, Rhipidomella bed, Medusa Portland Cement Co. Quarry, NE 1/4 SE 1/4 Sec. 7, T. 9 S., R. 6 E., 2 1/2 miles southwest of Sylvania, Ohio, gray calcareous shale

1532 "Hamilton," on Deer Creek, 1/2 mile east of Delphi, Ind., sandy limestone
Rhipidothryis Community

1660 Silica Fm., Berkey Member, Aulocystis bioherm, north quarry, Medusa Portland Cement Co.
NE 1/4 SE 1/4 Sec. 7, T. 9 S., R. 6 E., 2 1/2 miles southwest of Sylvania, Ohio, gray calcareous shale
Cupularostrum Community

1942 Basal Norway Point Fm., above disconformity, junction of French and Hamilton Roads, NW 1/4 Sec. 9, T. 31 N., R. 8 E., parallel to D.& L. Railroad, Alpena County, Mich. (Cooper No. 52F), gray limestone, silicified fossils
Stringocephalus Community

1825, 1826  Miami Bend Limestone, France Stone Co. Quarry, 2 miles east of Logansport city limits, west U.S. Rte. 24, SW 1/4 NW 1/4 Sec. 27, T. 27 N., R. 2 E., Cass County, Ind., light gray coarse to darker gray fine-grained limestone
Subrenaslandia Community

1527 Miami Bend Limestone, Fry Farm, east side Cass Station Road, 0.35 mile east of junction with U.S. Rte. 24, Cass County, Ind., light gray coarse bioclastic limestone

1528, 1529 Miami Bend Limestone, outcrop 150 feet west of Pottawatomie Point Road, 1/4 mile south of junction with U.S. Rte. 24, 1.3 miles east of Logansport, NE 1/4 SE 1/4 Sec. 28, T. 27 N., R. 2 E., Cass County, Ind., light gray coarse bioclastic limestone
Spiriferid-Atypid Community

1705  Solon Limestone, *Independensis* Bed, quarry at west edge of Solon, Johnson County, Iowa, gray limestone

1706  Solon Limestone, *Independensis* Bed, 1/2 mile north and 200 yards east of Lafayette, Iowa, gray limestone

1707  Solon Limestone, *Independensis* Bed, N 1/2 Sec. 5, T. 84 N., R. 7 W., Monroe Township, Linn County, Iowa, gray limestone

1708  Solon Limestone, *Independensis* Bed, Judge Nichols Quarry, S 1/2 section 10, 1 1/2 miles northeast of Vinton, Iowa, gray limestone

1709  Solon Limestone, *Independensis* Bed, 300 yards east of Alice, NW 1/4 Sec. 8, T. 85 N., R. 7 W., Otter Creek Township, Iowa, gray limestone

1710  Solon Limestone, *Independensis* Bed, N line 10, T. 88 N., R. 9 W., Summer Township, 1 mile southeast of Independence, Iowa, gray limestone

1711  Solon Limestone, *Independensis* Bed, bridge at creek 2 miles north of Palo, Iowa, gray limestone

1712  Solon Limestone, *Independensis* Bed, middle of section 23, Monroe Township, Linn County, Iowa, gray limestone

1713  Solon Limestone, *Independensis* Bed, 1 mile north of Ely, on Solon-Cedar Rapids road, Linn County, Iowa, gray limestone

1714  Solon Limestone, *Independensis* Bed, SE 1/2 Sec. 24, T. 85 N., R. 8 W., Washington Township, 12 miles north of Cedar Rapids on Iowa Rte. 11, Iowa, gray limestone

1715  Solon Limestone, *Independensis* Bed, SW 1/4 Sec. 24, T. 88 N., R. 8 W., Summer Township, 3 1/2 miles southeast of Independence, Iowa, gray limestone

1716  Solon Limestone, *Independensis* Bed, 1/4 mile east of Independence, Iowa, gray limestone

1717  Solon Limestone, *Independensis* Bed, Buffalo, Iowa, gray limestone

1718  Solon Member, *Independensis* Bed, south bank of Wapsipinicon River, 1/8 mile east of U.S. Rte. 150, opposite Mount Hope Cemetery, south of Independence, Iowa, gray limestone

1719  Solon Limestone, *Independensis* Bed, west edge of Independence, Iowa, gray limestone

1724  Rapid Limestone, *Bellula* Bed, Davenport Portland Cement Co. Quarry, Linwood Station, Iowa, gray limestone

1725  Rapid Limestone, *Bellula* Bed, N 1/2 section 26, Big Grove Township, 1 1/2 miles southwest of Solon, Iowa, gray limestone

1728  Rapid Limestone, Bellula Bed, cut on U.S. Rte. 61, 0.4 mile east of Linwood, Iowa, gray limestone

1729  Rapid Limestone, Bellula Bed, near Iowa City, Johnson County, Iowa, gray limestone

1730  Rapid Limestone, Pentamerella Bed, Davenport Portland Cement Co. Quarry, Linwood Station, Iowa, gray limestone

1731  Rapid Limestone, Pentamerella Bed, Rapid Creek, 1/2 mile northeast of bridge on Iowa Rte. 261, Iowa, gray limestone

1732  Rapid Limestone, Pentamerella Bed, 25 yards east of cemetery on Lime Creek, Brandon, Iowa, gray limestone

1734  Rapid Limestone, Pentamerella Bed?, W 1/2 Sec. 13, T. 93 N., R. 9 W., Center Township, Fayette County, near Randalia, Iowa, gray limestone

1735  Rapid Limestone, Pentamerella Bed, Dewey Portland Cement Co. Quarry, U.S. Rte. 61, 3/4 mile east of Buffalo, Iowa, gray limestone

1736  Rapid Limestone, Waterlooensis Bed, 50 yards east of dam at Littleton, on Wapsipinicon River, Iowa, gray limestone

1737  Rapid Limestone, Waterlooensis Bed, quarry southwest of Buffalo, Iowa, gray limestone

1738  Rapid Limestone, Waterlooensis Bed, NW 1/4 Sec. 31, T. 84 N., R. 8 W., Fayette Township, Iowa, gray limestone

1739  Rapid Limestone, Waterlooensis Bed, quarry on east bank of Lime Creek, 1 1/4 miles northeast of Brandon, Iowa, gray limestone

1740  Rapid Limestone, Waterlooensis Bed, Dewey Portland Cement Co. Quarry, Linwood, Iowa, gray limestone

1745  Basal Coralville Limestone, road fill, NE 1/4 Sec. 13, T. 93 N., R. 9 W., Volga Valley, near Randalia, Iowa, light gray limestone

1747  Rapid Limestone, Bellula Bed, on Mill Creek, N 1/2 Sec. 25, T. 17 N., R. 5 E., 1 1/2 miles southeast of Milan, Ill., gray limestone

1748  Rapid Limestone?, Monterey, Calhoun County, Ill., gray limestone

1749  Rapid or Coralville Limestone, Rock Island, Ill., gray limestone

1756  Cedar Valley Limestone ("Callaway"), Chicago and Alton Railroad cut, 1 1/2 miles south of Holt's Summit, Mo., dark gray fine-grained limestone

1757  Cedar Valley Limestone ("Mineola"), mouth of Cow Creek, Callaway County, Mo., tan sandy limestone
1763, 1764, 1766, 1767, 1768, 1769, 1770, 1771, 1772  Lower Potter Farm Fm., shale pit on west side of Evergreen Cemetery, 0.3 mile north of Mich. Rte. 32, SW 1/4 Sec. 21, T. 31 N., R. 8 E., Alpena, Alpena County, Mich. (Cooper No. 37A), gray limestone

1773, 1774  Potter Farm Fm., in fields on west side of Evergreen Cemetery, between Mich. Rte. 32 and Thunder Bay River, SE 1/4 Sec. 20, T. 31 N., R. 8 E., Alpena, Alpena County, Mich. (Cooper No. 37B), gray limestone

1775  Potter Farm Fm., 0.6 mile west of corner at Four Mile Dam, NE 1/4 NE 1/4 Sec. 13, T. 31 N., R. 7 W., Alpena County, Mich. (Cooper No. 41E), gray limestone

1786, 1787, 1789, 1790, 1791  Whiskey Creek Fm., quarry and road on Lake Michigan shore, 1.3 miles east of Bayshore, W 1/2 Sec. 27, T. 33 N., R. 9 W., Emmet County, Mich. (Cooper Nos. 7C, 7H, 7J), gray limestone

1792, 1793  Whiskey Creek Fm., Lake Michigan shore, 1 1/2 miles north of Norwood, Charlevoix County, Mich. (Cooper No. 7C), gray limestone

1754  Milwaukee Fm., Cleland Collection, "C Zone," Milwaukee, Wisc., gray fine-grained dolomite

1755  Milwaukee Fm., Teller Collection, "C Zone," Milwaukee, Wisc., gray fine-grained dolomite

2029  Milwaukee Fm., "C Zone," banks of the Milwaukee River, Estabrook Park, Milwaukee, Wisc., gray fine-grained dolomite

2005  Williams Island Fm., east side of unnamed island in Abitibi River at 50°19'45"N., 81°35'35"W., Ontario (Sanford and Norris, 1975, No. 319NB), gray calcareous shale and shaly limestone, possible sinkhole filling

2006  Williams Island Fm., west side of south third of unnamed island, Abitibi River, at 50° 19'55" N., 81°35'55" W., Ontario (Sanford and Norris, 1975, No. 320NB), blue-gray claystone

2025  Williams Island Fm., west bank of Kaskattami River at 56°47'20" N., 90°22'55", Ontario (Sanford and Norris, 1975, No. 199SA), red fragmental limestone, brachiopod fragments and pelamtozoan debris present
Pentamerella-Orthospirifer- Cranaena

1720 Solon Limestone, **Profunda** Bed, Lime Creek, just west of bridge 1/4 mile west of Brandon, Iowa, gray limestone

1721 Solon Limestone, **Profunda** Bed, cut on U.S. Rte. 20, 1 mile east of Jessup, Iowa, gray limestone

1741 Coralville Limestone, **Cranaena** Bed, S 1/2 section 15, Buffalo Township, Scott County, Iowa, light limestone

1742 Coralville Limestone, **Cranaena** Bed, center section 16, Penn Township, Johnson County, Iowa, light gray limestone

1743 Basal Coralville Limestone, mid-river, 1 block north of interurban station, 3.2 miles north of North Liberty, on U.S. Rte. 61 at Iowa River crossing, Iowa, light gray limestone

1744 Coralville Limestone, quarry on west side Sweetland Creek, Sweetland Township, Muscatine County, Iowa, gray sandy limestone

1746 Solon Limestone?, first hollow south of Kritesville, Calhoun County, Ill., gray limestone

1751 Cedar Valley Limestone, upper sandstone (Coralville?), Salt Spring Hollow, center N. Sec. 16, T. 11 S., R. 2 W., Calhoun County, Ill., gray sandstone

1761, 1762 Lower Potter Farm Fm., 1/4 mile south of Four Mile Dam, just north of center Sec. 18, T. 31 N., R. 8 E., Alpena County, Mich. (Cooper No. 41C), gray limestone, silicified fossils

1776, 1777 Potter Farm Fm., Orchard Hill Dome, center Sec. 31, T. 32 N., R. 7 E., cuts on Long Rapids Road, 4 1/2 miles east of Long Rapids, Alpena County, Mich., (Cooper Nos. 42, 42A), gray limestone

1778, 1779, 1780, 1781, 1782, 1783, 1784 Thunder Bay Limestone, Partridge Point, SE 1/4 Sec. 11, T. 30 N., R. 8 E., 4 miles south of Alpena, Mich. (Cooper No. 35), gray limestone

1752 Milwaukee Fm., Cleland Collection, "A and B Zones," Milwaukee, Wisc., gray dolomite

1753 Milwaukee Fm., Teller Collection, "A and B Zones," Milwaukee, Wisc., gray dolomite

2029 Milwaukee Fm., "B Zone," banks of Milwaukee River, Estabrook Park, Milwaukee, Wisc., gray dolomite
Renselandia Community

1722  Solon Limestone, Profunda Bed, middle Sec. 33, T. 86 N., R. 8 W., Grant Township, 1 1/2 miles north of Center Point, Iowa, gray limestone

1759  Cedar Valley Limestone ("Ashland"), 6.1 miles south and 1.25 miles east of Ashland, SE 1/4 SW 1/4 SW 1/4 Sec. 1, T. 45 N., R. 12 W., Boone County, Mo., gray limestone
Chonetid Community

1723 Rapid Limestone, *Bellula* Bed, upper shaly beds in quarry at Linwood, Iowa, gray shaly limestone

1750 Rapid or Coralville Limestone, Andalusia, near Rock Island, Ill., gray limestone
Mucrospirifer Community

2003 Williams Island Fm., lower red shale, south end of Mid-Bay Shoal, James Bay at about 57°40'N, 85°17'W, Ontario (Sanford and Morris, 1975, No. C-13074, station M-1), dredge sample of red shale

2004 Williams Island Fm., lower red shale, northeast bank of Albany River at 50°39'N, 85°24'W, Ontario (Sanford and Norris, 1975, No. 78433), red shale, possibly carried by glacier from outcrop on Mid-Bay Shoal
Emanuela Community

1530 Little Rock Creek Limestone, bank of Little Rock Creek at confluence of Little Rock Creek and Wabash River, near Lockport, Ind., light gray micritic limestone

1531 Little Rock Creek Limestone, west side of Little Rock Creek, 0.37 miles south of confluence with Wabash River, 1 mile S37E of Lockport, SW 1/4 NE 1/4 Sec. 20, T. 26 N., R. 1 W., Burrows Quadrangle, Ind., light gray micritic limestone
Leiorhynchus Community

1524  Basal New Albany Shale, New Albany, Ind., black, thin-bedded shale

2009  Upper Williams Island Fm., west bank Abitibi River, 1/4 mile downstream from north end of Williams Island, James Bay region, Ontario (J. Menteith Collection, 1953, see Sanford and Morris, 1975), dark gray shale
Chonetid-Leptaena Community

1488, 1489, 1490  Lingle Limestone, Microcyclus Bed, bluff facing Clear Creek, 1 1/4 mile southwest of Mountain Glen, NE 1/4 Sec. 34, T. 11 S., R. 2 W., Alto Pass Quadrangle, Ill., gray fine bioclastic limestone

1492, 1493, 1494  Lingle Limestone, Leptaena Bed, lowest exposed at Devils Bakeoven, north of Grand Tower, Ill., gray medium to coarse bioclastic limestone

1495  Lingle Limestone, above Leptaena Bed, Devils Bakeoven, north of Grand Tower, Ill., gray micritic limestone

1496  Lingle Limestone, above 1495, Devils Bakeoven, north of Grand Tower, Ill., gray micritic limestone

1497, 1498, 1499  Lingle Limestone, 1 1/2-3 feet below Microcyclus Bed, Devils Bakeoven, north of Grand Tower, Ill., gray bioclastic and micritic limestone

1500  Lingle Limestone, above 1496, Devils Bakeoven, north of Grand Tower, Ill., light coarse bioclastic limestone

1501  Lingle Limestone, lower Microcyclus Bed, cut at north end of Devils Backbone, north of Grand Tower, Ill., gray micritic limestone

1503  Lingle Limestone, Microcyclus Bed, cut at north end of Devils Backbone, north of Grand Tower, Ill., gray bioclastic limestone

1504  Lingle Limestone, Microcyclus Bed?, east bank Mississippi River, Sec. 28, T. 10 S., R. 4 W., north of Grand Tower, Jackson County, Ill., gray micritic limestone

1505  Lingle Limestone, upper Microcyclus Bed, Devils Bakeoven, north of Grand Tower, Ill., gray micritic limestone

1506  Lingle Limestone, upper Microcyclus Bed, cut at north end of Devils Backbone, north of Grand Tower, Ill., gray bioclastic limestone

1502  Lingle Limestone, lower Microcyclus Bed, Devils Bakeoven, north of Grand Tower, Ill., tan micritic limestone

1550  St. Laurent Limestone, Schizophoria Bed, section southwest of Union School, SW 1/4 Sec. 28, T. 35 N., R. 13 E., Altenburg Quadrangle, Mo., gray fine bioclastic limestone

1552  St. Laurent Limestone, Microcyclus Bed, section southwest of Union School, SW 1/4, Sec. 28, T. 35 N., R. 13 E., Altenburg Quadrangle, Mo., gray-tan bioclastic limestone

1547  St. Laurent Limestone, 1 mile south of Union School, NW 1/4 Sec. 33, T. 35 N., R. 13 E., Altenburg Quadrangle, Mo., gray very sandy limestone

1533  St. Laurent Limestone, Microcyclus Bed, 1/2 mile southeast of Union School, NW 1/4 Sec. 33, T. 35 N., R. 13 E., Altenburg Quadrangle, Mo., gray micritic limestone
1568 Lake Church Fm., shore of Lake Michigan at Lake Church, Ozaukee County, Wisc.,
gray fine-grained limestone and dolomite

2001 Lake Church Fm., type section at quarry in Harrington Beach State Park, Lake Church,
Ozaukee County, Wisc., coarse-grained tan dolomite
Brevispirifer Community

1513A Speeds Limestone, 300 yards east of Broser Railroad Station, Lexington, Ind., silicified fossils from gray limestone

1513B Speeds Limestone, loc. 34, Golf Course, Clark Grant, Clark County, Ind., gray limestone

1513C Speeds Limestone, near Prather, Clark County, Ind., gray limestone

1533 Dundee Limestone, Michigan Limestone and Chemical Co. Quarry, SE 1/4 Sec. 23, T. 35 N., R. 5 E., Rogers City, Presque Isle County, Mich., dark gray coarse bioclastic limestone

1551 St. Laurent Limestone, Brevispirifer Bed, section southwest of Union School, SW 1/4 Sec. 28, T. 35 N., R. 13 E., Altenburg Quadrangle, Mo., tan sandy limestone

1548 St. Laurent Limestone, Brevispirifer Bed, 1 mile south of Union School, NW 1/4 Sec. 33, T. 35 N., R. 13 E., Altenburg Quadrangle, Mo., gray coarse crinoidal limestone

1563 Dundee Limestone, Medusa Portland Cement Co. Quarry, NE 1/4 SE 1/4 Sec. 7, T. 9 S., R. 6 E., 2 1/2 miles southwest of Sylvania, Ohio, dark gray coarse crinoidal limestone

1564 Dundee Limestone, north end of north quarry of Medusa Portland Cement Co., NE 1/4 SE 1/4 Sec. 7, T. 9 S., R. 6 E., 2 1/2 miles southwest of Sylvania, Ohio, gray coarse bioclastic limestone

1565 Dundee Limestone, north end of north quarry of Medusa Portland Cement Co., NE 1/4 SE 1/4 Sec. 7, T. 9 S., R. 6 E., 2 1/2 miles southwest of Sylvania, Ohio, gray coarse bioclastic limestone

1566 Dundee Limestone, north end of north quarry of Medusa Portland Cement Co., NE 1/4 SE 1/4 Sec. 7, T. 9 S., R. 6 E., 2 1/2 miles southwest of Sylvania, Ohio, gray coarse bioclastic limestone

1567 Dundee Limestone, near top, north quarry of Medusa Portland Cement Co., NE 1/4 SE 1/4 Sec. 7, T. 9 S., R. 6 E., 2 1/2 miles southwest of Sylvania, Ohio, white coarse bioclastic limestone
Atrypid-Gypidulinid Community

1536 Rogers City Limestone, *Gypidula* Bed, Michigan Limestone and Chemical Co. Quarry, SE 1/4 Sec. 23, T. 35 N., R. 5 E., Rogers City, Presque Isle County, Mich., dark gray bioclastic limestone

1537 Rogers City Limestone, *Gypidula* Bed, False Presque Isle, E 1/2 10, T. 33 N., R. 8 E., Presque Isle County, Mich., dark gray bioclastic limestone

1538 Rogers City Limestone, Petty's Point on Lake Huron, Sec. 31, T. 33 N., R. 9 E., 1/8 mile north of Alpena County line, Presque Isle County, Mich., dark gray fine-grained dolomite and limestone

1539 Rogers City Limestone, Presque Isle Co. Quarry, Sec. 2, T. 33 N., R. 8 E., Presque Isle County, Mich., dark gray dolomite and limestone

1569 Lake Church, Fm., 5 feet above base, Drueckers Quarry, 3 miles north of Port Washington, Ozaukee County, Mich., tan-gray crystalline dolomite

2002 Lake Church Fm., exposures on beach, Lake Michigan shore, Harrington Beach State Park, Lake Church, Wisc., tan fine-grained dolomite

2010 Murray Island Fm., east side of south third of unnamed island, Abitibi River, 50°19′45″ N, 81°35′35″ W, Ontario (Sanford and Norris, 1975, No. 319NB), gray limestone

2011 Murray Island Fm., southwest tip of unnamed island, Abitibi River, 50°19′40″ N, 81°35′50″ W, Ontario (Sanford and Norris, 1975, No. 321NB), gray limestone

2012 Murray Island Fm., outcrop extending 0.4 miles along east bank of Abitibi River, between 50°20′36″ N and 50°20′54″ N, underlain by Moose River Fm., Ontario (Sanford and Norris, 1975, No. 324NB), gray limestone

2013 Murray Island Fm., southwest end of Murray Island, Moose River, 50°49′34″ N, 81°17′35″ W, Ontario (Sanford and Norris, 1975, No. 343NB), gray dolomite

2014 Murray Island Fm., southwest end of Murray Island, just west of bridge at Moose River Crossing, 50°49′20″ N, 81°17′40″ W, Ontario (Sanford and Norris, 1975, No. 35A), gray fine bioclastic dolomite common pelmatozoan debris, 2 snails, uncommon brachiopod debris

2015 Murray Island Fm., northwest bank of Moose River, 100 feet southwest of bridge at Moose River Crossing, 50°49′20″ N, 81°17′40″ W, Ontario (Sanford and Norris, 1975, No. 45A), gray fine-grained dolomite and limestone

2017 Murray Island Fm., east bank of North French River, 60°49′30″ N, 80°54′30″ W, Ontario (Sanford and Norris, 1975, No. 53SA), gray limestone and dolomite
Mucrostrophia-Pholidostrophia Community

1514  Speeds Limestone ("Deputy"), Hog Creek, 4 miles north of Lexington, Ind., gray fine bioclastic limestone

1515  Speeds Limestone ("Deputy"), 100 yards east of crossroads 1 mile south of Deputy, Ind., on Ind. Rte. 3, light gray coarse bioclastic limestone

1517  Speeds Limestone ("Deputy"), quarry 1 mile south and 4 miles east of Deputy, Ind., light gray coarse crinoidal limestone
Emanuella Community

1534 Rogers City Limestone, lower 6 feet, Michigan Limestone and Chemical Co. Quarry, SE 1/4 Sec. 23, T. 35 N., R. 5 E., Rogers City, Presque Isle County, Mich., gray to light brown fine-grained dolomite

1535 Rogers City Limestone, Emanuella Bed, Michigan Limestone and Chemical Co. Quarry, SE 1/4 Sec. 23, T. 35 N., R. 5 E., Rogers City, Presque Isle County, Mich., dark gray fine-grained limestone
Warrenella Community

1561  Lower Delaware Limestone, Deep Run, 5 1/2 miles north of Worthington, Ohio, dark gray coarse bioclastic limestone

1562  Upper Delaware Limestone, Deep Run, 5 1/2 miles north of Worthington, Ohio, dark gray coarse bioclastic limestone
Tropidoleptus Community

1516  Speeds Limestone ("Deputy"), Hog Creek, 4 miles north of Lexington, Ind., light coarse bioclastic limestone
Subrensselandia Community

1545 Beauvais Sandstone, south bank of Little Saline Creek, 1/4 mile east of Boarman School Road, Ste. Genevieve County, Mo., white coarse orthoquartzite

1554 St. Laurent Limestone, Subrensselandia Bed, section 1/4 mile southwest of Union School, NW 1/4 SW 1/4 Sec. 29, T. 35 N., R. 13 E., Altenburg Quadrangle, Mo., gray fine-grained limestone