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Macropaleontology of the Gunn Member, Stony Mountain Formation (Upper Ordovician), Manitoba and North Dakota

Frederick K. Lobdell

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MACROPALEONTOLOGY OF THE GUNN MEMBER, STONY MOUNTAIN FORMATION
(UPPER ORDOVICIAN), MANITOBA AND NORTH DAKOTA

by
Frederick K. Lobdell

Bachelor of Arts, Western Connecticut State College, 1978
Master of Science, University of North Dakota, 1984

A Dissertation
Submitted to the Graduate Faculty
of the
University of North Dakota
in partial fulfillment of the requirements
for the degree of
Doctor of Philosophy

Grand Forks, North Dakota

May
1988
This dissertation, submitted by Frederick K. Lobdell in partial fulfillment of the requirements for the Degree of Doctor of Philosophy from the University of North Dakota, has been read by the Faculty Advisory Committee under whom the work has been done and is hereby approved.

(Chairperson)

This dissertation meets the standards for appearance, conforms to the style and format requirements of the Graduate School of the University of North Dakota, and is hereby approved.

Dean of the Graduate School
Permission

Title Paleontology of the Gunn Member, Stony Mountain Formation (Upper Ordovician), Manitoba and North Dakota
Department Geology and Geological Engineering
Degree Doctor of Philosophy

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Date 4-28-88

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ACKNOWLEDGMENTS

Dr. F. D. Holland, Jr. suggested the problem, provided access to an extensive collection that he had assembled in the Paleontology Laboratory at the University of North Dakota over years of trips to the field area, and supervised the research. Dr. Alan M. Cvancara discussed the research and critically read the manuscript, as did Dr. Richard D. LeFever, Dr. Howard J. Fischer, and Dr. Paul B. Kannowski. The North Dakota Geological Survey provided access to well logs and core in its custody. Dr. Robert J. Stevenson, Mr. James C. Collier, and Mr. John J. Crashell took scanning electron photographs, and Mr. Timothy P. Huber operated the microprobe for an elemental analysis of some microfossils. The staff of the Manitoba Museum of Man and Nature provided access to their collections. My wife, Paulette, spent many hours collecting and curating fossils.

Financial support was provided by the Department of Geology and Geological Engineering, the Graduate School of the University of North Dakota, and the North Dakota Geological Survey. I thank all these individuals and institutions.
ABSTRACT

The Gunn Member of the Stony Mountain Formation has long been known to contain an abundant and diverse fauna. This study was undertaken to identify and describe the macrofauna of the Gunn Member in the subsurface of North Dakota, previously neglected.

As a necessary first step, collections of fossils from outcrop were examined and identified. With the outcrop fauna serving as a reference collection, twenty cores from the North Dakota subsurface were examined, described, and their fossils sampled. Fossil and sediment samples were washed and sieved and the residues were picked for microscopic representatives of phyla usually considered to be macroscopic.

One hundred sixteen species-level taxa were identified from the Gunn Member. Thirty-five of these were found only in the subsurface, 40 only in outcrop, and 41 were found in both outcrop and the subsurface. There are 42 species of mollusks, 40 bryozoans, 15 brachiopods, ten corals, eight arthropods, and one stromatoporoid. A microscopic molluscan fauna was found in core from four wells in North Dakota. Five new genera and 19 new species were described; one species is a coral and the remaining new taxa are bryozoans.

Outcrop assemblages are dominated by brachiopods and solitary corals, subsurface assemblages by bryozoans and brachiopods. Most of the preserved fauna is inferred to have been of epifaunal suspension feeders. Most of the fauna seems to have little biostratigraphic utility, although a Richmondian age for the Gunn Member is confirmed by the presence of several Richmondian index fossils.
The sediments of the Gunn Member were deposited on a gentle northwest-sloping ramp. The decreasing thickness and decreasing proportion of terrigenous material toward the northwest indicates a southeastern source for the Gunn siliciclastics; the Transcontinental Arch is inferred to have been that source.

The term "Gunn Member" is used throughout this study to avoid confusion. However, it is suggested that the term "Stony Mountain Formation" might be restricted to what is now the Gunn and Penitentiary Members, and that the Gunton and Williams Members might be incorporated into an expanded Stonewall Formation.
INTRODUCTION

General Statement

The Upper Ordovician Gunn Member of the Stony Mountain Formation crops out about 10 km north-northwest of the city of Winnipeg, Manitoba, on the outskirts of the village of Stony Mountain. It exists in the subsurface throughout most of North Dakota and in southeastern Manitoba, southwestern Saskatchewan, eastern Montana, and a small portion of northwestern South Dakota. The unit exceeds 30 m in thickness in eastern North Dakota, just west of its erosional margin, and thins to the north and west. The northern and western limits of the Gunn are depositional. The Gunn Member overlies the Red River Formation throughout the Gunn's extent and is overlain by the Penitentiary Member of the Stony Mountain Formation in outcrop, and by the Gunton Member in the subsurface.

The Gunn is composed of thin, relatively pure, bioclastic limestone interbedded with calcareous shale or very argillaceous limestone. The shale or argillaceous limestone is largely reddish purple in outcrop. In the subsurface, it is medium olive gray or pinkish gray in eastern North Dakota, becoming darker olive gray in the central part of the state and almost black in the deepest wells in western North Dakota.

In outcrop, the fauna consists of an articulate brachiopod-solitary coral assemblage. Articulate brachiopods and solitary corals are abundant, trepostome and cryptostome bryozoans and gastropods are common, tabulate corals and cephalopods are uncommon, and pelecypods and identifiable trilobites are rare.
In the subsurface, the fauna may be characterized as an articulate brachiopod-bryozoan assemblage. Articulate brachiopods and cryptostome and trepostome bryozoans are abundant, solitary corals are common, tabulate corals and mollusks (except for abundant microscopic mollusks in four wells) are uncommon, and inarticulate brachiopods and identifiable trilobites are rare.

The presence of several species of Richmondian index fossils indicates that the Gunn Member is Richmondian (Late Late Ordovician) in age. Previous suggestions that the unit is Maysvillian in age (Ethington and Furnish, 1960), in whole or in part, are not supported by the faunal evidence.

**Purpose of the Study**

The primary purpose of this study was to identify, describe, and illustrate the macrofauna of the Gunn Member of the Stony Mountain Formation in the subsurface of North Dakota. In order to accomplish this, it was necessary to study and redescribe the outcrop fauna. In addition, conflicting suggestions as to the age of the fauna will be addressed herein, the stratigraphy and stratigraphic nomenclature will be reviewed, and interpretations will be suggested regarding paleoecology and depositional environment.

**Methods**

For more than 30 years, individuals and classes from the University of North Dakota have been collecting fossils during various trips to the quarries at Stony Mountain, Manitoba. (Outcrop localities are listed and briefly described in Appendix A.) Many of
these collections were retained by the Department of Geology and Geological Engineering and were available for study. These collections totalled more than 6600 specimens. As a first step toward identifying the fossils from the subsurface, fossils from the outcrop collections were identified and described to serve as a reference collection.

More than 900 well logs, in the custody of the North Dakota Geological Survey, were examined and the contacts of the Gunn Member "picked." Cored intervals, as listed in Well Completion Reports in North Dakota Geological Survey files, were then compared to the picked depths to determine which wells had core from the Gunn Member. Core from 20 wells (Fig. 1), widely scattered around North Dakota, was available for study at the Wilson M. Laird Core and Sample Library of the North Dakota Geological Survey, located on the campus of the University of North Dakota.

All available core was described (Appendix B). Common, known fossils were usually left in place in the core and their presence was noted. Unusual, unidentified, or exceptionally well-preserved specimens were usually collected. Most cores, and all specimens, were washed in tap water and the washings were sieved. From the sieved residue, several hundred microscopic mollusks and more than 10,000 microscopic bryozoans were recovered.

The subsurface fauna was then identified and described. Microscopic specimens were gold-coated and photographed using a JEOL 35C scanning electron microscope. Macroscopic specimens were coated with sublimate of ammonium chloride and photographed using a
Figure 1. Location map of Gunn Member cores.
Nikon F3 HP 35-mm camera. Where necessary or desirable for identification or description, thin sections or, more commonly, acetate peels were made of specimens. Some of these thin sections and peels were photographed using a microscope; in other cases, the peels or thin sections were used as "negatives" and photographic prints were made directly from them. Photographs of individual specimens were "mocked up" on poster board and re-photographed to produce the plates herein.

Geologic Setting

In North Dakota, the Gunn Member of the Stony Mountain Formation is thickest in the eastern and south-central parts of the state (Fig. 2) just west of its erosional limits. The unit thins to the west and northwest, as shown by its isopachs (Fig. 2). The clay content also decreases in the same direction as that in which the unit thins, as shown by the decreased intensity of the gamma ray "kicks" on well logs. This implies a source area to the south and east. The Transcontinental Arch (Fig. 3), trending irregularly from the western tip of Lake Superior to the Four Corners area in the southwestern United States, is ideally located for that purpose. The Ordovician history of the Transcontinental Arch was summarized by Witzke (1980), who inferred it to be emergent during the time of deposition of the Gunn Member and to be the source area for the Gunn clastics. The depositional strike of the Gunn Member in North Dakota (Fig. 2) parallels the trend of the Transcontinental Arch, and all the available evidence seems to support Witzke's interpretation that that structure was, indeed, the source of the Gunn clastics.
Figure 2. Isopach map of the Gunn Member in North Dakota. Contour interval is 5 m.
Figure 3. Extent of the Gunn Member (heavy line) and approximate position of the Transcontinental Arch. Limits of the Gunn are from Porter and Fuller (1964), Foster (1972), and Kendall (1976). Lines of paleolatitude are from Witzke (1980).
Gunn sediments were deposed on a shallow carbonate ramp or shelf, with deeper water occurring toward the north and northwest. Wilson (1975, p. 89-90) has suggested that darker-colored carbonates imply conditions more strongly reducing than those for lighter-colored carbonates and thus are an indicator of deeper water. If he is correct, the very dark gray to almost black carbonates found in cores from wells in western North Dakota imply that the water depth was greater than that in which lighter-colored sediments were deposited.

The shelf onto which the Gunn sediments were deposited was part of a larger shelf, or seaway, stretching irregularly from northern Mexico to northwestern Greenland (Clark and Stearn, 1968, p. 145). Most of this area is inferred to have been equatorial or sub-equatorial during Richmondian time (Witzke, 1980), and thus the fauna represents a tropical or subtropical assemblage.

**Previous Work**

**Outcrop Stratigraphy**

Although the outcrops at Stony Mountain had been known since at least the late 1850s (Whiteaves, 1895, p. 111), the first formal description of the rocks was given by Dowling (1900, p. 46F-48F). Dowling named the Stony Mountain Formation and gave its lithology as "shaly beds below and thick-bedded limestones above." (Dowling, 1900, p. 47F). Okulitch (1943) formally subdivided the Stony Mountain Formation into (in ascending order) the Stony Mountain shale, Pentitentiary, Gunton, and Birse members. Baillie (1952) subsumed Okulitch's Birse Member within the Gunton Member and recognized only
three members in the Stony Mountain Formation. Sinclair and Leith (1958) proposed the name Gunn Member to replace Okulitch's Stony Mountain shale member, and Sinclair (1959) used this three-member nomenclature. Cowan (1971) recognized a fourth member, overlying the Gunton Member, that he called the Williams Member, thus formalizing the manuscript name originally suggested by Smith (1963). This four-member subdivision of the Stony Mountain Formation is the one currently used for the Manitoba outcrop.

Subsurface Stratigraphy

The first attempt to extend outcrop stratigraphy into the subsurface of Manitoba was that by Ower (1953), who recognized two informal members of the Stony Mountain Formation in the subsurface. He considered the Gunton Member of outcrop to be the "Upper Stony Mountain," and considered the Penitentiary Member together with the "Stony Mountain shale" to form the "Lower Stony Mountain." Ower wrote (1953, p. 738) of the Penitentiary, "In the subsurface, it cannot be distinguished from the Stony Mountain shale and is therefore included with it as ['Lower Stony Mountain']."

This two-member subdivision of the Stony Mountain Formation in the subsurface has been maintained by most subsequent workers. Ross (1957, p. 446) recognized a "lower shale member" and a "dolomitic member," whereas Andrichuk (1959) used "Lower Member" and "Upper Member (Gunton)." Porter and Fuller (1959, p. 130) included a "Stony Mountain Shale" and Gunton Member in their Stony Mountain Formation, terminology retained by Fuller (1961). Kent (1960, p. 12, 20) introduced the name Stoughton Member (which he subsequently subdivided
into a "shale facies" and a "carbonate facies") for the lower part of the Stony Mountain Formation, while retaining the name Gunton Member for the upper part. This terminology was used by Brindle (1960), Carlson and Eastwood (1962), Foster (1972), and Gerhard et al. (1982), and is the terminology currently used by the North Dakota Geological Survey (Bluemle et al., 1986). On the other hand, Bluemle et al. (1981) and Ballard et al. (1983) recognized the Gunton and Stoughton Members only in Montana; they did not subdivide the Stony Mountain Formation in North Dakota.

Porter and Fuller (1964) recognized a "Stony Mountain member" and the Gunton Member, whereas Roehl (1967) used "Stony Mountain shale" for the lower Stony Mountain Formation. Kendall (1976) was the first to use the name "Gunn Member" in the subsurface, applying it to the "shale facies" of Kent's (1960) Stoughton Member. Kendall (1976, p. 36) introduced the term "Hartaven Member" for the "calcareous facies" of Kent (1960). Kendall placed these beds below the Gunn Member in the Saskatchewan subsurface, but retained them in the Stony Mountain Formation. Unaccountably, Ross et al. (1982) reverted to the archaic "shale member" for the lower part of the Stony Mountain Formation in part of their stratigraphic column for Montana and North Dakota, while retaining Kendall's (1976) three-member subdivision for the rest of the column.

Paleontology

The first report of fossils from the Gunn Member was a sketchy faunal list published by Whiteaves (1880), who reported on two
collections made in the 1870s. Ulrich (1889) did the first systematic paleontology on Gunn fossils; he described a collection of bryozoans and ostracodes sent him by Whiteaves. Whiteaves (1895) published an annotated faunal list, much more complete than his earlier one, and Dowling (1900) also published a faunal list in conjunction with his lithologic and stratigraphic descriptions. Wilson (1938) illustrated the only Gunn gastropod ever to be pictured. Okulitch (1943) published faunal lists for the several members of the Stony Mountain Formation, and described and named two new species each of brachiopods and corals. Leith (1952) described two species and one new genus of heliolitide corals from the Gunn Member. Ethington and Furnish (1960) did a sketchy study of Gunn conodonts. Macomber (1970) described and illustrated a number of Gunn specimens in his study of articulate brachiopods from the Bighorn Formation of Wyoming, and Elias (1983) described and illustrated all four species of solitary corals from the Gunn. Macomber and Macomber (1983) investigated ribbing patterns in Diceromyonia, basing their study in part on a collection of Gunn specimens. From the subsurface, Ross (1957) illustrated a small fauna from the Gunn Member in eastern Montana, and Brindle (1960) did the same from well cores in Saskatchewan.

Several unpublished studies of Gunn fossils have been done. Procter (1957) studied brachiopods, cephalopods, and trilobites from outcrop. Caramanica (1973) worked on corals from outcrop at Stony Mountain and from outcrop of the correlative Bighorn Formation. Held (1976) did a small study on articulate brachiopods from the Gunn outcrop. The only unpublished studies from the subsurface, besides
the present one, are those by Morgan (1964) on scolecodonts and chitinozoans and by R. K. Hawbaker (M.S. thesis in progress) on conodonts.
the present one, are those by Morgan (1964) on scolecodonts and chitinozoans and by R. K. Hawbaker (M.S. thesis in progress) on conodonts.
STRATIGRAPHY

In outcrop at Stony Mountain, Manitoba, three members of the Stony Mountain Formation, as currently defined, are present. The Gunn Member is the lowest of these and is thought to be about 18 m thick at the type locality (Okulitch, 1943, p. 60), although only the uppermost 4 m are exposed in outcrop. The Gunn, although commonly referred to as a shale, is composed of relatively pure bioclastic limestone with thin interbeds of highly calcareous, abundantly fossiliferous shale. The dominant color is reddish purple, although locally it may be pale greenish gray to yellowish gray. The Penitentiary Member, about 4.5 m thick at Stony Mountain (Okulitch, 1943, p. 60), is pale yellowish orange, argillaceous dolostone. The Penitentiary is also abundantly fossiliferous, but in most cases the body fossils have been dissolved out and only molds remain. The contact between the Gunn and the Penitentiary Members appears to be gradational over about 0.5 to 1 m. The Penitentiary Member is overlain by the Gunton Member, about 6 m thick at Stony Mountain. The Gunton is pale gray thick-bedded dolostone. Fossils are not common and are poorly preserved, recrystallization and dolomitization commonly having destroyed fine detail. The contact with the underlying Penitentiary Member is "gradational, sometimes over an interval of one foot." (Smith, 1963, p. 68).

In the subsurface of North Dakota, the Gunn is composed of beds of argillaceous limestone or highly calcareous shale, alternating with relatively pure bioclastic limestone. The pure limestones...
or grainstones in the terminology of Dunham, 1962) commonly are pale bluish gray; the more argillaceous beds are medium olive gray or purplish gray in eastern North Dakota, becoming darker olive gray in the central part of the state and almost black in the deepest wells in western North Dakota. Contacts between beds, particularly the lower contact of the pure limestones, are usually quite sharp. The lower contact of the Gunn with the Red River Formation can be sharp, but is more commonly gradational over a few centimetres or tens of centimetres.

The Penitentiary Member can not be traced for any significant distance into the subsurface of Manitoba (Ower, 1953; Andrichuk, 1959) and I have seen nothing in core from North Dakota that is recognizable as the Penitentiary Member. The upper contact of the Gunn Member with the overlying Gunton Member is usually gradational over several tens of centimetres to one metre or so.

Dowling (1900) named the Stony Mountain Formation. At the time, the term "formation" was not used as we use it today. The currently accepted definition is, "a body of rock identified by lithic characteristics and stratigraphic position; it is prevailingingly but not necessarily tabular and is mappable at the Earth's surface or traceable in the subsurface." (North American Commission on Stratigraphic Nomenclature, 1983, p. 858). But in the 19th century, "formation" was commonly used as we use "system" or "series" today (e.g., "Carboniferous formation" or "Hudson River formation"). Another use of the term referred to composition, as "coal formation"
or "shale formation" (Dana, 1895, p. 90). An early definition, related to that of Dana, above, was, "A collection of beds, lying concordantly above one another and deposited during a given geological period of time, is called a formation." (Pirsson, 1915, p. 256). It is in this older sense that Dowling (1900, p. 46F-48F) described and named the "Stony Mountain formation," i.e., a series of concordant beds cropping out at a given geographic locality and deposited during a given interval of geologic time.

Current definitions of "formation" emphasize lithologic criteria: "A formation should possess some degree of internal lithic homogeneity or distinctive lithic features. It may contain between its upper and lower limits (i) rock of one lithic type, (ii) repetitions of two or more lithic types, or (iii) extreme lithic heterogeneity . . . ." (North American Commission on Stratigraphic Nomenclature, 1983, p. 858). The Gunn Member of the Stony Mountain Formation consists of a repetition of two lithic types, and the Penitentiary and Gunton Members are each composed of one lithic type (although not the same lithic type). The Stony Mountain Formation, as a whole, meets none of the lithic criteria set forth above for a formation.

Dowling (1900) named the Stony Mountain Formation in accordance with accepted stratigraphic practice of his day. There is little excuse for our continuing to use his terminology today. My recommendation would be to restrict the use of "Stony Mountain Formation" to the Gunn Member, or the Gunn and Penitentiary Members, of current usage. As Sinclair and Leith (1958, p. 244) pointed out,
"The 'Stony Mountain fauna,' which has become well known and recognized over a large area, is not the fauna of the formation, but only of the lower part of it." Restricting the use of the term Stony Mountain Formation to the lower part of the currently defined formation would bring into harmony the stratigraphic nomenclature and the commonly used paleontological terminology. However, revision ("minor changes in the definition of one or both boundaries or in the rank of a unit"; North American Commission on Stratigraphic Nomenclature, 1983, p. 854) is beyond the scope of this study; in order to avoid confusion, the term "Gunn Member" will be used throughout this report for the abundantly fossiliferous and highly argillaceous lower "Stony Mountain Formation."

As the question of mappability of the Penitentiary Member is moot at best, it probably would be simplest not to regard that unit as a distinct formation. The high clay content and faunal similarity of the Penitentiary and Gunn Members argue for keeping them together, and regarding the Penitentiary as a dolomitized lithofacies of the upper Gunn that crops out but that can not be traced very far into the subsurface.

If the term "Stony Mountain Formation" were to be restricted to the Gunn and Penitentiary Members, the Gunton Member would be left without a home. It would be possible to raise the Gunton to formational rank, but the easiest solution would seem to be to extend downward the lower boundary of the overlying Stonewall Formation to include the Gunton and Williams Members in the Stonewall Formation.
Kindle (1914, p. 249) proposed "the name Stonewall limestone for all of the Silurian beds between the Ordovician and Devonian terranes on the east side of Lakes Manitoba and Winnipegosis." Currently, the systemic boundary is thought to lie within the Stonewall Formation (e.g., Stearn, 1956; Bluemle et al., 1986). Of course, the age of a rock unit should have no bearing on its lithostratigraphic nomenclature. The Gunton is much more similar, lithologically, to the Stonewall Formation than it is to any other part of the currently-defined Stony Mountain Formation. The "Williams Member" may be regarded as an arenaceous marker bed within the Stonewall Formation.

In the subsurface, a two-member subdivision of the Stony Mountain Formation has long been recognized (e.g., Carlson and Eastwood, 1962; Bluemle et al., 1986). However, this, too, is unjustified, as discussed above and as noted by Kendall (1976). He suggested (p. 10) grouping the upper Stony Mountain (Gunton Member), Stonewall, and lower Interlake into one lithologic unit. In the subsurface, the Gunn is recognizable by a strong and distinctive gamma ray "kick" (Fig. 4). Above the Gunn is a relatively "clean" succession of carbonates punctuated by a series of "marker beds." Some of these marker beds have been singled out to serve as formational boundaries, but there seems to be little justification for this stratigraphic practice. With regard to the Stonewall, Kendall (1976, p. 8) said, "It closely resembles beds immediately above and below. The marker beds that define its upper and lower contacts appear to be no different from
Figure 4. Typical gamma-ray signature for part of the Upper Ordovician succession in north-central North Dakota, together with current stratigraphic nomenclature.
those within the unit or which occur in overlying Interlake
carbonates." He recommended (p. 8) abandoning the name "Stonewall,"
but that term has priority over "Interlake," and my recommendation
would be to abandon the latter name. Regardless of the names used,
separating similar lithologies by similar marker beds and arbitrarily
assigning formation names to the portions of the section thus defined
seems to me to be poor stratigraphic practice (Forgotson, 1957,
notwithstanding).

Kendall (1976, p. 36) introduced the name "Hartaven Member" for
calcareous beds underlying the Gunn Member. He assigned his Hartaven
Member to the Stony Mountain Formation in the Saskatchewan
subsurface. However, these beds thin abruptly southward (toward the
international border) and seem indistinguishable from underlying Red
River carbonates in North Dakota. For the purposes of this study, the
base of the Gunn Member is taken as the base of the Stony Mountain
Formation, which is defined in the subsurface as the base of the
strong gamma ray deflection by which the unit may be recognized.

These, then, are my stratigraphic nomenclatural recommendations
for the subsurface of North Dakota: (1) the name Stony Mountain
Formation should be restricted to the presently defined Gunn Member
(Stoughton Member of Bluemle et al., 1986); (2) the Gunton Member,
Williams Member, Stonewall Formation, and at least the lower Interlake
Formation should be incorporated into an expanded Stonewall Formation.
As stated above, however, existing terminology is used in this study
to avoid confusion and to sidestep revision.
PALEONTOLOGY

One hundred sixteen species-level taxa have been identified and described from the Gunn Member of the Stony Mountain Formation (Table 1). Of these, 40 have been found only in outcrop, 35 only in the subsurface, and the remaining 41 taxa were found both in outcrop and in the subsurface. These totals do not include echinoderms fragments, ostracodes, scolecodonts, or conodonts, none of which were a part of this study.

More than 6600 specimens have been collected from outcrop. Relative abundances are indicated semiquantitatively, as follows: very abundant, more than 500 specimens; abundant, 200 to 500 specimens; common, 50 to 200 specimens; rare, 6 to 50 specimens; and very rare, 5 or fewer specimens. In the subsurface, the necessity of preserving core for future study prohibited extensive or indiscriminate collecting; therefore, it is not possible to estimate relative abundances in the subsurface. However, based on collections and observations, some tentative conclusions as to relative abundances are reached in the discussions of the various groups below.

Table 1. Species-level taxa present in the Gunn Member.

<table>
<thead>
<tr>
<th>Taxon</th>
<th>Outcrop</th>
<th>Subsurface</th>
</tr>
</thead>
<tbody>
<tr>
<td>Porifera</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stromatoporoidea</td>
<td></td>
<td></td>
</tr>
<tr>
<td>?Aulacera sp. aff. A. cylindrica (Foerste)</td>
<td>vr</td>
<td></td>
</tr>
<tr>
<td>Cnidaria</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rugosa</td>
<td>vn</td>
<td>x</td>
</tr>
<tr>
<td>Bighornia patella (Wilson)</td>
<td>va</td>
<td>x</td>
</tr>
<tr>
<td>Deiracorallum angulatum (Billings)</td>
<td>a</td>
<td>x</td>
</tr>
<tr>
<td>Lobocorallum trilobatum (Whiteaves)</td>
<td>c</td>
<td>x</td>
</tr>
<tr>
<td>Salvadorea selecta (Billings)</td>
<td>va</td>
<td>x</td>
</tr>
<tr>
<td>Taxon</td>
<td>Outcrop</td>
<td>Subsurface</td>
</tr>
<tr>
<td>-------------------------------------------</td>
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</tr>
<tr>
<td><strong>Tabulata</strong></td>
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<tr>
<td>Paleofavosites prolificus (Billings)</td>
<td>c</td>
<td>x</td>
</tr>
<tr>
<td>P. okulitchi Stearn</td>
<td>r</td>
<td></td>
</tr>
<tr>
<td>P. manitobensis n. sp.</td>
<td>vr</td>
<td></td>
</tr>
<tr>
<td>Prorataea tenuis (Billings)</td>
<td>r</td>
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</tr>
<tr>
<td>Pragnellia arborescens Leith</td>
<td>vr</td>
<td></td>
</tr>
<tr>
<td>&quot;Catenipora&quot; sp.</td>
<td>vr</td>
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</tr>
<tr>
<td><strong>Bryozoa</strong></td>
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<tr>
<td><strong>Cyclostomata</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tubulotrypa auloporoides (Nicholson)</td>
<td>r</td>
<td>x</td>
</tr>
<tr>
<td><strong>Cryptostomata</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arthroclema brevis n. sp.</td>
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<td></td>
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<tr>
<td>A. pentagonalis n. sp.</td>
<td>r</td>
<td>x</td>
</tr>
<tr>
<td>Arthrotrypa ovata n. sp.</td>
<td>vr</td>
<td>x</td>
</tr>
<tr>
<td>Nematoporella ulrich n. sp.</td>
<td>r</td>
<td>x</td>
</tr>
<tr>
<td>N. falcata n. sp.</td>
<td>vr</td>
<td>x</td>
</tr>
<tr>
<td>Sceptropora facula Ulrich</td>
<td>a</td>
<td>x</td>
</tr>
<tr>
<td>S. umbelliformis n. sp.</td>
<td>r</td>
<td>x</td>
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<tr>
<td>Ulrichostylus costatus n. sp.</td>
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<tr>
<td>U. dakotensis n. sp.</td>
<td></td>
<td>x</td>
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<tr>
<td>Ptilodictya sulcata Billings</td>
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<tr>
<td>Dicranopora emacerata (Nicholson)</td>
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<td>x</td>
</tr>
<tr>
<td>D. fragilis (Billings)</td>
<td>r</td>
<td>x</td>
</tr>
<tr>
<td>D. meeki (James)</td>
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</tr>
<tr>
<td>D. brevis n. sp.</td>
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<tr>
<td>Goniotrypa bilateralis Ulrich</td>
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<tr>
<td>Platydictya renvillensis n. sp.</td>
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<tr>
<td>Pachydictya hexagonalis Ulrich</td>
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<tr>
<td>Endodictya pachyclema n. sp.</td>
<td>vr</td>
<td>x</td>
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<tr>
<td><strong>Trepostomata</strong></td>
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<tr>
<td>?Stigmatella sp.</td>
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<tr>
<td>Dekayia micropora n. sp.</td>
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<tr>
<td>D. aequalis n. sp.</td>
<td>vr</td>
<td>x</td>
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<tr>
<td>Lioclemella subfusiformis (James)</td>
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<td>x</td>
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<tr>
<td>Tarpophragma clinopora n. sp.</td>
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<td>Parvohallopora sp. aff. P. subplana (Ulrich)</td>
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<tr>
<td>P. sp. aff. P. ramosa (d'Orbigny)</td>
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<tr>
<td>Batostoma manitobense Ulrich</td>
<td>c</td>
<td>x</td>
</tr>
<tr>
<td>B. sp. cf. B. ovata (Ulrich)</td>
<td>vr</td>
<td>x</td>
</tr>
<tr>
<td>Bythopora striata Ulrich</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Eridotrypa nitida (Ulrich)</td>
<td>vr</td>
<td>x</td>
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<tr>
<td>E. compressa n. sp.</td>
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<tr>
<td>Monticulipora parasitica Ulrich</td>
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<td>x</td>
</tr>
<tr>
<td>M. plana Ulrich</td>
<td>r</td>
<td>x</td>
</tr>
<tr>
<td>Homotrypa glabra Cumings and Galloway</td>
<td>r</td>
<td>x</td>
</tr>
<tr>
<td>H. oligophragma n. sp.</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>H. tanulata n. sp.</td>
<td>vr</td>
<td>x</td>
</tr>
<tr>
<td>H. astrovae n. sp.</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Rhombotrypa quadrata (Rominger)</td>
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<td>Outcrop</td>
<td>Subsurface</td>
</tr>
<tr>
<td>--------------------------------------------</td>
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<tr>
<td>R. multitabulata Utgaard and Perry</td>
<td>c</td>
<td>x</td>
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<tr>
<td>R. subquadrata (Ulrich)</td>
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</tr>
</tbody>
</table>

**Brachiopoda**

**Inarticulata**

?Lingula sp. cf. L. narrawayi Wilson

**Articulata**

Hesperorthis pyramidalis (Twenhofel)  
Dinorthis (Dinorthis) carletona Twenhofel  
Hebertella occidentalis montoyensis Howe  
Diceromyonia storeya (Okulitch)  
Strophomena occidentalis Foerste  
S. planocorrugata Twenhofel  
?Furcitella sp.  
Megaamonia nitens (Billings)  
Oepikina pergibbosa (Foerste)  
Rhychotrema gigas (Wang)  
R. iowense Wang  
Hypsiptycha antostiensi (Billings)  
Zygospira sp.  
Cyclospira sp.

**Mollusca**

**Scaphopoda**

?Plagioglypta sp. cf. P. iowaensis (James)

**Gastropoda**

Cyrtolites sp.  
?Sinuiles sp.  
?Phragmolites sp. A  
?Phragmolites sp.  
Bucania sp.  
?Liospila sp. cf. L. americana (Billings)  
?Liospila sp.  
?Eotomaria sp. cf. E. supracingulata (Billings)  
Loxoplocus (Lophospira) sp. cf. L. (L.) milleri  
(Lall)  
?Loxoplocus (Lophospira) sp.  
Trochonema (Trochonema) sp. cf. T. (T.)  
ubilicata lata Ulrich and Scofield  
Trochonema (Trochonema) sp.  
Clclonea sp. cf. C. bilix (Conrad)  
Cyclonea sp.  
?Murchisonia (Hormotoma) sp. cf.  
M. (H.) gracilis (Hall)  
?M. (H.) sp. cf. M. (H.) salteri Ulrich and Scofield  
?M. (H.) sp. cf. M. (H.) bellicincta (Hall)  
?M. (H.) sp. cf. M. (H.) trentonensis  
Ulrich and Scofield  
?M. (H.) sp. cf. M. (H.) major Hall  


Table 1. (Continued)

<table>
<thead>
<tr>
<th>Taxon</th>
<th>Outcrop</th>
<th>Subsurface</th>
</tr>
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<tbody>
<tr>
<td>Palaeonella sp. A</td>
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<td>x</td>
</tr>
<tr>
<td>Palaeonella sp. B</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Palaeoneilo sp. A</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Palaeoneilo sp. B</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Matheria sp.</td>
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<td></td>
</tr>
<tr>
<td>Ambonychia sp. aff. A. obesa (Ulrich)</td>
<td>vr</td>
<td></td>
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<tr>
<td>Lyrodesma sp.</td>
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<tr>
<td>Cephalopoda</td>
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<tr>
<td>Actinoceras sp.</td>
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<tr>
<td>Kochoceras sp.</td>
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<tr>
<td>Huronia sp.</td>
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</tr>
<tr>
<td>Pleurothoceras sp. cf. P. selkirkense (Whiteaves)</td>
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<tr>
<td>Ephippiorthoceras sp.</td>
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<tr>
<td>Gorbyoceras sp.</td>
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<tr>
<td>Billingsites sp.</td>
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<tr>
<td>Probillingsites sp.</td>
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<tr>
<td>Digenuoceras sp.</td>
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<tr>
<td>Cyrtogomphoceras sp. cf. C. magnum (Whiteaves)</td>
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<td>Westonoceras sp.</td>
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<td>Genus A. sp. A</td>
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<td>Rostroconchia</td>
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<td>Pinnocaris sp.</td>
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<td>Hyolitha</td>
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<tr>
<td>Hyolithes sp. aff. H. versaillensis Miller and Faber</td>
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<td>Arthropoda</td>
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<tr>
<td>Trilobita</td>
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<tr>
<td>Isotelus sp. cf. I. gigas DeKay</td>
<td>vr</td>
<td></td>
</tr>
<tr>
<td>Trilobites sp. cf. I. maximus Locke</td>
<td>x</td>
<td></td>
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<tr>
<td>Bumastus sp.</td>
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<tr>
<td>Ceraurus sp. aff. C. tuberosus Troedsson</td>
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<tr>
<td>Ceraurinus icarus (Billings)</td>
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<td>Flexicalymene sp.</td>
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<tr>
<td>Calyptaulax (Calliops) sp.</td>
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<tr>
<td>Malacostraca</td>
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<tr>
<td>phyllocarid gen. et sp. indet.</td>
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<td>x</td>
</tr>
</tbody>
</table>

va=very abundant, a=abundant, c=common, r=rare, vr=very rare, x=present
Porifera

One very poorly preserved stromatoporoid was collected from outcrop. This is the first poriferan reported from the Gunn Member of the Stony Mountain Formation.

Cnidaria

Four species of solitary rugose corals and five species of tabulate corals from the Gunn Member of the Stony Mountain Formation have been described below under Systematic Paleontology. A sixth species of tabulate coral was seen but the specimen cannot now be located.

Rugose corals

Four species have been collected both from outcrop and from the subsurface. In outcrop, solitary corals are quite abundant and form a dominant group; in the subsurface, on the other hand, corals are much less abundant.

The four rugose coral species were all originally assigned to Streptelasma and are apparently closely related; they are retained in the Streptelasmataceae. The most abundant of these, both in outcrop and in the subsurface, is Salvadorea selecta (Billings). It apparently tolerated well a wide range of the environments available during deposition of the Gunn. Bighornia patella (Wilson) is the second most abundant coral in outcrop, but ranks third in the subsurface. It may be that specimens of this species, smaller than those of either S. selecta or Lobocorallium trilobatum (Whiteaves), are less likely to intersect the surface of a core and are, therefore, less likely to be noted and counted. However, several well-preserved
specimens were recovered from core. *Deiracorallium angulatum* (Billings) is the third most abundant coral in outcrop, but appears to be rare in the subsurface. Specimens of this species are the smallest of the solitary corals. It may be that many of the smaller specimens that I noted in core descriptions as "solitary rugosan" or "solitary coral fragment" are, in fact, *D. angulatum*. The least abundant (though not uncommon) solitary coral in outcrop, *Lobocorallium trilobatum*, seems to be the second most abundant in the subsurface. This may be due to its size and shape, which make it the most easily recognized and the most likely to be cut in a core, of any of the four species of solitary corals present.

A second factor must be considered concerning relative abundances of faunal elements in outcrop versus the subsurface. The outcrop reveals only about the upper one-third to one-quarter of the Gunn Member; the lower part of the unit does not crop out. Corals seem to attain their peak abundance near the top of the Gunn Member; this is true in core also. But in core, an entire section is commonly present. Where it is not, usually only the lower portion of the Gunn has been cored. Consequently, the apparent abundance of corals in outcrop has been diluted in the subsurface by the presence of the entire section or by the omission of the upper portion. Nevertheless, I think the lesser abundance of corals in the subsurface is real, although it may be accentuated by the factors discussed above.

I have seen no colonial rugosan corals in the Gunn Member, and none has been reported in the literature.
Tabulate corals

Tabulate corals are much less common in the Gunn Member than are rugose corals. However, they are a bit more diverse, with six species in four genera.

The great majority of tabulate corals in the Gunn Member are assignable to the genus *Paleofavosites*. Three species of this genus are present: *P. prolificus* (Billings), *P. okulitchi* Stearn, and *P. manitobensis* n. sp. Of these, *P. prolificus* is, appropriately, the most prolific; about 85 percent of the identifiable *Paleofavosites* material from outcrop, and all the identifiable material from the subsurface, are assignable to this species. Most of the rest of the identifiable specimens are *P. okulitchi*. *Paleofavosites manitobensis* n. sp. is represented by a single specimen from outcrop.

While neither of the latter two species has been identified from the subsurface of North Dakota, this does not mean that they are not present. First, a number of small fragments were present in core, but could not be extracted and identified to species level. Second, both *P. okulitchi* and *P. manitobensis* are rather rare species, the latter especially so. The outcrop area covers a couple of sections, whereas the subsurface is represented by 20 "outcrops" of 5 to 10 cm diameter. Far more material is available for collecting and analysis on the outcrop than in the subsurface, and it should not be surprising that rare species from outcrop are not represented at all in collections from the subsurface.

The encrusting heliolitid, *Protaraea tenuis* (Billings), is also found in outcrop but not in the subsurface. This rather uncommon
widespread. It seemed to be indiscriminate in its selection of substrates; it has been found on several species each of brachiopods, corals, and other bryozoans.

Cryptostomata

Eighteen species of cryptostomes, evenly divided between the rhabdomesines and the ptilodictyines, were found in the Gunn Member. The rhabdomesine species are all members of the Arthrostylidae. Most of the genera are segmented and all are at least basally articulated. Of these nine species, eight are previously undescribed; only the Richmondian index fossil, Sceptropora facula Ulrich, has been reported beyond the limits of the Gunn Member. Only six of these species were found in outcrop, and only S. facula is common. In the subsurface, S. facula is the most abundant bryozoan, with Arthroclema pentagonalis n. sp. and Sceptropora umbelliformis n. sp. also being abundant.

Among the nine ptilodictyine species, six were found in outcrop, although none was common there, and seven were found in the subsurface. The most common species in the subsurface are the segmented forms Dicranopora emacerata (Nicholson), D. fragilis (Billings), D. brevis n. sp., and Goniotrypa bilateralis Ulrich. Indeed, one of the unanticipated findings of this study is the quantity and diversity of segmented bryozoan species. Whether this represents a real difference from other Richmondian faunas or whether the difference is simply due to the underreporting of these microscopic fossils is not possible to determine at this time.
Trepostomata

The trepostomes constitute the most diverse group of fossils in the Gunn Member, with 21 species being present. Of these, 13 are present in outcrop and 18 in the subsurface. Only 10 are definitely assignable to previously described species.

In outcrop, the trepostomes constitute about four percent of the fauna in numbers. The two most common species are the robust branching forms Batostoma manitobense Ulrich and Rhombotrypa multitabulata Utgaard and Perry. Two encrusting species of Monticulipora are also relatively easy to find. Other trepostomes are rare to very rare in outcrop.

In the subsurface, the most abundant trepostomes are those inferred to be segmented species: Eridotrypa nitida (Ulrich), E. compressa n. sp., Bythopora striata Ulrich, and Lioclemella subfusiformis (James). Other relatively common trepostomes include Homotrypa glabra Cumings and Galloway and Batostoma manitobense Ulrich. As is true of the cryptostomes, segmented trepostomes seem to be relatively much more numerous in the subsurface than in outcrop.

Brachiopoda

Both in outcrop and in the subsurface, brachiopods appear to be the most abundant component of the macrofauna. In outcrop, brachiopods constitute almost half the macrofauna, by numbers. Extensive collections were not made from the subsurface, but brachiopods appeared to be dominant there also.

Inarticulate brachiopods are very rare. Two specimens of a
lingulide valve have been collected from core from wells in western North Dakota. No inarticulates are known from outcrop.

The orthide brachiopod *Diceromyonia storeya* (Okulitch) seems to be the most abundant macrofossil, both in outcrop and in the subsurface. In outcrop, it constitutes more than 18 percent of the fauna. The second most abundant brachiopod, both in outcrop and in the subsurface, is the orthide *Dinorthis* (*Dinorthis*) *carletona* Twenhofel. This species represents more than 13 percent of the outcrop fauna, and is the third most abundant macrofossil in outcrop.

About 600 rhynchonellides have been collected from outcrop, half assignable to *Hypsiptycha anticostiensis* (Billings), and the rest about equally divided between *Rhynchotrema gigas* (Wang) and *R. iowense* Wang. More than 300 strophomenides have been collected, with *Oepikina pergibbosa* (Foerste) being the commonest member of this order. *Megamyonia nitens* (Billings) is also well represented, but the two species of *Strophomena*, *S. occidentalis* Foerste and *S. planocorrugata* Twenhofel, are relatively rare. Single specimens of the strophomenide *Furcitella* sp., and the orthides *Hesperorthis pyramidalis* (Twenhofel) and *Hebertella occidentalis montoyensis* Howe, have been collected from outcrop. Only the last of these was found in the subsurface, from which about a dozen specimens have been recovered.

The subsurface has also provided the only atrypides. About 30 specimens, most 2 to 3 mm in diameter, have been collected and are assignable to *Zygospira* sp. and *Cyclospira* sp.
Mollusca

The mollusks are a rather diverse group, but not very abundant. In outcrop, they comprise only about four percent of the macrofauna, and they seem to be an even rarer component of the macrofauna in the subsurface. The gastropods are the most abundant and diverse class of mollusks, with 20 species and more than 90 percent of the total molluscan fauna. Twelve of these species are found in outcrop and 11, mostly microscopic forms less than 1 mm in their greatest dimension, are found in the subsurface.

Cephalopods are quite rare in outcrop, with total cephalopod material comprising less than 0.5 percent of the macrofauna. Only one definite cephalopod has been recovered from the subsurface. Pelecypods are even rarer than cephalopods. All the collections made over the years on field trips to the outcrop have produced only five specimens. From the subsurface, a couple of small steinkerns and several microscopic specimens have been recovered.

The finding of these microscopic mollusks was one of the more interesting and unexpected discoveries of this study. It should not be assumed, however, that these microscopic mollusks are in any way similar to those of the "depauperate fauna" of the Maquoketa Group. First, the Gunn specimens are an order of magnitude smaller than those of the Maquoketa. Second, the Gunn specimens occur with brachiopods and bryozoans that are of a normal size for their species, whereas the Maquoketa specimens occur in a "depauperate zone" that lacks other fossils (Ladd, 1929; Snyder and Bretsky, 1971). Third, there is no evidence for phosphatic sedimentation in the Gunn besides the
microscopic steinkerns, whereas in the basal Maquoketa there are phosphatic nodules. And fourth, the basal Maquoketa appears to be slightly older than the Gunn Member, although a direct comparison is difficult due to the lack of diagnostic guide fossils in the basal Maquoketa. I have not studied the Maquoketa, and have no explanation to offer for the existence of the "depauperate fauna." The microscopic mollusks found in the Gunn seem most likely to be due to a normal molluscan juvenile mortality that has been preserved due to the precipitation of phosphates in the microenvironments of the tiny shells (Lobdell, 1987b).

**Arthropoda**

Trilobite material is fairly common, both in outcrop and in the subsurface, but identifiable trilobite specimens are quite rare. Only 14 specimens, or less than one-quarter of one percent of the outcrop fauna, may be assigned to a genus with any confidence. Only two identifiable specimens have been recovered from the subsurface.

Ostracodes are fairly common in outcrop, where Ulrich (1889) identified eight species. They are abundant in core from the subsurface, but were not studied for this project.

There has been recovered from core some thin, dark brown or black, organic-appearing films. These appear as though they might be phyllocarids, but they are so poorly preserved that nothing more can be done with them.

**Other phyla**

Four other phyla are present in the Gunn Member, but none is treated in this study. Microscopic echinoderm columnals form a
BIOSTRATIGRAPHY

Rare species are too sparsely distributed in the Gunn Member to be of any use as guide fossils, and the commoner species are generally found throughout the unit. This is certainly true of the corals, brachiopods, mollusks, and arthropods. Only the cryptostome bryozoans, and only a few of those, show any indication of being useful as biostratigraphic markers (Lobdell, 1987a).

Stratigraphic information from the subsurface should be interpreted with the greatest caution. The "outcrops" are only 5 to 10 cm in diameter. Indiscriminate collecting is not possible. Given the patchy distribution of most organisms, it seems merely a matter of chance whether a core or core interval will contain members of a species. Also, less material was obtained from the better-indurated cores from western North Dakota. Finally, it must be remembered, when dealing with segmented colonial animals, that one colony may contribute tens or hundreds of specimens, whereas another species, only a short distance away, may contribute very little to the core. Nevertheless, even with all these caveats, it seems possible to draw a few tentative conclusions.

Unfortunately, few wells have a completely cored section of the Gunn Member, and of those that do, only North Dakota Geological Survey (NDGS) Well 20 (locality A2602), in Ramsey County, and NDGS 8803 (A2603), in McHenry County, have contributed enough specimens to be worth considering. Locality A2602 is in northeastern North Dakota (Fig. 1) in an area inferred to have been a rather shallow shelf, and locality A2603 is in central North Dakota, where the water is inferred
to have been somewhat deeper than that at locality A2602. (A more complete discussion of depositional environment is given below; paleogeography was discussed above, under geologic setting.) Regardless of whether inferences as to water depth are correct, these two sites seem to have some differences in relative abundances of cryptosome bryozoans, as summarized in Table 2. The lateral, biostratigraphic differences are particularly striking between the two species of Arthroclema, among the four species of Dicranopora, and in the reduction in the numbers of Sceptropora facula from dominance at locality A2602 to a subordinate role at locality A2603. It is not possible to determine whether these differences reflect water depth, turbulence, or merely geographic separation and patchy distribution of the fauna (the two wells are about 175 km apart).

Table 2. Relative abundances of cryptosome bryozoans, localities A2602 and A2603, expressed as percentage of identified cryptosome specimens.

<table>
<thead>
<tr>
<th>Species</th>
<th>A2602</th>
<th>A2603</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arthroclema brevis</td>
<td>3.4%</td>
<td>15.2%</td>
</tr>
<tr>
<td>A. pentagonalis</td>
<td>15.1</td>
<td>0.8</td>
</tr>
<tr>
<td>Arthrotrypa ovata</td>
<td>0.7</td>
<td>-</td>
</tr>
<tr>
<td>Nematoporella ulrichi</td>
<td>0.7</td>
<td>0.6</td>
</tr>
<tr>
<td>N. falcata</td>
<td>1.2</td>
<td>1.1</td>
</tr>
<tr>
<td>Sceptropora facula</td>
<td>42.9</td>
<td>15.3</td>
</tr>
<tr>
<td>S. umbelliformis</td>
<td>11.6</td>
<td>15.3</td>
</tr>
<tr>
<td>Ulrichostylus costatus</td>
<td>&lt;0.1</td>
<td>1.1</td>
</tr>
<tr>
<td>U. dakotensis</td>
<td>0.5</td>
<td>4.5</td>
</tr>
<tr>
<td>Dicranopora brevis</td>
<td>1.7</td>
<td>27.3</td>
</tr>
<tr>
<td>D. emacerata</td>
<td>9.3</td>
<td>6.1</td>
</tr>
<tr>
<td>D. fragilis</td>
<td>3.5</td>
<td>0.1</td>
</tr>
<tr>
<td>D. meeki</td>
<td>1.0</td>
<td>6.1</td>
</tr>
<tr>
<td>Goniotrypa bilateralis</td>
<td>5.8</td>
<td>1.4</td>
</tr>
<tr>
<td>Endodictya pachyclema</td>
<td>2.6</td>
<td>5.3</td>
</tr>
</tbody>
</table>
These animals are even less useful stratigraphically. The only reasonably good index fossil among them is *Sceptropora facula* Ulrich, generally found in Richmondian strata over much of northeastern and north-central North America, as well as in Greenland and the Baltic area. *Sceptropora facula* is found throughout the entire vertical extent of the Gunn at locality A2602 but is restricted to the upper three-quarters of the interval at locality A2603. However, this absence from the lowest 5.6 m of the section at locality A2603 seems more likely to be due to local conditions, rather than to a real age difference; only four specimens of all species were collected from this lower interval.

Among the other arthrostylids, only *Arthrotrypa ovata* n. sp. and the two species of *Ulrichostylus* show any possibility of being stratigraphically useful. *Arthrotrypa ovata* is restricted to the lowest 10 m at locality A2602, and is not found west of there. *Ulrichostylus costatus* and *U. dakotensis* are also restricted to the lowest 10 m at A2602, but are distributed much as the other arthrostylids at A2603. However, these species are all endemic to the Gunn Member, and therefore have no utility beyond its limits. None of the ptilodictyines seem to have any stratigraphic utility.

**Age of the Gunn Member**

Most workers have considered the Gunn Member to be of Richmondian age (e.g., Whiteaves, 1880, 1895; Dowling, 1900; Okulitch, 1943; Baillie, 1952; Ross, 1957; Witzke, 1980; Barnes et al., 1981; Ross et al., 1982). However, Ethington and Furnish (1960, p. 268-269), in their discussion of the age of the Gunn, observed that most of the
conodonts belonged to long-ranging species. They noted the absence of three genera found in the type Richmondian, and largely on that basis, concluded (p. 269) that the Gunn was "pre-Richmondian, probably Maysvillian; a possibility of early Richmondian must also be considered." They supported their conclusions by citing Sweet et al. (1959, p. 1038-1039), whose "stated conclusions on known conodont ranges," reinforced, Ethington and Furnish believed, their suggested age assignment. However, my interpretation of Sweet et al. (1959, p. 1038) is that, according to their discussion, an early Richmondian age would seem most likely for the Gunn Member.

Macomber (1970), working with brachiopods from the upper Bighorn and Stony Mountain Formations, supported Ethington and Furnish's (1960) conclusions regarding the age of the Gunn. In addition to citing their work, Macomber (1970, p. 424-425) correlated the "Stony Mountain shale" with the Brainard Shale of the Maquoketa Group on lithologic grounds and cited (p. 425) Sweet et al. (1959) in support of his conclusions, that the Brainard Shale is Maysvillian in age.

It must be noted here that no positive evidence has been advanced for a Maysvillian age of the Gunn Member. No Maysvillian index fossil, either conodont or non-conodont, has ever been reported as occurring in the Gunn. The argument for a Maysvillian age was based on a lack of species from the type Richmondian in the Gunn and on lithologic correlation with a unit also lacking these species.

The negative "evidence" may be dismissed out of hand. The fact that index fossils from the type Richmondian are not found 1500 km away, on the other side of a major geographic barrier, is not evidence
either for or against any given age assignment. And lithologic
correlation, between units for which there is no evidence of former or
present interconnection, is a risky business at best.

Indeed, the conodonts may not be very useful in assigning an age
to the Gunn Member. Sweet (1979, p. 50) noted seven species or
subspecies endemic to Richmondian strata of the western midcontinent,
and stated, "Although it can be shown by other means that the rocks to
which these species are apparently restricted are of Richmondian or
post-Richmondian Ordovician age, none is known as yet from strata in
the type area of the Richmondian Stage." Sweet (1979, p. 53)
considered the Gunn Member to be late Richmondian.

Sweet did not enumerate his "other means" by which the Gunn may
be dated as Richmondian, but I would assume that they would include
the presence of recognized Richmondian index fossils in the Gunn.
Established Richmondian index fossils include the solitary coral
Lobocorallium trilobatum (Whiteaves), the cryptostome bryozoan
Sceptropora facula Ulrich, the trepostome bryozoan Rhombotrypa
quadrata (Rominger), and the trilobite Ceraurinus icarus (Billings).
Many other Gunn species have been previously reported only from
Richmondian strata, but are not widespread enough to be considered
index fossils. No index fossil to the Maysvillian or any other stage
was found. Therefore, the Gunn Member is here considered Richmondian
in age.

As I have done no work above or below the Gunn Member, and none
outside of Manitoba and North Dakota, it would seem presumptuous of me
to suggest Upper Ordovician correlations over much of North America.
Recent correlation charts (e.g., Barnes et al., 1981; Ross et al., 1982) seem quite reasonable to me. More information about Upper Ordovician successions and correlations may be obtained by consulting these charts.
PALEOECOLOGY

It was the purpose of this study to identify and describe that macrofauna of the Gunn Member of the Stony Mountain Formation in the subsurface of North Dakota. Thus, many elements necessary in order to make a reasonable attempt at a community analysis have been neglected. Groups such as conodonts, scolecodonts, and ostracodes were not studied. No attempt was made to identify and analyze the ichnofossils, though these are abundant at some horizons and may be quite informative with regard to a paleoecological analysis. No bed-by-bed analyses of either the fauna or the stratigraphy were attempted. Indeed, such analyses might be quite misleading dealing with subsurface material, as cores are invariably fragmented and incomplete. Also, it was not possible to do extensive collecting from the subsurface, as the bulk of the cores must be retained for reference by the North Dakota Geological Survey. So the subsurface collections are biased toward different and unusual specimens, thus skewing relative abundances. From outcrop, only the upper 4 m of the Gunn (all that is exposed) were collected and no stratigraphic collecting was attempted. Nevertheless, within the limits of the study and the constraints imposed by the available material and collecting methods, it is possible to make a few remarks about paleoecology, following the guidelines laid down by Walker and Bambach (1974).

Taphonomy

Most of the fossils are abraded to some degree, but do not show evidence of extensive transportation (Elias, 1982a, 1982c). It is
inferred that they have been reworked "in place" by waves, currents, and the actions of other animals; modern studies have shown that transportation of biotic debris is minimal (Stanton, 1976; Warme et al., 1976).

In outcrop, and in shallow wells from eastern and central North Dakota, brachiopods, bryozoans, and corals are generally well preserved. Skeletons of these animals are inferred to have been calcitic originally, and usually preserve original structure. In wells from western North Dakota, where the Gunn is buried deeper than 3 km, brachiopods are commonly badly decorticated, sometimes to such an extent that identification is difficult or impossible. Many of the orthides and strophomenides are disarticulated, but a large portion of the brachiopods belonging to these orders, and almost all the rhynchonellides, are preserved as articulated fossils.

Mollusks are almost invariably preserved as steinkerns. All of the pelecypods, and all the gastropods except for Phragmolites, are preserved as steinkerns. The larger molluscan steinkerns are composed of calcareous shale or argillaceous limestone, similar to the matrix, and the smaller (less than 2 mm) steinkerns are phosphatic. It is inferred that these mollusks had shells that were originally aragonitic, and that they were lost due to diagenetic processes after the shells were filled with sediment or precipitated minerals. Most of the cephalopods are also preserved as steinkerns, but some of the larger siphuncles appear to have been originally calcitic.
Trilobites are apparently preserved as original material. The hypothesized phyllocarids are preserved as thin, dark brown or black films.

**Niche Analysis**

A faunal list (Table 1), with semiquantitative relative abundances for outcrop, is given above. It would be reasonable to characterize the outcrop fauna as consisting of a brachiopod-solitary coral assemblage. In the subsurface, corals are much less abundant, and the fauna may be considered a brachiopod-bryozoan assemblage, or, in places, just a bryozoan assemblage.

A summary of life habit and trophic group is given below (Table 3). The faunal categories are listed in order of relative abundance; minor groups are not listed.

<table>
<thead>
<tr>
<th>Group</th>
<th>Life habit</th>
<th>Trophic group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brachiopods</td>
<td>Epifaunal, sessile or free-lying</td>
<td>Low-level suspension feeders (filter feeders)</td>
</tr>
<tr>
<td>Bryozoans</td>
<td>Epifaunal, sessile</td>
<td>High-level suspension feeders (most)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low-level suspension feeders (few)</td>
</tr>
<tr>
<td>Corals</td>
<td>Epifaunal, free-lying</td>
<td>Passive carnivores</td>
</tr>
<tr>
<td>Gastropods</td>
<td>Epifaunal, vagile</td>
<td>Browsers, scavengers</td>
</tr>
<tr>
<td></td>
<td>(possibly also shallow infaunal)</td>
<td></td>
</tr>
<tr>
<td>Cephalopods</td>
<td>Nekto-benthic</td>
<td>Active carnivores</td>
</tr>
<tr>
<td>Trilobites</td>
<td>Shallow infaunal or epifaunal, vagile</td>
<td>Deposit feeders, scavengers</td>
</tr>
<tr>
<td>Burrowers</td>
<td>Infaunal, vagile</td>
<td>Deposit feeders</td>
</tr>
<tr>
<td>(not studied)</td>
<td></td>
<td>Suspension feeders (?)</td>
</tr>
</tbody>
</table>
These data must be interpreted with caution. While the inferred life habits and trophic groups are probably fairly accurate for the groups listed, Stanton (1976, p. 121) has demonstrated that, "The trophic structure of a fossil community is not a good estimate of that of the original biocoenosis." He concluded that, "the amount of in-sediment food utilized is underestimated," and, "The proportion of carnivores to primary consumers in each shelled community commonly bears little relation to that in the total community." Thus, given Stanton's conclusions and the limitations of this study, this is about as far as the Gunn community analysis can be pursued safely.
DEPOSITIONAL ENVIRONMENTS

With regard to the physical environment, the presence of abundant brachiopods, bryozoans, and corals indicates that conditions were "normal marine," whatever that was for the Richmondian sea in this area. Nutrients must have been abundant, and it may be inferred that the Gunn community existed within the photic zone. While the substrate may have been rather soft -- the sediments seem to have been clays and fine-grained carbonates -- it could not have been "soupy." Benthic organisms flourished, and bryozoans were obviously able to find suitable substrates. The abundance of filter-feeding organisms indicates that the water was reasonably clear, except during storms; from this we may infer that the Gunn community probably existed below fair-weather wave base.

Much work has been done in recent years on storm depositional systems. A fine case study on Ordovician shelf sediments was done by Kreisa (1981). Good recent summaries have been done by Kreisa and Bambach (1982) and, on a larger scale, by Aigner (1985).

The model proposed by Kreisa (1981, p. 828-829) for his "idealized storm sequence" seems to be pertinent, with modifications, to the Gunn Member. As Kreisa (1981, p. 828) noted, "The model is commonly not found complete in individual beds . . . ." Very briefly, the usual storm sequence begins with a sharp erosional contact between the "normal" mudstone and the overlying limestone. This limestone represents a winnowed bed of shells and other biogenic material, with a very low terrigenous content. Above this is a "laminated unit" (Kreisa, 1981, p. 829) composed of sand- and silt-sized terrigenous
grains, commonly exhibiting "hummocky cross-stratification" (Harms et al., 1975, p. 126). Above these beds is the "normal" mudstone lithology. Upper contacts are usually not as sharp as lower contacts of the sequences, and are commonly further obscured by bioturbation. The theory is that storm waves throw the fine material into suspension, erode the sea bed, and winnow the coarse material, including bioclastic material. As the storm wanes, the coarser suspended material settles out first, creating the hummocky cross stratification and a fining-upward bed. Finally, the fine material settles out and conditions return to "normal."

In the Gunn Member, hummocky cross stratification seems to be absent. This may be attributed to the lack of sand- and silt-sized terrigenous material in the unit. That part of the Gunn that has been preserved in Manitoba and North Dakota apparently lay a few hundred km from the Transcontinental Arch, the postulated source area for the Gunn clastics. Thus, what remains in North Dakota and Manitoba is the clay-sized fraction, and that is not conducive to the formation of bedding structures. Further, bioturbation probably eliminated whatever lamination might have been formed.

Otherwise, the limestone-"shale" couplets found in the Gunn Member, both in outcrop in Manitoba and in the subsurface of North Dakota, seem to agree well with the criteria for storm beds. The basal contacts of the limestones are commonly sharp, and in outcrop they are usually undulatory. Most disarticulated brachiopod valves are found in the hydrodynamically stable convex-upward position, supporting the interpretation that they were reworked. The "shales"
(commonly highly argillaceous limestones) apparently have been thoroughly bioturbated; fossils are preserved in random orientations.

Thus, the environment of deposition of the Gunn Member in North Dakota seems to have been a shallow carbonate shelf or ramp, sloping to the northwest and receiving an input of terrigenous sediment from the southeast. The shelf supported a diverse and abundant fauna of brachiopods, bryozoans, and corals, with minor components of other groups. The sediments were reworked by storms at irregular intervals.

**Suggestions for further study**

This study is not an exhaustive study of the fauna of the Gunn Member; rather, it should be viewed as a reconnaissance in depth. Accurate taxonomic identification must form the basis for all biostratigraphic and paleoecological studies. It is hoped that the present study will provide a platform from which additional problems may be attacked.

The Gunn fauna has been treated as though it were a single community. This may be true, but it is more likely that several communities are represented, distributed both stratigraphically and geographically. Detailed bed-by-bed stratigraphy and paleontology is needed to resolve these questions. Although this work would be complicated by a lack of completeness of the cores, it is possible that a fairly meaningful successional study, such as that done by Bayer (1967) for the Elgin Member of the Maquoketa Formation in southeastern Minnesota, could be done.

Groups that were not a part of this study need work. This gap is being partly filled by R. K. Hawbaker's conodont study (M.S. thesis
in progress), but the ostracodes are untouched and a good deal more scolecodont material is available to update Morgan's (1964) study. It might also prove useful to attempt to do something with the echinoderm columnals.

One of the most urgent needs brought home to me by this study is that for generic, familial, or higher level taxonomic monographs. This most useful sort of paleontologic study, seemingly out of favor today, is especially needed for the Favositidae, Arthrostylidae, Ptilodictyina, Halloporidae, Trematoporidae, Plaesiomyidae, Dalmanellidae, and Rhynchonellacea, to name a few taxa. However, all groups would benefit from monographic treatment.
SUMMARY AND CONCLUSIONS

1. One hundred sixteen species-level taxa were described from the Gunn Member of the Stony Mountain Formation. Forty of these have been found only in outcrop, 35 only in the subsurface, and 41 were found in both outcrop and the subsurface. Of the described taxa, 42 are mollusks, 40 bryozoans, 15 brachiopods, ten corals, eight arthropods, and one stromatoporoid.

2. New genera erected as a result of this study are the cyclostome bryozoan Tubulotrypa and the cryptostome bryozoans Arthrotrypa, Nematoporella, Platydictya, and Endodictya. New species are the tabulate coral Paleofavosites manitobensis; the cryptostome bryozoans Arthroclema brevis, A. pentagonalis, Arthrotrypa ovata, Nematoporella ulrichi, N. falcata, Sceptropora umbelliformis, Ulrichostylus costatus, U. dakotensis, Dicranopora brevis, Platydictya renvillensis, and Endodictya pachyclema; and the trepostome bryozoans, Dekayia micropora, D. aequalis, Tarphophragma clinopora, Eridotrypa compressa, Homotrypa oligophragma, H. tabulata, and H. astrovae.

3. The preserved fauna in outcrop may be considered a brachiopod-solitary coral assemblage. In the subsurface, it is a brachiopod-bryozoan assemblage.

4. Most of the fauna has little utility for biostratigraphic detail. There is a possibility that a few species of microscopic cryptostome bryozoans may be stratigraphically useful, although only one has so far been found outside the Gunn Member.
5. Most of the preserved Gunn fauna consists of animals inferred to have been suspension feeders. Sessile carnivores and vagile browsers and scavengers were less numerous elements of the preserved community, and active predators were rare.

6. A microscopic molluscan fauna, preserved as phosphatic steinkerns, was found in core from four wells in eastern and central North Dakota. This fauna is interpreted to have resulted from normal juvenile mortality, preserved due to the precipitation of phosphate in the microenvironments within the shells.

7. The presence of several Richmondian guide fossils indicates a Richmondian age for the Gunn Member. No index fossils of any other age were found, and no evidence has been adduced for any other age assignment.

8. The term Gunn Member is used herein for the abundantly fossiliferous, alternating, thin limestones and calcareous shales that overlie the Red River Formation and underlie the Penitentiary Member or Gunton Member of the Stony Mountain Formation, both in outcrop and in the subsurface. The term "Stoughton Member" is rejected on the grounds of priority of the name Gunn Member.

9. It is suggested that the name "Stony Mountain Formation" might be restricted to the Gunn Member (or Gunn and Penitentiary Members) of current usage. The Stonewall Formation might be expanded to include the Gunton Member of the Stony Mountain Formation (as presently defined) and at least some of the Interlake Formation.

10. The Gunn is thickest in eastern and south-central North Dakota, just west of its erosional limit. It thins to the northwest
and reaches its depositional limit in eastern Montana and southeastern Saskatchewan.

11. The alternating limestones and calcareous shales or argillaceous limestones of the Gunn Member seem likely to have resulted from a storm depositional system. The decreasing thickness of the Gunn toward the northwest and the decreasing proportion of terrigenous material in the same direction indicate a southeastern source for the clastics. The Transcontinental Arch is inferred to have been the source for the Gunn clastics.
SYSTEMATIC PALEONTOLOGY

Species Concept

The accepted biological definition of species emphasizes gene exchange and naturally interbreeding populations. Obviously, we have no way of determining if a given population of extinct organisms exchanged genes or freely interbred with any other population of similar (or seemingly identical) extinct organisms. Therefore, we must fall back on morphology. Morphology is all we have and all we are ever likely to have for the overwhelming majority of fossil organisms. Our species may be characterized as "morphospecies" rather than "true" species.

Geographic and temporal separation count for something if they are sufficiently large; there is little likelihood that similar-appearing organisms from the Ordovician of North America and the Cretaceous of Australia are closely related. But given the patchiness of the fossil record, I feel strongly that very similar or identical organisms separated by only relatively slight geographic or temporal distance must be considered the same species.

Further, we must accept morphological variation, sometimes quite a lot of variation, among individuals of a species. For instance, Okulitch (1943, p. 71) proposed a new brachiopod species, one individual of which had 28 costae and a width of 30 mm. He thus differentiated it from Twenhofel's (1928, p. 182-183) similar species, an "average" specimen of which had 30 costae and a width of 28 mm. I
regard these differences as trivial and well within the range of individual variation (see Fig. 6, p. 198, for a plot of width versus number of costae in Dinorthis (Dinorthis) carletona). All individuals of a sexually reproducing species must be different from the type specimen; the practice of considering minor variation grounds for erection of a new species, carried to its logical extreme, would leave each individual with its own species name. I have, therefore, embraced a rather broad species concept, and have placed species in synonymy when I could find no significant difference between them. For species occurring outside the Williston Basin, I worked solely from published descriptions and illustrations, and thus may be in error in some of my taxonomic decisions. If I should unite two species that should have been kept separate, they may be separated again by some future worker. But I regard it as a greater disservice to science to perpetuate distinct species names for groups of organisms having no significant morphological differences from other organisms that happened to live a few kilometers or a few years apart from each other. Indeed, given the spottiness of the fossil record, it may well be that populations were originally connected either spatially or temporally, and it is only the lack of preservation or subsequent erosion that has rendered them discrete populations.

Organization

In so far as possible, higher taxa are presented as given in the Treatise on Invertebrate Paleontology. In many groups, however, supra-generic classification is in a state of flux. In these cases, a classification has been followed that seems to represent the best of
current thinking of workers in a given field. For example, Rzhonsnitskaya (1960) has elevated the Atrypida to ordinal rank, and this has been accepted by Copper (1977, 1986), among others. It seems likely that this change will be adopted in the revised brachiopod volume of the Treatise; Copper is doing the revision of the atrypides.

Under the genus, I have listed the type species, diagnosis, and, if necessary, a discussion. In the diagnosis, I have tried to give characters of the genus that are most helpful in distinguishing the genus from similar genera in the same family or subfamily.

Species Description

Under the species description are the synonymy, material and occurrence, diagnosis, and discussion.

Synonymy

In the synonymy I have listed all the authors and works in which a description or illustration of a given species could be found. Additionally, I have included in the synonymy all faunal lists in which the species is mentioned as having been found at Stony Mountain. I have also listed other works in which I believe that specimens were questionably or erroneously assigned to the species under consideration; these listings are preceded by a "[?]

Material and Occurrence

In this section I give a close estimate of the number of specimens, their condition in general, and the localities where I found them. I believe it important to give this information. As a paleontologist reading others' papers, I want to know if their species
descriptions are founded on one fragmentary specimen, several well-preserved specimens, or a population of 50 or 500 individuals.

If I had just a few specimens, I give a precise count. If I had a considerable number, I give a minimum figure. Thus, if I have counted 912 individuals assignable to a given species, I say that I have "more than 900" specimens. This includes not only the counted specimens, but others too fragmentary or imbedded in matrix to be counted as part of the collection. This is particularly true of subsurface work. It is not prudent to destroy large quantities of core in order to extract the fossils; therefore, I collected sparingly from the subsurface, usually restricting my collecting to unusual or rare specimens. However, I noted the existence of many specimens in core that I did not collect. In addition, I have seen specimens in private collections and at the Manitoba Museum of Man and Nature. All of these specimens contributed to my concept of a species.

**Diagnosis and Discussion**

The diagnosis gives those features by which a species may most readily be distinguished from congeneric species. Where possible, it is based on features seen in many specimens; the approach is population-based rather than typological. Particular characters by which the species under consideration may be differentiated from similar-appearing species are given in the discussion. The discussion also contains the reasoning supporting my taxonomic decisions.
However, more recent stromatoporoid workers (Galloway and St. Jean, 1961; Flugel and Flugel-Kahler, 1968; Stearn, 1980) have accepted Aulacera as the correct genus for species previously assigned to Beatricea.

The designation of a type species for Aulacera has also engendered some controversy. Plummer (1843) described and illustrated Aulacera from material collected in the vicinity of Cincinnati, Ohio. However, he named no species, and included none in his new genus. By 1919, when Schuchert placed the two genera in synonymy, at least five species and subspecies of Beatricea had been named. Schuchert, however, mentioned only two of these (B. nodulosa and B. undulata) in quoting Billings's (1857) original description. Schuchert (1919, p. 293-294) felt that Plummer's original material was conspecific with B. undulata, and wrote (p. 294) of the latter, "this, therefore, becomes the genotype of Aulacera."

Galloway and St. Jean (in Galloway, 1957; 1961) disagreed with Schuchert (1919) regarding the specific assignment of Plummer's material. Galloway and St. Jean found significant differences between Plummer's specimens and those designated Beatricea undulata by Billings (1857). Galloway and St. Jean (in Galloway, 1957), therefore, erected Aulacera plummeri to accomodate material from the Cincinnati area, and regarded this species as the type species of Aulacera, as it was the species described (but not named) by Plummer (1843). Galloway and St. Jean (in Galloway, 1957; 1961) cited Opinion 46 of the International Rules of Zoological Nomenclature as their authority. The designation of A. plummeri as the type species
of Aulacera by monotypy was accepted by Flugel and Flugel-Kahler (1968, p. 530).

In my opinion, Article 69 of the most recent Code (ICZN, 1985a, p. 131-137) is fairly clear on this subject: Article 69 (a) (i) (1) reads, "If no nominal species was included at the time the nominal genus or subgenus was established, the nominal species that were first subsequently and expressly included in it in any of the ways referred to in this Subsection are deemed to be the only originally included nominal species." As Schuchert (1919) mentioned only two species (Beatricea nodulosa and B. undulata) these then became the only "originally included nominal species." Article 69 (a) reads, "... [T]he first author who subsequently designates one of the originally included nominal species ... validly designates the type species ..., and no later designation is valid." I am, therefore, regarding Schuchert's (1919, p. 294) statement, quoted above, as the designation of the type species of Aulacera; the subsequent designation by Galloway and St. Jean (in Galloway, 1957) should be regarded as invalid.

?Aulacera sp. aff. A. cylindrica (Foerste, 1909)

Diagnosis.—Coenosteum cylindrical, about 25 to 30 mm in diameter and probably exceeding 200 mm in length; surface smooth, lacking nodes or ridges; axial column may be about 10 mm in diameter; latilaminae 3 to 5 mm thick; pillars not observed.

Material and occurrence.—One specimen (UND 6999.) has been recovered from outcrop (locality A2597). The specimen is partly crushed and is extensively bored and recrystallized.
Discussion.--Boring and recrystallization have obscured many of the details necessary to make a confident generic and specific assignment. The specimen has been compressed so that the cross section is now an ellipse measuring about 18 by 38 mm. The presence of large hemispherical cysts in the axial column is a diagnostic feature of Aulacera. It may be that when the specimen was crushed these cysts were all ruptured, with any evidence of these cysts being destroyed due to dissolution and recrystallization. The axial column is now filled with matrix and sparry calcite; thus, the generic assignment is only tentative.

This specimen seems most like Aulacera cylindrica (Foerste, 1909a). In their discussion of A. cylindrica, Galloway and St. Jean (1961, p. 38-39) gave maximum dimensions of 25 mm for the diameter and 100 mm for the length of their largest fragment. The Gunn Member specimen seems somewhat larger than that. The restored diameter appears to be close to 30 mm, and the fragment measured about 185 mm in length, with no basal attachment evident. I do not regard the larger size of this specimen as precluding assignment to the same species as the slightly smaller specimens collected in the Cincinnati area. Aside from the larger size, the Stony Mountain specimen seems no different, insofar as the preservation permits comparison, from specimens of A. cylindrica collected in the type area.

Four species of Aulacera have been previously reported from the Gunton Member of the Stony Mountain Formation (Baillie, 1952, p. 32). This constitutes the first report of a stromatoporoid from the Gunn Member.
Phylum CNIDARIA Hatschek 1888
Class ANTHOZOA Ehrenberg 1834
Subclass RUGOSA Milne-Edwards and Haime 1850
Order STAURIIDA Verrill 1865
Suborder STREPTELASMATINA Wedekind 1927
Family Streptelasmatidae Nicholson 1889
Subfamily Streptelasmatinae Nicholson 1889
Genus Bighornia Duncan 1957

Type species.--Bighornia parva Duncan, 1957 (by original designation).

Diagnosis.--Corallum solitary; cardinal side concave; apical region flattened; minor septa very short; cardinal septum short, in cardinal fossula; septa completely dilated in early stages, moderately to strongly dilated in later stages; axial structure usually a solid columella contiguous with the counter septum; tabulae sometimes present in late stages of larger species; cross-section oval, subtriangular, crescentic, or circular (adapted from Duncan, 1957, p. 608; Neuman, 1969, p. 70-71; Elias, 1981, p. 24; Hill, 1981, p. F151-F153).

Discussion.--Elias (1982b, p. 80) commented on the similarity between Bighornia and Densigrewingkia. The latter genus was named by Neuman (1969, p. 50) for an Upper Ordovician streptelasmatic from Norway. Both genera, in unusually large specimens, tend to resemble Grewingkia, and their precise relationship was termed "uncertain" (Elias, 1982b, p. 80). If these two genera should prove to be synonymous, Bighornia has priority and would be retained.
Bighornia patella (Wilson, 1926)

Plate 1, figs. 1-5

Streptelasma patellum Wilson, 1926, p. 13, pl. 2, fig. 1.

[?] Streptelasma aff. breve (Ulrich) Winchell and Schuchert Troedsson, 1929, p. 109, pl. 26, figs. 6, 7.

Lindstromia solearis Ladd, 1929, p. 397-399, pl. 4, figs. 6-12.

Holophragma anticonvexa Okulitch, 1943, p. 68-69, pl. 1, figs. 11, 12; Bassler, 1950, p. 22; Baillie, 1952, p. 32.

"Holophragma" sp. Duncan, 1956, pl. 22, figs. la-1c; Ross, 1957, pl. 37, figs. 3, 5-7.

Bighornia parva Duncan, 1957, p. 611-614, pl. 70, figs. 1-18; Norford, 1962, pl. 6, figs. 12, 16.


Bighornia sp. Nelson, 1959, pl. 4, figs. 3a-3d.


Diagnosis.--Small to medium size for genus (length up to 34 mm); shape usually trochoid, but cetartoid or subcalceolid; cross section subtriangular, or crescentic, becoming oval to subcircular in later stages; apex usually flattened in alar-alar plane, becoming less flattened during ontogeny; major septa as many as 45; spoon-shaped depression commonly near the apex on cardinal side; columella usually formed by expansion of counter septum; cardinal septum becomes short,

Material and occurrence.--More than 850 specimens of Bighornia patella have been collected from the outcrop area at Stony Mountain, Manitoba; the bulk of these have come from locality A417. In the subsurface, specimens have been collected from localities A2602, about 3 m and 10 m above the base of the Gunn Member, and A2618, about 15 m above the base. Most specimens are somewhat abraded and the calices are usually filled with matrix, but diagnostic features are normally preserved.

Discussion.--Wilson's (1926, p. 13, pl. 2, fig. 1) sketchy description and single illustration of the exterior of a broken specimen of Bighornia patella are so inadequate as to make positive assignment of the Stony Mountain material to that species uncertain. Elias (1983, p. 952) felt that it is more prudent to await a redescriptions of Wilson's holotype and the collection and description of topotype material before pronouncing the final word on the specific assignment of the Stony Mountain Bighornia. There is certainly merit in this view, but my personal preference is for making a definite assignment now. The Stony Mountain material undoubtedly constitutes a valid species, and there is an abundance of material. I can not distinguish between the Stony Mountain forms and Wilson's description and illustration. A subsequent redescriptions may necessitate a reassignment of or the erection of a new species for the Stony
Mountain forms, but in the meantime, I am considering the latter

B. patella.

Caramanica (1973, p. 397) noted that the species description for

Bighornia parva "falls well within" the species diagnosis for

B. patella. Nevertheless, he (p. 398) distinguished these species on

the basis of the former being "more consistently triangulate in

outline" than the latter. I feel that the cross-sectional outline of

this species is rather variable, as documented by Elias (1983, his

figs. 14 and 16) and can not be used as a diagnostic feature at the

species level.

Caramanica (1973, p. 385, 387-391) also informally erected a new

species based on 13 specimens from the Gunn Member. He distinguished

his new species from other species of Bighornia by "its compressed

ceratical shape, its prominently inclined, shallow calyx, and the

absence of minor septa." The variability of cross-sectional outline

within B. patella was discussed above, and Caramanica (1973, p. 394)

commented on the variability of the orientation of the calical rim in

the latter species.

With regard to the minor septa, Elias (1983, p. 951) reported,

"Minor septa . . . are poorly defined throughout ontogeny." Writing

of B. patella, Caramanica (1973, p. 396) said, "The minor septa are

completely embedded in the septal sclerenchyme . . . ." I have

examined the thin sections of one specimen of Caramanica's new species

(UND 13606.) and I believe that minor septa are indeed present in this

"species." Therefore, I am considering all of Caramanica's Bighornia

material to be B. patella.
Elias (1981, p. 24-25) gave an extensive listing of the species of Bighornia. Many of these have been placed in synonymy with B. patella (see above); of the remaining species, many are so poorly described and illustrated that it can not be determined whether they are synonymous. Bighornia patella may be distinguished from B. integriseptatum (Parks, 1915) and B. bottei (Nelson, 1963) by the much smaller size of B. patella. Other species are questionable or too poorly known for purposes of comparison.

Bighornia patella is readily distinguishable from other solitary corals in the Gunn Member. It is the only coral to have a concave cardinal side, and the only one that is consistently wider in the alar-alar plane than in the cardinal-counter plane.

Genus Deiracorallium Nelson, 1963

Type species.--Deiracorallium manitobense Nelson, 1963 (by original designation).

Diagnosis.--Coral solitary, trochoid, triangular to weakly trilobate in cross-section; the convex (cardinal) side formed into a distinct angulation; axial structure absent or small; cardinal fossula well-defined; major septa numerous and may meet at the center, with or without contortion; minor septa present, confined to the stereozone or extending beyond it; tabulae present or absent (adapted from Nelson, 1963, p. 37; Nelson, 1981, p. 52; Elias, 1981, p. 21).

Deiracorallium angulatum (Billings, 1862)

Plate 1, figs. 6, 7, 10

Petraia angulata Billings, 1862, p. 103, fig. 90; Billings, 1866, p. 7.
Streptelasma angulatum (Billings) Lambe, 1901, p. 112; Twenhofel, 1928, p. 111-112, pl. 3, fig. 5.

"Streptelasma angulatum (Billings)" Cox, 1937, p. 4, pl. 1, fig. 5; Nelson, 1959, pl. 4, fig. 2.

Streptelasma trilobatum (Whiteaves) Okulitch, 1943, pl. 1, figs. 13, 14.


Deiracorallium angulatum (Billings) Elias, 1982b, p. 64-65, pl. 6, figs. 21-33; Elias, 1983, p. 938-942, figs. 7C. 11A-11T.

**Diagnosis.**—Small corals, strongly angulate at cardinal margin; major septa meet at axis; septal dilation strong to complete throughout most of ontogeny; minor septa short (based on Nelson, 1963, p. 38; Caramanica, 1973, p. 368; Nelson, 1981, p. 54; Elias, 1982b, p. 64; Elias, 1983, p. 939).

**Material and occurrence.**—More than 450 specimens have been collected from outcrop. In the subsurface, a single specimen was collected from locality A2600, about 4 m above the base of the Gunn Member, and five specimens were collected from A2602, scattered through the lowest two-thirds of the Gunn. Most of these corals show signs of wear, although the epitheca is preserved on a substantial portion of them.

**Discussion.**—The angulate cardinal margin and small size of Deiracorallium angulatum serve to distinguish this species from most of the other Stony Mountain corals. As noted by Elias (1983, p. 941), it may be difficult or impossible to distinguish immature specimens of...
Lobocorallium trilobatum from D. angulatum of the same size. There are, however, certain differences. Based on my examination of the apices of a number of specimens of L. trilobatum, I find it is less sharply angulate, expands more abruptly, and has a greater alar-alar dimension in proportion to its counter-cardinal dimension than do specimens of D. angulatum. These differences were also noted by Elias (1983, p. 941). In fact, Nelson's (1963, pl. 13, fig. 3) illustration of his D. manitobense var. churchillense looks a good deal like a young L. trilobatum, a species also present in the Hudson Bay lowlands, where Nelson worked. For this reason, D. manitobense var. churchillense is not included in the synonymy above.

Elias (1983, p. 938) erected a new subspecies, D. angulatum gunni, to accommodate the Stony Mountain material. He distinguished these specimens from the Anticosti Island form (D. angulatum angulatum) on the basis of the more common tabulae, shorter minor septa, and less sharp angulation in early ontogenetic stages of D. angulatum gunni. I am reluctant to accept these subspecies on the grounds of these subjective and, at best, semi-quantitative differences. I would like to see tests of statistical significance, based on adequate population samples, applied to the differences in number of tabulae and minor septal length. For the present, I think it prudent to place both the Stony Mountain and the Anticosti Island material in the same species, without subspecies distinction.

Genus Lobocorallium Nelson, 1963

Type species.—Streptelasma rusticum var. trilobatum Whiteaves, 1895 (by original designation).
Diagnosis.—Coral solitary, medium to large; trilobate cross-section created by two broad longitudinal furrows; cardinal side convex; cardinal fossula narrow or indistinct; major septa numerous, completely dilated in early stages but may become less dilated in mature forms, and meet in the center to twist together and form an axial structure, which may be absent occasionally; minor septa poorly developed; tabulae numerous, complete (adapted from Nelson, 1963, p. 34; Nelson, 1981, p. 49; Hill, 1981, p. F158; Elias, 1982b, p. 75).

Discussion.—There is a dispute between current workers as to the characteristics of the genus. Elias (1982b, 1983) would include only L. trilobatum (and its two subspecies) in Lobocorallium. Nelson (1963, 1981), on the other hand, would also include L. haysi, a species that Elias (1982b, 1983) referred to Grewingkia. Lobocorallium haysi (or G. haysi) is moderately trilobate, though not as strongly so as L. trilobatum. Septal dilation is strong also in L. haysi, but complete dilation does not persist to the calice, as it does in L. trilobatum. It becomes a fairly subjective exercise as to where one wishes to draw the line, and I share Nelson's preference to draw the generic distinction between no (or almost no) trilobation on the one hand, and moderate to strong trilobation on the other, rather than between moderate and strong trilobation. An alternative is to assign L. haysi and L. trilobatum both to Grewingkia. But I am most reluctant to separate L. haysi and L. trilobatum at the generic level. I have therefore tailored the above diagnosis to accommodate L. haysi, following Nelson (1963, 1981) most closely.
Lobocorallium trilobatum (Whiteaves, 1895)

Plate 1, figs. 9, 14, 15, 19

Streptelasma rusticum var. trilobatum Whiteaves, 1895, p. 113; Lambe, 1901, p. 115.


Streptelasma trilobatum Whiteaves Cox, 1937, p. 13-14, pl. 2, figs. 5a-5c; Okulitch, 1943, p. 61 (non pl. 1, figs. 13, 14); Bassler, 1950, p. 22; Baillie, 1952, p. 32; Duncan, 1956, pl. 21, figs. 3a, 3b; Ross, 1957, pl. 37, figs. 1, 2; Nelson, 1959, pl. 3, fig. 3; Brindle, 1960, pl. 4, figs. 1, 2.

[?] Deiracorallium manitobense var. churchillense Nelson, 1963, pl. 13, fig. 3.


Diagnosis.--Major septa completely dilated almost to base of calice; axial structure small and simple, commonly trilobate in large specimens; minor septa insignificant or lacking (modified from Caramanica, 1973, p. 358-359 and Elias, 1983, p. 944).

Material and occurrence.--Almost 100 specimens have been collected from outcrop. From the subsurface of North Dakota, specimens have been collected from localities A2600, about 4 m above the base of the Gunn Member, and A2614, about 2 m above the base. These specimens are in various states of preservation. All have been abraded, though a surprising number retain the epitheca. Most are fragmentary, many lack the apex and others are broken in some other
manner. Nevertheless, a collection of this size permits all the
features of the species to be adequately studied and known.

Discussion.—Lobocorallium trilobatum is the largest of the Stony
Mountain solitary corals, and the only trilobed one. There is not the
slightest difficulty in distinguishing it from the other species
present in the Gunn Member except in the earliest ontogenetic stages,
when trilobation is only incipient and young L. trilobatum may
resemble Deiracorallium angulatum.

Elias (1982b, p. 75) placed Zaphrentis vaurealensis Twenhofel,
1928, in Lobocorallium, erecting the subspecies L. trilobatum
vaurealense and assigning the Stony Mountain material to L. trilobatum
trilobatum. Elias (1982b, p. 76; 1983, p. 948) distinguished these
two subspecies on the basis of the Anticosti Island forms
(L. trilobatum vaurealense) being less markedly trilobate,
particularly in later stages; having less strongly dilated major septa
in intermediate and late stages; having fewer major septa; and having
a larger axial structure. Lobocorallium trilobatum vaurealense
appears to occupy a position, with respect to these morphologic
features, between L. haysi and L. trilobatum trilobatum, although
somewhat closer to the latter (Elias, 1982b, p. 76). Subspecific
status may be about right for these two forms; however, as they are
readily distinguishable on both external and internal morphology and
are currently separated by about 3500 km, I would prefer to recognize
L. vaurealense and L. trilobatum as distinct species.

Elias (1981, p. 17-18) assigned both Streptelasma foerstei
Troedsson, 1929 and Lobocorallium trilobatum var. major Nelson, 1963,
to Grewingkia haysii. I concur in these assignments, except that I would reassign Elias's G. haysii to Lobocorallium. I therefore recognize three species of Lobocorallium: L. haysi, L. vaurealense, and L. trilobatum. The last of these, the species found in the Gunn Member, is easily distinguished from the other two species by its stronger trilobation and septal dilation and weaker axial structure.

Genus Salvadorea Nelson, 1981

Type species.—Salvadorea kingae Nelson, 1981 (by original designation).


Salvadorea selecta (Billings, 1865)

Plate 1, figs. 8, 11, 12

Petraia selecta Billings, 1865, p. 429; Billings, 1866, p. 7, 33.

Streptelasma corniculum Hall Whiteaves, 1880, p. 49C.

Streptelasma rusticum (Billings) Whiteaves, 1895, p. 113; Dowling, 1900, p. 49F; Bassler, 1915, p. 1204 (partim); Bassler, 1950, p. 22; Baillie, 1952, p. 32.

Streptelasma latusculum (Billings) Lambe, 1901, p. 114-115 (partim; non pl. 6, fig. 9); Okulitch, 1943, p. 61; Bassler, 1950, p. 22.
Streptelasma selectum (Billings) Lambe, 1901, p. 113 (partim; non pl. 6, fig. 8); Bassler, 1915, p. 1204-1205 (partim); Twenhofel, 1928, p. 113 (partim).

? Streptelasma aff. S. latusculum (Billings) Duncan, 1956, pl. 21, fig. 1.

? Streptelasma cf. S. latusculum (Billings) Ross, 1957, pl. 37, figs. 4, 8.

Helicelasma selectum (Billings) Elias, 1982b, p. 62-63, pl. 6, figs. 10-20; Elias, 1983, p. 934-938, figs. 6A-6X, 7A.

Salvadorea selecta (Billings) Elias, 1985, p. 43, 45.

Diagnosis.—Salvadorea "... with generally small axial structure of a few septal lobes and lamellae in late stage. Septa and axial structure normally completely dilated until immediately below calice, where dilation decreases; axial ends of major septa remain greatly to completely dilated below calice. Cardinal septum becomes thin in late stages and short immediately below or within calice. Cardinal fossula moderately broad in late stages. Tabulae rare." (Elias, 1983, p. 934).

Material and occurrence.—More than 1000 specimens of Salvadorea selecta have been collected from Locality A417 and other localities in the vicinity of Stony Mountain, Manitoba. Specimens have been collected from subsurface localities A2602, from horizons about 4 m and 20 m above the base of the Gunn Member; A2616, about 24 m above the base; A2618, about 15 m above the base; and A2624, about 15 m above the base. Unidentifiable fragments of solitary corals have been noted from all cores; many of these are probably Salvadorea selecta. Almost all
of these specimens have been more or less abraded, and have their calices filled with matrix.

Discussion.—This species has been, in the past, most commonly called *Streptelasma rusticum* or *Streptelasma latusculum*. Elias (1983, p. 938), who has examined both the Stony Mountain and the Anticosti Island solitary rugosan faunas, reported that the Stony Mountain material "... cannot be distinguished from *Helicelasma selectum* [Salvadorea selecta] ... on Anticosti Island ..." He also reported (p. 938) specimens in the collections of the Geological Survey of Canada labelled *Streptelasma rusticum* by Whiteaves (1895) and subsequently called *Streptelasma latusculum* by Lambe (1901) are all *Salvadorea selecta*.

Caramanica (1973, p. 299) informally erected a new species to accommodate the Stony Mountain material. He recognized that this material was assignable to neither *S. rusticum* nor *S. latisculum*, but failed to realize its identity with *Streptelasma selecta*. Given the inadequacy of the descriptions and complete lack of illustration of the latter species, this is understandable. It required a re-examination of the syntype and toptype material (see Elias, 1982b, p. 62-63) in order to determine that the Stony Mountain species is identical with *Salvadorea selecta* from Anticosti Island.

*Salvadorea selecta* may be distinguished from the other Stony Mountain solitary corals by being the only species that retains a circular or subcircular cross-section throughout ontogeny. It may be distinguished from *S. randi*, present in the underlying Red River
Formation, by retaining complete septal dilation until the latest stages of ontogeny, whereas the latter species has non-dilated septa in later stages (Elias, 1983, p. 938).

Elias (1983) originally assigned this species to Helicelasma Neuman, 1969, but he (1985, p. 43, 45) reassigned it to Salvadorea due to the presence of a pronounced cardinal fossula in the Stony Mountain material, and the belief that the fossula is of generic significance.

Subclass TABULATA Milne-Edwards and Haime, 1850
Order FAVOSITIDA Wedekind, 1937
Suborder FAVOSITINA Wedekind, 1937
Superfamily Favositicae Dana, 1846
Family Favositidae Dana, 1846
Subfamily Paleofavositinae Hill, 1981
Genus Paleofavosites Twenhofel, 1914

Type species.—Favosites asper d'Orbigny, 1850 (by original designation).

Diagnosis.—Corallum massive, ramose, foliaceous, or encrusting; corallites prismatic, thin-walled, usually contiguous and polygonal; mural pores in the corners of the corallites, usually alternating in position on either side of the angle; wall pores and solenia are more or less abundant in some species; septal spines and squamulae in some species; tabulae thin, complete, subhorizontal (adapted from Powell and Scrutton, 1978, p. 313).

Discussion.—Much confusion and controversy has attended the description of this genus and its contained species. Twenhofel (1914, p. 24) designated Favosites asper the type species of Paleofavosites
in the mistaken belief that the European species *P. asper* was conspecific with *P. prolificus* (Billings) and *P. capax* (Billings) from Anticosti Island. He subsequently (1928, p. 125) tried to rectify the situation by designating *P. prolificus* as the type species, but his original designation must stand unless the International Commission on Zoological Nomenclature determines that the type species was misidentified as provided for in Article 70(b) of the Code (ICZN, 1985a, p. 137). There is no evidence that Twenhofel saw a specimen of *P. asper*, and it is clear from his (1914, p. 24) diagnosis ("pores at the angles with none on the sides") that he had in mind the Anticosti specimens. However, barring action by the Commission, his original designation of a type species must stand.

Powell and Scrutton (1978) redescribed *Paleofavosites asper*, including the holotype and a topotypes. Angle pores ranged from 55 to 91 percent of the total pores, while wall pores ranged from less than one percent (but never zero) to 40 percent. (The remainder of the pores were solenia.) This redescription, showing that the type species possessed wall pores, sometimes in substantial quantities, necessitated a redefinition of *Paleofavosites* to include species with angle pores only and those with both angle and wall pores.

Based on the redescription and redefinition, Powell and Scrutton (1978, p. 312-313) placed a number of genera in synonymy with *Paleofavosites*, most notably *Mesofavosites*. This latter genus was erected by Sokolov (1951, p. 61) to accommodate favositids having pores both at the angles and in the walls of the corallites. However, due to the wide range of intraspecific variability in a number of
characteristics previously considered diagnostic at the generic level, Powell and Scrutton (1978, p. 312-313) placed five genera in synonymy with Paleofavosites.

Powell and Scrutton (1978, p. 310) favored a broad interpretation of this genus, as may be seen from the diagnosis above, which is largely theirs. I am not entirely convinced that it would be inappropriate to erect a genus (perhaps Protofavosites?) to accommodate those favositids meeting Twenhofel's (1914, p. 24) original description: favositids having pores only in the corners of corallites, and none in the walls. Unfortunately, Billings's types are apparently lost: Bolton (1960), in his catalogue of type fossils of the Geological Survey of Canada, failed to mention Billings's types. What seems to be required is a description of a topotype collection. Lacking this, I feel that it would be premature to erect a new genus at this time.

Even the spelling of the generic name (Paleofavosites versus Palaeofavosites) has been the subject of controversy. This controversy has now been resolved in favor of retaining Twenhofel's (1914, p. 24) original spelling, as recommended by Caramanica (1975). Laub (1979, p. 260-263) has presented an interesting account of this dispute.

**Paleofavosites prolificus** (Billings, 1865)

Plate 1, figs. 17, 18, 20

**Favosites prolificus** Billings, 1865, p. 429; Billings, 1866, p. 6, 32;
Whiteaves, 1880, p. 49C; Whiteaves, 1895, p. 113-114;
Dowling, 1900, p. 49F.
Favosites aspera d'Orbigny Lambe, 1899, p. 4-6, pl. 1, fig. 2
(partim).
Paleofavosites aspera (d'Orbigny) Twenhofel, 1914, p. 24 (partim).
non Paleofavosites prolificus (Billings) Twenhofel, 1928, p. 126;
   Nelson, 1963, p. 52, pl. 7, fig. 5; Laub, 1979, p. 263-271,
   pl. 9, figs. 1-5, pl. 29, figs. 3, 4, pl. 39, figs. 1, 3;
   Bolton, 1981, pl. 8, figs. 5, 6.
Paleofavosites capax (Billings) Twenhofel, 1928, p. 125-126; Okulitch,
   1943, pl. 1, fig. 17; Bassler, 1950, p. 22.
[?] Paleofavosites cf. capax (Billings) Okulitch, 1943, p. 61;
   Baillie, 1952, p. 32.
Paleofavosites asper (d'Orbigny) Bassler, 1950, p. 22.
Paleofavosites prolificus (Billings) Bassler, 1950, p. 22; Baillie,
   1952, p. 32; Stearn, 1956, p. 60, pl. 4, fig. 1, pl. 10,
   fig. 13.
[?] Paleofavosites kuellmeri Flower, 1961, p. 74-75, pl. 36,
   figs. 1-8.
[?] Palaeofavosites capax (Billings) Nelson, 1963, p. 53 (partim)
   (non pl. 7, fig. 4).
Paleofavosites sp. A Bolton, 1980, p. 16, pl. 2.3, fig. 3.
[?] Paleofavosites sp. cf. P. forbesiformis Sokolov Bolton, 1981,
   pl. 2, figs. 3, 4, pl. 3, figs. 9, 10.

Diagnosis.—Coralla small and nodular to large and discoidal,
intermediate forms appearing somewhat hemispherical; adult corallites
thin-walled, subpolygonal in outline, averaging between 2.0 and 2.5 mm
in diameter; pores common to abundant in corners; solenia not uncommon;
wall pores rare to absent; septal spines uncommon; tabulae may be crenulate and deflected where attached to walls (modified from Stearn, 1956, p. 60, and Caramanica, 1973, p. 221).

Material and occurrence.—More than 50, more or less complete coralla, ranging in size from less than 20 mm in their largest dimension to 355 mm, have been collected from the outcrop area, largely from locality A417. Most of the larger coralla are preserved in growth position, although at least one overturned colony has been found. In the subsurface, fragments have been collected from localities A2602, about 10 m above the base of the Gunn Member, and A2626, about 18 m above the base; an entire small corallum was collected from A2601, about 25 m above the base; and fragments of two larger coralla were cored at A2618, about 20 m above the base. Only the specimens from the last two localities may be positively identified as belonging to this species. The others, and the fragments noted in core from localities A2603, A2616, A2619, A2624, and A2625, probably belong to P. prolificus, though the possibility must be admitted that they may be assignable to a different species of Paleofavosites.

Discussion.—Many characteristics have been used in an effort to differentiate species of favositid corals. One of these has been corallite diameter. Many coralla display a remarkable homogeneity of corallite size, but some show a considerable variation. Jones (1936, p. 3-7, text-figs. 1-12) demonstrated, using a set of serial sections spaced at 2 to 3 mm intervals in a "Favosites forbesi," that small corallites represented immature individuals, and that they enlarged until the adult size was reached as they approached the surface of the
corallum. Sutton (1966, p. 255, 257) tested various criteria, including abundance of spines, corallite wall thickness, and corallite "diameter" (which he defined [p. 257; text-fig. 1, p. 259] as the mean of the longest corner-to-corner measurement and the shortest wall-to-wall measurement). He suggested (p. 257) that in a thin section containing a thousand or more corallites, the 100 largest "could certainly be considered as adult." Sutton found adult corallite diameter to be the most reliable specific characteristic. Powell and Scrutton (1978) tested form of septal processes (spines versus squamulae on *Paleofavosites asper*, as well as mural pore diameter and distribution) and found these features also to be of limited taxonomic value at the species level. They concurred (p. 317) with Sutton (1966) in considering adult corallite diameter the most diagnostic feature, as did Laub (1979, p. 222) who worked with Lower Silurian favositids in the Cincinnati Arch region. Scrutton subsequently (1981) advocated using corallite area, rather than "diameter," when measuring irregularly shaped corallites.

The above discussion of the diagnostic value of corallite diameter seems necessary in view of the confusion and conflicting descriptions that have attended various accounts of *Paleofavosites prolificus*. Billings (1865, p. 429) described the species as having corallites "about 1 line [2.1 mm] in diameter." Whiteaves (1895, p. 113), who examined a specimen "labelled 'Favosites prolificus' in Mr. Billings's own handwriting," reported that the corallites "average about two millimetres in diameter."
Lambe (1899, p. 5) mistakenly placed three North American species (including *Favosites prolificus*) in synonymy with *F. aspera*, and reported an "average width of nearly 2 mm" for the corallites of this species as he conceived it. He documented considerable variability in corallite diameter, which is understandable in view of his lumping what are now considered to be four species into one, and in considering corallite diameter as opposed to adult corallite diameter.

Twenhofel (1928, p. 126) re-established *Paleofavosites prolificus* as a species apart from *F. aspera*, but unaccountably redefined the former to include species having corallites ranging in diameter from 1.0 to 1.5 mm. He assigned to *P. capax* coralla with corallites 2 to 3 mm in diameter, in spite of Billings (1866, p. 6) having described a specimen of *P. capax* with corallites "about two lines [4.2 mm] in diameter." Some other workers (e.g., Okulitch, 1943; Nelson, 1963; Laub, 1979; Bolton, 1981) have followed Twenhofel's concept of *P. prolificus*. I believe that Twenhofel's "*P. capax*" is more like what Billings described as *P. prolificus*, and that Twenhofel's "*P. prolificus*" may well represent an undescribed species. It may be that Billings's types have been lost; they were not listed in Bolton's (1960) catalogue of type specimens held by the Geological Survey of Canada. If they can not be found and redescribed, it then becomes necessary to describe a topotype collection. Until such time, it seems to me desirable that Billings's concept (and that of Whiteaves, who apparently examined some of Billings's material) be followed; i.e., that *P. prolificus* be restricted to corals having mean adult corallite diameters about, or slightly larger than, 2 mm.
Certainly the Manitoba material fits the original description well. Stearn (1956, p. 60) reported a mean corallite diameter of 2.34 mm for specimens from the Stonewall and Interlake Formations. Caramanica (1973, p. 224), working with specimens from the Gunn Member of the Stony Mountain Formation, reported a mean diameter of 2.1 mm.

I found mean adult corallite diameters to range from 1.99 mm to 2.47 mm, although a direct comparison of my measurements with those of earlier workers is not possible. There are three reasons for this. First, I measured corallite diameters using Sutton's (1966) method of taking the average of the shortest wall-to-wall dimension and the longest corner-to-corner dimension; earlier workers did not specify how they measured "diameter." Second, I measured only the 50 largest corallites, trying to determine the adult size, whereas earlier workers commonly measured corallites of all sizes, as may be seen from the ranges of measurements given. Third, other workers commonly measured corallite diameter from thin section; I measured, where possible, from the surface of the corallum. I did this to avoid errors due to thin sections not being cut normal to corallite walls, which would tend to increase the size of the corallites. The net result of these changes, based on my measurements compared with those of Caramanica (1973) for three of his specimens, is an increase in mean corallite diameter of from 0.2 mm to 0.4 mm.

Caramanica (1973, p. 226-229) included, among his species of Paleofavosites, a form that he called Paleofavosites sp. B cf. P. prolificus. In the present collection, there are about 20 small (less than 20 mm diameter) nodular or hemispherical colonies. These
include the specimens that Caramanica included in his Paleocharonites sp. B cf. P. prolificus. The only morphological difference between this form and P. prolificus noted by Caramanica was the presence of planar tabulae (as opposed to crenulate tabulae) in the smaller colonies. I find the form of the tabulae to be variable within a given corallum, and believe that this is a non-diagnostic characteristic. I can find no significant difference, other than colony size, between these forms and larger P. prolificus.

Caramanica (1973, p. 229) suggested the possibility that other species may be represented in this collection of small colonies. However, no wall pores were noted in any of the specimens, and no other indication that they are anything other than P. prolificus. I am, therefore, assigning these specimens to that species.

Caramanica (1973, p. 228-229) noted the relative abundance of these small colonies, and they do, indeed, constitute the most common size range. However, there exists a continuum of sizes up to a moderately-sized colony (>100 mm diameter). It may well be, as Caramanica (1973, p. 228) speculated, that these small colonies may have been particularly susceptible to some "unfavorable environmental factor." Or it may be that these smaller colonies were especially prone to being overturned and smothered in the muddy substrate during storms, a misfortune to which they became less susceptible as they grew larger and more hydrodynamically stable.

Paleoflavosites prolificus may be distinguished from P. capax, P. sparsus, and P. mccullochae by the former's smaller corallite diameter. From P. poulseni and P. prayi, P. prolificus may be
distinguished by its larger corallites. *P. prolificus* may be
distinguished from *P. okulitchi* by its lack, or near lack, of wall
pores and smaller corallite diameter. Caramanica (1973, p. 225) noted
the "very strong resemblance" between *P. prolificus* and *P. kuellmeri,*
and all but suggested that these forms may be conspecific. I, too, can
see no significant difference between these species. I concur with
Caramanica that a final determination of this question, and many
others, awaits a restudy of the Anticosti Island topotype material.

**Paleofavosites okulitchi** Stearn, 1956

*Plate 1, fig. 16*

non *Favosites intermedius* Stewart, 1938, p. 62-63, pl. 13, figs. 4, 5.

*Favosites intermedius* Okulitch, 1943, p. 70, pl. 1, fig. 16;
Bassler,

1950, p. 22; Baillie, 1952, p. 32.

*Paleofavosites okulitchi* Stearn, 1956, p. 61-62, pl. 3, figs 4, 6,
pl. 8, fig. 3.

non *Paleofavosites okulitchi* Stearn Hill, 1959, p. 11-12, pl. 2,
figs. 7, 8 (fide Flower, 1961, p. 72).


**Diagnosis.**—Coralla small and tabular to hemispherical, to massive
and discoidal; adult corallites thin-walled, polygonal (commonly
hexagonal) in outline, averaging about 3.0 mm in diameter; pores common
to abundant in angles, less common in walls, appearing in walls in one
or two rows; septal spines rare or absent; tabulae planar, horizontal,
commonly deflected marginally (modified from Stearn, 1956, p. 61, and
Material and occurrence.—One entire corallum and fragments of at least seven other colonies comprise this collection. The whole corallum measures 48.0 mm in length, 46.5 mm in width, and 26.4 mm in thickness. The largest fragment came from a corallum whose greatest dimension was about 300 mm. This fragment has a thickness of 46 mm, but two other fragments, about which no conclusions may be drawn as to the maximum width of their coralla, have thicknesses of about 80 mm and 90 mm. All specimens were collected from outcrop. No specimens definitely assignable to this species were found in the subsurface of North Dakota.

Discussion.—This species was originally named *Favosites intermedius* by Okulitch (1943, p. 70); however, that name was preoccupied and it was redesignated *Paleofavosites okulitchi* by Stearn (1956, p. 61). Corallite diameters were given by Okulitch (1943, p. 70) as 2 to 3 mm, and Caramanica's (1973) figures accord well with this. I find the mean adult corallite diameter to be somewhat larger than this: three measured specimens gave means of 3.02, 3.03, and 3.30 mm. The first of these (UND 13791) was found by Caramanica (1973, p. 524) to have a mean corallite diameter of 2.63 mm. Reasons for the larger measurements that I obtained are given above under the discussion of *P. prolificus*.

Stearn (1956, p. 61) stated that the mean diameter for the larger corallites was 3.73 mm. I did not find any individual corallites that large, much less a mean diameter, on my specimens or those of Caramanica. Using Stearn's (1956, pl. 3, fig. 6, pl. 8, fig. 3) illustrations, which are supposedly natural size, I measured the
diameters of the 20 largest corallites I could find. For his hypotype, GSC 12865, I obtained a mean of 3.17 mm (n=12); for GSC 10404, I got a mean of 3.11 mm (n=8). In this last specimen, one corallite did exceed Stearn's (1956, p. 61) stated mean of 3.73 mm. A re-examination of Stearn's hypotypes is in order; his stated value is not supported by the evidence he presented.

The means that I obtained from Stearn's illustrations are well within the range that I found for the Gunn Member specimens. If it turns out that it is Stearn's numbers, rather than his illustrations, that are correct, then it would seem that he described a new species under *Paleofavosites okulitchi*. This would leave Okulitch's *Favosites intermedius* without a valid name. However, until the inconsistency in Stearn's (1956) work is clarified, I prefer to consider all this material as *Paleofavosites okulitchi*.

I have also included in this material a specimen that Caramanica (1973, p. 202) referred to *Paleofavosites sp. cf. P. kuellmeri*. Only fragments of Caramanica's specimen (UND 13730) remain. No weathered surface remains, thus rendering observation of mural pores difficult. However, the mean corallite diameter of 3.03 mm is too large for *P. kuellmeri* as originally described (2.0 to 2.5 mm; Flower, 1961, p. 74) but is well within the range for *P. okulitchi*. The lack of wall pores in Caramanica's hypotype presented a real problem; I could find no wall pores in Caramanica's thin sections. However, this specimen appears lithologically identical to one of my specimens of *P. okulitchi*, of which I made two transverse acetate peels. One had
no wall pores, but the other contained several. It may be that
Caramanica's thin sections were cut in such an orientation so as to
avoid the wall pores. In any event, I am tentatively referring
Caramanica's specimen (UND 13730.) to P. okulitchi.

Paleofavosites okulitchi differs from all other Late Ordovician
species of Paleofavosites by the common occurrence of both corner and
wall pores, and from most others (P. poulsenii, P. prolificus,
P. prayi, and P. kuellmeri) by having significantly larger corallite
diameters. P. okulitchi has slightly larger corallites than
P. sparsus and P. mccullochae, but wall pores are rare or lacking in
the latter two species. Paleofavosites okulitchi differs from the
Silurian species P. transiens, P. kirki, and P. groenlandicus by having
substantially larger corallites.

Paleofavosites manitobensis n. sp.

Plate 2, fig. 38

Etymology.--From the province of Manitoba, where the specimen was
found.

Diagnosis.--Corallum large, massive, flattened hemispherical;
adult corallites thin-walled, polygonal, averaging slightly more than
3.00 mm in diameter; pores common in angles but even more abundant in
walls, in two to four longitudinal rows; short, relatively thick septal
spines common; tabulae complete, planar to slightly curved and
crenulate (modified from Caramanica, 1973, p. 265-266).

Material and occurrence.--One fragment of an originally much
larger corallum (estimated 200 to 300 mm in largest dimension) has been
collected from the contact of the Gunn and Penitentiary Members of the
Stony Mountain Formation at locality A841, Stony Mountain, Manitoba. This fragment (UND 13757., here designated the holotype) measures about 125 mm in length, 61 mm in width, and 72 mm in thickness. It is apparent that the original corallum was considerably larger in all dimensions.

Discussion.—Caramanica (1973, p. 265-270) informally erected this species to accommodate a specimen having more wall pores than corner pores. The wall pores are arranged in two to four longitudinal rows, depending on the width of the corallite. Caramanica originally assigned this species to Favosites, on the grounds that the wall pores outnumbered the corner pores, in accordance with Stearn's (1956, p. 59-60) redefinition of Favosites and Paleofavosites. However, Powell and Scrutton (1978, p. 313) have defined Paleofavosites to include species having only corner pores as well as those with both corner and wall pores. Favosites (and the subfamily Favositinae) has been defined as having pores on the corallite walls (Hill, 1981, p. F541), omitting, by implication, those species that have pores in both loci. Therefore, this new species is properly assigned to Paleofavosites.

I know of no other species of Paleofavosites having common corner pores and abundant wall pores in as many as four rows. The only species with which P. manitobensis might reasonably be compared is P. okulitchi, and it differs by the predominance of wall pores and the common occurrence of septal spines (which are rare in P. okulitchi). The two species have an almost identical adult corallite diameter, and the possibility can not be ruled out that P. manitobensis is merely
an aberrant form of P. okulitchi. More collecting and thin section work would be required to confirm that possibility. Meanwhile, I feel that the weight of the evidence supports the erection of this new species.

Order HELIOLITIDA Frech, 1897
Suborder HELIOLITINA Frech, 1897
Superfamily Coccoseridicae Kiaer, 1899
Family Coccoserididae Kiaer, 1899
Genus Protaraea Milne-Edwards and Haime, 1851

Type species.—Porites vetustus Hall, 1847 (subsequent designation by Miller, 1889, p. 201).

Diagnosis.—Corallum small, thin, commonly encrusting; coenenchyme narrow to absent, when present consisting of contiguous thick trabeculae normal to the surface; septa also composed of vertical trabeculae; tabulae rare or absent (modified from Hill, 1981, p. F622).

Discussion.—This genus may be distinguished from others in the family by its extreme thinness and encrusting habit.

Protaraea tenuis (Billings, 1865)
Plate 1, fig. 13

Heliolites tenuis Billings, 1865, p. 428-429; Billings, 1866, p. 32.
Protaraea vetusta (Hall) Whiteaves, 1895, p. 114; Lambe, 1899, p. 90-91 (partim), non pl. 5, figs. 8, 8a; Dowling, 1900, p. 49F;
Bassler, 1915, p. 1044 (partim); Baillie, 1952, p. 32.
Protaraea richmondensis Foerste Bassler, 1915, p. 1043 (partim);
Bassler, p. 22.
Protaraea tenuis (Billings) Bassler, 1915, p. 1044 (partim);
Protaraea cutleri Leith, 1952, p. 793-794, pl. 115, figs. 7-11.


**Diagnosis.**—Coralla thin, encrusting, conforming to the surface of their substrates; calices shallow, gently rounded; corallites commonly average 1.0 mm or slightly less in diameter; 12 septa composed of papillae project into the calice about one-quarter of its diameter; corallites possess no apparent walls, the coenenchyme being continuous from the edge of one calice to the edge of the next; coenenchyme also composed of papillae; corallites commonly separated by about 0.2 mm of coenenchyme (adapted from Twenhofel, 1928, p. 136; Leith, 1952, p. 793-794; Caramanica, 1973, p. 176-177).

**Material and occurrence.**—The collection from Stony Mountain, Manitoba, contains 24 specimens, the majority from locality A417. Many of these coralla are entire, and most of the remainder are almost entire. Preservation varies; all are weathered, making surficial detail difficult, and in some cases impossible, to distinguish. From the subsurface, only one very poorly preserved specimen, questionably assignable to Protaraea, has been recovered from locality A2603, about 13 m above the base of the Gunn Member. It requires an exercise of the imagination to assign it to this species with any degree of confidence.

**Discussion.**—Billings (1865, p. 428) described this species as having corallites "a little less than half a line [1.06 mm] in diameter, and half their own width distant." Twenhofel (1928, p. 136) gave 1.0 to 1.5 mm as the corallite diameter, but measurements of his
illustrations (his pl. 3, fig. 6) of one of Billings's synotypes would seem to indicate that the mean diameter is slightly less than 1.0 mm, as Billings (1865, p. 428) reported. Leith (1952) did not give a corallite diameter for his "Protaraea cutleri," but his illustrations (his pl. 115, figs. 7-11) also would seem to indicate an average corallite diameter of slightly less than 1 mm. Caramanica (1973, p. 176) reported an average of 0.9 mm for two specimens. I find, based on measurements of 14 coralla, that the mean corallite diameter is somewhat variable between colonies, and may range from 0.6 to 1.1 mm, with the overall mean falling around 0.9 mm. The largest corallite diameters approach 1.5 mm, conforming to Twenhofel's (1928, p. 136) measurements.

Leith (1952, p. 793) gave a maximum corallum thickness of 1.5 mm, whereas Caramanica (1973, p. 176) reported a thickness of 0.7 mm. Twenhofel's (1928, p. 136) measurements fall between these figures, "little more than 1 mm." I have examined cross-sections or edges of four of the colonies and find a maximum thickness of about 0.8 mm, though, of course, thicker colonies can not be ruled out. Leith (1952, p. 793) reported a maximum corallum width, or diameter, of 17 mm. I have several larger than this, the largest being 31 mm in its greatest dimension. The size of the colony seems to depend upon the size of the substrate.

The Stony Mountain specimens have been referred to Protaraea vetusta, P. richmondensis, and P. cutleri, in addition to P. tenuis. Protaraea vetusta is a Middle Ordovician (lower Trentonian) species named by Hall (1847, p. 71). It is built up of multiple laminar
layers, and Hall's (1847, pl. 25, figs. 5a, 5b) illustrations clearly show that the corallites are almost contiguous and that there is very little coenenchyme. Clearly, the Stony Mountain forms are not assignable to Hall's species.

An apparently much more closely related species is *P. richmondensis* (Foerste, 1909a, p. 210-211, pl. 4, figs. 9A, 9B; Foerste, 1909b, p. 308-309, pl. 7, fig. 8, pl. 10, figs. 2A, 2B). However, *P. tenuis* "has smaller and less distinctly marked off corallites with a wider zone of coenenchyme surrounding the corallites" (Leith, 1952, p. 794). Also, *P. richmondensis* has thicker coralla, from 2 to 4 mm (Foerste, 1909a, p. 210). I have collected and examined specimens of *P. richmondensis* from Richmond, Indiana, and I find these observations to be entirely valid. These differences preclude the assignment of the Stony Mountain material to *P. richmondensis*.

Leith (1952, p. 793-794) erected a new species, *Protaraea cutleri*, to accommodate the Stony Mountain material. I can not understand why he compared *P. cutleri* to both *P. vetusta* and *P. richmondensis*, but failed to mention *P. tenuis*. He cited Twenhofel (1928) in which *P. tenuis* is described and, for the first time, illustrated. Fortunately, Billings's syntypes are still available (Bolton, 1960, p. 28). However, based on the descriptions and illustrations in the literature and my own observations on the Stony Mountain material, I can see no significant difference between *P. tenuis* and Leith's *P. cutleri*.

Pending a comparison of the Manitoba material with the syntypes and a definitive statement of the differences found between the two sets of
specimens, I must assign the Manitoba fossils, including Caramanica's (1973, p. 176) Protaraea sp. cf. P. cutleri, to Protaraea tenuis.

Dixon (1986) examined ten specimens of Protaraea tenuis from Anticosti Island, including Billings's syntypes, and reassigned this material to Acidolites. There is, however, a good deal of subjectivity and a lack of agreement with regard to what constitutes significant features at the generic level. Hill (1981, p. F622) regarded Coccoseris as a valid genus but placed Esthonia in synonymy with Acidolites (and not, as stated by Dixon [1986, p. 30] in synonymy with Protaraeae). Sokolov (1962, p. 276-277), on the other hand, regarded Coccoseris as a junior synonym of Protaraea, and considered Esthonia a valid genus that represented an intermediate stage in the phylogentic lineage Protaraea—Esthonia—Acidolites (Sokolov, 1962, p. 273, 275). So there appears to be some overlap among the various authors' diagnoses. Dixon (1986, p. 29-30) provided a diagnosis and discussion of Acidolites, but not of Protaraea, mentioning the latter genus only in his discussion of the former and in his discussion (p. 45-47) of his A. tenuis.

The precise basis on which Dixon (1986) distinguished Protaraea and Acidolites is not clear; it seems to be largely, if not entirely, based on the uncommon presence of horizontal skeletal elements in species assigned to Acidolites, and their supposed absence in Protaraea. Lindstrom (1899, p. 112), in his description of Acantholithus [=Acidolites], noted: "In some species there are tabulae, ... but as a rule the walls have increased in thickness as to leave
accommodated both conditions in his diagnosis of Acidolites. It seems that the genetic capacity for the production of tabulae and dissepiments is retained by some organisms, but that this is masked by the full dilation of the trabeculae, leaving, as noted by Lindstrom, no room for the horizontal structures to grow. Consequently, it seems a little risky to use the presence or absence of horizontal skeletal elements as a part of the generic or specific diagnoses within the Coccoserididae.

Lindstrom (1899, p. 109), Sokolov (1962, p. 276) and Hill (1981, p. 622) all emphasized the thin, usually encrusting growth habit of Protaraea, whereas Dixon (1986, p. 47) felt that this was "not diagnostic" at the species level. The original generic diagnosis, however, emphasized the encrusting nature of this genus; it began with, "Polypier encroutant; ..." and also mentioned the shallow ("peu profonds") calices (Milne-Edwards and Haime, 1851, p. 208). This last characteristic was also mentioned by Sokolov (1962, p. 276), who noted the flat, indistinct calices. Lindstrom (1899, p. 112) remarked that Acantholithus [=Acidolites] is composed of several lamellae, in contrast to the single sheet of Protaraea; this distinction was noted by Hill (1981, p. 622) but not mentioned by Dixon (1986). Dixon noted, however (p. 45), "The extreme thinness and curvature of the colonies ..." and further, "the species description, therefore, relies much more on study of well preserved or abraded natural surfaces, than is the case for other species described." This clearly
implies a different growth form for Dixon's A. tenuis than for the other species of Acidolites that he discussed.

As Hill (1981, p. F622) suggested, what is needed is a modern study of Hall's (1847) and Milne-Edwards and Haime's (1851) specimens of Protarae a vetusta. In the meantime, given the disagreement as to what various workers consider generic characteristics, it would seem most prudent to retain Billings's Heliolites tenuis in the genus Protaraa.

Family Uncertain
Genus Pragnellia Leith, 1952

Type species.--Pragnellia arborescens Leith, 1952 (by monotypy).

Diagnosis.--"Polyparium branching by dichotomy; branches of internodes of calcareous material and nodes that were not calcareous, possibly proteinous; internodes phalangoid, with 'corallites' lacking distinct walls surrounded by common tissue of loosely packed, prickly rods perpendicular to surface; neither septa nor tabulae noted, but barlike connections are found between rods of common tissue; 'corallites' almost filled with sclerenchyme." (Hill, 1981, p. F625).

Discussion.--The suprageneric classification of Pragnellia has not been finally determined. Hill (1981) included it in the Coccoseridicae, a group containing the same genera as Sokolov's (1962) Order Protaraeida. Pragnellia does indeed show some affinities to other genera within these groups. On the other hand, it also displays some similarities to alcyonarians, as noted by Leith (1952, p. 796) and Hill (1981, p. F625). No solution to this problem is suggested here;
I will follow Hill's (1981) lead in considering Pragnellia to be of uncertain familial assignment within the Superfamily Coccoseridicae.

**Pragnellia arborescens** Leith, 1952

Plate 2, figs. 23, 37


**Diagnosis.**—Corallum large, branching dichotomously and irregularly; base of corallum subcircular, about 35 mm in diameter and about 20 mm in height; major branches about 20 mm in diameter and taper gradually upward; minor branches about 6 mm to 12 mm in diameter; internodes from 4 mm to more than 30 mm in length; corallites closely and irregular spaced but nowhere touching, about 0.8 mm to 1.3 mm in diameter, averaging about 1.0 mm, three or four in space of 5 mm; corallites circular to subcircular, and defined by a ring of coenenchymal rods, otherwise corallite walls lacking; calices shallow; coenenchymal surface papillate.

**Material and occurrence.**—The single specimen known previously (MMMN 1206, formerly MMNN 429P) was found at outcrop locality A417. It is fairly well preserved, still largely articulated, though probably incomplete.

**Discussion.**—The specimen described is about 260 mm high. However, the distal termini of the various branches do not appear to be branch termini, but merely internodes. Therefore, I did not wish to estimate a corallum size in the species diagnosis above.

Recently a second specimen (UND 4353.), probably assignable to this species, was found in outcrop in the Selkirk Member of the Red
River Formation. Unfortunately, this second specimen is much less well preserved, less complete, and adds little to our knowledge of the genus and species except to extend the stratigraphic range downward.

This species is so distinctive that it is not possible to confuse it with any other coral in the Gunn Member. Prior to seeing it, I was able to recognize the Red River specimen from only a sketchy oral description.

Phylum BRYOZOA Ehrenberg, 1831
Class STENOLAEMATA Borg, 1926
Order CYCLOSTOMATA Busk, 1852
Suborder PALEOTUBULIPORINA Brood, 1973
Family Sagenellidae Brood, 1975
Genus Tubulotrypa n. gen.

Etymology.--From the Latin tubus, pipe, and the Greek trypa, hole, referring to the tubular peristomes that bear the apertures.

Type species.--Alecto auloporoides Nicholson, 1875 (here designated).

Diagnosis.--Zoaria encrusting, uniserial or biserial anastomosing growths to broad expansions covering their substrates; zooecia oval; peristomes cylindrical to bulbous with circular apertures, nearly vertical to angled as much as 30 degrees from the vertical toward the direction of growth; apertures may be elevated, one-tenth to several tenths of a millimeter above the frontal wall of the zooecia; frontal walls simple; interzoooidal pores unknown; pseudopores may be present; ovicells unknown.
Discussion.--This genus is erected to accommodate Middle and Upper Ordovician species previously assigned to Proboscina or Berenicea. These two genera range from the Jurassic to the present (Bassler, 1953, p. G48), and Tubulotrypa differs from them by the presumed absence of ovicells and interzooidal pores. Corynotrypa is a strictly uniserial genus with zooecia that are narrowly restricted proximally and flaring distally. Sagenella possesses ovicells and transversely striated frontal walls and is multiserial.

Tubulotrypa seems to be restricted to the upper Middle and Upper Ordovician (Rocklandian to Richmondian) of North America. Species included are Alecto auloporoides Nicholson, 1875; Alecto frondosa Nicholson, 1875 (non James, 1871, nomen nudum); Alecto confusa Nicholson, 1875; Berenicea primitiva Ulrich, 1882; Berenicea vesiculosa Ulrich, 1882; Berenicea minnesotensis Ulrich, 1886; and Proboscina tumulosa Ulrich, 1893.

Whiteaves (1891, p. 212, pl. 28, figs. 9, 9a) erected the species Proboscina laxa for specimens from the Middle Devonian of the MacKenzie River Basin, Northwest Territories, but an examination of his description and illustrations seems to indicate that his species would be better placed in Corynotrypa; the zooecia seem to be irregularly uniserial, except where the zoarium is about to bifurcate, and the zooecial borders follow the zooecial outlines.

Several Silurian species were assigned to Berenicea by Nickles and Bassler (1900) and Bassler (1915). These had been originally assigned to Sagenella. The original assignments are currently considered valid.
(Bassler, 1953; Brood, 1975); thus, *Tubulotrypa* is restricted to the Ordovician.

Brood (1975, p. 91) noted that "the growth form of the zoarium is not a reliable systematic character among the cyclostomes." The Ordovician genera *"Proboscina"* and *"Berenicea"* were distinguished entirely on their zoarial growth forms; Ulrich, who retained both genera, said (1893b, p. 116) that "good and probably sufficient reasons can be advanced" to place *"Proboscina"* in synonymy with *"Berenicea."* It seems appropriate to me that Paleozoic species previously assigned to both *Proboscina* and *Berenicea* should be united in the new genus *Tubulotrypa*.

A tentative phylogeny for the new genus is here suggested (Fig. 5). The primitive condition seems to be represented by *T. minnesotensis*, a form that normally covered its substrate, leaving only a few bare patches, and that had a slightly bulbous peristome. This species gave rise in the Kirkfieldian to *T. tumulosa*, which was irregularly biserial (but that had as many as five zooecia in series) and that had somewhat bulbous peristomes. I can find no report of species assignable to *Tubulotrypa* in the Shermanian stage; it may be that the distribution of the genus was environmentally controlled. The various species have been reported from shales and argillaceous carbonates, and mid-continent rocks of Shermanian age seem to be largely limestones and dolostones.

By early Edenian time, the lineage had bifurcated; one line gave rise to *T. confusa*, a species having almost cylindrical peristomes,
Figure 5. Suggested phylogeny of Tubulotrypa n. gen. "Ranges" are reported occurrences within a stage, and are from Nicholson (1875) and Ulrich (1882a; 1886; 1893b).

Key:

K Kirkfieldian
S Shermanian
E Edenian
M Maysvillian
R Richmondian
G Gamachian

1 T. minnesotensis (Ulrich)
2 T. tumulosa (Ulrich)
3 T. confusa (Nicholson)
4 T. vesiculosa (Ulrich)
5 T. auloporoides (Nicholson)
6 T. primitiva (Ulrich)
Increased Swelling of Peristomes
and the other line produced *T. vesiculosa*, a form whose peristomes were even more bulbous than those of *T. tumulosa*. It is a curiosity that both of these Edenian species have been reported as being adnate almost exclusively on smooth crinoid columnals. Perhaps suitable substrates were in short supply. Also, it seems likely that it was an advantage to have been elevated above a muddy seafloor.

By early Maysvillian time, the line culminating in *T. vesiculosa* had died out, but *T. confusa* had produced the Maysvillian-Richmonian species *T. auloporoides* (which includes *Proboscina frondosa* and *Berenicea primitiva*). This species, and the genus, did not survive the Late Ordovician extinction.

**Tubulotrypa auloporoides** (Nicholson, 1875)

Plate 2, fig. 39

*non Aulopora frondosa* James, 1871 *nomen nudum*

*Alecto auloporoides* Nicholson, 1875, p. 267, pl. 25, figs. 2, 2b.

*Alecto frondosa* James Nicholson, 1875, p. 266-267, pl. 25, figs. 3, 3b.

*Berenicea primitiva* Ulrich, 1882a, p. 157-158, pl. 6, fig. 4;

Nickles and Bassler, 1900, p. 182; Bassler, 1915, p. 120.

*Proboscina auloporoides* (Nicholson) Ulrich, 1889, p. 28; Whiteaves, 1895, p. 115; Nickles and Bassler, 1900, p. 375; Cumings, 1908, p. 872-873, pl. 32, figs. 4, 4a, 5; Bassler, 1915, p. 1035;

Baillie, 1952, p. 32.
Proboscina frondosa (Nicholson) Ulrich, 1889, p. 28-29; Ulrich, 1893b, p. 119-120, pl. 1, fig. 28; Whiteaves, 1895, p. 115; Nickles and Bassler, 1900, p. 375; Bassler, 1906, p. 50; Cumings, 1908, p. 873-874, pl. 32, figs. 3, 3a, 3b; Bassler, 1913, p. 319, fig. 439C; Bassler, 1915, p. 1036; Shimer and Shrock, 1944, p. 250, pl. 95, fig. 14; Baillie, 1952, p. 32.

Stomotopora frondosa (Nicholson) Miller, 1889, p. 325.

Bernicea primitiva Ulrich Cumings, 1908, p. 779, pl. 26, fig. 12.

"Proboscina" aulioporoides (Nicholson) Brood, 1975, pl. 3, fig. 4.

**Diagnosis.**—Zoarium encrusting, branches commonly reuniting, forming a reticulate or anastomosing pattern, and in some cases combining into a broad expansion; zooecia about 0.2 mm wide and 0.3 mm long, tapered slightly proximally; about 3 zooecia per mm in the direction of growth and 4 to 5 per mm normal to the growth direction; peristomes appear cylindrical, only widening slightly at their bases where they join the zoarium; peristomes elevated about 0.15 to 0.20 mm above the surface of their zooecia and commonly inclined about 30 degrees from the vertical toward the distal margin of the zoarium; apertures subcircular, about 0.1 mm in diameter.

**Material and occurrence.**—About 25 specimens, ranging in condition from poor to fair, were studied. Of these, about 60 percent came from outcrop and about 40 percent from the subsurface in North Dakota (all from locality A2602, from the lower half of the Gunn Member, except for one questionable specimen from A2603, from about 10 m above the base of the unit).
Discussion.—Both *A. auloporoides* and *A. frondosa* were named in the same publication (Nicholson, 1875). As the first reviser, it is my privilege to select which of the two names is to be retained; their relative position in the original publication is no longer of consideration (ICZN, 1985a, p. 53). I am selecting *auloporoides* as the specific name, as I feel that it is more descriptive of the *Aulopora*-like encrusting habit of this species.

The remark made above, with regard to zoarial variability within the genus *Tubulotrypa*, applies equally well to the species within the genus. As originally defined (Nicholson, 1875, p. 266-267), *Alecto frondosa* commonly took the form of a "thin expanded crust," but was capable of producing branches having as few as one zooecium in each rank, whereas *A. auloporoides* more commonly had zooecia in single or double rows, but also produced areas of expansion. This seems to me a distinction of less than specific value (see plate 2, fig. 39, for an illustration of both growth forms occurring in the same colony). I think it much more likely that these slightly different growth forms are merely ecophenotypic expressions; I am here placing them in synonymy.

I have not seen specimens that others referred to *Berenicea primitiva*. Nevertheless, I am here placing this species in synonymy with *T. auloporoides*. The description makes it clear that there is little or no difference between *B. primitiva* and the species described above. Cumings (1908, p. 729) noted that *Berenicea* was "very similar to *Proboscina*, from which it differs in the fact that it forms expansions which are continuous rather than reticulated, as in the
latter genus." Features that I consider to be of specific value include the size and shape of the zooecia, peristomes, and apertures. The presence of pseudopores may depend on the state of preservation of the material. The form taken by a particular colony does not appear to be diagnostic in this genus.

Order CRYPTOSTOMATA Vine, 1884
Suborder Rhabdomesina Astrova and Morozova, 1956
Family Arthrostylidae Ulrich, 1882
Genus Arthroclema Billings, 1865

Type species.—Arthroclema pulchellum Billings, 1865 (by monotypy).

Diagnosis.—"Zoarium branching, with well-defined axial stem and alternate secondary and tertiary branches; jointed longitudinally, laterally. Primary segments up to about 1 mm in diameter. Segment diameters generally constant except for terminal flanges in some specimens; cross sections subcircular. Apertural arrangement predominantly longitudinal, locally weakly rhombic. In most species, sinuous or straight longitudinal ridges separate apertural rows and longitudinally successive apertures. Proximal and lateral margins of aperture commonly bordered by peristome. Metapores absent. Axial region formed by well-defined linear axis. . . . Longitudinal arrangement of zooecia regular. Diaphragms few in some species. Exozonal width varied. . . . Extrazooecial skeleton well developed. . . . Paurostyles scattered to common, usually developed on ridges." (Blake, 1983, p. 554-555).
Arthroclema brevis n. sp.

Plate 2, figs. 1-15

Etymology.--From the Latin brevis, short, referring to the unusually short segments of this species.

Diagnosis.--Zoarium articulated, probably consisting of primary, secondary, and tertiary segments; growth form unknown. Segments usually with six ranges of zooecia, commonly (in about 20 percent of the specimens) with seven, rarely with five. Proximal terminus slightly convex; distal terminus flat to shallowly concave; ends vary from the same diameter as the rest of the segment to moderately enlarged; segment faces slightly concave. Primary segments 2.5 to 4 mm long, averaging a little more than 3 mm, and fairly uniformly about 0.7 mm thick; zooecia commonly poorly defined. Zooecial apertures elongate-ovate, about 0.2 mm long and 0.08 to 0.12 mm wide; 4 to 6 zooecia in 2 mm, average 5. Peristomes faint to moderately strong, in some cases produced into small, spine-like protuberances proximally. Surface ornamentation usually subdued; lateral sockets commonly not well defined. Rare, stubby segments (UND 6216. and 6217.; plate 2, figs. 14, 15) may be as much as 1.0 mm thick and 1 to 2 mm long; zooecia rare on these segments, interpreted as aberrant primary segments. Secondary segments 1.8 to 4.0 mm long, average of 21 measured segments 2.4 mm, and 0.45 to 0.7 mm thick, average about 0.56 mm. Tertiary segments 1.35 to 2.1 mm long, average about 1.75 mm; and 0.35 to 0.50 mm thick, average about 0.45 mm.

Material and occurrence.--Approximately 400 segments or fragments of segments were collected, all from the subsurface of North Dakota.
Six specimens were collected from locality A2616, from 15 to 20 m above the base of the Gunn Member; about 100 from A2603, from the middle third of the Gunn; and the remainder from A2602, from the lowest three-fourths of the unit. All specimens appear to be abraded to a greater or lesser degree, but otherwise preservation is quite good.

Discussion.—The major problem with identifying and describing species assigned to Arthroclema is that partial or complete zoaria are known for only two species. Thus, it is not possible to document within-colony and between-colony variation. However, the lateral sockets and overall morphology identify these segments as Arthroclema, and they differ sufficiently from all known species to be regarded with fair confidence as a separate species.

I regret the necessity of designating a holotype. It is certainly far preferable that an entire organism or colony be designated the holotype, rather than a part or fragment. It almost seems irresponsible to designate a holotype when so little is known about the form of the colony and the variation present within the species. But I have so much material, and it is so obviously a new species, that it would be irresponsible not to describe this species. Therefore, I am designating UND 6213. (Plate 2, fig. 1) as the holotype, and UND 6214. through 6223. and UND 6380. through 6383. as paratypes.

Arthroclema brevis has shorter segments with a larger width:length ratio than any other species of Arthroclema except A. cornutum; the latter species is five-sided and has a papillose exterior (Ulrich, 1893b). Arthroclema brevis also has an unusually smooth exterior.
Arthroclema pentagonalis n. sp.

Plate 2, figs. 24-36

Arthroclema angulare (non) Ulrich, 1889, p. 45 (nomen nudum)

Arthroclema angulare Ulrich Whiteaves, 1895, p. 117; Nickles and Bassler, 1900, p. 169 (partim); Dowling, 1900, p. 50F; Bassler, 1915, p. 69 (partim); Baillie, 1952, p. 32.

Etymology.--From the Greek penta, five, referring to the number of sides normally possessed by the segments of this species.

Diagnosis.--Zoarium articulated, probably consisting of primary, secondary, and tertiary segments; growth form unknown. Segments more or less pentagonal in cross section, rarely hexagonal. Primary segments more obscurely pentagonal than either secondary or tertiary segments. Length of segments unknown. Zooecial apertures elongate-ovate, about 0.1 by 0.2 mm; 4 to 5 zooecia in 2 mm longitudinally. Primary segments about 0.5 to 0.6 mm thick; some fragments exceed 4 mm in length. Primary segments more obscurely pentagonal than either secondary or tertiary segments. Peristome not well developed. Proximal terminus swollen and rounded; distal terminus flared into a five-sided flange, usually bearing a planar surface or a shallow socket; lateral sockets oval, and may be more than 0.5 mm in all dimensions; surface ridged. Secondary segments 0.4 to 0.5 mm thick, angles sharply defined and flaring into projections at the distal end, giving the distal terminus the appearance of a five-pointed star; proximal portion of peristome commonly produced into a spine-like projection; proximal terminus rounded and slightly
swollen; striae strong; lateral sockets uncommon, oval, around 0.2 by 0.3 mm. Tertiary segments 0.2 to 0.35 mm thick; peristomes and distal projections relatively less pronounced than those of the secondary segments, otherwise much like small secondary segments.

Material and occurrence.—Approximately 1500 fragments definitely or probably assignable to this species have been collected. The vast majority of these (about 1300) come from subsurface locality A2602, scattered throughout the Gunn Member. Another 120 were collected from A2600, from the lowest 6 m of the Gunn; and several specimens each were collected from A2603, scattered throughout the lowest three-fourths of the Gunn; A2614, from the lowest 4 m of the Gunn; A2615, from the lowest 2 m of the Gunn; and A2616, from the highest one-third of the unit. Only 22 specimens were collected from outcrop. Many of the specimens from the lower portion of the Gunn in the subsurface are excellently preserved, except for being broken; those from the upper strata and from outcrop are commonly coated with matrix that obscures surface detail.

Discussion.—The difficulties attendant upon working with isolated segments of Arthroclema and in identifying, describing, and naming new species have been discussed above for A. brevis. These difficulties are even more pronounced in the case of the present species; unbroken segments are unknown. However, the lateral sockets and overall morphology identify these segments as Arthroclema, and the segments differ sufficiently from all known species of Arthroclema so that they may be assigned with fair confidence to a separate species.

I am here designating UND 6226. (Plate 2, fig. 28) the holotype
of *Arthroclema pentagonalis*. This specimen lacks both distal and proximal ends, but does show two lateral sockets. It displays the typical primary segment morphology proximal to the more distal socket, and the typical secondary segment morphology distal to that socket. Other features, such as the distal and proximal ends, the spinose projections of the peristome, and the typical forms of primary, secondary, and tertiary segments together with internal features, are shown by UND 6225. through 6233. and UND 6373. through 6377., here all designated paratypes.

It should be recognized that identification of primary, secondary, and tertiary segments represents a somewhat arbitrary exercise of judgment, as examples of intact colonies, and even whole segments, are lacking. Especially, it may be that the slender segments here regarded as tertiary segments actually represent a separate species assignable to *Arthroclema* or *Ulrichostylus*. If I am wrong, I have tried to err on the side of conservatism, believing that less harm will result from the lumping of distinct species than will result from the erection of two or more species that future collecting will show to be one.

*Arthroclema pentagonalis* differs from *A. angulare*, the only previously described Cincinnatian species of *Arthroclema*, by possessing substantially slenderer segments and by normally being five-sided rather than six-sided. I have tentatively included Ulrich’s (1889) *A. angulare* from the Stony Mountain, and subsequent citations of that work, in synonymy as I have not seen any undoubted
specimens of that species in my collections. I believe it likely that Ulrich misidentified a few poorly preserved specimens of *A. pentagonalis* as being conspecific with the only Cincinnatian species of *Arthroclema* known to him.

*Arthroclema pentagonalis* has much longer segments and a rougher exterior than *A. cornutum* (Ulrich, 1890b, 1893b). *Arthroclema pentagonalis* has longer and thinner segments than *A. striatum* (Ulrich, 1893b) and is more strongly ornamented. *Arthroclema armatum* (Ulrich, 1890b) has a similar appearance to *A. pentagonalis* but is six-sided, as is *A. pulchellum*. *Arthroclema billingsi* has shorter segments and four lateral sockets in each primary segment.

**Genus *Arthrotropa* n. gen.**

_Etymology._—From the Greek arthron, joint, and trypa, hole, referring to the segmented form of these zoaria.

_Type species._—*Helopora harrisi* James, 1883 (here designated).

_Diagnosis._—Zoarium segmented, jointed longitudinally; lateral articulation unknown but branching probably occurred at segment terminations; segments slender, less than 0.5 mm thick, and exceeding 3 mm in length; zoaria arranged in six longitudinal rows, each face slightly concave and separated from adjacent faces by a longitudinal ridge, giving the segment a hexagonal cross section; zooecia alternate in position on adjacent faces, so that each zooecium is flanked by interzoooidal skeleton; proximal end of segments slightly to moderately tapered and striated; distal terminus somewhat inflated and bearing one or two articulation surfaces.
Discussion.—This genus has been erected to accommodate segmented species that are lacking features such as ornamentation and apertural shape and arrangement that would justify their being assigned to Ulrichostylostr. Specifically, in Arthrotrypa the peristome is a thin, fine structure of about equal height throughout, whereas in Ulrichostylostr that structure is much thicker and commonly produced proximally into a spine-like projection. Arthrotrypa has zooecia arranged in an alternating pattern; in Ulrichostylostr, the zooecia on adjacent faces are at the same level as each other, or only very slightly offset from that level, producing a gentle spiral arrangement of zooecia. At present only two species, Arthrotrypa harrisi (James, 1883) and A. ovata n. sp. are assigned to this genus, although I suspect that as Ordovician members of this family become better known, more species will be placed here.

The generic placement of James's (1883) Helopora harrisi has presented a bit of a problem. The genus Helopora, as constituted in the 19th century, was divisible into at least two genera, as recognized and elaborated upon by Ulrich (1893b, p. 189-191). Bassler (1952) erected a second genus, Ulrichostylostr, to accommodate Ordovician species previously assigned to Helopora, but this still left H. harrisi uncomfortably placed. The latter species seems to differ from others assigned to Ulrichostylostr in apertural shape and arrangement, segment thickness, and ornamentation. Blake (1983, p. 592) assigned H. harrisi to Nematopora, making N. harrisi the only species of Nematopora to be segmented and not known to bifurcate. This seems an unsatisfactory arrangement also. I am, therefore, erecting
the genus Arthrotrypa to accommodate Helopora harrisi and the new species, Arthrotrypa ovata. As A. harrisi is better known and was the species first described, I am here designating Helopora harrisi James, 1883 the type species of Arthrotrypa.

Arthrotrypa ovata n. sp.

Plate 2, figs. 16-22

Helopora Harrisii James Ulrich, 1889, p. 45-46.

Helopora Harrisii James Whiteaves, 1895, p. 117; Dowling, 1900, p. 50F.

Helopora harrisi James Nickles and Bassler, 1900, p. 284 (partim);

Bassler, 1915, p. 604 (partim); Baillie, 1952, p. 32.

Etymology.--From the Latin ovatus, egg-shaped, referring to the shape of the zooecial apertures.

Diagnosis.--Segments about 0.25 to 0.35 mm thick, length probably about 3.5 mm, possibly somewhat longer; strong longitudinal ridges mark angles between faces; zooecial apertures oval and rimmed by sharp, distinct peristome of low, uniform height, the peristome, in some cases, appearing to merge into longitudinal ridges; zooecial apertures about 0.1 mm wide and 0.2 mm long, about 7 in 2 mm, separated longitudinally by about half their length.

Material and occurrence.--More than 100 specimens, all fragmentary, have been collected. Four of these, poorly preserved and encrusted with matrix, are from outcrop and are questionably assigned here. An additional 40 or so specimens are from subsurface locality A2600, from the lowest 6 m of the Gunn Member, and the remainder from A2602, from the lowest 9 m of the Gunn. The specimens from the
subsurface are generally preserved fairly well, although commonly fine
detail is obscured.

Discussion.--This species bears a strong resemblance to
Arthrotropa harrisi (James, 1883) as described and illustrated by
Ulrich (1890b, 1893b). The size and shape of the segments are quite
similar, as are the number of ranges, the longitudinal ridges on the
angles between the faces, and the proximal termination. The distal
termination appears slightly different. It seems apparent that the two
species are closely related. Certainly Ulrich (1889, p. 45)
can not be blamed for referring "a number of very slender segments

. . . not in a very good state of preservation" to Helopora harrisi.
If his material was as poorly preserved as are my outcrop specimens,
he would have been on very shaky ground in attempting to describe a new
species. Fortunately, the subsurface material is considerably better
preserved.

The major difference between the two species is that Arthrotropa
ovata has almost twice as many zooecia as does A. harrisi: 7 in 2 mm
compared to 4 in 2 mm (Ulrich, 1893b, p. 195). The peristomes are more
distinct in A. ovata, and the segments somewhat thicker. These
differences serve to distinguish the two species.
Specimen UND 6348. is here designated the holotype; UND 6343. through 6347., 6367., and 6368. are designated paratypes. The type locality is A2600.07.

Genus Nematoporella n. gen.

Etymology.--From the Latin suffix ella, small, appended to the genus name Nematopora.

Type species.--Nematoporella ulrichi n. sp., here designated.

Diagnosis.--Zoarium unbranched, unjointed, articulated only basally. Zoaria slender, diameters about 0.2 mm to 0.6 mm. Cross section polygonal to subcircular. Zoarial apertures usually in 4 to 6 longitudinal ranges. Longitudinal ridges commonly strong between ranges. Peristomes usually present, metapores absent. Linear axis well defined.

Discussion.--As it has been the usual practice, in this family, to consider segmentation and branching characters of generic significance, this genus has been erected to accommodate unbranched, unsegmented arthrostylids. It may be, however, that these genera bear little relation to actual phylogeny of the species within the family. This merely emphasizes the need for a family-level monograph, though I doubt that such a monograph could be competently done without a good deal more collecting and processing of samples.

For the present, I am restricting this genus to the two species described below. However, it is quite possible that other species, previously referred to Helopora and now assigned to Ulrichostylus, actually belong here. For instance, Ulrich (1890b, p. 191-192) named and illustrated Helopora mucronata and H. alternata. He considered
them segmented but did not describe the distal termination of the
segments. *Helopora alternata*, particularly, seems a good candidate for
assignment to *Nematoporella*, but I do not wish to make this
reassignment without examining the type material myself.

*Nematoporella ulrichi* n. sp.

Plate 3, figs. 1-5

*Nematopora (?)* n. sp. Ulrich, 1889, p. 47.

**Etymology.**—Named in honor of E. O. Ulrich, who first described
this species.

**Diagnosis.**—Zoarium slender, about 0.2 to 0.3 mm thick. Zooecial
apertures elongate-oval, about 0.1 by 0.2 mm, with about 3 in 1 mm
longitudinally. Zooecia usually in 6 ranges, occasionally in 5,
separated by longitudinal ridges displaced by zooecial apertures.
Second set of ridges forms lateral margins of apertures; third ridge
sometimes present. Proximal articulation a blunt planar surface, about
0.1 mm thick, tapering gradually over initial 0.5 mm of the zoarium.
Distal ends apparently growth surfaces.

**Material and occurrence.**—About 75 specimens have been recovered.
Of these, 7 are from outcrop; one each, questionably, from subsurface
localities A2600, about 2 m above the base of the Gunn Member, and
A2616, about 20 m above the base; 4 from A2603, from 10 to 20 m above
the base; and the remainder from A2602, from about 6 to 20 m above the
base. Preservation is fair to good on the specimens from outcrop and
the lower half of A2602, otherwise it is poor to fair.

**Discussion.**—This is undoubtedly the unnamed species described
briefly by Ulrich (1889, p. 47). He reported it as being five-sided.
them segmented but did not describe the distal termination of the segments. Helopora alternata, particularly, seems a good candidate for assignment to Nematoporella, but I do not wish to make this reassignment without examining the type material myself.

**Nematoporella ulrichi** n. sp.

Plate 3, figs. 1-5

*Nematopora (?)* n. sp. Ulrich, 1889, p. 47.

**Etymology.**--Named in honor of E. O. Ulrich, who first described this species.

**Diagnosis.**--Zoarium slender, about 0.2 to 0.3 mm thick. Zooecial apertures elongate-oval, about 0.1 by 0.2 mm, with about 3 in 1 mm longitudinally. Zooecia usually in 6 ranges, occasionally in 5, separated by longitudinal ridges displaced by zooecial apertures. Second set of ridges forms lateral margins of apertures; third ridge sometimes present. Proximal articulation a blunt planar surface, about 0.1 mm thick, tapering gradually over initial 0.5 mm of the zoarium. Distal ends apparently growth surfaces.

**Material and occurrence.**--About 75 specimens have been recovered. Of these, 7 are from outcrop; one each, questionably, from subsurface localities A2600, about 2 m above the base of the Gunn Member, and A2616, about 20 m above the base; 4 from A2603, from 10 to 20 m above the base; and the remainder from A2602, from about 6 to 20 m above the base. Preservation is fair to good on the specimens from outcrop and the lower half of A2602, otherwise it is poor to fair.

**Discussion.**--This is undoubtedly the unnamed species described briefly by Ulrich (1889, p. 47). He reported it as being five-sided.
The majority of my specimens are six-sided, but this is not an
insuperable obstacle to considering them the same species: a few are
indeed five-sided, and Ulrich's specimen was imbedded in matrix.

I have no specimen definitely retaining both distal and proximal
terminations. I am, therefore, selecting as the holotype a specimen
having the proximal termination (UND 6234.; plate 3, fig. 5); UND
6235., 6236., 6378., and 6379. are designated paratypes. These
specimens are from locality A2602.183. I chose this horizon as the
type locality because the material is abundant (more than 40 percent
of the specimens in this species) and quite well preserved.

Nematoporella falcata n. sp.
Plate 3, figs. 6-11

Etymology.--From the Latin falcatus, sickle-shaped, referring to
the usual shape of the zoarium.

Diagnosis.--Zoarium usually gently curved, a few straight; short,
1 mm to 2.5 mm long, 0.2 to 0.3 mm wide; zooecia in 6 ranges,
alternating in position so zooecial apertures in one face are at same
level as interzooecial spaces on adjacent faces; apertures oval, about
0.13 by 0.20 mm, three in 1 mm longitudinally; peristome thin, sharp,
commonly with low, rounded projection proximally; lateral peristome
ridges continuous longitudinally, giving appearance of demarking
margins of faces; proximal end of segment tapering, narrowly rounded
to acute, striated; distal end commonly surface of growth cessation,
having no apparent area for articulation.

Material and occurrence.--More than 100 specimens have been
collected from subsurface locality A2602, scattered throughout the Gunn
Member. An additional 13 specimens come from A2600, from the lowest 3 m of the Gunn, and 7 from A2603, from 6 to 20 m above the base of the unit. Other specimens, including a few from outcrop, may questionably be assigned here, but most of these are too fragmentary or encrusted with matrix to be positively identified. Preservation is poor to good in A2600 and A2602, and poor elsewhere.

Discussion.—It is possible that the shorter zoaria (1 to 1.5 mm in length) represent a different species than those that are longer; lengths seem to be bimodally distributed. This could also be due to shorter colonies being more susceptible to smothering by sediments. I do not feel that I have sufficient well-preserved material to make such a determination, and I am, therefore, placing these forms under one species.

Specimen UND 6355. is here designated the holotype, and A2602.19 the type locality. Specimens UND 6356. through 6359. and 6361. are designated paratypes.

Genus Sceptropora Ulrich, 1888

Type species.—Sceptropora facula Ulrich, 1888 (by original designation).

Diagnosis.—"Zoarium dendroid, jointed longitudinally, bifurcations rare. Segments straight; slender proximally, expanding more or less abruptly in distal direction to form bulbous or discoidal end; subcircular in cross section. Apertures aligned in 12 to 20 distal rows, absent proximally. Prominent longitudinal ridges separating apertural rows. Angular metapores with diaphragms may enclose zooecial chambers. Axial region formed by a well-defined

**Sceptropora facula Ulrich, 1888**

Plate 3, figs. 17-21

*Sceptropora facula Ulrich, 1888, p. 228-229, fig. 1; Ulrich, 1889, p. 46-47, fig. 2; Ulrich, 1890b, p. 401, fig. 15; Whiteaves, 1895, p. 117; Nickles and Bassler, 1900, p. 399; Bassler, 1911, p. 153, fig. 74; Bassler, 1915, p. 1142-1143; Bassler, 1928, p. 160; Baillie, 1952, p. 32; Bassler, 1953, p. G130, fig. 90, 3; Ross, 1957, p. 474-475, pl. 37, figs. 10, 11; Kiepura, 1962, p. 401-402, pl. 10, figs. 1-3; Ross, 1982, pl. 2, fig. 6; Blake, 1983, p. 566, fig. 279; Bolton and Ross, 1985, p. 30-31, pl. 5.1, pl. 52., figs. 2-6, 8, 9, pls. 5.3-5.6, pl. 5.7, figs. 3, 4, 6, 8.

*Sceptropora estoniensis Brood, 1980, p. 166-168, fig. 3.

**Diagnosis.**—Zoarium dendroid, bifurcating occasionally; segments usually straight, some slightly curved, slightly less than 1 mm to a little more than 2 mm long; segments club-, bell-, or mushroom-shaped, and continuum of shapes within these ranges; proximal end slender, usually forming a bulbous expansion with diameter of less than 0.2 mm to more than 0.8 mm in exceptionally robust forms; distal end ranges from only slight swelling (diameter less than 0.6 mm) to broad expansion (more than 2 mm), with intermediate values being more common;
zooecia aligned between vertical ridges, circular to oval, about 0.1 mm in diameter; zooecia commonly in 2 to 3 rows both below and above margin of distal expansion, the proximal portion of segment consisting of extra-zooecial skeleton; center of distal surface bears a socket of about same diameter as proximal end of segment.

Material and occurrence.—More than 4000 segments have been collected. Of these, slightly fewer than 300 came from outcrop. The great majority (almost 3700) came from the subsurface of North Dakota (locality A2602, scattered throughout the Gunn Member) with additional collections from A2600, from the lowest 6 m of the Gunn; A2603, from 6 to 20 m above the base; and A2616, from 15 to 25 m above the base. A single specimen was recovered from A2620, about 3 m above the base. Most of these specimens are entire and many are quite well preserved.

Discussion.—The range of variation present in this species has been well documented by Bolton and Ross (1985), although there is a possibility that some of their "bell-shaped" forms may be assignable to _S. umbelliformis_ (see discussion under that species, below).

I have included _S. estoniensis_ Brood, 1980, in synonymy. Brood distinguished his species on size and shape, but the range of variation in _S. facula_ encompasses the forms assigned to _S. estoniensis_, as noted by Bolton and Ross (1985, p. 31).

With respect to other species of _Sceptropora_, _S. florida_ Kiepura, 1962 is discussed below under _S. umbelliformis_, the species to which it is apparently most closely related. _Sceptropora spinosa_ Kiepura, 1962 is a very spinose form that resembles _S. facula_ with the addition
of large, blunt projections on the zoarial exterior. *Sceptropora fustiformis* Ulrich, 1889 is very poorly known, having been described rather cursorily and never having been illustrated. *Sceptropora? obscura* Astrova, 1965, is not, according to Bolton and Ross (1985, p. 30), a *Sceptropora*.

*Sceptropora umbelliformis* n. sp.

*Plate 3, figs. 22-27, 29*

**Diagnosis.**—Zoarial shape unknown, but some segments show two attachment surfaces indicating that the colony bifurcated; segments straight, umbrella-shaped to bell-shaped; length about 1.3 to 1.8 mm; proximal end slender, cylindrical, almost flat to gently rounded to almost pointed, and about 0.1 mm in diameter; distal end moderately to markedly expanded, subcircular except for segments that have two attachment surfaces, which may be strongly oval; diameter of distal expansion from slightly less than 0.4 mm to slightly more than 1 mm, with unusual specimens exceeding 1.5 mm in diameter; two or three rows of zooecia usually both on distal expansion and just below edge of expansion; center of distal surface with attachment surface <0.03 mm in diameter to little more than 0.1 mm in diameter.

**Material and occurrence.**—More than 1000 segments, mostly from locality A2602, scattered throughout the Gunn Member in the subsurface, have been collected. The outcrop contributed only 16 segments; the remainder have come from subsurface localities A2600, from the lowest 6 m of the Gunn; A2603, from 8 m to 18 m above the base; A2616, from 15 to 25 m above the base. The great majority of specimens have had their proximal ends broken off; otherwise, preservation is fairly good.
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Discussion.--Bolton and Ross (1985) documented a wide range of variability within *Sceptropora facula*, and, for the most part, I agree with them. However, with respect to the articulation surfaces of the segments, there is an either-or condition, and I feel that this can be used to discriminate between *S. facula* and *S. umbelliformis*. *Sceptropora facula* has a socket (or two sockets) at the distal end, and, commonly, a bulbous expansion at the proximal end. *Sceptropora umbelliformis*, in contrast, has an attachment surface at the distal end, rather than a socket, and a proximal end that is rounded, but not expanded. In almost all cases where the distal end is adequately preserved and relatively free of matrix, these two species may be discriminated almost instantly. Other differences are that *S. umbelliformis* is more delicate than most segments of *S. facula*, has a greater distal expansion relative to the thickness of the "stem", and has a distal expansion that is usually planar or slightly rounded on its distal surface compared to the classic "club" shape of the distal terminus of the majority of *S. facula* segments.

The species most similar to *S. umbelliformis* seems to be *S. florida* Kiepura, 1962. *Sceptropora umbelliformis* conforms fairly well to Kiepura's (1962, p. 403) description of *S. florida*, but rather less well to her illustrations (her pl. 10, figs. 4, 5). Kiepura (1962, p. 403) emphasized the differences in the longitudinal ridges on the segments of her *S. florida* and those of her *S. facula*. (These latter specimens were assigned to *S. estoniensis* by Brood in 1980, but I have returned them to *S. facula*.) I don't see the differences in the ridges noted by Kiepura. On the other hand, she did note (p. 403) that
the distal socket was "slightly concave to nearly flat, occasionally
with a central slit." This approaches the condition of
S. umbelliformis; I, too, have noted the rare occurrence of a central
slit in the attachment surface. There is, I believe, enough of a
difference between S. umbelliformis and Kiepura's S. florida to justify
the erection of a new species. Sceptrpora umbelliformis seems to have
a more delicate central shaft and a greater distal expansion than does
S. florida. The distal attachment surface in the former species is a
point or a small circular flat area; in the latter species, it is a
shallow socket. The longitudinal ridges in S. umbelliformis are not
pronounced as they are in S. florida. On these bases, I feel that the
two species may be distinguished.

The possibility remains, of course, that they are conspecific.
Kiepura (1962, p. 403) named S. florida based on only 10 specimens,
"in various states of preservation." They were all etched from their
matrix using hydrochloric acid. When better-preserved specimens of
S. florida are found, it may be that that species will prove
conspecific with S. umbelliformis. Until such time, I think it best
to consider S. umbelliformis a distinct species.

Specimen UND 6327. is here designated the holotype, and locality
A2602.30 the type locality. Specimens UND 6322. through 6326., 6328.
through 6334., and 6369. through 6371. are here designated paratypes.
Genus Ulrichostylus Bassler, 1952

Type species.—Helopora divaricatus Ulrich, 1886 (by original designation).

Diagnosis.—Zoarium articulated, jointed longitudinally, branching and lateral articulation unknown; bifurcation may occur at ends of segments; proximal articulation surfaces commonly weakly concave to accommodate weakly convex, distal articulation surface of preceding segment; segments straight to slightly curved, 1 mm or less thick, 2 to 10 mm long, and weakly flared at ends; zooecial apertures usually in 4 to 8 longitudinal ranges; prominent longitudinal ridges separate ranges; peristome commonly developed proximally into spinose projection; metapores and acanthopores absent.

Discussion.—Bassler's (1952, p. 384) original description of Ulrichostylus was: "Narrow, cylindrical stems bearing eight or more longitudinally arranged zooecial rows. Base articulated, circular sockets on sides for new branches." The genus is not recognizable from this "description." Of the four characteristics given by Bassler, two (narrow, cylindrical stems and articulated bases) are family characters. The remaining two characters are, as far as I can determine, simply wrong. The type species (Helopora divaricatus Ulrich, 1886) has 6 to 8 longitudinal rows of zooecia. Other species assignable to the genus make the generic range 4 to 8 rows; no included species has more than 8 rows.

As for the lateral articulation sockets, none of the included species has been described as possessing them. Bassler (1953, p. G130, fig. 90, 4) gives four pen and ink drawings, purportedly of
the type species of *Ulrichostylus*, *U. divaricatus*. Three of these (4b, 4c, and 4d) were redrawn from Ulrich (1893b, pl. 3, figs. 4, 5, and 3, respectively) and two of these three are actually of *U. spiniformis* rather than *U. divaricatus*. It is the fourth illustration (fig. 4a) that is of concern; it constitutes the only "evidence" for lateral articulation in *Ulrichostylus*.

I have been unable to find Bassler's source for this drawing. However, if it is indeed done to the same scale as the others in Bassler's figure 4, then several points may be made about the specimen that it represents. First, it is somewhat thinner than the type species; second, the zooecial apertures are more than twice the size than those of the type species; third, the apertures have a rhombic arrangement, rather than a gentle spiral arrangement; fourth, the apertures are strongly elongate, whereas those of Ulrich's illustration are weakly ovate; and fifth, the apertures are much closer together and there is much less extra-zooecial skeleton in Bassler's illustration than in the type species. Given these differences, I do not believe the specimen illustrated by Bassler (1953, p. G130, fig. 90,4a) to be referrable to *Ulrichostylus* at all. If that is so, then no evidence remains for the existence of lateral articulation sockets in *Ulrichostylus*. Until some reliable evidence is adduced, I must regard *Ulrichostylus* as lacking lateral articulation and having only longitudinal jointing.

Fortunately, Bassler (1952) designated a type species, and from Ulrich's (1886, 1893b) description and illustration of this species,
together with Ulrich's (1893b, p. 189-191) excellent discussion of the
group to which this species belongs, the generic characters may be
deduced. Particularly, Ulrich (1893b, p. 190), in his discussion of
Helopora, elucidated the differences distinguishing his group b
(containing Ordovician genera referred to Helopora) from his group a
(Silurian genera of Helopora). Included in group b was
H. divaricatus, now the type species of Ulrichostylus, together with
seven other Middle and Upper Ordovician species (Ulrich, 1893b). Of
these eight species, I am referring Helopora harrisi James, 1883 to
Arthrotrypa n. gen.; it differs from the remainder of the species of
Ulrichostylus in characters that I regard as generically significant.

It has been suggested (Ulrich, 1890b, 1893b; Nickles and Bassler,
1900; Bassler, 1915) that several of the species assigned to
Ulrichostylus actually represent tertiary segments of Arthroclema. The
two genera are very close, morphologically; the major difference
seems to be that Arthroclema has lateral articulations to accomodate
branches, whereas Ulrichostylus lacks lateral branches. It is not
inconceivable that all species assigned to Ulrichostylus are actually
Arthroclema, but in the absence of complete colonies of the latter
genus, it is probably best to maintain the generic distinction.

Ulrichostylus costatus n. sp.

Plate 3, figs. 30-34

Etymology.—From the Latin costa, rib, referring to the strong
longitudinal ridges possessed by this species.

Diagnosis.—Zoarial segments about 0.5 to 0.6 mm thick and 2.5 to
3.5 mm long; zooecial apertures in 7 or 8 longitudinal ranges, the
faces of the segment separated by strong longitudinal ridges; proximal end of segments slightly tapered and broadly rounded; distal end somewhat flared, with inter-facial ridges produced into projections; distal surface containing zooecial apertures and central attachment surface that may be produced into central boss; zooecial apertures elongate-ovate, about 0.1 by 0.2 mm, separated by about their own length, 5 or 6 in 2 mm longitudinally; zooecial apertures bordered by sinuous ridges that serve as lateral borders of peristomes, continuous from aperture to aperture; proximal margin of peristome commonly weakly produced into low rounded projection from which a ridge extends to distal margin of next proximal aperture.

Material and occurrence.—Sixteen specimens have been assigned to this species. All are from the subsurface of North Dakota. One is from locality A2616, about 15 m above the base of the Gunn Member; seven from A2603, about 8 to 12 m above the base of the Gunn; and the remaining eight from A2602, from 15 to 25 m above the base. Preservation is fair to good.

Discussion.—Although this species closely resembles Ulrichostylus imbricata (Ulrich, 1890b), there are consistent major differences between U. costatus and U. imbricata in the ornamentation. Ulrich's (1890b, p. 644) description of the latter species included these characters: "Zooecia in seven or eight vertical sets around the segment, the rows being separated by rather inconspicuous carinae; ... the lower margin [of the peristome] strongly elevated and produced posteriorly into three small ridges. ..." In contrast,
U. costatus possesses strongly raised longitudinal ridges between the faces and only weakly produced, proximal, peristomal margins. These differences are so pronounced that, at first blush, the two species do not appear as similar as they apparently are. Further examination, however, reveals that they are the only significant differences. As these differences are evidently consistent in the two populations on the opposite sides of the Transcontinental Arch, I think they are sufficient to differentiate the species.

Specimen UND 6353. is here designated the holotype, and locality A2602.183 is the type locality and horizon. Specimens UND 6352., 6354., 6387., and 6388. are designated paratypes.

**Ulrichostylus dakotensis** n. sp.

*Plate 3, figs. 12-16*

**Etymology.**—Name derived from the state of North Dakota, where the material was collected.

**Diagnosis.**—Segments five-sided, slender, about 0.3 mm thick, length unknown; proximal end moderately tapering and striated, distal end unknown; lateral articulation unknown, branching at segment ends uncommon; angles between faces marked by longitudinal ridges; second set of ridges outlines sides of apertures and approach, but do not touch, each other in zooecial interspaces; proximal end of zooecial apertures in some cases marked by low, rounded projection; apertures elongate-ovate, about 0.1 mm wide by 0.2 mm long, and separated by about their own length, 5 in 2 mm longitudinally.

**Material and occurrence.**—About 70 specimens, in poor to moderately good condition, have been collected from subsurface
localities A2602, from the lowest quarter of the Gunn, and A2603, from
the middle third of the Gunn. About 30 of the specimens are from the
latter locality, and many of these are only tentatively assigned here.

Discussion.--This species is similar to Ulrichostylus elegans
(Ulrich, 1893) but differs in being five-sided, rather than six-sided.
U. elegans also has stronger ornamentation. U. dakotensis is also
rather similar to tertiary segments of Arthroclema pentagonalis
n. sp., but lacks its spinose projections at the proximal margins of
the zooecial apertures. The two species also differ in that
U. dakotensis has tapering proximal segment ends, whereas
A. pentagonalis has proximal ends that are rounded without tapering,
as is characteristic of Arthroclema.

Suborder PTILODICTYINA Astrova and Morozova, 1956

Family Ptilodictyidae Zittel, 1880

Genus Ptilodictya Lonsdale, 1839

Type species.--Flustra lanceolata Goldfuss, 1829 (by monotypy).

Diagnosis.--"Zoarium lanceolate with tapering proximal segment.
Mesothecae straight, rarely zigzag locally. In endozones, autozooecia
in straight ranges, subrectangular to subhexagonal in cross section.
In exozones, autozooecia in straight ranges, arranged in rhombic to
reticulate pattern in adjacent ranges; contiguous; commonly
subrectangular in cross section, few irregularly polygonal in lateral
regions. Autozooecial boundaries generally not visible; pustules
rare. Living chambers elliptical to subrectangular in cross section;
lining common in endozones, discontinuous or lacking in exozones.
Superior hemisepta few, blunt, short, thick; inferior hemisepta few,

Discussion.—Karklins (1983, p. 490) indicated that Flustra lanceolata Goldfuss is the type species of Ptilodictya by original designation. I can find nothing in Lonsdale's (1839, p. 676) description and discussion of either Ptilodictya or P. lanceolata that could be considered a designation of type species. However, P. lanceolata was the only species originally included in Ptilodictya, and it thus becomes the type species by monotypy (ICZN, 1985a, p. 129).

Ptilodictya sulcata Billings, 1866

Plate 4, fig. 1

Ptilodictya sulcata Billings, 1866, p. 35; Bassler, 1928, p. 162, pl. 10, figs. 9-11; Ross, 1960, p. 1069-1072, pl. 125, figs. 1-9.

Diagnosis.—Zoarium apparently articulated only basally and unbranched; zoaria consist of parallel-sided strap-like colonies, ranging from 5 to 30 mm in length and from 1 to more than 3 mm in width; zooecia in 8 to more than 20 longitudinal ranges, usually with some of these ranges being median ranges and the rest lateral ranges; zooecial apertures elongate-oval, about 0.1 by 0.2 mm in size; exozone several times the width of endozone; superior hemisepta common, thick, blunt, located at base on exozone; a second superior hemiseptum may be
developed distally to the first; inferior hemisepta common; diaphragms may be present. (Based on Ross, 1960, p. 1069-1071.)

Material and occurrence.--One specimen (UND 14325.) has been collected from outcrop locality A2569. The specimen is embedded in matrix but is otherwise in good condition.

Discussion.--This species is apparently somewhat variable, as documented by Ross's (1960, p. 1071) measurements. The Stony Mountain specimen has a maximum width of slightly less than 3 mm and 13 zooecial ranges, 7 of which are median ranges. These values fit in well with Ross's data.

This is the first report of *Ptilodictya sulcata* from an area other than Anticosti Island. The only previously reported species of *Ptilodictya* from Stony Mountain is *P. whiteavesi* Ulrich, a species tentatively synonymized with *P. canadensis* Billings by Ross (1960, p. 1064). There appears to be no material in my collections assignable to *P. canadensis*.

Whiteaves (1880, p. 49C) reported "*Ptilodictya (Stictopora) acuta* Hall" in a Stony Mountain faunal list. This species is now assigned to *Pachydictya*. There is no determining which of the several bifoliate cryptostomes present at Stony Mountain was the inspiration for that entry.

*Ptilodictya sulcata* is much more slender with substantially fewer zooecial ranges than *P. canadensis*. *Ptilodictya ensiformis* is an even more slender species with fewer ranges than *P. sulcata*. *Ptilodictya denticulata* has an explanate growth form and tooth-like projections on its surface. Other species of *Ptilodictya* from Anticosti have either
been synonymized with the above species or are regarded as not recognizable (Ross, 1960, p. 1064).

Genus Dicranopora Ulrich, 1882

Type species.—Ptilodictya internodia Miller and Dyer, 1878 (by original designation).

Diagnosis.—Zoarium segmented, the segments commonly bifurcating; segments usually parallel-sided; autozooecia in 3 to 12 or more longitudinal ranges; median ranges have long axes of zooecial apertures vertically; apertural axes in lateral ranges are commonly oriented obliquely, about 30 degrees from the vertical; ranges commonly separated by longitudinal ridges; endozone commonly several times wider than exozone; autozooecia in straight ranges in both endozone and exozone, subrectangular or rhombic in cross section in endozone and elliptical to subcircular in exozone; mesotheca straight, median rods apparently lacking; hemisepta present or absent, variable; mural styles absent.

Discussion.—Karklins (1983, p. 507) considered Dicranopora a junior synonym of Stictopora. No justification was given for this taxonomic decision. Based on my material, and on descriptions and illustrations of the type species, I am retaining Dicranopora as a separate genus.

Karklins (1983, p. 489) characterized the Ptilodictyidae as having zooecia "aligned on opposite sides of mesothecae." In contrast, he described (p. 506) the Rhinidictyidae as having zooecia "alternating on opposite sides of mesothecae." Further, the latter family is usually characterized by median rods in the mesothecae, structures that are
absent in the Ptilodictyidae. *Dicranopora* and *Goniotrypa* apparently lack median rods and have their zooecia aligned on opposite sides of their mesotheca. I am, therefore, removing these genera from the Rhinidictyidae and reassigning them to the Ptilodictyidae.

Descriptions and illustrations of the type species of *Dicranopora*, *D. internodia* (Miller and Dyer), are sketchy at best. There is nothing in the existing descriptions that would invalidate this familial reassignment, but it may be that a subsequent examination of topotype material would indicate that *D. internodia* would be best retained in the Stictoporidae. If that should prove to be the case, then the three species following would seem to require a new genus. For now, I think parsimony would be best served by retaining these species in *Dicranopora*.

*Dicranopora* differs from *Ptilodictya* in being segmented, rather than merely basally articulated and in having exceptionally wide endozones. *Dicranopora* and *Goniotrypa* are very similar, but the latter possesses a strongly elevated median ridge that runs the length of each segment.

*Dicranopora emacerata* (Nicholson, 1875)

Plate 4, figs. 10-15

*Ptilodictya emacerata* Nicholson, 1875a, p. 179, pl. 14, figs. 2, 2a, 2b; Nicholson, 1875b, p. 261, pl. 25, figs. 5, 5a, 5b.

*Dicranopora emacerata* (Nicholson) Ulrich, 1889, p. 40; Whiteaves, 1895, p. 118; Dowling, 1900, p. 50F; Nickles and Bassler, 1900, p. 232; Cumings, 1908, p. 827-828, pl. 32, figs. 13, 13a, 13b;
Diagnosis.--Zoarial segments parallel-sided, commonly bifurcating, ranging in width from 0.5 to 1.0 mm, and in length from 3.5 to 4 mm or a little more; proximal end gently convex; distal end ranges from gently concave to gently convex; zooecia arranged in 4 to 10 longitudinal ranges, 5 to 7 being commonest; ranges separated by longitudinal ridges, median ridges most pronounced; zooecial apertures elliptical, about 0.1 by 0.2 mm, those in lateral ranges commonly slightly larger than that; zooecial apertures possessing low, thin peristome on well preserved specimens; zooecia elliptical in exozone, subrectangular or rhombic in endozone; one long, thin, slightly curved superior hemiseptum usually present at distal boundary of the endozone, commonly connected to mesothecal wall; second hemiseptum, thin, curved, occasionally present, located about one-third of distance from mesothecal wall to distal hemiseptum, usually attached to the mesothecal wall.

Material and occurrence.--More than 1000 specimens have been collected. Of these, about 60 are from outcrop, 1 is from subsurface locality A2614, near the base of the Gunn Member; 5 from A2618, about 12 m above the base of the Gunn; 9 from A2615, near the base of the unit; about 30 from A2616, in the upper half of the Gunn; about 40 from A2603, from the lower two-thirds of the Gunn; about 110 from A2600, in the lowest quarter of the Gunn; and the rest (more than 800) from A2602, present throughout the Gunn although concentrated in the
lower half. Most of the segments are broken; intact segments are uncommon. Many have surficial detail obscured by abrasion and matrix.

**Discussion.**—Nicholson (1875a, p. 179) in his discussion of his new species, *Ptilodictya emacerata*, noted, "It is possible our form is only a variety of *P. fragilis*; but in the absence of figures of the latter, and in the face of the differences above mentioned, I think it safest to regard *P. emacerata* as a distinct species." The "differences above mentioned" refer to the segments of *P. emacerata* being shorter and more slender than those of *P. fragilis*, and in the former's having fewer zooecial ranges than the latter, a character that is probably a function of segment width. Ulrich (1889, p. 40), working with only one specimen of *Dicranopora emacerata*, also noted that this species "differs from *D. fragilis* in its smaller size, . . . In other respects the species agree very closely." I, too, find that that these species differ only in size; there appear to be no significant internal differences. Indeed, based on the quantity of material in my collections, I find it difficult to draw a boundary between the *D. emacerata* and *D. fragilis*. It may well be, as suggested above by Nicholson, that the two species are conspecific, and that separate species have been recognized by previous workers only due to a lack of sufficient material. However, I do not wish to synonymize these species based solely on the Gunn material; the type specimens and topotype collections should be examined to confirm a continuum of sizes.

*Dicranopora emacerata* may be distinguished from *D. brevis* n. sp. by the former's longer but narrower segments, from
D. internodia (Miller and Dyer) by D. emacerata's shorter and somewhat narrower segments, and from D. meeki (James) by D. emacerata's shorter but wider segments.

**Dicranopora fragilis** (Billings, 1866)

*Plate 4, figs. 9, 16-18*

**Ptilodictya fragilis** Billings, 1866, p. 9.

[?] **Stictopora fragilis** (Billings) Whitfield, 1882, p. 253, pl. 11, fig. 24.

**Dicranopora fragilis** (Billings) Ulrich, 1889, p. 40; Whiteaves, 1895, p. 118; Dowling, 1900, p. 50F; Nickles and Bassler, 1900, p. 232; Bassler, 1915, p. 419-420; Bassler, 1928, p. 166, pl. 14, figs. 12, 13; Baillie, 1952, p. 32.

**Diagnosis.**—Zoarial segments parallel-sided, commonly bifurcating, ranging in width from slightly more than 1 mm to slightly less than 2 mm; segments up to 10 mm long; proximal end of segments convex, usually tapered; distal end weakly convex to planar, rarely slightly concave; zooecia in 7 to 13 longitudinal ranges, 3 to 7 median ranges bracketed by 4 to 6 lateral ranges; ranges separated by longitudinal ridges, more pronounced between median ranges; zooecial apertures elliptical, about 0.1 by 0.2 mm, slightly larger in lateral ranges, surrounded by low, thin peristome in well-preserved specimens; zooecia elliptical in exozone, rhombic to subrectangular in endozone; long, thin, slightly curved superior hemiseptum, commonly extending proximally to mesothecal wall, usually present at distal margin of endozone; second superior hemiseptum, thin, curved, about one-third width of endozone from...
mesothecal wall, occasionally present, usually attached to the mesothecal wall.

Material and occurrence.—About 400 specimens have been collected, only six of them from outcrop. From the subsurface, one specimen each has been recovered from localities A2603, near the top of the Gunn Member, and from localities A2614, and A2624, about 5 m above the base; 3 specimens from A2615, near the base of the unit; 3 from A2618, about 8 m below the top of the Gunn; about 20 specimens from A2616, from the upper half of the Gunn; about 50 specimens from A2600, in the lowest quarter of the Gunn; and more than 300 specimens from A2602, concentrated in the lower half of the Gunn but present throughout. Almost all the specimens are fragmented, and most are abraded and have matrix adhering to them.

Discussion.—The fragmentary condition of the material makes it impossible to determine a range of segment lengths. The longest segments of D. fragilis appear to be significantly longer than those of D. emacerata, but this may just be a function of increased overall size. The possibility that these two species are conspecific is discussed above under D. emacerata.

Dicranopora fragilis may be distinguished from D. brevis n. sp. by the former's much longer and slightly wider segments and from D. meeki (James) and D. internodia (Miller and Dyer) by the substantially wider and somewhat longer segments of D. fragilis.

Dicranopora meeki (James, 1878)

Plate 4, figs. 19-23

Helopora meeki James, 1878, p. 3.
Diagnosis.--Zoarium segmented; segments subcylindrical, commonly bifurcating; segment width from 0.3 to 0.5 mm, "average length being 5.8 mm." (Bassler, 1906, p. 36). Proximal end obtusely pointed to moderately convex; distal end usually gently convex; zooecia in 3 to 5 longitudinal ranges, 4 being usual; ranges separated by sharp longitudinal ridges; zooecial apertures elliptical, about 0.1 by 0.2 mm; zooecia elliptical in exozone, rhombic to subrectangular in endozone; hemisepta and diaphragms not noted.

Material and occurrence.--About 160 specimens have been collected, all from the subsurface of North Dakota. About 90 of these are from locality A2602, from the lower two-thirds of the Gunn Member; 40 from A2603, from the lower two-thirds of the unit; 25 from A2600, from the lowest quarter of the Gunn; 3 from A2616, near the top of the Gunn; and 1 from A2615, near the base. Almost all are fragmented, and many are somewhat abraded.

Discussion.--This species has been previously reported only from Maysvillian strata in the Cincinnati area. Thus, this report represents an extension of both the geographic and stratigraphic range of Dicranopora meeki.

Distinguishing this species from D. emacerata (Nicholson) presents a problem similar to that of distinguishing that species from D. fragilis (Billings). It is not always apparent into which species a given specimen should be placed, as the upper size limit of D. meeki overlaps the lower limit of D. emacerata. This is especially true when dealing with worn specimens of D. meeki. However, in cases where when
surficial detail is sharp, D. meeki may be distinguished from all other species of Dicranopora by its extreme thinness, the sharpness and strength of the longitudinal ridges defining the zooecial ranges, and the thickness of the segment normal to the mesotheca. The thickness can almost equal the width of the segment, giving a cross section the appearance of a regular hexagon, similar to that of many of the Arthrostylidae.

**Dicranopora brevis** n. sp.

Plate 4, figs. 2-8

**Etymology.**—From the Latin *brevis*, short, for the exceptionally short segments of this species.

**Diagnosis.**—Zoarium segmented, about 10 to 15 percent of segments bifurcating; proximal and distal ends of segments thickened, tapering not at all or only slightly; proximal end moderately convex; distal end slightly concave to slightly convex; segments range from 1.4 to 2.85 mm long, averaging 1.94 mm, and 0.9 to 2.1 mm wide, average 1.44 mm; zooecia usually in 7 to 11 longitudinal ranges, mode 8; zooecial apertures in the 4 or 5 median ranges aligned longitudinally, those in the 4 to 6 lateral ranges aligned obliquely; apertures elliptical, about 0.1 by 0.2 mm, separated longitudinally by about their own length; endozone usually about 3 times width of exozone; zooecia elliptical in exozone, subrectangular or rhombic in endozone; one or two superior hemisepta may be present; proximal hemisepta thin, curved, located about one-third from the mesothecal wall to distal margin of endozone and occasionally connected to mesothecal wall; distal
hemisepta thin, slightly curved, commonly connected to mesothecal wall; inferior hemisepta occasionally present.

Material and occurrence.—More than 350 specimens have been collected from the subsurface of North Dakota. Localities A2600, near the base of the Gunn Member, and A2616, from 3 to 5 m above the base of the unit, have each provided about 10 specimens; about 150 specimens came from locality A2602, largely from the lower half of the Gunn. The remainder were from an interval about 7.5 to 11 m above the base of the Gunn at locality A2603. A majority of the specimens are complete segments and are fairly well preserved, except that the zooecial apertures are usually filled with matrix.

Discussion.—Dicranopora brevis may be distinguished from all previously known species of the genus by the shortness of the segments. Specimen UND 6479. is here designated the holotype. Paratypes here designated are UND 6480. through 6488. and 14326. through 14328. The type locality and horizon is A2603.18, about 10 m above the base of the Gunn Member, where the species is abundant and well preserved.

Genus Goniotrypa Ulrich, 1889

Type species.—Goniotrypa bilateralis Ulrich, 1889 (by monotypy).

Diagnosis.—Zoarium segmented, segments bifurcating infrequently, possessing strongly elevated longitudinal ridge; segments from 0.7 to 1.5 mm wide; length may exceed 6 mm; proximal ends moderately convex, distal ends usually weakly to moderately concave; zooecia in 4 to 6 longitudinal ranges, equally divided by median ridge; outer 2 ranges usually lateral ranges, middle 2 to 4 ranges median ranges; zooecial
apertures elliptical to subcircular; zooecia elliptical to subcircular in cross sections in exozone, rhombic in endozone; endozone much wider than exozone; superior hemisepta short, blunt, located at distal margins of endozone; inferior hemisepta, mural styles, and diaphragms absent.

Discussion.—The reassignment of Goniotrypa to the Ptilodictyidae is discussed above under Dicranopora. The alignment of the zooecia across the mesotheca and the lack of median rods would seem to preclude its assignment to the Rhinidictyidae.

**Goniotrypa bilateralis** Ulrich, 1889

Plate 4, figs. 24-28

**Goniotrypa bilateralis** Ulrich, 1889, p. 41, pl. 9, fig. 1; Whiteaves, 1895, p. 118; Dowling, 1900, p. 50F; Nickles and Bassler, 1900, p. 279-280; Bassler, 1915, p. 565; Bassler, 1928, p. 165; Baillie, 1952, p. 32; Bassler, 1953, p. G142, fig. 102,4; Karklins, 1983, p. 512, fig. 254,2.

**Diagnosis.**—Most segments simple, about 2 to 3 percent bifurcating; segments parallel-sided, from about 0.7 to 1.5 mm wide; length about 4 to 6 mm; longitudinal ridge strongly elevated, sharp; zooecia in 2 lateral ranges, 2 to 4 median ranges; zooecial apertures subcircular in median ranges, elliptical in lateral ranges; subcircular apertures about 0.15 mm diameter, elliptical apertures about 0.15 by 0.25 mm; zooecia subcircular in exozone, rhombic in endozone; endozone several times width of exozone.
Material and occurrence.—Approximately 650 specimens have been recovered. More than 500 of these were from subsurface locality A2602, concentrated in the lower half of the Gunn Member but present throughout; another 50 from the lowest quarter of the Gunn at A2600; 9 specimens, most only questionably assigned to this species, from the middle third of the Gunn at A2603; 1 from A2615, near the base; and about 75 specimens from outcrop. No segment is complete; the longest fragment in the collection is somewhat longer than 4 mm. Most specimens are encrusted by matrix to some degree, and most have either their lateral flanges or their median ridge, or both, broken. However, enough well-preserved material remains so that a reasonably accurate picture of the species may be drawn.

Discussion.—To my knowledge, Goniotrypa is a monospecific genus. Thus, this constitutes the first report of bifurcation for both the genus and the species. The strongly raised median ridge makes this species easily distinguishable from any other segmented species.

Family Escharoporidae Karklins, 1983

Genus Platydictya n. gen.

Etymology.—From the Greek platys, wide, flat, and dictyon, net, referring to the explanate growth habit of this genus.

Type species.—Platydictya renvillensis n. sp., here designated.

Diagnosis.—Zoarium explanate, unbranched; mesotheca generally straight, locally curved; zooecial ranges aligned or irregularly alternate across mesotheca; endozone, exozone subequal in width; zooecia subrectangular to rhombic in cross section in endozone, in longitudinal ranges; zooecia subcircular in exozone, arranged in weak
diagonal pattern; exilazooecia absent; hemisepta and diaphragms absent; monticules uncommon, indistinct; mural styles common, usually indistinct.

Discussion.--The combination of diagonally arranged zooecial apertures, U-shaped lamellae in the stereom, and lack of median rods, mark this genus as a member of the Escharoporinae. Only two other explanate genera are known in this family. Both Championdictya and Chazydictya have common basal diaphragms and abundant pustules, structures that are lacking in Platydictya.

Platydictya renvillensis n. sp.

Plate 5, figs. 7-9

Etymology.--From Renville County, North Dakota, where the specimen was found.

Diagnosis.--Zoarium explanate frond of unknown length and width, from 0.7 to 1.3 mm thick; mesotheca straight to sinuous; zooecial ranges irregularly alternate across mesotheca; autozooecia subrectangular in cross section in endozone, subcircular in exozone; zooecial apertures subcircular, about 0.17 to 0.20 mm in diameter; about 6 zooecia in 2 mm both longitudinally and laterally; monticules rare, irregularly spaced, consisting of slightly raised areas lacking zooecial apertures to 1.5 mm diameter.

Material and occurrence.--A single specimen (UND 6470.), here designated the holotype, has been collected from subsurface locality A2628.1, about 4 m above the base of the Gunn Member. The specimen measured slightly more than 30 mm by 50 mm before parts were sacrificed.
to sectioning. Partial recrystallization has occurred, but preservation is generally fairly good.

Discussion.—I regret the necessity of erecting a new genus and species based on a single specimen. However, the material is good enough to determine that it doesn't fit into a previously described genus and species.

The only other explanate bifoliate bryozoan in the Gunn Member is *Pachydictya hexagonalis* Ulrich, which has hexagonal zooecial apertures and only a small amount of interzoooidal skeleton. In contrast, *Platydictya renvillensis* n. sp. has subcircular apertures that are significantly smaller than those of *Pachydictya hexagonalis* and a substantial amount of interzoooidal skeleton.

Family Rhinidictyidae Ulrich, 1893

Genus *Pachydictya* Ulrich, 1882

*Type species.*—*Pachydictya robusta* Ulrich, 1882 (by monotypy).

Discussion.—Karklins (1983, p. 512) excluded explanate growth forms from his description of Pachydictya. Previously, he (Karklins, 1969) had erected Athrophragma, into which he placed several explanate species previously assigned to Pachydictya. My reasons for retaining P. hexagonalis in Pachydictya are discussed below under that species. The retention of P. hexagonalis in this genus necessitated the modification of Karklins's (1983) generic description to include explanate growth forms.

Pachydictya hexagonalis Ulrich, 1889

Plate 4, figs. 29-33

Pachydictya hexagonalis Ulrich, 1889, p. 42-43, pl. 9, figs. 2-2c;
Whiteaves, 1895, p. 118; Dowling, 1900, p. 50F; Nickles and Bassler, 1900, p. 340; Bassler, 1915, p. 930; Bassler, 1928, p. 166; Baillie, 1952, p. 32; Ross, 1961, p. 341-343, pl. 45, figs. 1-5, 7, 8.

Diagnosis.—Zoarium explanate, of unknown size; monticules irregularly spaced at about 5 mm intervals, of larger or smaller zooecia and larger interzooecial spaces; zooecial apertures about 0.3 mm in diameter, irregularly hexagonal, may be subquadrate; diaphragms more common in exozone than in endozone; in exozone, zooecial boundaries defined by gently curving rows of mural styles.

Material and occurrence.—About 90 fragments of zoaria have been collected from outcrop. None is complete; the largest fragment slightly exceeds 40 mm by 60 mm. Most of the specimens are partly imbedded in or encrusted by matrix. No material assignable to this species has been recovered from the subsurface.
Discussion.--Karklins (1983, p. 509) gives as one of the characters of Athrophragma, "mural styles indistinct or lacking," in contrast to Pachydictya, which he characterizes (p. 513) with, "mural styles common." As these two genera seem to differ only by this character and the zoarial growth form, and the growth form seems to be of less than generic significance in this suborder, P. hexagonalis is here retained in Pachydictya.

Family Uncertain

Genus Endodictya n. gen.

Etymology.--From the Greek endon, inside, and dictyon, net, referring to the unusually wide endozone in this genus.

Type species.--Endodictya pachyclema n. sp. (here designated).

Diagnosis.--Zoarium subcylindrical, continuous with base, branching rare or absent; zoocia in longitudinal ranges, subrectangular in cross section in endozone, elliptical in exozone; superior hemisepta common, long, thin, curved; inferior hemisepta, mural styles, basal diaphragms, monticules absent; spines may be present.

Discussion.--Endodictya is erected to accommodate the species described below. As with 8 of the 36 genera assigned to this suborder in the Treatise (Karklins, 1983), it does not seem to fit into any of the established families. In Endodictya, the zoocia in longitudinal ranges alternate on opposite sides of the mesotheca, in contrast to the ptilodictyids, whose ranges are aligned. The zoocia in Endodictya are in straight ranges in the exozone, in contrast to the rhombic
arrangement in the escharoporids, intraporids, stictoporellids, and virgatellids. *Endodictya* lacks the median rods that characterize the rhinidictyids, and lacks the exilazooecia that are common among the stictoporellids.

Among previously established families, the Rhinidictyidae seem closest to providing a home for *Endodictya*. The major differences seem to be the lack of median rods in *Endodictya* and its relatively wide endozones. It is possible, of course, that recrystallization and other diagenetic processes have obliterated evidence of rods in *Endodictya*; if median rods were to be found, I would feel comfortable assigning this genus to the Rhinidictyidae.

**Endodictya pachyclema** n. sp.

Plate 5, figs. 1-6

*Etymology.*—From the Greek *pachys*, thick, and *klema*, twig, referring to the thick subcylindrical zoaria.

*Diagnosis.*—Zoarium subcylindrical, branching rare; length unknown; width from about 0.5 to 1.3 mm, thickness from about 0.5 to 1.0 mm; zooecia in 4 to 8 longitudinal ranges; zooecial apertures elongate elliptical, from about 0.08 by 0.17 mm to about 0.12 by 0.25 mm; endozone about twice to thrice width of exozone; superior hemisepta long, thin, curving proximally from distal margin of endozone about two-thirds width of endozone toward mesothecal wall; mural spines short, blunt, few.

*Material and occurrence.*—About 275 specimens have been collected. Of these, 5 are from outcrop, 1 very poorly preserved
specimen is from subsurface locality A2618, in the upper third of the Gunn Member; 13 from A2600, in the lowest quarter of the Gunn; about 35 from A2603, from the middle third of the unit; and the rest (more than 225) are from A2602, concentrated in the lower half of the Gunn but present throughout. All specimens are fragmented, and most seem to be somewhat abraded. Most specimens have their lateral margins broken.

Discussion.--Specimen UND 14641., from locality A2602.20, about 10 m above the base of the Gunn Member, is here designated the holotype. Specimens UND 14642., 14643., and 14594. through 14600. are designated paratypes.

This species may be distinguished from other twig-like ptilodictyines by its lack of proximal and distal terminations and its lack of obliquely-directed zooecial apertures in lateral zooecial ranges. It is also thicker, most of the other species being compressed strap-like forms.

Order TREPOSTOMATA Ulrich, 1882
Suborder HALLOPOROIDEA Astrova, 1965
Family Heterotrypidae Ulrich, 1890
Genus Stigmatella Ulrich and Bassler, 1904

Type species.--Stigmatella crenulata Ulrich and Bassler, 1904 (by original designation).

Diagnosis.--"Zoaria encrusting, massive, or branching. Zooecia with angular, round-angular, and petaloid orifices, with very thin, fused walls, longitudinally- and obliquely-laminar microstructure, with periodic thickenings at various levels in the exozones,
associated with the development of acanthozooecia here. Diaphragms thin, abundant or very rare, sometimes absent. Mesozooecia commonly rare, with abundant diaphragms, often beaded, developed only in the exozone. Acanthozooecia mainly abundant, short, discontinuously developed, confined mainly to zoarial exozones, of one type, embedded in zooecial walls." (Astrova, 1978, p. 91-92).

Discussion.—Suprageneric classification in the trepostomes follows Astrova (1978). This should not be construed to mean that I believe it to be without fault; rather, I believe it to be the best current approximation of the classification of a group that still requires much work.

? Stigmatella sp.
Plate 5, figs. 13, 14, 19

Diagnosis.—Zoarium ramose, subcylindrical, diameter 5 to 10 mm; maculae apparently lacking; exozone fairly narrow, poorly defined; zooecial apertures subcircular, elliptical, or subpolygonal; zooecia curving gently from endozone into exozone, intersecting zoarial surface at about 45 degrees; zooecial walls uniformly very thin throughout zoarium, crenulated in places; one or two diaphragms usually present in outer exozone in each zooecium; mesozooecia common, rising in proximal exozone, with common diaphragms constricting their walls, giving beaded appearance; acanthopores absent.

Material and occurrence.—Three specimens, all heavily abraded, were collected from outcrop locality A2569.

Discussion.—These specimens are tentatively assigned to Stigmatella. The thin, crenulated zooecial walls, beaded mesozooecia,
and sparse diaphragms are all characteristic of this genus, but I know of no species of *Stigmatella* that completely lacks acanthopores and that has the zooecia intersecting the zoarial surface at such an oblique angle. It may be that the distal exozone has been lost due to erosion; this would change the angle of intersection of the zooecial walls and possibly eliminate both the acanthopores and the thickened zooecial walls in the exozone. I believe it would be unwise to erect a new species based on the material at hand; more and better-preserved material is needed.

**Genus Dekayia** Milne-Edwards and Haime, 1851

*Type species.*—*Dekayia aspera* Milne-Edwards and Haime, 1851 (by original designation).

*Diagnosis.*—"Zoaria branching, less frequently encrusting or massive. Zooecial orifices polygonal or rounded-polygonal. Walls curved and wrinkled, unevenly thickened in exozone, from separate to fused, the latter with a transversely-laminar microstructure. Diaphragms commonly rare almost exclusively in the exozone. Mesozooecia few in number (only in area of maculae), and diaphragms in them rare. Acanthozooecia commonly abundant, large and long, developing in exozone; those in some species shorter and smaller." (Astrova, 1978, p. 100).

**Dekayia micropora** n. sp.

*Plate 5, figs. 8, 9*

*Etymology.*—From the Greek mikros, small, and poros, hole, referring to the unusually small zooecia in this species.
Diagnosis.—Zoarium forming subcircular encrustations about 1 mm thick and with diameters about 2 to 8 mm; maculae absent; zooecial apertures small, polygonal; diaphragms and mesozooecia absent; acanthopores sparse, indistinct.

Material and occurrence.—Two small zoaria, in fairly good condition, were found encrusting a brachial valve of Dinorthis (Dinorthis) carletona Twenhofel at outcrop locality A417. The larger of the two zoaria of this specimen (UND 14660.) is designated the holotype, and locality A417 the type locality.

Discussion.—This species closely resembles Dekayia gregaria (Ulrich) and D. scabiosa (Ulrich). However, Dekayia micropora n. sp. possesses zooecia only slightly more than half the size of those of D. gregaria (18 or 19 zooecia in 2 mm, compared to 10 in 2 mm). It also differs from the other two species in having only rare indistinct acanthopores, in contrast to the common to abundant large structures of D. gregaria and D. scabiosa. Dekayia micropora has smaller zooecia than any other encrusting species of Dekayia known to me.

Dekayia aequalis n. sp.

Plate 5, figs. 20, 23, 24

Etymology.—From the Latin aequalis, equal, referring to the relatively constant size of acanthopores in this species.

Diagnosis.—Zoarium ramose, robust; maculae of slightly elevated areas of zooecia smaller than usual for species; zooecial apertures polygonal; exozone well defined, large; zooecia intersect zoarial surface at about right angles; diaphragms sparse in endozone, common
in exozone and in curve to exozone; zooecial walls irregularly thickened in exozone; mesozooecia apparently absent; acanthopores abundant, large, of one size in tangential section.

**Material and occurrence.**—Five specimens have been collected from outcrop, and one (UND 14685.) from subsurface locality A2620.06, in the upper half of the Gunn Member. Specimen UND 14661., from locality A417, is designated the holotype. Paratypes are UND 14684., 14685., and 14729.

**Discussion.**—*Dekayia aequalis* n. sp. may be distinguished from other erect species of *Dekayia* by its acanthopores of uniform size in tangential sections, and by the presence of diaphragms in the endozone and their abundance in the exozone. *Dekayia aequalis* n. sp. shares with *D. maculata* James the abundant large acanthopores of that species, but has many more diaphragms. *Dekayia aequalis* is similar to *D. mesospinosa* Brown and Daly but lacks the different-sized acanthopores of that species; also, *D. aequalis* has a few endozonal diaphragms, lacking in *D. mesospinosa*. I know of no other species of *Dekayia*, erect or encrusting, that contains this combination of acanthopore and diaphragm characters.

**Genus Lioclemella Foerste, 1895**

**Type species.**—*Callopora ohioensis* Foerste, 1887 (by original designation).

**Diagnosis.**—"Zoaria cylindrical, spindle-shaped, less frequently with appendages, with sharpened proximal articulations, attached to the expanded base. Zooecia with rounded-angular orifices, weakly thickened fused longitudinally-fibrous walls and diaphragms more
numerous in the endozone or ubiquitously rare. Mesozooecia abundant, large, often exceeding the zooecia in size, with frequent straight diaphragms, not constricting their walls. Acanthozooecia numerous and commonly large." (Astrova, 1978, p. 94).

**Lioclemella subfusiformis** (James, 1882)

Plate 5, figs. 10-12

**Monticulipora (?Monotrypa) subfusiformis** James, 1882, p. 52; James, 1883, pl. 1, fig. 1.

**Monticulipora fusiformis** James and James, 1888, p. 26 (non Whitfield, 1878); James, 1895, p. 83-84.

[?] **Batostomella gracilis** (Nicholson) Ulrich, 1889, p. 35.

[?] **Homotrypella gracilis** (Nicholson) Whiteaves, 1895, p. 116-117; Dowling, 1900, p. 50F.


**Lioclemella subfusiformis** (James) Nickles and Bassler, 1900, p. 309; Bassler, 1906, p. 42-43, pl. 7, figs. 4-7.

**Diagnosis.**—Zoarium cylindrical, 1 to 3 mm thick, rarely branching; maculae apparently absent; exozone relatively wide; zooecia intersect zoarial surface at about 70 degrees; diaphragms rare, absent in most zooecia; mesozooecia abundant, rising in proximal exozone, with abundant diaphragms; acanthopores large, indistinct.

**Material and occurrence.**—More than 150 zoarial fragments have been collected, of which only 7 are from outcrop. One specimen each was recovered from subsurface localities A2614, about 4 m above the base of the Gunn Member, and A2616, just above the middle of the unit; 3 from A2615, in the lowest 5 m of the Gunn; about 20 from A2600, in
the lowest quarter of the Gunn; about 35 from A2603, most from the lower half of the unit; and about 85 from A2602, from the lower two-thirds of the Gunn. All are fragmented and surficial detail is somewhat obscured by matrix and abrasion on most.

Discussion.--Bassler (1906, p. 42), in his redescription of James's type specimens, gave a figure of 10 to 12 zooecia in 2 mm. I find an average of about 14 zooecia in 2 mm for the Gunn material. I do not believe this to be a significant difference based on so few measurements. Bassler (1906, p. 43) also said, "Acanthopores small and usually inconspicuous . . . ." From Bassler's (1906, pl. 7, figs. 5, 6) illustrations, I would judge his sections to be considerably deeper than mine. In shallow tangential sections, I find the acanthopores to be rather large, although poorly defined. As Lioclemella subfusiformis (James) has never been adequately described and illustrated, the minor differences noted here are insufficient, in my opinion, to justify the establishment of a new species.

Among other Ordovician species of Lioclemella, L. subfusiformis is smaller, and has smaller zooecia, than L. clava Bassler, L. solidissima (Whitfield), and L. fusiformis (Whitfield). Lioclemella bifurcata Bassler is inadequately described and illustrated, and apparently bifurcates regularly, in contrast with L. subfusiformis. I consider Trematopora? nitida Ulrich, assigned to Lioclemella by Nickles and Bassler (1900), to be an Eridotrypa and discuss it under that genus.

I have tentatively included in synonymy Ulrich's (1889)
identification of *Batostomella gracilis* (Nicholson) and subsequent citations of Ulrich's work. As discussed by Ross (1967) and Astrova (1973), *Batostomella gracilis*, the type species of *Batostomella*, is an inadequately described species for which the type specimens apparently have been lost. None of my material conforms to either Nicholson's (1875) original description and illustrations or those of the evidently different species described and illustrated as *Bythopora gracilis* (Nicholson) by Utgaard and Perry (1964) or as *Batostomella gracilis* (Nicholson) by Singh (1979) and Brown and Daly (1985). It is possible that Ulrich (1889) misidentified a few poorly preserved fragments of *Lioclemella subfusiformis* as *Batostomella gracilis*; the external appearance of these two species is not dissimilar, especially if preservation is not good.

Family Halloporidae Bassler, 1911

Genus *Tarphophragma* Karklins, 1984

*Type species.*—*Monotrypella multitabulata* Ulrich, 1886 (by original designation).

*Diagnosis.*—Zoarium branching; maculae common, flush or slightly raised; zooecial apertures polygonal to subcircular; zooecial walls somewhat thickened in exozone; diaphragms abundant throughout zoaria; mesozooecia rare to common, with abundant diaphragms (based on Karklins, 1984, p. 175).

*Discussion.*—Karklins (1984) assigned this genus to the Family Caloporidae, an invalid family name. I have no desire to continue to debate the merits of the generic names *Calopora*, *Callopora*, and *Hallopora*; that has been done by Singh (1970) and Ross (1970). Based
on her interpretation that *Calopora* is the valid generic name for bryozoans referred to *Hallopora* for the preceding half century, Ross (1961b, p. 55) renamed the family also. However, Article 40 (a) of the Code (ICZN, 1985a, p. 81) states that, after 1960, the family name is not to be rejected even if the generic name on which it is founded is replaced. Even if such a replacement were valid, the family name would have to revert to *Halloporidae* because Opinion 1034 (ICZN, 1975, p. 33-35) officially rejected *Calopora* and accepted *Hallopora*. Thus, I have no idea why Karklins used *Calopora* and *Caloporidae*; he offered no justification.

*Tarthophragma* may be distinguished from *Hallopora* by *Tarthophragma* 's "regular occurrence of abundant basal diaphragms throughout zoaria" (Karklins, 1984, p. 175), by its zooecial budding pattern and zooecial cross-sectional shape, and by its lack of spines and cysts (Karklins, 1984, p. 175-176). The species described below constitutes the first Upper Ordovician North American taxon assigned to this genus, and thus extends the North American range of the genus from the Middle Ordovician into the Richmondian.

**Tarthophragma clinopora** n. sp.

**Plate 5, figs. 17, 18, 21, 22**

**Etymology.**—From the Greek *klino*, slant, and *poros*, hole, referring to the inclination of the zooecia at the zoarial surface.

**Diagnosis.**—Zoarium ramose, branches cylindrical to subcylindrical; maculae obscure, apparently of flush or very slightly elevated areas of slightly larger zooecia, with thicker walls than normal, and mesozooecia; zooecial apertures polygonal to elliptical to
subcircular; zooecial walls and diaphragms slightly thickened in exozone; exozone narrow, commonly poorly defined; diaphragms abundant throughout zoarium, usually slightly more so in exozone; zooecia commonly intersect zoarial surface at low angles; zooecia occasionally become mesozooecia and vice versa; mesozooecial diaphragms slightly more abundant than those in zooecia.

Material and occurrence.---About 30 zoarial fragments have been collected. Of these, 8 are from outcrop, one each from about 10 m below the top of the Gunn Member at subsurface localities A2618 and A2623; one from A2602, about 8 m above the base; three from A2614, about 4 m below the top of the Gunn; and the rest from A2602, scattered throughout the Gunn Member although concentrated in the lower two-thirds. Most specimens have matrix partially obscuring the surface, but the interior is in good condition in most of the material. Specimen UND 14663, from locality A2569, is designated the holotype. Specimens UND 14662 and 14664 through 14673 are designated paratypes.

Discussion.---Tarphophragma clinopora n. sp. may be distinguished from the type species, T. multitabulata (Ulrich), by a larger zooecial diameter, significantly fewer diaphragms in the exozone, a narrower and less well defined exozone, and zooecia that intersect the zoarial surface at smaller angles. Tarphophragma clinopora perhaps most closely resembles T. angulans (Ulrich), from which it differs most significantly in having fewer diaphragms in the exozone. There is no Upper Ordovician species with which T. clinopora need be compared.
Genus Parvohallopora Singh, 1979

Type species.—Monticulipora ramosa d'Orbigny, 1850 (by original designation).

Diagnosis.—Zoarium ramose, cylindrical; maculae present or absent; exozone wide; zooecial apertures polygonal to subcircular; zooecial walls thickened in exozone; diaphragms throughout zoaria in some species, only in endozone in others; mesozooecia usually abundant, containing abundant diaphragms (Singh, 1979, p. 226).

Discussion.—Parvohallopora may be distinguished from Hallopora by its smaller zooecia and mesozooecia, polygonal zooecia in the endozone, and lack of spines and cystose diaphragms (Singh, 1979, p. 227-228). From Tarphophragma, Parvohallopora may be distinguished by its wide exozone and relative paucity of diaphragms.

Parvohallopora sp. aff. P. subplana (Ulrich, 1882)

Plate 6, figs. 3, 4

Diagnosis.—Zoarium ramose, subcylindrical; maculae somewhat raised, of slightly larger zooecia and clustered mesozooecia; zooecial apertures usually subcircular, occasionally elliptical; zooecia intersect zoarial surface at right angles; diaphragms common in endozone, abundant in exozone; mesozooecia abundant, with very abundant and closely spaced diaphragms.

Material and occurrence.—Two zoarial fragments (UND 14682.) were collected from subsurface locality A2603.181, about 10 m above the base of the Gunn Member. Unfortunately, the interiors have been largely dissolved and filled with matrix. The remaining material is
too sparse and poorly preserved to justify the erection of a new species.

**Discussion.**—This material seems very close to *Parvohallopora subplana* (Ulrich), as described by Brown and Daly (1985, p. 72). The only difference seems to be in the number of diaphragms, but my material is too sparse to determine if the difference is significant. The Gunn material is also similar to *P. congrua* (Utgaard and Perry) but has larger zooecia and more mesozooecia; it also has larger zooecia and more mesozooecia at the surface than does *P. aequalis* (Dyer). The Gunn form may be distinguished from *Parvohallopora ramosa* (d'Orbigny), *P. subnodosa* (Ulrich), and *P. onealli* (James) by its much more numerous diaphragms.

*Parvohallopora sp. aff. P. ramosa* (d'Orbigny, 1850)

Plate 6, figs. 7, 8

**Diagnosis.**—Zoarium ramose, subcylindrical; zooecial apertures usually subcircular, occasionally polygonal; exozone wide; zooecial walls moderately thickened in exozone; diaphragms common in endozone only in newly budded zooecia, otherwise common only in exozone; mesozooecia common, containing abundant diaphragms.

**Material and occurrence.**—One core slab (UND 14683.) from subsurface locality A2620.07, about in the middle of the Gunn Member, containing a substantial portion of an anastomosing colony, was collected. The exterior is embedded in matrix, but it was possible to make a satisfactory acetate peel from the polished slab surface.

**Discussion.**—The internal structural features of this specimen agree in all respects with those of *Parvohallopora ramosa* (d'Orbigny),
as described by Brown and Daly (1985, p. 72). The Gunn material is not positively assigned to *P. ramosa* only because it is not possible to verify the presence of large conical to elongate maculae, a diagnostic feature of *P. ramosa*.

Family Trematoporidae Miller, 1889

Genus *Batostoma* Ulrich, 1882

Type species.—*Monticulipora (Heterotrypa) implicata* Nicholson, 1881 (by monotypy).

**Diagnosis.**—"Zoaria branching, sometimes in the form of compact branches, less frequently encrusting or massive. Zooecia with rounded-polygonal, circular, and oval orifices. Walls weakly or intensely thickened in the exozones, having a separated nature and an obliquely-laminar microstructure. Diaphragms predominantly numerous, often curved, and cystiphragmoid, mainly only in the exozones. Mesozooecia [usually] rare, only sometimes forming small accumulations between the orifices, covered from surface by thin deposits of calcareous matter. Acanthozooecia numerous, small or large, and in some species there are large, thin-walled acanthozooecia with a very wide cavity and rare thin diaphragms." (Astrova, 1978, p. 121-122).

*Batostoma manitobense* Ulrich, 1889

Plate 6, figs. 15, 16, 19

*Batostoma manitobense* Ulrich, 1889, p. 33-34, pl. 9, figs. 3-3c; Whiteaves, 1895, p. 117; Dowling, 1900, p. 50F; Nickles and Bassler, 1900, p. 178; Bassler, 1915, p. 109; Baillie, 1952, p. 32.
Diagnosis.--Zoarium ramose, robust; maculae common, of slightly raised areas of larger zooecia and clusters of mesozooecia, 3 to 5 mm apart; zooecial apertures subpolygonal to subcircular; exozone fairly narrow; zooecial walls slightly to moderately thickened in exozone; diaphragms sparse in endozone, sparse to common and somewhat thickened in exozone; mesozooecia common to abundant, commonly overgrown, usually budded in distal endozone, with abundant diaphragms; acanthozoecia abundant, large, indistinct, lumens small to lacking.

Material and occurrence.--About 150 zoarial fragments have been collected from outcrop and another 100 from the subsurface of North Dakota. Of the subsurface specimens, one each has been recovered from subsurface localities A2600 and A2614, near the base of the Gunn Member; two are from A2623, about 3 to 5 m above the base; three from A2617, about 2 m above the base of the Gunn; four each from A2615 and A2624, all within 2 m of the base of the unit; six from A2603, about 2 m above the base of the Gunn; and the rest (about 80) from A2602, all but one from the bottom half of the Gunn Member. Most specimens are in fairly good condition, although structural details are somewhat obscured by dissolution and recrystallization in specimens from deeper wells in western North Dakota.

Discussion.--In his original description, Ulrich (1889, p. 33) said, "... acanthopores are unusually small." I find, on the contrary, that the acanthopores in this species are large, but are poorly defined and have tiny or non-existent lumens. It may be that Ulrich's sectioned specimens had smaller or less well defined acanthopores than is normal for this species.
Batostoma sp. cf. B. ovata (Ulrich, 1893)

Plate 6, figs. 5, 6

**Diagnosis.**—Zoarium encrusting; maculae absent; zooecial apertures elliptical to subcircular, separated by calcareous deposits at zoarial surface; zooecial walls thin; several diaphragms in each zooecium; diaphragms commonly curved or intersecting; mesozooecia common, with about twice the number of diaphragms as the zooecia; acanthopores not seen; indistinct pustules in interzooecial stereom in tangential section.

**Material and occurrence.**—A single specimen (UND 14976.), in relatively good condition, was collected from outcrop.

**Discussion.**—The single specimen conforms in all respects to *Batostoma ovata* (Ulrich, 1893) except that the zooecia are about 30 percent smaller. It would be a little surprising if they proved to be conspecific; *B. ovata* is from the Decorah Shale (Middle Ordovician). However, I do not wish to erect a new species until more material becomes available.

*Batostoma ovata* (Ulrich, 1893) was originally designated the type species of *Stromatopora*. Boardman (1960, p. 6-7, pl. 7, fig. 3) re-examined the type specimens of *S. ovata* and reassigned the species to *Batostoma*, thus making *Stromatopora* a junior synonym of *Batostoma*.

**Genus Bythopora** Miller and Dyer, 1878

**Type species.**—*Bythopora fruticosa* Miller and Dyer, 1878 (by original designation; junior objective synonym of *Helopora dendrina* James, 1878).

Discussion.--Bassler (1906, p. 20) and Ross (1967, p. 641) have provided interesting discussions on the confusion surrounding the type species of Bythopora. Briefly, Miller and Dyer (1878) described Bythopora fruticosa, which they designated the type species of their new genus Bythopora, from the same specimen that James (1878) had, 20 days earlier, published as Helopora dendrina.

Bythopora striata Ulrich, 1889
Plate 6, figs. 1, 2

Bythopora striata Ulrich, 1889, p. 36; Whiteaves, 1895, p. 116;
Dowling, 1900, p. 50F; Nickles and Bassler, 1900, p. 186;
Cumings, 1908, p. 784, pl. 27, fig. 4; Bassler, 1915, p. 152;
Bassler, 1928, p. 152; Baillie, 1952, p. 32.

Diagnosis.--Zoarium slender, cylindrical, bifurcating, tapered proximally, apparently basally articulated; maculae absent; exozone narrow, poorly defined; zooecia at about 25 degrees to zoarial surface; zooecial apertures elongate-oval or pyriform, tapering distally; longitudinal ridges, several zooecia long, commonly separate adjacent zooecia; diaphragms, mesozooecia, and acanthopores absent.
Material and occurrence.—About 175 specimens have been collected, all from the subsurface of North Dakota. One specimen each was collected from locality A2614, about 4 m above the base of the Gunn Member, and A2620, in the upper half of the Gunn; three each from A2615, near the base of the unit, and A2616, near the middle of the Gunn; about 25 specimens from A2603, most from 7 to 10 m above the base; about 70 from A2600, in the lowest quarter of the Gunn; and about 70 from A2602, mostly from the lower half of the unit. All specimens are fragmented, and surficial detail is unclear on most.

Discussion.—Bythopora striata was erected by Ulrich (1889) upon a single specimen from Stony Mountain, Manitoba. The material assigned here to B. striata agrees in all respects with Ulrich's (1889) description, but the holotype should be sectioned and redescribed.

This species bears a remarkable external similarity to the next species described, Eridotrypa nitida (Ulrich). Bythopora striata lacks the common mesozooecia of E. nitida, but as those structures are usually overgrown by calcareous deposits at the zoarial surface, the differentiation of the two species can be difficult. It is possible that some specimens I have assigned to B. striata are actually E. nitida, and vice versa.

Bythopora striata Ulrich may be distinguished from all other species of Bythopora by its striated exterior. It is also somewhat smaller than other Upper Ordovician species, i.e., B. arctipora (Nicholson), B. dendrina (James), B. delicatula (Nicholson), and B. parvula (James). "Batostomella" gracilis (Nicholson), often assigned
to *Bythopora*, is substantially larger than *Bythopora striata* and is not, in my opinion, a *Bythopora*.

Genus *Eridotrypa* Ulrich, 1893

**Type species.**—*Eridotrypa mutabilis* Ulrich, 1893 (by original designation).

**Diagnosis.**—"Zoaria branching, sometimes originating from an encrusting base, with narrow exozone. Zooecia weakly rotated towards surface of zoarium, with oval and oval-circular, tapered orifices, arranged in longitudinal rows... Diaphragms numerous throughout the entire zoarium in the older species, but reduced in number in the younger forms, being concentrated only within the exozones. Mesozooecia [commonly] rare and short, covered in varying degrees by deposits of calcareous matter, the diaphragms in them ranging from abundant in the older species to less common in the later forms. Acanthozooecia small and short, and sometimes absent..." (Astrova, 1978, p. 130-131).

**Discussion.**—The type species of *Eridotrypa*, *E. mutabilis* Ulrich, was placed in synonymy with *Cladopora aedilis* Eichwald, by Bassler (1911, p. 242). Since then, many workers have considered the type species of *Eridotrypa* to be *Eridotrypa aedilis* (Eichwald). Karklins (1984, p. 165-166), who examined specimens of *E. aedilis* collected in Estonia by Bassler, reported that the differences between that species and *E. mutabilis* were "subtle but recognizable." Both Ross (1967) and Karklins (1984) recommended retaining *E. mutabilis* Ulrich as the type species of *Eridotrypa* until the type specimens of *E. aedilis* (Eichwald) were redescribed. Their recommendation is followed here.
Astrova (1978, p. 130) reported that mesozooecia were rare in Eridotrypa, but Ross' (1967) description and illustrations of the type specimens of E. mutabilis indicate that, at least in the type species, they are actually fairly common. This seems to be yet another difference, not noted by either Ross (1967) or Karklins (1984), between E. mutabilis and E. aedilis.

Eridotrypa nitida (Ulrich, 1890)

Plate 6, figs. 9-11


[?] Bythopora delicatula (Nicholson) Whiteaves, 1895, p. 116; Dowling, 1900, p. 50F; Nickles and Bassler, 1900, p. 184 (partim);
Bassler, 1915, p. 151 (partim); Baillie, 1952, p. 32.

Trematopora? nitida Ulrich, 1890b, p. 419-420, pl. 34, figs. 2-2f.


Diagnosis.—Zoarium slender, cylindrical, tapered proximally, apparently basally articulated; maculae absent; exozone very narrow; zooecial angle with zoarial surface about 40 degrees; zooecial apertures oval, tapering distally; diaphragms rare in endozone, sparse in exozone; mesozooecia sparse to common, short, each with two or three diaphragms, overgrown by calcareous deposits at zoarial surface; acanthopores short, small, indistinct.

Material and occurrence.—More than 250 specimens have been collected. Only two of these are from outcrop. Three came from
subsurface locality A2615, near the base of the Gunn Member; seven from A2616, in the upper half of the unit; about 25 from A2600, in the lowest quarter of the Gunn; about 25 from A2603, 10 to 12 m above the base of the Gunn; and more than 200 from A2602, from the lower two-thirds of the unit. Most specimens are fragmentary and surficial details commonly lack clarity.

**Discussion.**—Previous workers have assigned this species to *Lioclemella* since that genus was established, apparently solely on the basis of its proximally tapering and evidently basally articulating zoarium. I find that the narrow exozone, short mesozooecia, and sparse acanthopores of *E. nitida* are all in contrast with the relatively wide exozone, long and abundant mesozooecia, and abundant acanthopores of *Lioclemella*. These features all indicate that this species can be more comfortably accommodated in *Eridotrypa*. The possibility remains that basal articulation is a character of overriding generic importance, in which case the generic concept of *Lioclemella* would require a revision. Until the phylogeny of Ordovician trepostomes can be elucidated with some confidence, I think less violence will be done to traditional generic concepts by including this material in *Eridotrypa*.

I have tentatively included in synonymy Ulrich’s (1889) mention of material he tentatively assigned to *Bythopora delicatula* (Nicholson), and subsequent citations of Ulrich’s work. As discussed under *Bythopora striata* Ulrich (above), these species all have a rather similar external appearance.
Eridotrypa compressa n. sp.

Plate 6, figs. 12-14

Etymology.—From the Latin *compressus*, squeezed, referring to the flattened shape of this species.

Diagnosis.—Zoarium branching, elongate-elliptical in cross section, width several times thickness; maculae absent; exozone narrow; zooecia intersecting zoarial surface at about 45 degrees; zooecial apertures elliptical; diaphragms sparse, in both endozone and exozone; mesozoecia sparse, overgrown; acanthozoecia not noted.

Material and occurrence.—More than 100 zoarial fragments have been recovered, all from the subsurface of North Dakota. One specimen has been collected from locality A2614, about 4 m above the base of the Gunn Member; about 15 from A2602, in the lowest quarter of the Gunn; about 15 from A2615, in the lowest 2 m of the unit; about 30 from A2603, 7 to 10 m above the base of the Gunn; and about 50 specimens from A2600, from the lowest quarter of the Gunn. Specimen UND 14843., from locality A2602.30, about 2 m above the base of the Gunn Member, is designated the holotype. Specimens UND 14857. and 14858. are designated paratypes. All material is fragmented, although preservation of surficial detail is fairly good.

Discussion.—In cross section the endozone of this species appears rather disordered, as if the compression were the result of deformation rather than a growth form. However, the exteriors show no evidence of fracturing, and I believe the growth form to be of specific value.
This species could easily be assigned to *Bythopora* except for the presence of a few diaphragms in the zooecia, especially in the endozone. The compressed growth form appears to be unique to *Eridotrypa*; *E. compressa* is not similar to any other species of the genus.

Family *Monticuliporidae* Nicholson, 1881

Genus *Monticulipora* d'Orbigny, 1849

*Type species.*—*Monticulipora mammulata* d'Orbigny, 1850

*(subsequent designation by Opinion 443, ICZN, 1957, p. 165).*

*Diagnosis.*—"Zoaria encrusting, leaf-like, and massive, less frequently branching. Zooecial orifices polygonal, walls thin, vaguely laminar with nodular granular clumps in their central part. Cystihragms and thin horizontal diaphragms are present in the zooecia in all the zones of the zoarium. Surface often with projecting maculae, consisting of megazooecia with thickened walls and accumulations of mesozooecia and acanthozooecia. Mesozooecia with horizontal diaphragms in the spaces between the maculae rare or absent. Acanthozooecia short and small." (Astrova, 1978, p. 142).

*Monticulipora parasitica* Ulrich, 1882

Plate 6, figs. 17, 18

*Monticulipora parasitica* Ulrich, 1882b, p. 238–239, pl. 10, figs. 3, 3a; James, 1895, p. 81; Utgaard and Perry, 1964, p. 44–45, pl. 2, figs. 1–3; Astrova, 1965, p. 196, pl. 33, figs. 2a, 2b.

*Diagnosis.*—Zoarium thin, encrusting, with raised maculae more or less regularly arranged, spaced 2 to 5 mm apart; maculae of several
mesozooecia covered by calcareous deposits and surrounded by larger zooecia; zooecial apertures polygonal; zooecial walls thin; mesozooecia confined to maculae; overlapping cystiphragms line entire zooecia or only proximal portions of zooecia; diaphragms transverse, thin, straight, none to several per zooecium; acanthopores sparse to abundant, of variable size.

Material and occurrence.—Fourteen specimens have been recovered. One is from subsurface locality A2602.183, just below the middle of the Gunn Member, and the rest are from outcrop. Zoarial surfaces are commonly partially obscured by matrix and clarity has been lost to abrasion, but interiors are fairly well preserved.

Discussion.—There seems to be some uncertainty as to the character of the acanthopores in this species. Ulrich (1882b, p. 239) reported, "... almost invariably, a minute lucid spot ..." at the junction of zoarial walls. He hypothesized: "They represent in all probability very small spiniform tubuli [acanthopores]." In contrast, Utgaard and Perry (1964, p. 45) reported: "Acanthopores rare, small, obscure, and customarily at the angles of zooecia." Among my material, otherwise closely similar, I find one specimen (UND 14877.) to have moderately large, abundant acanthopores; a second specimen (UND 14871.) with small and sparse acanthopores; and a third (UND 14876.) in which they seem to be absent. It may be that this structure is highly variable in this species. Another possibility is that the acanthopores are very short, and small variations in the depth at which tangential sections are made produce large variations in the number and size of acanthopores reported.
Monticulipora plana Ulrich, 1889

Plate 6, figs. 24, 26

Monticulipora parasitica var. plana Ulrich, 1889, p. 35, pl. 8, figs. 3-3b; Whiteaves, 1895, p. 115; Dowling, 1900, p. 50F; Troedsson, 1929, p. 97-98, pl. 52, fig. 2, pl. 53, fig. 3; Baillie, 1952, p. 32.

Monticulipora parasitica-plana Ulrich Nickles and Bassler, 1900, p. 326.


Diagnosis.—Zoaria thin, encrusting; maculae flush, of several mesozooecia covered by calcareous deposits, and larger zooecia, irregularly arranged; zooecial apertures polygonal, walls thin; mesozooecia only in maculae; overlapping cystiphragms in proximal portions of zooecia or throughout zooecia; diaphragms horizontal, thin, straight, in varying numbers; acanthopores variable, commonly fairly large, numerous, somewhat indistinct.

Material and occurrence.—Two zoaria, both from about 7 m below the top of the Gunn Member, have been recovered from the subsurface of North Dakota, one each from localities A2602, and A2620. An additional 31 specimens were collected from outcrop. As with M. parasitica, abrasion and matrix have taken their toll on surficial detail, but internal structure remains fairly distinct.

Discussion.—Ulrich (1889) originally separated these two forms (M. plana and M. parasitica) solely on the lack of raised maculae in M. parasitica var. plana and their presence in M. parasitica. I find both conditions present among my collection of encrusting
Monticulipora from the Gunn Member. It may be that the presence of raised maculae is merely an ecophenotypic expression and that these two forms should be united under Monticulipora parasitica. If this were the case, however, the lack of any forms attributable to M. plana from areas southeast of the Transcontinental Arch would require explanation. Therefore, I am conditionally retaining both species.

Ulrich's (1889, pl. 8, fig. 3b) original illustration of a tangential section seems to indicate that moderately large acanthopores are relatively common in this species, a finding confirmed by both tangential sections I made. This may represent a second specific distinction between M. plana and M. parasitica.

Genus Homotrypa Ulrich, 1882

Type species.—Homotrypa curvata Ulrich, 1882 (by original designation).

Homotrypa glabra Cumings and Galloway, 1913
Plate 6, figs. 21, 25, 27, 28

Homotrypa glabra Cumings and Galloway, 1913, p. 430-431, pl. 11, figs. 1-1d.

Homotrypa streetsvillensis similis Caley, 1936, p. 70-71, pl. 5, figs. 1-3 (non Homotrypa similis Foord, 1883).

Diagnosis.—Zoarium usually cylindrical, sometimes compressed, about 2 to 10 mm in diameter; maculae flush or slightly raised, of several mesozooecia closed by calcareous deposits, surrounded by zooecia larger than normal; exozozone narrow, commonly poorly defined; zooecial apertures subpolygonal; zooecial walls thin in endozoone, thickening appreciably into exozozone; zooecia usually intersect zoarial surface obliquely, rarely at right angles; diaphragms sparse in exozozone and in transition to exozoone, almost invariably absent in endozoone; cystiphragms sparse to common in transition to exozoone, rare in exozoone; incomplete cystiphragms common; mesozooecia present in maculae, rare elsewhere; acanthopores rare, small.

Material and occurrence.—About 125 zoarial fragments have been recovered, only five of which are from outcrop. About 60 are from subsurface locality A2602, mostly from the lower half of the Gunn Member but present throughout; 20 from A2603, most from the lower half but present also in the upper half; 20 from A2614, about 4 m above the base of the unit; 10 from A2600, about 5 m above the base; five each from A2618 and A2620, from the upper half of the Gunn in both localities; and one from A2616, also from the upper half of the Gunn Member. Most specimens are in fairly good condition.
Discussion.—The above diagnosis gives a range of 2 to 10 mm for zoarial diameter, which is about the range of my material. Cumings and Galloway (1913, p. 430) gave a range of 2 to 5 mm, but their illustration (plate 5, fig. 1c) measures more than 8 mm at its widest. Caley (1936, p. 70) gave a range of 4 to 6 mm for his species.

The most distinctive character of this species seems to be the oblique angle (about 60 degrees) at which the zooecia intersect the zoarial surface. In most species of Homotrypa, this value is 90 degrees or close to it, and the exozone is much wider and better defined. Homotrypa obliqua Ulrich has zooecia at an angle similar to those of H. glabra, but has many more diaphragms and cystiphragms. Perhaps the species most similar to H. glabra is H. austini Bassler (synonymized with H. communis Bassler by Brown and Daly, 1985, p. 55). However, acanthopores, rare in H. glabra, are abundant in H. austini, which also has a wider exozone and zooecia that intersect the zoarial surface at a larger angle.

Some of the Gunn material assigned to this taxon approaches Bythopora in internal structure. Most of the zooecia are empty, and only the occasional diaphragm and cystiphragm causes the assignment of this material to Homotrypa. From this condition, documented also by Caley (1936, p. 71) in his H. streetsvillensis similis, there seems to exist a continuum to a condition in which the majority of zooecia bear cystiphragms, diaphragms, or both. These structures are never numerous, however, and are concentrated in the transitional curve from the endozone into the exozone.
Homotrepa oligophragma n. sp.
Plate 6, figs. 20, 22, 23

Homotrepa nodulosa Bassler Utgaard and Perry, 1964, p. 55-56, pl. 4, figs. 5-7 (non Homotrepa nodulosa Bassler, 1903).

Etymology.—From the Greek oligos, few, and phragma, partition, referring to the few diaphragms present in most zooecia in this species.

Diagnosis.—Zoaria subcylindrical, ramose, 3 to 6 mm in diameter; maculae conical, gently to sharply elevated, of larger zooecia surrounding accumulations of mesozooecia; exozone well defined, narrow to moderately wide; zooecial apertures subpolygonal; zooecial walls thin, occasionally crenulated in endozone, substantially thickened in exozone; zooecia intersect zoarial surface at or nearly at right angles; diaphragms absent in proximal endozone; several diaphragms usually in each zooecium in distal endozone and curve into exozone; cystiphragms common in proximal exozone, less common in distal exozone, usually in overlapping series; incomplete cystiphragms present but uncommon; mesozooecia abundant, with abundant diaphragms, rising in proximal exozone; acanthopores small to medium-sized, moderately common.

Material and occurrence.—About 30 zoarial fragments were collected, all from subsurface locality A2603. Those specimens for which the stratigraphic horizon is known came from A2603.301, about 1.5 m above the base of the Gunn Member. Specimen UND 14928. is here designated the holotype, and specimens UND 14929. through 14931. are
paratypes. The material is in good condition; although some abrasion has occurred, surface detail can usually be discerned and sections show internal detail well.

Discussion.—Homotrypa oligophragma n. sp. differs from H. nodulosa Bassler in only a couple of characters. Most importantly, H. oligophragma commonly bears diaphragms in a majority of zooecia. These structures were reported lacking, except for those in the mesozooecia, by Bassler (1903, p. 582). This lack was essentially confirmed by Brown and Daly (1985, p. 60-61) who reported that, from a population of at least 12 specimens, only one had diaphragms. In contrast, both the Gunn material and that of Utgaard and Perry (1964, p. 55-56) has common diaphragms.

Secondly, Bassler's (1903) original material, and that of Brown and Daly (1985), has cystiphragms consisting largely of incomplete hook-like structures. The Gunn material, together with that from the upper Whitewater Formation (Utgaard and Perry, 1964) have largely complete cystiphragms, commonly in overlapping series. These structural differences, in my opinion, justify the erection of a new species.

Homotrypa oligophragma n. sp. differs from most other species of Homotrypa by its numerous mesozooecia. Of those species possessing mesozooecia in some quantity, H. oligophragma differs from both H. wortheni (James) and H. cincinnatiensis Bassler in having fewer acanthopores. Another difference is that H. oligophragma has sharp, conical maculae, in contrast to the elongate ridges common in H. wortheni and the smooth surface of H. cincinnatiensis.
Homotrypa tabulata n. sp.
Plate 7, figs. 2-4

Etymology.---From the Latin tabula, plate, referring to the numerous diaphragms in the endozone of this species.

Diagnosis.---Zoaria cylindrical, about 5 to 10 mm in diameter; maculae slightly raised accumulations of mesozooecia and larger zooecia, about 3 to 4 mm apart; exozone narrow, poorly defined; zooecial apertures elliptical to subpolygonal; zooecial walls thin in endozone, slightly to moderately thickened in exozone; zooecia intersect zoarial surface at about 45 degrees; diaphragms abundant, present throughout zoarium, less common in distal exozone; cystiphragms throughout exozone, usually in overlapping series; mesozooecia common in exozone, with abundant diaphragms; acanthopores moderately large, scattered, not abundant.

Material and occurrence.---The holotype (UND 14925.) was collected from outcrop locality A2569. Paratype UND 14926. was collected from outcrop locality A2572, and paratype UND 14927. came from subsurface locality A2603.301, about 1.5 m above the base of the Gunn Member. All three specimens are cylindrical zoarial fragments, partially encrusted by matrix.

Discussion.---The presence of numerous diaphragms in the endozone, together with moderately abundant mesozooecia and a cylindrical growth form, renders this species unique. Of species of Homotrypa having endozonal diaphragms, H. curvata Ulrich, H. flabellaris Ulrich, H. pulchra Bassler, and H. splendens Bassler, all have flabellate growth forms. Homotrypa tabulata n. sp. has more diaphragms,
cystiphragms, and mesozooecia than does H. nitida Bassler and has more mesozooecia and fewer acanthopores than does H. curvata praecipta Bassler.

Homotrypa tabulata n. sp. seems most like Homotrypa similis Foord. Homotrypa tabulata differs largely in its moderately abundant mesozooecia, structures lacking (except for those in the maculae) in H. similis. Homotrypa tabulata also has larger and fewer acanthopores than does H. similis.

Homotrypa astrovae n. sp.

Plate 7, figs. 1, 5, 9

Etymology.—This species is named in honor of G. G. Astrova, whose works on Paleozoic bryozoans are of inestimable value.

Diagnosis.—Zoaria ramose, 5 to 15 mm in diameter, massive with ramose protrusions, or encrusting, cylindrical or slightly compressed; maculae raised, of clusters of mesozooecia surrounded by larger zooecia, spaced about 3 mm apart; exozone large, well defined; zooecial apertures usually subcircular, occasionally inflected by acanthopores; zooecia curve gently into exozone, intersecting zoarial surface at right angles; zooecial walls thin in endozone, substantially thickened in exozone; diaphragms abundant throughout zoarium, more so in exozone; cystiphragms abundant in proximal exozone, less common in distal exozone; cystiphragms or cystoid diaphragms commonly present in endozone in some zooecia; mesozooecia abundant, with abundant diaphragms, throughout exozone; acanthopores abundant, fairly large.
Material and occurrence.--Ten zoarial fragments have been recovered, all from the subsurface of North Dakota. Two are from A2602.19, about 11 m above the base of the Gunn member, and the remainder are from A2603, from the lowest third of the Gunn. All specimens are in fairly good condition, although somewhat encrusted by matrix.

Specimen UND 14932. is designated the holotype, and locality A2603.171, about 12 m above the base of the Gunn Member, is the type locality and horizon. Specimens UND 14933. and 14934. are designated paratypes.

Discussion.--It might appear that this species should be assigned to Atactoporella, a genus with abundant overlapping cystiphagms in the endozone, but rarely having a ramose growth form. Homotrypa astrovae n. sp., a ramose species, has scattered cystose diaphragms in the endozone, structures that appear qualitatively different from the overlapping cystiphagms in the exozone. It does not seem to be congeneric with species assigned to Atactoporella.

Other workers might assign this species to Homotrypella. Homotrypella was considered a junior synonym of Homotrypa by Astrova (1978, p. 146). As she pointed out (Astrova, 1978, p. 149), the major distinction made by previous workers (Ulrich, 1890b, p. 412; 1893, p. 228) between Homotrypa and Homotrypella was the presence of numerous mesozooecia in the Homotrypella. Astrova (1978, p. 149-150), based on a study of both Soviet material and "syntypes and toptotypes of the type species of Homotrypa and Homotrypella from the U. S. National Museum," concluded that the number of mesozooecia was a
character subject to considerable variability and not a sound basis on which to erect a genus. Further, several species of Homotrypa exhibit significant numbers of mesozooecia, and the difference merely becomes one of relative abundance. On the other hand, Karklins (1984, p. 132) retained Homotrypella as a separate genus, although without offering any justification. I find the presence of numerous mesozooecia in several species of Homotrypa, together with that character being offered as the only significant difference between the two genera, a compelling reason to accept Astrova's argument, and the synonymization of Homotrypella with Homotrypa. If further research should establish the validity of Homotrypella, then Homotrypa astrovae n. sp. should be reassigned.

Homotrypa astrovae n. sp. is very similar to Homotrypa cumingsi (Utgaard and Perry), differing only in having over 50 percent more mesozooecia and fewer than half as many acanthopores. In all other respects the two species seem to be quite close. There is no other species of Homotrypa with which H. astrovae need be compared; none has its combination of ramose growth form, wide exozone, and very abundant mesozooecia.

Suborder AMPLEXOPOROIDEA Astrova, 1965
Family Amplexoporidae Miller, 1889
Genus Rhombotrypa Ulrich and Bassler, 1904

Type species.--Chaetetes quadratus Rominger, 1866 (by original designation).

Diagnosis.--"Zoarium branching with discrete exozone, the section of the zooecia in the endozone square or rhombic. Zooecial orifices
polygonal. Unfused walls with sharply-defined border zone thickened on periphery of zoarium. Diaphragms thin, developed mainly in the exozone. Exilazoecia very rare and only near the zoarial surface. Acanthazoecia very small, rare, often absent. (Astrova, 1978, p. 168).

**Rhombotrypa quadrata** (Rominger, 1866)

Plate 7, figs. 6, 7

**Chaetetes quadratus** Rominger, 1866, p. 115-116.

**Chaetetes rhombicus** Nicholson, 1874, p. 507, pl. 29, figs. 11-11b;

   Nicholson, 1875, p. 201-202, pl. 21, figs. 12, 12a; Nicholson, 1876, p. 86, pl. 5, figs. 1-1b.

**Monticulipora rectangularis** Whitfield, 1878, p. 70-71; Whitfield, 1882, p. 249, pl. 11, figs. 11, 12.

**Monticulipora (Monotrypa) quadrata** (Rominger) Nicholson, 1881, p. 179-182, fig. 36.

**Monotrypella quadrata** (Rominger) Ulrich, 1882b, p. 248.

**Monticulipora quadrata** (Rominger) James and James, 1888, p. 176; James, 1894, p. 198.

**Rhombotrypa quadrata** (Rominger) Ulrich and Bassler, 1904, p. 45;

   Nickles, 1905, p. 58, pl. 3, fig. 11; Cumings, 1908, p. 877, pl. 23, figs. 4-4b, pl. 25, fig. 5; Cumings, 1912, pl. 22, fig. 40; Foerste, 1924, p. 106, pl. 9, fig. 2; Dyer, 1925, p. 54, pl. 4, fig. 5, pl. 6, fig. 4; McFarlan, 1931, p. 106, pl. 16, fig. 11; Shimer and Shrock, 1944, p. 258, pl. 97, figs. 24, 25; Cuffey and Perry, 1964, p. 38-43, pl. 1, 2; Utgaard and Perry, 1964, p. 99-101, pl. 21, fig. 7, pl. 22, figs. 1-4; Boardman and
Rhombotrypa quadratus (Rominger) Bassler, 1953, p. G110, fig. 73, 5a-5e.

Diagnosis.—Zoarium ramose; maculae rare to common, raised or flush; exozone fairly wide; zooecia curve gently into exozone; diaphragms rare to absent in endozone, common to abundant in exozone; mesozooecia absent; acanthopores apparently absent.

Material and occurrence.—About 10 zoarial fragments have been recovered from subsurface locality A2620.07, just below the middle of the Gunn Member. All are in fairly good condition. Another couple of fragments were collected from locality A2618.3, also near the middle of the Gunn.

Discussion.—Rhombotrypa quadrata (Rominger) may be distinguished from R. multitabulata Utgaard and Perry by the lack of diaphragms in the endozone, and from R. subquadrata (Ulrich) by the larger zoarium and the complete lack of mesozooecia. Rhombotrypa quadrata lacks the crenulated walls of Tetratoechus crassimuralis (Ulrich) and has many more diaphragms. No other Ordovician trepostomes have the quadrate zooecia that characterize these species.
Rhombotrypa multitabulata Utgaard and Perry, 1964

Plate 7, figs. 8, 12, 13

Rhombotrypa multitabulata Utgaard and Perry, 1964

non Chaetetes quadratus Rominger, 1866.

Monotrypella quadrata (Rominger) Ulrich, 1889, p. 36-37; Whiteaves, 1895, p. 116-117; Dowling, 1900, p. 50F; Nickles and Bassler, 1900, p. 318 (partim).

Rhombotrypa quadrata (Rominger) Bassler, 1915, p. 1115-1116 (partim); Baillie, 1952, p. 32.

Rhombotrypa multitabulata Utgaard and Perry, 1964, p. 97-99, pl. 20, figs. 5-8, pl. 21, figs. 1-6.

Rhombotrypa subquadrata (Ulrich) Boardman and McKinney, 1976, pl. 12, fig. 2 (non Monotrypella subquadrata Ulrich, 1882).

Diagnosis.—Zoarium ramose; maculae usually somewhat elevated, of zooecia larger than normal; exozone fairly wide; zooecia curve gently into exozone; diaphragms common in endozone, abundant in exozone; mesozooecia and acanthopores apparently absent.

Material and occurrence.—About 60 zoarial fragments have been collected from outcrop. From the subsurface, five specimens have been recovered from locality A2602.15, just above the middle of the Gunn Member, and one specimen came from A2616.07, about 6 m below the top of the unit. Preservation is fairly good.

Discussion.—Rhombotrypa multitabulata Utgaard and Perry may be distinguished from all other Ordovician species having quadrate zooecia by its abundant diaphragms in the endozone. The illustration by Boardman and McKinney (1976, pl. 12, fig. 2) of "Rhombotrypa subquadrata" was included in the synonymy above because of the
endozonal diaphragms and the maculae, which look exactly like those illustrated by Utgaard and Perry (1964, pl. 21, figs. 3, 4). The specimens of *R. multitabulata* from the Gunn Member seem to have slightly fewer diaphragms than those illustrated by Utgaard and Perry (1964) but agree closely in all other respects and are here considered conspecific with the illustrated type.

*Rhombotrypa subquadrata* (Ulrich, 1882)
Plate 7, figs. 10, 11, 14

*Monotrypella subquadrata* Ulrich, 1882b, p. 249-250, pl. 11, figs. 4-4b.

*Monticulipora quadrata var. subquadrata* (Ulrich) James, 1894, p. 199.

*Rhombotrypa subquadrata* (Ulrich) Ulrich and Bassler, 1904, p. 46; Cumings, 1908, p. 877-879, pl. 23, figs. 3-3b; Troedsson, 1929, p. 101-102, pl. 54, figs. 5a, 5b; McFarlan, 1931, p. 106, pl. 16, figs. 9, 10 (non *Rhombotrypa subquadrata* (Ulrich) Boardman and McKinney, 1976, pl. 12, fig. 2).

**Diagnosis.**—Zoarium ramose, slender, subcylindrical; maculae common, irregularly spaced, of larger circular or polygonal zooecia and several mesozooecia; exozone variable, commonly relatively wide; zooecia curve gently to sharply from endozone to exozone; diaphragms usually absent in endozone, common in exozone; mesozooecia, with diaphragms of about same spacing as those in zooecia, common in maculae, uncommon elsewhere; acanthopores absent.

**Material and occurrence.**—About 20 specimens were collected from subsurface locality A2602, mostly from the lower half of the Gunn Member. Two additional fragments were recovered from locality
A2600.13, about 2 m above the base of the Gunn. All specimens are relatively small fragments, but fairly well preserved.

Discussion.--Astrova (1978, p. 169) doubted the validity of Rhombotrypa subquadrata (Ulrich, 1882), and a study of the literature leaves a hazy impression of the species. The only illustrations of the interior are Ulrich's (1882b, pl. 11, figs. 4-4b) original pen-and-ink drawings, and copies thereof by Cumings (1908). The few other reports of R. subquadrata illustrate only the exterior. The Gunn material agrees in all respects with the original (Ulrich, 1882b) description and illustrations, but a redescription and re-illustration of the type specimens is needed. The specimen assigned to this species by Boardman and McKinney (1976) is here considered to be a R. multitabulata, as discussed above under that species.

Rhombotrypa subquadrata may be distinguished from the other species of Rhombotrypa by its smaller size and the presence of mesozooecia.

Phylum BRACHIOPODA Dumeril, 1906
Class INARTICULATA Huxley, 1869
Order LINGULIDA Waagen, 1885
Superfamily Lingulacaea Menke, 1828
Family Lingulidae Menke, 1828
Genus Lingula Bruguiere, [1797]

Type species.--Lingula anatina Lamarck, 1801 (subsequent designation by Opinion 1355, ICZN, 1985b, p. 332).

Diagnosis.--"Elongate, lateral margins gently convex to subparallel, ornament only of concentric growth lines; shell thin,
slightly thickened in areas of muscle attachment. Internally without septa, low median ridge in brachial valve may be present extending from central scars to anterior lateral scars." (Rowell, 1965, p. H263).

? Lingula sp. cf. L. narrawayi Wilson, 1921

Plate 7, fig. 21

Diagnosis.—Shell elongate-ovate, small, less than 10 mm long; width:length ratio about 4:7; apical angle about 90 degrees; beak sharply rounded, anterior margin broadly rounded; lateral margins gently convex, almost parallel; ornamentation of concentric growth lines; interior details unknown.

Material and occurrence.—Two molds of the exterior have been collected, both from the subsurface of North Dakota. The exact locality for only one specimen (UND 14977.) was recorded, locality A2621.2, about 10 m above the base of the Gunn Member. Only molds of the exterior have been preserved.

Discussion.—The quality of the preserved material precludes a definite species assignment. The shape and ornamentation seem to indicate an assignment to Lingula, but even that is open to question; for Rowell (1965, p. H262-H263) has said, "Many Ordovician species have been loosely referred to Lingula, but the internal structure of the valves is unknown and in these circumstances even the family assignment is doubtful." It may be that Elliptoglossa would better accommodate this material, but there is no way of determining that, given the material available.
The Gunn material seems most like *Lingula narrawayi* Wilson, a Blackriveran species of about the same size and proportions. It is also very close to *L. riciniformis* Hall, also from Middle Ordovician strata. Both species seem to be slightly wider, relative to their length, than the Gunn specimens. Most other Ordovician linguloid brachiopods, including all those from the Upper Ordovician, seem to be larger and relatively wider than the material at hand.

This is the first report of a linguloid brachiopod from the Stony Mountain Formation. Previously, the only inarticulate brachiopod reported was a "very imperfect" valve of *Dinobolus* from the Gunton Member (Whiteaves, 1895, p. 119).

Class ARTICULATA Huxley, 1869

Order ORTHIDA Schuchert and Cooper, 1932

Suborder ORTHIDINA Schuchert and Cooper, 1932

Superfamily Orthacea Woodward, 1852

Family Dolerorthidae Opik, 1934

Subfamily Hesperorthinae Schuchert and Cooper, 1932

Genus Hesperorthis Schuchert and Cooper, 1932

Type species.—*Orthis tricenaria* Conrad, 1843 (by original designation).

Diagnosis.—"Plano- to gently cancavo-convex, with high pedicle valve, costate, with very fine parvicostellae in the interspaces; apical plates and antigydidum commonly developed especially in later species; median parts of ventral *vascula media* long, arcuate branches subperipheral." (Williams, 1965, p. H317).
Discussion.—Both Schuchert and Cooper (1932, p. 85) and the Treatise (Williams, 1965, p. H316–H317) cite Schuchert and Cooper 1931 as the authors of the genus *Hesperorthis* and the subfamily *Hesperorthinae*. However, the International Code of Zoological Nomenclature (ICZN, 1985a, p. 35, 37) states that, after 1930, a new genus name must be accompanied by a description or a bibliographic reference to a description. Schuchert and Cooper (1931) merely listed new taxa that they intended to publish at some future date and that were, in fact, published in 1932. Therefore, it would seem that *Hesperorthis* should date from 1932. As a "family-group name must, when first published, be . . . based on the generic name then used as valid for a genus . . ." (ICZN, 1985a, p. 25), the Hesperorthinae should also date from 1932, and I am citing Schuchert and Cooper (1932) as the authors of these taxa.

*Hesperorthis pyramidalis* (Twenhofel, 1928)

Plate 7, figs. 15, 19, 20

*Orthis davidsoni var. pyramidalis* Twenhofel, 1928, p. 174–175, pl. 15, figs. 4, 5, 7 (non fig. 6).

*Hesperorthis pyramidalis* (Twenhofel) Schuchert and Cooper, 1932, p. 86.


Diagnosis.—Shell moderately large for the genus, plano-convex; pedicle area unusually high, apsacline to nearly catacline (modified from Macomber, 1970, p. 427).
Material and occurrence.—One specimen, slightly broken and with matrix adhering to the pedicle area, was collected from outcrop. The specimen has 24 costae and is 5.4 mm thick, 7.4 mm long, and 9.4 mm wide.

Discussion.—The Gunn specimen is slightly more than half the average size given by Twenhofel (1928, p. 174) and Macomber (1970, p. 428). It has slightly fewer costae (24) compared with Macomber's four measured specimens (25 to 33 costae) and Twenhofel's "average" of 32. In addition, the pedicle area is slightly procline. In other respects, however, it matches published descriptions well.

It may be that the Gunn specimen is a juvenile. Because costae are added along the cardinal margins, a larger individual should have more costae. Also, it is possible that the growth rate along the pedicle margin exceeded that along the brachial margin; this would cause a procline pedicle area in a juvenile to become a catacline or an apsacline area in an adult. The differences between this specimen and published descriptions of *H. pyramidalis* do not seem significant at the species level, and I believe this specimen to be referrable to that species.

Family Plaesiomyidae Schuchert, 1913
Subfamily Plaesiomyinae Schuchert, 1913
Genus *Dinorthis* Hall and Clarke, 1892

Type species.—*Orthis pectinella* Emmons, 1842 (by original designation).

Diagnosis.—"Convexo-concave to unequally biconvex, pedicle valve commonly shallowly sulcate, costate to costellate, deltidium absent;
teeth with oblique fossettes, dental plates short; ventral muscle field bilobed anteriorly, with diductor scars enclosing central oval adductors; adjustors prominent." (Williams, 1965, p. H319; description for the genus Plaesiomys).

Discussion.—The genera Dinorthis and Plaesiomys were named by Hall and Clarke (1892, p. 195-196) for similar groups of orthids. They noted the near identity of the internal features of the two groups, but separated the genera on the basis of external characters such as shell outline and ornamentation. Winchell and Schuchert (1895, p. 421), however, suppressed Plaesiomys on the grounds that there existed a continuum between Hall and Clarke's genera, and Schuchert (1897) indicated that Plaesiomys was a junior synonym of Dinorthis.

However, Schuchert (1913, p. 382) resurrected Plaesiomys, designating it the type genus of a new subfamily and relegating Dinorthis to subgeneric status under Plaesiomys. In 1932, Schuchert and Cooper (p. 93) reversed this relationship, considering Plaesiomys a subgenus of Dinorthis and renaming the family Dinorthidae. They stated (p. 95) that they were unable to find any "internal generic distinction" between Hall and Clarke's genera, and they selected Dinorthis as the generic name on the grounds (Schuchert and Cooper, 1932, p. 96) of page priority. The Treatise (Williams, 1965, p. H319) reverted to Schuchert's (1913) classification, placing Dinorthis under Plaesiomys. No reasons were given for this change.

The International Code of Zoological Nomenclature (ICZN, 1985a,
p. 53) stated, under the "Principle of the First Reviser," that priority of generic names in the case of simultaneous publication is determined by the first author "to have chosen one of them in precedence over the other(s), . . ." In the case of Dinorthis and Plaesiomys (both published by Hall and Clarke, 1892) the first revisers were Winchell and Schuchert (1895), who suppressed Plaesiomys and placed under Dinorthis the species previously assigned to both genera. Therefore, I am regarding Dinorthis as the correct generic name, and Plaesiomys as a subgenus under Dinorthis. This, of course, in no way affects the status of the name Plaesiomyidae (which has priority over Dinorthidae): the Code specifically states (ICZN, 1985a, p. 81) that the family name should not be replaced due to a change in generic name.

Subgenus Dinorthis (Dinorthis) Hall and Clarke, 1892


Discussion.--The above diagnosis has been modified from Williams (1965, p. H319) to accommodate species previously assigned to Pionorthis. Macomber (1970, p. 429) pointed out that, "All members of the genus Plaesiomys [Dinorthis of this study] are biconvex in early growth stages and many remain biconvex, even if unequally, to a fairly large size . . . ." Further, he felt that the species referred to Pionorthis by Schuchert and Cooper (1932, p. 95) did not constitute a natural phyletic grouping. On these grounds, Macomber (1970, p. 429) recommended that Pionorthis be suppressed. Macomber's arguments seem cogent and convincing, and his recommendations are followed here.
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*Dinorthis (Dinorthis) carletona* Twenhofel, 1928

Plate 7, figs. 16-18, 22-25

*Orthis subquadrata* Hall Billings, 1863, p. 165, fig. 146; Whiteaves, 1880, p. 50C (non Hall, 1847).

*Orthis proavita* Winchell and Schuchert Whiteaves, 1895, p. 120 (non Winchell and Schuchert, 1895).

*Dinorthis subquadrata* (Hall) Schuchert, 1897, p. 217 (partim).

*Orthis (Dinorthis) proavita* Winchell and Schuchert Dowling, 1900, p. 51F.

*Dinorthis carletona* Twenhofel, 1928, p. 182-183, pl. 16, figs. 4-8.

*Dinorthis (Pionorthis) carletona* Twenhofel Schuchert and Cooper, 1932, p. 95.

*Pionorthis occidentalis* Okulitch, 1943, p. 71-72, pl. 1, figs. 8-10.

*Pionorthis cf. carletona* (Twenhofel) Okulitch, 1943, pl. 1, fig. 7.

*Dinorthis (Plaesiomys) occidentalis* (Okulitch) Baillie, 1952, p. 33.

*Dinorthis (Plaesiomys) proavita* (Winchell and Schuchert) Baillie, 1952, p. 33.


*Dinorthis (Pionorthis (?)) cf. D. (P.) occidentalis* Okulitch Ross, 1957, p. 475-476, pl. 37, figs. 17, 18, 21, 22.

*Dinorthis (Pionorthis (?)) n. sp.* Ross, 1957, p. 475-476, pl. 38, figs. 1, 2, 5, 6.

*Dinorthis (?) (Pionorthis (?)) n. sp.* Ross, 1957, p. 475-476, pl. 38, figs. 15, 17-19.
Dinorthis (?) sp. Ross, 1957, p. 475-476, pl. 38, figs. 3, 4, 7, 8, 11.

Dinorthis ("Pionorthis") cf. occidentalis Okulitch Brindle, 1960, p. 15, pl. 4, fig. 7.

[?] Plaesiomys (Dinorthis) occidentalis (Okulitch) Macomber, 1970, p. 430-433, pl. 75, figs. 12-15, pl. 76, figs. 1-27, text-fig. 5.

Diagnosis.--Shell large for the genus, unequally to subequally biconvex, coarsely costate; brachial valve commonly weakly sulcate in mature specimens (modified from Twenhofel, 1928, p. 182; Okulitch, 1943, p. 71; Macomber, 1970, p. 430-433).

Material and occurrence.--Almost 900 specimens have been collected from outcrop. An additional 100 or so have been recovered from the subsurface of North Dakota. Seven of these came from locality A2600, from the lowest 6 m of the Gunn Member; about 80 from A2602, scattered throughout the Gunn; five from A2603, from the lowest 8 m of the Gunn; four from A2614, from the lowest 3 m of the unit; two from A2615, from the lowest 2 m of the Gunn; and one from A2626, about 5 m above the base of the Gunn. All of the material has been abraded and a lot of it is fragmented or encrusted by matrix, but so much material is available that all structural details may be seen on one or another of the specimens.

Discussion.--This highly variable species is one of the two commonest brachiopods in the Gunn Member. Its presence in Manitoba was first recorded by Whiteaves (1880, p. 50C) as "an unusually coarsely ribbed variety" of Orthis subquadrata Hall. Schuchert and Cooper (1932, p. 95) assigned to Pionorthis "an unnamed species from
the Upper Ordovician of the Bighorn formation . . ." and Okulitch (1943, p. 71) named the Gunn species *Pionorthis occidentalis*. Okulitch's original description is rather imprecise; there is nothing to indicate a range of size or ornamentation. Nevertheless, it seems certain that Okulitch was referring to the abundant plaesiomyid present in the Gunn Member.

Macomber (1970, p. 430-433) expanded on Okulitch's species concept, including specimens that Okulitch (1943, pl. 1, fig. 7) had referred to "Pionorthis" cf. *carletona* and specimens that Ross (1957, p. 475-476) had considered to represent possible new species. Macomber also included specimens from the Bighorn Formation in *Dinorthis (Dinorthis) occidentalis*. His illustrations (pl. 75, figs. 12-15; pl. 76, figs. 1-27; text-fig. 5, p. 426) and measurements (his Table 5, p. 433) document the range of variation found among his specimens.

Nevertheless, there are some discrepancies between Macomber's descriptions and illustrations, on the one hand, and Okulitch's description and my specimens, on the other. Okulitch (1943, p. 71) noted the "faintly sulcate" brachial valve, whereas Macomber (1970, p. 430) placed his "moderate" sulcus in the pedicle valve. I find it possible for either valve, or both, to be shallowly sulcate, although it is commonest for the brachial valve to bear the sulcus.

Okulitch (1943, p. 71) gave measurements and counted costae for only one specimen; Macomber (1970, p. 432) attributed Okulitch's small number of costae to the abraded condition of his specimen. But I find that the number of costae for a specimen of given size from the Gunn
Member is generally smaller than for the same size specimen from the Bighorn Formation. It may be that these populations are geographical variants (i.e., subspecies or incipient subspecies).

Okulitch (1943, p. 72) felt that *D. (D.) occidentalis* differed from *D. (D.) carletona* only by having fewer costae. Okulitch (1943, p. 71) reported that a specimen 30 mm wide had 28 costae, whereas Twenhofel (1928, p. 182) reported that a specimen 28 mm wide had 32 to 40 costae. This range is about what I find for the Gunn specimens (a plot of width versus number of costae is given in Figure 6) and I can find no significant difference between the two species. Therefore, I am placing *D. (D.) occidentalis* (Okulitch) in synonymy with *D. (D.) carletona* Twenhofel, and am assigning the Gunn material to Twenhofel's species.

*Dinorthis (Dinorthis) carletona* is about 50 percent larger than *D. (D.) proavita* (Winchell and Schuchert) and is also more coarsely costate. *Dinorthis (Dinorthis) carletona* has coarser costae and a more gibbous profile than *D. (D.) columbia* Wilson.

Family Plectorthidae Schuchert and LeVene, 1929
Subfamily Plectorthinae Schuchert and LeVene, 1929

Genus *Hebertella* Hall and Clarke, 1892

Type species.—*Orthis sinuata* Hall, 1847 (by original designation; junior subjective synonym of *Orthis occidentalis* Hall, 1847).

Diagnosis.—Shell convexo-concave or unequally biconvex; costellate, the costellae commonly hollow; commonly with broad fold in brachial valve and broad sulcus in pedicle valve; "wide diductor scars
Figure 6. Width versus number of costae for 141 measured specimens of Dinorthis (Dinorthis) carletona Twenhofel.

**Hebertella occidentalis** montoyensis Howe, 1966

Plate 8, figs. 1, 2, 9, 10

**Hebertella occidentalis** montoyensis Howe, 1966, p. 255-256, pl. 30,

figs. 15-23.

**Plaesiomys** (Plaesiomys) aff. *P. rockymontana* (Wilson) Macomber, 1970,

p. 429-430, pl. 75, figs. 8-11.

**Diagnosis.**—Shell large for the genus; cardinal margins rounded;
greatest width at about middle; finely costellate; broad, shallow
sulcus in pedicle valve; brachial valve strongly convex.

**Material and occurrence.**—One brachial valve was collected from
outcrop and 11 pedicle valves or fragments thereof were recovered from
the subsurface. Of the subsurface specimens, one each was collected
from localities A2600 and A2614, two from A2615, and seven from A2602.
All were from the lowest 4 m of the Gunn Member.

**Discussion.**—**Hebertella occidentalis** (Hall) is currently a
broadly defined species and is credited with a wide range of variation
in many characters (e.g., Walker, 1982). Shell outline, fineness or
coarseness of costellae, and the presence or absence of a faint median
sulcus on the brachial valve, are all considered unreliable characters
on which to distinguish Hall's (1847) three species, *Orthis occidentalis, O. sinuata,* and *O. subjugata* (Walker, 1982, p. M6-M8).

Consequently, **Hebertella occidentalis** incorporates characters
previously used to define Hall's species.
Howe (1966, p. 256) distinguished, as a separate subspecies, a group of *Hebertella occidentalis* from New Mexico from the *H. occidentalis* found in the Cincinnati Arch area on the basis of sulcus height. Howe found the New Mexico specimens to have a significantly shallower sulcus than specimens from eastern North America (Howe, 1966, p. 254-255; text-fig. 5; Table 8). This seemed to be the only character by which the two groups differed significantly.

The Gunn Member specimens retaining the anterior margin all display a shallow sulcus, comparable to Howe's (1966) specimens, but much shallower than the specimens from the Cincinnati area that Howe measured. In all other respects the Gunn material agrees well with *H. occidentalis*, and I am, therefore, assigning my specimens to *Hebertella occidentalis montoyensis* Howe.

I have included in my synonymy the two complete and two fragmentary specimens from the Bighorn Formation assigned by Macomber (1970, p. 429) to *Plaesiomys* (*Plaesiomys*) aff. *P. rockymontana* (Wilson). These appear to be assignable to *Hebertella occidentalis montoyensis*, although no interiors are available to confirm the generic assignment. They appear to differ from *D. (P.) rockymontana* in that Macomber's specimens possess a shallow pedicle sulcus and a uniplicate anterior commissure, both features that are lacking in Wilson's species. Also, Procter (1957, unpub. M.S. thesis) assigned two specimens from the outcrop of the Gunn Member to *Dinorthis iphigena* (Billings). Procter's specimens are larger, more finely costate, and have a more convex brachial valve than does *D. iphigenia*
These are presumed to be H. occidentalis montoyensis; again, no interiors are available. This is the first report of Hebertella from the Stony Mountain Formation.

Superfamily Enteletacea Waagen, 1884
Family Dalmanellidae Schuchert, 1913
Genus Diceromyonia Wang, 1949

Type species.—Orthis tersa Sardeson, 1892 (by original designation).


Discussion.—There has been considerable confusion regarding the family assignment of Diceromyonia. Indeed, Howe (1965a, p. 241-242) questioned the validity of the genus altogether, on the grounds that the designated type species (D. tersa) did not agree with Wang's (1949, p. 35-36) published description. Howe subsequently (Howe and Reso, 1967) accepted Diceromyonia as a valid genus, modifying Wang's generic concept to allow greater variability in muscle scar patterns.

When Wang (1949, p. 35-36) originally erected Diceromyonia, he assigned it to the Dalmanellidae. This assignment was retained by Williams and Wright (1963), by Howe (1965, p. 238) and by the Treatise (Wright, 1965, p. H333-H334). However, Boucot et al. (1965a, p. 332-333) reassigned Diceromyonia to the subfamily Heterorthinae of the family Rhipodomellidae on the grounds that Diceromyonia's outline, short hinge line, muscle scars, and lack of fulcral plates indicated a
rhipodomellid rather than a dalmanellid. Later, Harper et al. (1969, p. 81) transferred Diceromyonia to the subfamily Platyorthinae, still within the Rhipodomellidae, on the basis of Diceromyonia's short hinge line and cardinalia.

Howe and Reso (1967, p. 354-358) followed the assignment made by Boucot et al. (1965a). However, they pointed out characters (a range of muscle scar patterns, the "linear adductor track of D. ignota," and rudimentary fulcral plates) that indicate a probable descent from the Dakmanellidae for Diceromyonia. Howe and Reso (1967) suggested that Diceromyonia occupies an intermediate position between the Dakmanellidae and the Rhipodomellidae, and concluded (p. 358), "Thus, the family assignment of Diceromyonia to either Rhipodomellidae or Dakmanellidae is purely arbitrary."

Macomber (1970, p. 434-435), however, returned Diceromyonia to the Dalmanellidae. He argued that the muscle scars and cardinalia of Diceromyonia were typically dalmanellid, in strong contrast to the Heterorthinae, and other internal and external features differentiated Diceromyonia from the Platyorthinae.

Amsden (1974, p. 38-39) retained the assignment of Diceromyonia to the Platyorthinae, while noting that the problems regarding familial assignment of Diceromyonia "cannot be solved here." (p. 39). Alberstadt (1973, p. 35) reverted to the older assignment (Dalmanellidae) without discussion.

In view of the foregoing, it seems best to continue using the classification espoused by the Treatise (Wright, 1965, p. H333-H334) and by Macomber (1970, p. 434-435). Macomber's arguments seem quite
strong, and remain unrefuted by subsequent authors. Therefore, 
Diceromyonia is here retained in the Dalmanellidae. 

Diceromyonia storeya (Okulitch, 1943) 
Plate 8, figs. 3-8, 11

Orthis testudinaria Dalman Whiteaves, 1880, p. 50C.
Orthis (Dalmanella) testudinaria Dalman Whiteaves, 1895, p. 121; Dowling, 1900, p. 51F.

Dalmanella storeya Okulitch, 1943, p. 70-71, pl. 1, figs. 1-4.
Dalmanella cf. jugosa subplicata Foerste Okulitch, 1943, p. 61.

Diceromyonia cf. jugosa subplicata (Foerste) Baillie, 1952, p. 33.

Diceromyonia storeya (Okulitch) Ross, 1957, p. 487, pl. 41, figs. 5, 6, 9, 12, 16; Macomber, 1970, p. 436-439, pl. 77, figs. 1-43.


Diagnosis.--Almost plano-convex to subequally biconvex, convexity generally increasing with size; brachiophores prominent; trilobed cardinal process high (modified from Okulitch, 1943, p. 70-71, and Macomber, 1970, p. 436).

Material and occurrence.--More than 1200 specimens were collected from outcrop. An additional 400 or so were recovered from the subsurface of North Dakota. Of these, one each came from localities A2601, A2614, A2615, A2620, and A2624; three were from A2616; about 15 from A2603; about 20 from A2600; and the rest (more than 375) came from A2602. Many more specimens were observed in core, but not
collected. This species is present throughout the Gunn Member, although more abundant in the lower two-thirds. All specimens are more or less abraded and encrusted by matrix. Many valves are disarticulated.

Discussion.—This is the commonest species of macrofossil in the Gunn Member. Okulitch (1943, p. 70) asserted that there were two species of dalmanellids in the Gunn, his new species (Dalmanella storeya) and a species he called Dalmanella cf. jugosa subplicata Foerste. He did not say on what basis he was differentiating these species, and I can not recognize any species-level distinctions between groups of Gunn dalmanellids. I believe all the Gunn dalmanellids are assignable to a single species, Diceromyonia storeya (Okulitch). A plot of length versus thickness is given (fig. 7) for Gunn specimens of D. storeya.

Both Howe (1965a, p. 241-242) and Macomber (1970, p. 438-439) noted the variability and overlap among species of Diceromyonia. Macomber, particularly, emphasized the range of variability in D. storeya: "A perfect match in shape, if not in size, can also be found in the Wyoming collections [of D. storeya] for every other named species of Diceromyonia." (Macomber, 1970, p. 439). He concluded that it was "inadvisable" to synonymize D. storeya with any previously named species "prior to a comprehensive restudy of the genus."

I have to agree with Macomber. I don't feel that it would be correct to synonymize D. storeya with other species without examining large collections of those other species, but the genus — indeed, the entire family — is in urgent need of monographic treatment.
Figure 7. Length versus thickness (height) for 234 measured specimens of Diceromyonia storeya (Okulitch).
Order STROPHOMENIDA Opik, 1934
Suborder STROPHOMENIDINA Opik, 1934
Superfamily Strophomenacea King, 1846
Family Strophomenidae King, 1846
Subfamily Strophomeninae King, 1846
Genus Strophomena Rafinesque, 1825

Type species.—Strophomena rugosa Rafinesque, 1825 (subsequent designation by King, 1846).

Diagnosis.—Unequally parvicostellate; teeth smooth or striated, dental plates obsolescent; pedicle muscle scar subcircular to suboval; strong, lateral, bounding ridges not united with strong, median, adductor ridge; trans-muscle septa variably developed (after Williams, 1965, p. H384).

Strophomena occidentalis Foerste, 1912

Plate 8, figs. 13-18

Strophomena hecuba Billings Whiteaves, 1880, p. 49C; Ross, 1957, p. 482-483, pl. 40, figs. 10, 11, 13, 16; Brindle, 1960, p. 16-17, pl. 5, figs. 4, 5.

Strophomena fluctuosa Billings Hall and Clarke, 1892, pl. 11A, figs. 4, 5; Winchell and Schuchert, 1895, p. 395-397, pl. 31, figs. 14-17; Whiteaves, 1895, p. 119; Schuchert, 1897, p. 431 (partim); Dowling, 1900, p. 50F; Bassler, 1915, p. 1228 (partim); Okulitch, 1943, p. 61; Baillie, 1952, p. 33; Macomber, 1970, p. 440-441, pl. 78, figs. 16-24.

Strophomena fluctuosa-occidentalis Foerste, 1912, p. 113-115, pl. 9, fig. 17, pl. 10, fig. 9.
Strophomena fluctuosa occidentalis Foerste Bassler, 1915, p. 1228; Ladd, 1929, p. 323.


Diagnosis.--Shell moderate-sized, strongly concavo-convex, wider than long, widest along hinge line; shell variably alate, nasute; posterior planar portion frequently marked by rugae; sharply geniculate, anterior portion commonly forming an acute or right angle with posterior portion; ornamentation parvicostellate, the subsidiary costellae becoming stronger anteriorly; brachial muscle scar subcircular.

Material and occurrence.--About 40 specimens have been collected from outcrop. Two specimens were recovered from the subsurface, one from locality A2600, about 5 m above the base of the Gunn Member, and the other from A2602, about 8 m below the top of the unit. Many additional strophomenid valve fragments have been recovered from the subsurface, but these are not identifiable at the specific, or (in many cases), even the generic, level. The material is abraded, and ornamentation is faint or lacking. Interiors are difficult to obtain; most are obscured by matrix.

Discussion.--Foerste (1912, p. 113) named Strophomena fluctuosa-occidentalis for a smaller form of S. fluctuosa Billings. Wang (1949, p. 24) elevated Foerste's subspecies to species rank. This form, from the lower Maquoketa Group of southeastern Minnesota, was felt to differ sufficiently from S. fluctuosa, from Anticosti Island, to merit being considered a separate species.
Most previous workers (e.g., Whiteaves, 1880, 1895; Okulitch, 1943) assigned the Gunn specimens to *S. fluctuosa*. This assignment was maintained by Macomber (1970, p. 440-441) who argued that *S. fluctuosa* and *S. occidentalis* differed only in size. This is not entirely correct. Size is indeed the major difference, but the Gunn Member and Bighorn Formation specimens appear to be generally less rugose and less alate than do the Anticosti Island specimens of *S. fluctuosa*.

Billings (1860a, p. 57-59) gave a width for his *S. fluctuosa* of about 25 to 38 mm, but illustrated a specimen about 45 mm wide. Twenhofel (1928, pl. 22, figs. 3-5) illustrated specimens 32, 33, and 38 mm wide. Troedsson (1929, pl. 22, fig. 13) illustrated a broken specimen from Greenland that probably exceeded 45 mm in width. In contrast to these specimens of *S. fluctuosa*, I find that the Gunn material ranges in width from about 17 to 29 mm, which is in good agreement with Macomber's (1970, p. 440) measurements. Foerste (1912, p. 114) stated, "The shell does not usually exceed 23 to 25 mm. in width." Many of the Gunn and Bighorn specimens are slightly larger than this, but the size difference does not appear to be significant. In any event, they are much closer in size to *Strophomena occidentalis* than they are to *S. fluctuosa*.

I agree with Macomber (1970, p. 441) that size alone is an insufficient basis on which to separate these species. However, the size difference, coupled with the lesser degree of rugosity and alateness in *S. occidentalis*, together with the 2000 km separation of the two groups, *S. fluctuosa* from Anticosti and *S. occidentalis* from
the Gunn Member, leads me to conclude that they are, indeed, separate species.

_**Strophomena occidentalis**_ is smaller and more rugose than _S. hecuba_ Billings and is larger and has the geniculation farther from the anterior margin than does _S. rugulifera_ Wang. _Strophomena occidentalis_ is also larger and more alate than is _S. amoena_ Wang.

_Strophomena planocorrugata_ Twenhofel, 1928

*Plate 8, figs. 12*

_Strophomena subtenta_ (Conrad) Billings, 1862, p. 132, fig. 109;

Billings, 1866, p. 11; Bassler, 1915, p. 1233 (partim).

_Strophomena incurvata_ (?) (Shepard) Whiteaves, 1895, p. 119;

Schuchert, 1897, p. 431-432 (partim); Dowling, 1900, p. 50F;


_Strophomena rugosa subtenta_ (Hall) Schuchert, 1897, p. 435 (partim).

_Strophomena planocorrugata_ Twenhofel, 1928, p. 194, pl. 17, figs. 4-6;


_Strophomena cf. S. vetusta_ James Ross, 1957, p. 482, pl. 40, fig. 4.

**Diagnosis.**—Moderately large, gently concavo-convex; shell wider than long to subequal in width and length; posterior margin marked by several strong rugae, perpendicular to margin; outline semicircular to anteriorly elongate (based on Twenhofel, 1928, p. 194, and Macomber, 1970, p. 441).

**Material and occurrence.**—About 25 specimens were collected from outcrop. One specimen each was collected from subsurface locality A2602, about 9 m above the base of the Gunn Member, and from
localities A2600, A2603, and A2614, all about 3 m above the base. Most of the specimens are fragmented, and all are abraded.

Discussion.—Strophomena planocorrugata is a fairly distinctive species. It may be distinguished from S. subtenta (Conrad) by being larger, less convex, and by having stronger costellae and posterior rugae. It may be distinguished from S. vetusta James by being less convex and by having a more elongate outline. Strophomena planocorrugata differs from S. incurvata (Shepard) by being somewhat less convex, and by having the posterior rugae at right angles to the margin.

Subfamily Furcitellinae Williams, 1965

Genus Furcitella Cooper, 1956

Type species.—Furcitella plicata Cooper, 1956 (by original designation).

Diagnosis.—"Biconvex, with deeper brachial valve and pedicle valve commonly flattened to concave anteriorly; ventral muscle field trapezoidal, with strong bounding ridges; median ridge of notothyrial platform divided, trans-muscle septa normally well developed, with curved submedian septa." (Williams, 1965, p. H386).

Discussion.—Furcitella was originally based on two Middle Ordovician species, one from Minnesota and the other from Virginia (Cooper, 1956, p. 875-879). The range of the genus is Middle Ordovician to Lower Silurian (Williams, 1965, p. H386).
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? Furcitella sp.

Plate 8, figs. 19, 20

Diagnosis.--Brachial valve gently convex, pedicle valve almost planar; finely costellate on umbones, becoming more coarsely costate and even plicate at anterior margins; growth lines prominent; greatest width about one-third the distance from posterior to anterior margin; pseudodeltidium large, strongly convex; foramen large, subcircular, epithyridid; pedicle area large, strongly apsacline, almost orthocl ine; interior unknown.

Material and occurrence.--One specimen (UND 15141.) was collected from outcrop locality A1988. This specimen is chipped around the margins, but is otherwise complete. A second, very fragmentary specimen (UND 15142.), from subsurface locality A2623.1 about 10 m below the top of the Gunn Member, may belong here also.

Discussion.--No interiors are available for study; therefore, the generic and subfamilial assignments of this unusual and very rare species are open to question. The available material fits the description (Cooper, 1956, p. 875–877) of Furcitella well, and is tentatively assigned to that genus until more material is collected.

This specimen is, perhaps, most similar to a specimen tentatively assigned by Wang (1949, p. 35, pl. 9E, figs. 1–4) to Holtedahlin a. As noted by Wang (1949, p. 35), his specimen differs from Holtedahlin a in lacking a fold and sulcus, in having a very long pedicle area, and in being less apsacline. The Gunn specimen differs from the Wang's Maquoketa specimen in being more quadrate and in having an epithyridid rather than a mesothyridid foramen.
In the Gunn collections, *Furcitella* sp. is, perhaps, closest to *Strophomena*. *Furcitella* sp. is biconvex, rather than concavo-convex, lacks a geniculation, has a large foramen and distinct growth lines, and is finely costellate or costate, rather than parvicostellate.

**Subfamily Rafinesquininae Schuchert, 1893**

**Genus Megamyonia Wang, 1949**

*Type species.*—*Megamyonia knighti* Wang, 1949 (by original designation).

*Diagnosis.*—"Concavo-convex, with sharp dorsal geniculation; thick median costa commonly well developed, posterolateral rugae weak. Dental plates absent; ventral muscle field large subcircular; trans-muscle septa commonly absent, rarely variably and feebly developed." (Williams, 1965, p. H388).

**Megamyonia nitens** (Billings, 1860)

Plate 8, figs. 18, 21-23

*Strophomena nitens* Billings, 1860a, p. 53-54, fig. 1; Billings, 1862, p. 118-119, fig. 97; Billings, 1866, p. 11; Whiteaves, 1880, p. 49C.

*Leptaena nitens* (Billings) Whiteaves, 1895, p. 120; Dowling, 1900, p. 51F; Bassler, 1915, p. 710; Okulitch, 1943, p. 61.

*Rafinesquina nitens* (Billings) Hall and Clarke, 1892, p. 283;

Schuchert, 1897, p. 339.

*Leptaena * ? nitens* (Billings) Twenhofel, 1928, p. 186, pl. 17, fig. 19, pl. 18, figs. 13, 14.


Megamyonia cf. *M. ceras* (Billings) Ross, 1957, p. 484, pl. 40, figs. 15, 17, 19-21; Brindle, 1960, pl. 4, figs. 10-12.


Megamyonia sp. Ross, 1957, p. 485, pl. 40, fig. 18; Brindle, 1960, pl. 5, figs. 1, 2.

**Diagnosis.**—Semi-elliptical to semicircular; moderately to sharply geniculate; width greatest at hinge line, about 15 to 25 mm; cardinal angles rounded to somewhat alate; median costa only occasionally more prominent than ancillary costae (from Billings, 1860a, p. 53 and Macomber, 1970, p. 442-443).

**Material and occurrence.**—More than 100 specimens have been collected from outcrop, and almost 100 from the subsurface of North Dakota. Of the subsurface specimens, one each was from localities A2615 and A2620, about 35 from A2603, and about 60 from A2602. The subsurface specimens were found throughout the Gunn Member, although more abundant in the lower two-thirds. All the shells were abraded to some degree; as a result, only traces of surface ornamentation remain. Matrix has obscured internal detail in all but a few specimens.

**Discussion.**—Macomber (1970, p. 442-443) correctly emphasized the variability of this species in its dimensions, outline, degree of geniculation, and degree of alation. He also pointed out the
continuity between the extremes in these variations. I agree with him that this material constitutes one species.

_Megamyonia nitens_ may be distinguished from _M. ceres_ (Billings) by being smaller, relatively wider, and more sharply geniculate. It may be distinguished from _M. unicostata_ (Meek and Worthen) by being less alate, smaller, and by lacking the pronounced median costa that Meek and Worthen (1868, p. 336) described as being "five or six times as large" as the other costae.

**Subfamily Oepikininae Sokolskaya, 1960**

**Genus Oepikina** Salmon, 1942

**Type species.**—_Oepikina septata_ Salmon, 1942 (by original designation).

**Diagnosis.**—"Concavo-convex, with convex or gently geniculate pedicle valve and dorsally geniculate brachial valve; unequally parvicostellate, pseudodeltidium small. Teeth commonly crenulate or tuberculate, dental plates widely divergent; trans-muscle septa strongly developed and high anteriorly, dorsal subperipheral rim conspicuous." (Williams, 1965, p. H389-H390).

_Oepikina pergibbosa_ (Foerste, 1917)

Plate 8, figs. 24, 28-31

_Rafinesquina ceres_ (Billings) Whiteaves, 1895, p. 120; Dowling, 1900, p. 50F; Bassler, 1915, p. 1086 (partim); Okulitch, 1943, p. 61; Baillie, 1952, p. 33.

_Rafinesquina pergibbosa_ Foerste, 1917, p. 101-102, pl. 4, figs. 8A-8D;

_Hussey, 1926, pl. 4, figs. 7-9.

_Rafinesquina altidorsata_ Bradley, 1921, p. 516-517, pl. 2, fig. 2.
Rafinesquina subquadrata Bradley, 1921, p. 517, pl. 2, fig. 1.

Oepikina limbrata Wang, 1949, p. 22-23, pl. 6B, figs. 1-7.

Oepikina sp. Wang, 1949, p. 23, pl. 6C, figs. 1, 2.

Oepikina cf. pergibbosa (Foerste) Baillie, 1952, p. 33.

Oepikina cf. O. limbrata Wang Ross, 1957, p. 485, pl. 41, figs. 1, 2.


**Diagnosis.**—Medium-sized; subquadrate to subcircular, with rounded margins; pedicle valve strongly convex, frequently almost hemispherical, with greatest convexity commonly slightly posterior of middle; parvicostellate; cardinal process and brachiophores strong (from Foerste, 1917, p. 101, and Wang, 1949, p. 22).

**Material and occurrence.**—More than 150 specimens were collected from outcrop. Six additional specimens were collected from subsurface locality A2602, and two from A2615, mostly from the lower half of the Gunn Member. These shells are all abraded, and preservation of ornamentation is rare. Matrix usually obscures brachial exteriors and pedicle interiors, due to the extreme convexity of the valves.

**Discussion.**—Billings (1860a, p. 54) named Strophomena ceras. However, no illustration of this species was published until Twenhofel (1928, pl. 17, figs. 16-18) illustrated Billings's holotype and an additional specimen. The original description (Billings, 1860a, p. 54) emphasized the extreme variability of *S. ceras* with respect to convexity, and it is possible that Billings grouped more than one species under this name. Billings (1860a, p. 54) gave a width for his new species of 25 to 32 mm and a length of 20 to 25 mm, values that
conform to those obtained for larger specimens of *Oepikina pergibbosa* from the Gunn Member. It seems likely that it was *O. pergibbosa* to which earlier workers (Whiteaves, 1895; Dowling, 1900; Okulitch, 1943) were referring when they listed *Rafinesquina ceras* as occurring in the Gunn Member. The correct generic assignment of *R. ceras* is still in doubt; Bolton (1981) tentatively assigned it to *Megamyonia*. Thus, it would seem that the Gunn material requires a name other than Billings's (1860a) *R. ceras*. Baillie (1952, p. 33) was the first to assign this material to *Oepikina cf. O. pergibbosa*, and subsequent workers (Ross, 1957; Macomber, 1970) have followed his lead. Macomber (1970, p. 441-442) summarized the arguments in favor of this assignment, saying that his Bighorn specimens differed from Foerste's *O. pergibbosa* only by that species having thicker cardinal lobes. Macomber (1970, p. 441) also placed other species (*Rafinesquina altidorsata* Bradley, *R. subquadrata* Bradley, and *O. limbrata* Wang) in synonymy with *O. pergibbosa*. I have not examined either the Michigan material (Foerste's specimens) or the Maquoketa specimens (Bradley's and Wang's fossils), but I agree with Macomber that there seem to be no species-level differences between the Gunn material and the published descriptions and illustrations of Foerste (1917), Bradley (1921), and Wang (1949). Therefore, I am following Macomber's recommendation and placing the Gunn fossils in *Oepikina pergibbosa*.

Order RHYNCHONELLIDA Kuhn, 1949

Superfamily Rhynchonellacea Gray, 1848

Family Rhynchotrematidae Schuchert, 1913

Subfamily Rhynchotrematinae Schuchert, 1913
Genus *Rhynchotrema* Hall, 1860

*Type species.* — *Atrypa increbescens* Hall, 1847 (by original designation).

**Diagnosis.** — Shell small to large, rostrate, rounded triangular to transversely elliptical, wider than long; delthyrium narrow to wide, deltoidal plates narrow or lacking; teeth small to medium, stout, rounded; dental plates rudimentary to well formed; cardinal process high and blade-like; exterior ornamentation usually lamellose (modified from Howe, 1965c, p. 1127).

**Discussion.** — The genus *Rhynchotrema* has undergone much revision and discussion in the past few decades. Wang (1949, p. 11-12) restricted and redefined the genus. He placed into two new genera (*Lepidocyclus* and *Hypsiptycha*) several species that had previously been assigned to *Rhynchotrema*, together with a number of new species. *Rhynchotrema*, as restricted by Wang (1949, p. 11) consisted of "small, neat shells" having a narrow delthyrium, no deltoidal plates, and rudimentary dental plates. *Hypsiptycha* comprised a group of small species with well-developed deltoidal plates, and medium to large shells possessing strong, concave deltoidal plates were placed in *Lepidocyclus*.

Cooper (1956, p. 628-629) modified Wang's diagnosis of *Rhynchotrema* to include shells with "narrow, elongate deltoidal plates" creating a restricted delthyrium. Cooper (1956, p. 657) also erected a new family, Lepidocyclidae, to accommodate Wang's genus *Lepidocyclus*, and characterized the family as, "Rhynchonellacea with concave deltoidal plates (?) in the pedicle valve and a cardinal
process in the brachial valve." As rhynchotrematids may or may not have a cardinal process and incomplete deltidial plates, these characters ascribed by Cooper to a new family seem to me a slim basis on which to have erected a new family. Schmidt (1965, p. H554) appears to have shared this opinion; she placed the Lepidocyclidae in synonymy with the Rhynchotrematinae. However, several subsequent workers (Howe, 1965c, 1967, 1969, 1979; Howe and Reso, 1967; Amsden, 1983) have retained Cooper's family, based on Howe's (1965c, p. 1127) emended diagnosis.

Howe (1965c, p. 1126-1127) also emended the diagnoses of the Rhynchotrematidae and the genera Rhynchotrema and Lepidocyclus, and noted the large degree of overlap among the characters of these genera, together with those of Hypsiptycha. Because of this overlap, Macomber (1970, p. 443) preferred to follow the Treatise (Schmidt, 1965, p. H554) regarding family assignments of these genera.

Amsden (1983) revised the Lepidocyclidae, erecting one new genus (Hiscobeccus) and two new subfamilies (including the monogeneric Hiscobecchinae). Amsden (1983, p. 37) characterized Hiscobeccus as having "a thick posterior ventral shell wall and deeply impressed muscle area," rudimentary or absent dental plates, a blade-like cardinal process, strong costae and lamellae, and an open delthyrium with rudimentary or no deltidial plates. With the exception of the thickened shell wall and deep muscle scars, probably both a function of larger size, these are all characteristics of Rhynchotrema. In effect, Amsden created a new genus and subfamily, and placed these taxa in a different family than Rhynchotrema, solely on the basis of
I do not mind using size as a specific criterion, but I feel it is not valid to use size alone as a generic distinction, and even less valid to use size as the criterion for separation at the subfamily or family level. I believe that the three species that Amsden assigned to Hiscobecus (Atypa capax Conrad, Lepidocyclus gigas Wang, and Rhynchotrema rowleyi Foerste) may be comfortably accommodated in Rhynchotrema, and Hiscobecus Amsden is here considered a junior synonym of Rhynchotrema Hall. Thus, the subfamily Hiscobecchinae becomes a junior synonym of Rhynchotrematinae. Also, due to the considerable overlap in characters of Lepidocyclus and Rhynchotrema documented by Howe (1965c), and for the reasons given above, I am following the Treatise (Schmidt, 1965, p. H554) and Macomber (1970, p. 443) in considering Lepidocyclidae a synonym of Rhynchotrematidae.

Rhynchotrema gigas (Wang, 1949)
Plate 8, figs. 44-46, 48-50

Rhynchohelia capax (Conrad) Whiteaves, 1880, p. 50C.
Rhynchotrema capax (Conrad) Whiteaves, 1895, p. 121; Dowling, 1900, p. 51F; Bassler, 1915, p. 1121 (partim).
Rhynchotrema perlamellosum (Whitfield) Okulitch, 1943, p. 61.
Lepidocyclus gigas Wang, 1949, p. 16-17, pl. 10D, figs. 1-5; Ross, 1957, p. 477-478, pl. 38, figs. 16, 20-25; Macomber, 1970, p. 447, pl. 80, figs. 1-17.
Lepidocyclus sp.--"Rhynchotrema perlamellosum" (Whitfield) Baillie, 1952, p. 33.
Lepidocyclus perlamellosa (Whitfield) Ross, 1957, p. 477, pl. 39, figs. 1-5.
Lepidocyclus capax (Conrad) Ross, 1957, p. 477, pl. 39, figs. 21, 24-27.

Lepidocyclus cf. gigas Wang Brindle, 1960, pl. 4, figs. 8, 9.


**Diagnosis.**—Shell large for genus; unequally biconvex to globose in gerontic forms; beaks appressed; deltidial plates lacking; high fold usually with 4 costae, 16 to 20 costae on each valve; anterior portion commonly strongly lamellose (modified from Wang, 1949, p. 16-17, and Macomber, 1970, p. 447).

**Material and occurrence.**—More than 150 specimens have been collected from outcrop. Six specimens were recovered from the subsurface, three from locality A2602 and one each from A2601, A2616, and A2623. Many other specimens were noted in core. This species is never abundant, but is present throughout the Gunn Member. The shells are all abraded, and many no longer display the characteristic zigzag lamellae. A number of pedicle valves are present, but few brachial valves; most specimens are articulated.

**Discussion.**—Wang (1949, p. 16-17) apparently erected Lepidocyclus gigas on the basis of a single specimen. Amsden (1983, p. 38) reported, "I have examined the holotype, which is an articulated shell showing no internal features; because the pedicle beak is pressed tightly against the brachial umbo, this species is provisionally included in Hiscobecus." Previously on the same page, Amsden had related the condition of the pedicle beak's being pressed against the brachial umbo to the lack of deltidial plates in some species, and he therefore inferred their lack in H. gigas. Certainly
in the Gunn material, and in Macomber's (1970, pl. 80, figs. 1-17) illustrations of his Bighorn material, deltidial plates are lacking. In other respects, also, the Gunn and Bighorn specimens agree with Wang's (1949) description and illustrations. The largest of the Gunn and Bighorn specimens are somewhat larger than the holotype, but that specimen fits well into Macomber's measured series. With regard to the generic assignment, the material seems to meet all the criteria for inclusion in *Rhynchotrema*; therefore, following the recommendation of H. J. Howe (oral communication, 1985) it is here so assigned.

This species has been referred to *Rhynchotrema perlamellosum* and *R. capax* by many previous workers. However, it is significantly larger than either of those species. It is, indeed, the largest *Rhynchotrema* known, and, quite possibly, the largest member of the family. The only other species with which *R. gigas* need be compared is *Rhynchotrema windermeris* Wilson, a large rynchonellid of Richmondian age from the Rocky Mountains of British Columbia. However, Wilson (1926, p. 21) referred to the "large deltidial plates," structures lacking in *R. gigas*. Wilson's species is probably referrable to *Lepidocyclus*.

*Rhynchotrema iowense* Wang, 1949

*Plate 8, figs. 40-43*

*Rhynchotrema iowense* Wang, 1949, p. 12, pl. 4C, figs. 1-9; Ross, 1957, p. 476, pl. 38, figs. 9, 10, 12-14; Macomber, 1970, p. 444, pl. 80, figs. 33-47.

**Diagnosis.**—Shell small, wider than long; fold of moderate height, usually with four costae; about 18 to 20 costae on each valve;
exterior finely lamelllose; delthyrium open, deltidial plates rudimentary or lacking; beaks appressed.

Material and occurrence.—More than 150 specimens were collected from outcrop. Another 17 specimens were collected from the subsurface: 12 from locality A2602, two from A2620, and one each from A2603, A2617, and A2623. The specimens from A2602 are scattered throughout the Gunn Member. Other specimens were noted in core, but distinguishing the small rhynchonellids is difficult to impossible without well-preserved specimens. Almost all specimens are articulated shells that have been abraded to some degree.

Discussion.—Prior to the work of Ross (1957), it had not been recognized that at least two species of small rhynchonellids were present in the Gunn Member. Part of this problem has been the difficulty of separation and identification of Rhynchotrema and Hypsiptycha. Virtually the entire collection consists of articulated shells, and the only reliable distinguishing feature that commonly separated the two genera is the presence or absence of deltidial plates and an open or closed delthyrium. For this to be determined, the beak must be well preserved. Unfortunately, this relatively delicate area seems to be the first to be damaged or lost when the shell is damaged, and of the more than 450 small rhynchonellids present in the collections, I can only identify about 50 with a strong degree of confidence.

Other features may be used as a guide, but not with complete certainty. Rhynchotrema is almost invariably wider than long, whereas Hypsiptycha is usually longer than wide. This means that if a shell
is longer than wide, it may be assigned with reasonable confidence to Hypsiptycha, but the reverse is not necessarily true. Also, if the beak has been damaged or lost, the length measurement is correspondingly reduced.

Transverse outline is another semi-diagnostic feature. Rhynchotrema is usually subelliptical, having its greatest width about two-thirds of the distance from the beak to the anterior margin. Hypsiptycha, on the other hand, has more of a teardrop shape, and has its greatest width about five-sixths of the distance to the anterior margin.

These criteria are all useful, but there is undoubtedly much variation and some overlap in these features. Also, when a shell has undergone even a small amount of distortion, it is easy for a length that was originally only slightly greater than a width to become slightly smaller, and vice versa. Unfortunately, the only certainly diagnostic feature is usually lost. As Macomber (1970, p. 444) noted: "Several specimens collected from ... Stony Mountain, Manitoba, have the size and shape of Rhynchotrema iowense, but their beaks are not well-preserved, and the identification is not certain."

Wang (1949, p. 12) distinguished R. iowense from R. increbescens (Hall) on the basis of its "less globose profile, more transversely elliptical outline, and shorter dorsal median ridge," and from R. plicatum Wang on the basis of "general outline" and number of costae on the fold.
Genus Hypsiptycha Wang, 1949

Type species.—Hypsiptycha hybrida Wang, 1949 (by original designation; junior subjective synonym of Rhynchonella anticostiensis Billings, 1862).

Diagnosis.—Shell small, longer than wide; unequally biconvex; strongly costate and finely lamellose; fold and sulcus moderate to strong; deltidial plates well-developed; teeth strong; cardinal process blade-like (from Wang, 1949, p. 17, and Amsden, 1983, p. 39).

Discussion.—Howe (1965) demonstrated the overlap in characters of Rhynchotrema and Hypsiptycha. Therefore, following Schmidt (1965, p. H554-H555) and Macomber (1970, p. 443), and as discussed above under Rhynchotrema, Hypsiptycha is retained in the Rhynchotrematinae.

Hypsiptycha anticostiensis (Billings, 1862)

Plate 8, figs. 32-38

Rhynchonella anticostiensis Billings, 1862, p. 142; Billings, 1866, p. 13; Whiteaves, 1895, p. 122; Dowling, 1900, p. 51F.

Rhynchonella janae Billings, 1866, p. 43.

Rhynchonella (?) anticostiensis Billings Winchell and Schuchert, 1895, p. 464; Schuchert, 1897, p. 354.

Rhynchonella (?) janae Billings Schuchert, 1897, p. 359; Bassler, 1915, p. 1118-1119.


Rhynchotrema anticostiense (Billings) Twenhofel, 1928, p. 207, pl. 21, figs. 4-6.

Rhynchotrema janeum (Billings) Twenhofel, 1928, p. 207, pl. 22, figs. 20, 21.
Rhyncotrema [sic] anticostiensis (Billings) Okulitch, 1943, p. 61.


Hypsiptycha neenah (Whitfield) Wang, 1949, p. 18, pl. 10C, figs. 1-6.


Hypsiptycha cf. H. anticostiensis (Billings) Ross, 1957, p. 478, pl. 39, figs. 6-8, 12, 13; Howe and Reso, 1967, p. 358-359, pl. 40, figs. 17-20.


Diagnosis.--Shell medium-sized for genus, outline subtriangular to subpentagonal; unequally biconvex, fold and sulcus moderate to strong; brachial valve with 16 to 20 strong costae; fold usually with 4 costae; beak suberect; cardinal process moderately stout; weakly to strongly lamelllose (from Billings, 1862, p. 142, and Wang, 1949, p. 17-18).

Material and occurrence.--Almost 300 specimens have been collected from outcrop. From the subsurface, seven specimens were recovered from locality A2602, just below the middle of the Gunn Member, and one from locality A2620.03, near the top of the unit. Most specimens were abraded to some degree, and most had damage to the pedicle beak. Almost all specimens were articulated shells.

Discussion.--Imperfect preservation rendered positive identification of most specimens difficult to impossible. These
difficulties are more fully discussed under *Rhynchotrema iowense* above.

*Hypsiptycha anticostiensis* (Billings) may be compared with *H. janea* (Billings), *H. hybrida* Wang, *H. argenturbica* (White), and *H. neenah* (Whitfield). All these species, with the exception of *H. janea*, were assigned to *Hypsiptycha* by Amsden (1983, p. 39).

*Hypsiptycha janea* was originally distinguished from *H. anticostiensis* on the basis of the stronger curvature of its beak; to this Twenhofel (1928, p. 207) added greater width and weaker lamellae. Macomber (1970, p. 445) noted the variability of the above characters among his specimens of *H. anticostiensis* and placed the two species in synonymy.

*Hypsiptycha hybrida* was erected by Wang (1949, p. 17-18) for a form he felt to be intermediate between *H. anticostiensis* and *H. neenah*. Wang (1949, p. 18) differentiated *H. hybrida* from *H. anticostiensis* on the basis of its "more triangular and convex dorsal valve, stronger fold and sulcus, and in having the 2 [lateral] costae on the fold slightly weaker than the median ones." All the differentiating features mentioned by Wang exhibit considerable variation in my collections, an observation made also by Macomber (1970, p. 445-446) for his collections; Macomber placed the two species in synonymy. Howe and Reso (1967, p. 358-359) found no significant differences between the two species, except for a slightly greater number of costae in *H. hybrida*. However, Howe and Reso stopped short of placing these species in synonymy. But I believe that the overlap between the two "species" is so great, and the
differences, if real, so minor, that they are here considered to be the same species.

_Hypsiptycha argenturbica_, according to its author (White, 1877, p. 75-76) differs from _H. anticostiensis_ by being smaller and by having a more rounded outline and a more elevated fold. These species were compared by Howe and Reso (1967, p. 358-359) and by Howe (1967, p. 846-848). Howe and Reso (1967, p. 359) concluded that all these features except size were highly variable, and that the only significant difference between the two species is size (_H. argenturbica_ being somewhat smaller). They suggested that subspecies status might be appropriate based on the size difference and geographic separation. However, Howe and Reso (1967) and Howe (1967) retained the separate species.

Whitfield (1882, p. 265-266, pl. 12, figs. 19-22) described and illustrated _Hypsiptycha neenah_. He differentiated it from _H. janae_ and _H. anticostiensis_ on the basis of _H. neenah_'s being narrower and having only two costae on the fold. He stated (p. 266) that each valve bore "about ten" costae, but illustrated a specimen (fig. 22) having at least 14. Wang (1949, p. 18, pl. 10C, figs. 1-6) and Macomber (1970, p. 446-447, pl. 80, figs. 23-26) both identified _H. neenah_ as occurring in their faunas, based on a single specimen each. It is my observation that the strength of the two lateral costae on the fold relative to the two median ones is another of the variable features of _H. anticostiensis_, as is the height of the fold itself. In my collections there are a number of specimens where the
lateral costae of the fold are slightly to moderately reduced. Macomber's specimen, and, to a lesser extent, Wang's also, appear to be a variant of *H. anticostiensis* showing a morphological trend toward *H. neenah*.

**Order ATRYPIDA Moore, 1952**

Superfamily Atrypacea Gill, 1871

Family Zygospiridae Waagen, 1883

Subfamily Zygospirinae Waagen, 1883

Genus *Zygospira* Hall, 1862

**Type species.**--*Atrypa modesta* Hall, 1847 (by original designation).

**Diagnosis.**--"Unequally biconvex, elongate or transverse shells, pedicle valves more convex, commonly with ventral fold and dorsal sulcus, simple plications; foramen mesothyridid, deltidial plates conjunct, beak ridges strong and well defined. Dental plates lacking; hinge plates disjunct, parallel medially, diverging ventrally, and supported by myophragm; spiralia directed submedially with dorsal inclination; jugum a simple band curving toward middle of valve, origin of jugum variable, anterior or posterior." (Boucot et al, 1965a, p. H634).

**Discussion.**--Suprageneric classification in the Atrypida follows Copper (1977, 1986). Authorship of the order is here credited to Moore (1952), who first named the Suborder Atrypoidea, rather than to Rzhonsnitskaya (1960), who first used Order Atrypida.
The type species (*Zygospira modesta*) is generally credited to Say in Hall, 1847. Say's name was apparently a manuscript name, preserved by Hall, who credited it to Say. However, Hall (1847) was the first to describe and illustrate the species, and he should be cited as its author.

**Zygospira sp.**

*Plate 8, figs. 25-27*

**Diagnosis.**—Shell small, subcircular to elongate-elliptical, longer than wide, with shallow brachial sulcus and weak to moderately strong pedicle fold; coarsely costate, with about 16 to 30 costae per valve; beak almost orthocline to somewhat anacline; delthyrium apparently open; interior unknown.

**Material and occurrence.**—*Zygospira* is known from the Gunn Member only in the subsurface of North Dakota, where 37 specimens have been collected. One of these is from locality A2615, five are from A2600, and the rest from A2602. All specimens are from the lower half of the Gunn Member, and all are slightly to moderately crushed, deformed, and abraded.

**Discussion.**—This group of specimens ranges in length from less than 1 mm to a "giant" exceeding 8 mm; the majority are from 2 to 5 mm long. The larger specimens tend to have more costae. It may be that more than one species is present here, and the larger specimens bear some resemblance to material assigned to *Anazyga*, lacking only the strongly recurved beak of that genus.

No previously described species is as small as most of my material, and species that are of a size similar to my larger
specimens have fewer costae. However, given the quality of my material, I do not wish to name a new species at this time.

Family Cyclospiridae Schuchert, 1913
Subfamily Cyclospirinae Schuchert, 1913
Genus Cyclospira Hall and Clarke, 1894

Type species.--Orthis bisulcata Emmons, 1842 (by original designation).

Diagnosis.--"Unequally biconvex shells, pedicle valve more convex; dorsal sulcus and ventral fold modified in some by low medial plication. Dental plates, if present, buried in secondary shell material present in umbonal region; hinge plates conjunct; median septum present; spiralia planospiral, with few volutions, jugum lacking." (Boucot et al., 1965a, p. H645-H646).

Discussion.--Copper (1986) assigned the Cyclospirinae to the family Lissatrypidae (Twenhofel, 1914). However, Cyclospiridae (Schuchert, 1913) has priority, and is here considered the valid family name.

Cyclospira sp.

Diagnosis.--Shell small, subcircular to obscurely pentagonal, longer than wide, smooth, non-plicate; beak somewhat anacline; interior unknown.

Material and occurrence.--Four specimens have been collected from subsurface locality A2602, from about 10, 15, and 20 m below the top of the Gunn Member. All specimens are abraded and deformed.

Discussion.--The four specimens range in diameter from about 1 mm to about 2.5 mm. No previously described species is that small, but,
considering the paucity and quality of the material, I do not wish to erect a new species.

Phylum MOLLUSCA Cuvier, 1797
Class SCAPHOPODA Bronn, 1862
Family Dentaliidae Gray, 1834
Genus Plagioglypta Pilsbry and Sharp, 1897

Type species.--Dentalium undulatum Munster, 1844 (by original designation).

Diagnosis.--"Shell tapering, circular or elliptical in section, without longitudinal sculpture, with close and fine obliquely encircling wrinkles throughout or on anterior portion. Aperture with a fairly long and broad slit." (Ludbrook, 1960, p. 139-140).

? Plagioglypta sp. cf. Plagioglypta iowaensis (James, 1890)
Plate 8, fig. 52

Diagnosis.--Slender tapering cones, straight or very slightly curved, circular in cross section; faint transverse annulations may be present; exterior unknown.

Material and occurrence.--Five specimens have been collected from subsurface locality A2602, about 5 to 10 m above the base of the Gunn Member. These specimens are all phosphatic steinkerns preserving no trace of the shell. A sixth specimen was recovered from locality A2603, about 15 m above the base of the unit. All specimens are fragmentary.

Discussion.--Fisher (1962) provided a history of attempts at classification of "small conoidal shells of uncertain affinities." Many of them Fisher assigned to the Mollusca; others, including
Coleolus (the genus to which James [1890] originally assigned Plagioglypta iowaensis), Fisher regarded as still being of "uncertain affinities."

Bretsky and Bermingham (1970) reassigned Coleolus iowaensis James, from the Maquoketa Group of Iowa, to the Late Paleozoic and Mesozoic genus Plagioglypta, thereby considerably extending the range of that genus. Many of their specimens were steinkerns; but some retained fragments of shell, enabling Bretsky and Bermingham (1970) to describe their fossils fairly completely. They seemed to regard the Maquoketa specimens unequivocally as being scaphopods.

An alternative point of view was expressed by Harrison and Harrison (1975, p. 216) who described their Lower Silurian fossils "Plagioglypta" iowaensis under the heading, "Phylum, Class, Order, and Family Uncertain." These workers held open the possibility that their "Plagioglypta" was a worm tube. Therefore, it should be kept in mind that, while I have described these fossils under the heading "Class Scaphopoda," that assignment is by no means certain; the supra-generic, and even the generic, assignment of these specimens is still moot.

The Gunn specimens differ from those of the Maquoketa by being smaller and less curved. It may even be that they represent a different species, but to erect a new taxon based on such material would be irresponsible.
Class GASTROPODA Cuvier, 1797

Subclass PROSOBRANCHIA Milne-Edwards, 1848

Order ARCHAEOGASTROPODA Thiele, 1925

Suborder BELLEROPHONTINA Ulrich and Scofield, 1897

Superfamily Bellerophontacea M'Coy, 1851

Family Cyrtolitidae Miller, 1889

Genus Cyrtolites Conrad, 1838

Type species.--Cyrtolites ornatus Conrad, 1838 (by monotypy).

Diagnosis.--"Anterior lip with somewhat shallow, angular sinus, aperture quadrate, whorls barely in contact or possibly disjunct in some species; with sharp median carina and pair of lateral ridges; umbilici widely open; ornament with collabral undulations and fine canceling threads." (Knight et al., 1960, p. 1175).

Discussion.--There has been a good deal of debate in recent years as to the correct taxonomic placement of the bellerophontaceans. Many workers now regard them as monoplacophorans (e.g., Runnegar, 1985); others, however, maintain the gastropod affinities of this superfamily (e.g., Yochelson, 1984). A brief summary of arguments on both sides of this question may be found in Signor (1985, p. 162-165). The placement of this superfamily is beyond the scope of the present study; my collection of microscopic steinkerns contributes nothing to the debate. For now, I will adopt a conservative course and retain the Bellerophontacea in the Gastropoda.
Cyrtolites sp.
Plate 8, figs. 39, 47

**Diagnosis.**—Very small, less than 1 mm in their greatest dimension, quadrate to subquadrate aperture; whorls in contact; median carina sharp, lateral carinae subdued; phaneromphalous; collabral undulations, external ornamentation unknown.

**Material and occurrence.**—More than 200 specimens have been recovered from the subsurface of North Dakota, of which three are from locality A2600, two from A2603, one (questionably) from A2616, and the remainder from A2602. All are from the lower half of the Gunn. All specimens are phosphatic steinkerns; none preserves the apertural lip or any trace of surficial ornamentation.

**Discussion.**—These specimens agree in every respect with Microceras inornatum Hall, as described and figured by Knight (1941, p. 196, pl. 5, figs. 6a, 6b). Knight felt that Hall's specimens were steinkerns of embryonic Cyrtolites and Sinuites, and selected a lectotype for Microceras that conformed to the generic characters of Cyrtolites. Microceras was regarded as a junior synonym of Cyrtolites by Knight et al. (1960, p. II75).

The lack of external detail makes it impossible to suggest a species assignment for these specimens. However, the characteristic subquadrate to quadrate cross-sections of the whorls together with the sharp median carina make the generic assignment fairly certain.

Cyrtolites has a shallow sinus, without a slit or selenizone, a quadrate aperture, a sharp median carina and two lateral ridges, and open umbilici. Sinuites has a wide, U-shaped sinus, a rounded whorl
profile, and is anomphalous. *Bucania* has a slit and selenizone, open umbilici, and a whorl profile that may have a depressed or slightly raised selenizone. Some of the specimens assigned here seem to have the sinusoidal dorsal surface of *Bucania*, or the rounded whorl profile of *Sinuites*, in earlier whorls, before developing the quadrate profile and strong carina characteristic of *Cyrtolites*. However, many smaller specimens, of a size comparable to the earlier whorls of larger specimens, also display a strong carina, so the situation is somewhat confusing. It may be that some specimens I have included in *Bucania* and *Sinuites* should actually be assigned to *Cyrtolites*. It may be that we are dealing here with embryonic or juvenile forms of several species that cannot be separated on the basis of the material at hand.

Family Sinuitidae Dall and Bassler, 1913

Subfamily Sinuitinae Dall and Bassler, 1913

Genus *Sinuites* Koken, 1896

*Type species.*—Bellerophon bilobatus Sowerby, 1839 (subsequent designation by Bassler, 1915).

*Diagnosis.*—"Aperture large but not abruptly expanded, the outer lip bilobate, with a broad and more or less deep sinus but neither a slit nor band; dorsum convex, never carinate; umbilicus closed; surface markings very fine, generally consisting of more or less obscure crowded lines of growth and delicate revolving striae . . . ." (Ulrich and Scofield, 1897, p. 848).

*Discussion.*—The above diagnosis was taken from Ulrich and Scofield's (1897) diagnosis for their new genus *Protowarthia*, regarded
as a junior synonym of Sinuites Koken, 1896, by Knight et al. (1944, p. 441).

? Sinuites sp.

Plate 8, fig. 51; plate 9, fig. 36

**Diagnosis.**—Very small, bellerophontiform; whorl profile broadly rounded; carina, external ornamentation lacking.

**Material and occurrence.**—Four specimens have been collected from subsurface locality A2602, from horizons about 6 m and 12 m above the base of the Gunn Member. These may be anomalously shaped Cyrtolites (discussed above under Cyrtolites sp.) but as these specimens have a rounded whorl profile and are completely lacking a carina, it seemed best to classify them separately.

**Family Bellerophontidae M'Coy, 1851**

**Subfamily Tropidodiscinae Knight, 1956**

**Genus Phragmolites Conrad, 1838**

**Type species.**—Phragmolites compressus Conrad, 1838 (by monotypy).

**Diagnosis.**—"Whorls more or less rounded; apertural margins flaring periodically to form narrow, strongly scalloped varices; deep, narrow slit between low, sharp keels which are joined at top by the selenizone; ornament obscure spiral threads." (Knight et al., 1960, p. 1179).

Phragmolites sp. A

Plate 9, fig. 1, 23

[?] Cyrtolites ornatus? Conrad Whiteaves, 1880, p. 50C.


[?] Cyrtolites compressus (Conrad) Whiteaves, 1895, p. 124; Dowling, 1900, p. 52F.

[?] Phragmolites compressus Conrad Bassler, 1915, p. 971 (partim).

[?] Phragmolites compressus (Conrad) [sic] Baillie, 1952, p. 33.

**Diagnosis.**—Shell small, discoidal, thickness less than one-third diameter; 2 to 3 whorls; varices of inner whorls with 2 or 3 loops, those of last whorl with 4 or 5; varices about 2 mm apart; carina strongly elevated; apertural details unknown.

**Material and occurrence.**—Two specimens collected from outcrop seem definitely to be Phragmolites. Two others, also from outcrop, are steinkerns, and are questionably assigned here based on their size and shape; lack of external ornamentation precludes a definite assignment. Two additional fragments were recovered from subsurface locality A2614.22, about 3 m above the base of the Gunn Member.

**Discussion.**—Previous reports of specimens from the Gunn Member assignable to species of Phragmolites have been included in the synonymy above. It seems probable that they are conspecific with the material at hand.

The Gunn material at hand differs from the type species, Phragmolites compressus Conrad, by being smaller and by having closer-spaced varices. Most other species of Phragmolites have still closer-spaced varices than do the Gunn specimens. Among other Cincinnatian Phragmolites, the Gunn material seems most similar to P. elegans (Miller). The Gunn specimens, however, have wider-spaced varices and seem to be a bit thinner. The surface ornamentation of
the Gunn specimens seem to be about that of *P. desideratus* (Billings), as described by Twenhofel (1928, p. 247), but the Gunn specimens are much more compressed. The Gunn specimens are about the same size and proportions as *P. pannosus* (Billings) but have much more closely-spaced varices. The Gunn material has wider-spaced varices than does *P. bellula* (Ulrich and Scofield) and lacks lunulae on the carina. None of the previously described species of *Phragmolites* seems capable of providing a satisfactory repository for the Gunn specimens. However, I do not wish to name a new species based on the two rather poor specimens and two steinkerns I have at my disposal.

? *Phragmolites* sp.

Plate 9, figs. 2, 3

[?] *Bellerophon bilobatus* Sowerby Whiteaves, 1895, p. 124; Dowling, 1900, p. 52F.

[?] *Sinuites cancellatus* (Hall) Bassler, 1915, p. 1159 (partim).

[?] *Sinuites bilobatus* (Sowerby) Baillie, 1952, p. 33.


**Diagnosis.**—Shell small, discoidal, weakly carinate; details of umbilicus, aperture, ornamentation unknown.

**Material and occurrence.**—A single steinkern, with the umbilici obscured by matrix, was collected from outcrop.

**Discussion.**—This specimen is the only planispiral gastropod, besides the four specimens described above under *Phragmolites* sp. A, to be collected from outcrop. Its proportions are somewhat different (it is relatively thicker) from *Phragmolites* sp. A, and the carina does not seem to be as strongly elevated. I am not at all sure that
this specimen corresponds to those listed above in the synonymy; none of them have been illustrated. I am not even sure that it is a Phragmolites, but as that is the only planispiral genus known to occur in outcrop, and as the proportions of this specimen are well within the range known for that genus, I think it best to assign it questionably to Phragmolites. It might be assignable to Sinuites, but that genus lacks a carina.

Subfamily Bucaniinae Ulrich and Scofield, 1897
Tribe Bucaniides Ulrich and Scofield, 1897
Genus Bucania Hall, 1847

Type species.--Bellerophon sulcatus Emmons, 1842 (subsequent designation by Waagen, 1880).

Diagnosis.--Shell of three to five whorls; aperture only slightly expanded; ornamentation of transverse or longitudinal threads, or both; selenizone raised or depressed. (from Ulrich and Scofield, 1897, p. 850, and Knight et al., 1960, p. 1180).

Bucania sp.
Plate 9, figs. 32, 33

Diagnosis.--Very small, selenizone a slight median depression between rounded lateral carinae; aperture and ornamentation unknown.

Material and occurrence.--About 90 specimens have been collected from the lower half of the Gunn Member at subsurface locality A2602. These consist exclusively of phosphatic steinkerns, most less than 1 mm in their greatest dimension.

Discussion.--Few bellerophontaceans have a depressed selenizone, and the redescription of the type species (Knight, 1941, p. 60) makes
it clear that these specimens can be accommodated here. The possibility remains that some of the specimens assigned here are really *Cyrtolites*, as discussed above under *Cyrtolites* sp. The major feature distinguishing *Bucania* sp., *Cyrtolites* sp., and *Sinuites* sp. is the whorl profile; otherwise, their proportions and size are similar.

Suborder **PLEUROTOMARIINA** Cox and Knight, 1960

Superfamily **Pleurotomariacea** Swainson, 1840

Family **Raphistomatidae** Koken, 1896

Subfamily **Liospirinae** Knight, 1956

Genus **Liospira** Ulrich and Scofield, 1897

*Type species.*—*Pleurotomaria micula* Hall, 1862 (subsequent designation by McLearn, 1942).

**Diagnosis.**—"Surface glossy, without ornament; selenizone convex, forming periphery but largely on upper side; cryptomphalous." (Knight et al., 1960, p. 1201).

? **Liospira** sp. cf. *L. americana* (Billings, 1866)

Plate 9, figs. 10, 31, 35

*Pleurotomaria* (species uncertain) Whiteaves, 1895, p. 123.

*Pleurotomaria acuta* (?) Sowerby Dowling, 1900, p. 51F.

*Liospira parva* Wilson, 1938 (partim)


"*Pleurotomaria*" sp. uncertain Baillie, 1952, p. 33.

**Diagnosis.**—Shell large for genus, height about one-third maximum width; apical angle about 150 degrees; periphery of steinkern angular;
width of umbilicus about one-quarter of greatest width; external details unknown.

Material and occurrence.—About 50 specimens, all from outcrop, are assignable to this taxon. About an equal number of fragments are probably assignable here also. All specimens are steinkerns, and none retains the apex, the aperture, or surficial details. Many specimens are somewhat deformed.

Discussion.—As with all the Gunn gastropods, only steinkerns are preserved, and as Miller et al. (1954, p. 14) reported, "... J. Brookes Knight, the foremost American authority on Paleozoic gastropods, has assured us orally that such material cannot be divided into genera and species very satisfactorily." Specifically, the loss of external ornamentation commonly prevents positive assignment even at the family level.

The material here assigned certainly meets all the criteria for Liospira, but the possibility can not be ruled out that it may be Raphistoma or Raphistomina. Wilson (1951, p. 49) discussed this problem:

Most of the species of the two latter genera have greater height than Liospira and the lower part of the whorl descends more abruptly from the periphery giving the two genera a more robust appearance. Raphistoma has a slightly flatter whorl, a difference not always evident in a cast, but the raised line on the upper surface formed by the piled up strata is usually reflected in the cast. The sharply angular periphery of Raphistomina projects over the succeeding whorl. The casts of the genus can be distinguished thus if adequately preserved. If the initial whorls are worn or lacking, the almost vertical outer margin of the whorl, approximately at right angles to the upper surface, marks Raphistomina.
In this species the height:width ratio is around 1:3, lower than most other species of Liospira and much lower than species of Raphistoma or Raphistomina. The angulate to subangulate periphery also points to Liospira being the correct generic designation. However, the apical angle of about 150 degrees is exceptionally large for Liospira, whereas Raphistoma commonly has an even flatter upper surface. But, considering all the morphologic features, this species fits best into Liospira.

This material seems most like Liospira americana (Billings). This species is also large for the genus, attaining a width of 50 mm (Billings, 1860a, p. 164; Twenhofel, 1928, p. 236). However, the height:width ratio was reported as "one-half the diameter or less" (Ulrich and Scofield, 1897, p. 996), whereas the Gunn specimens are somewhat shorter. L. americana has been reported as having an apical angle of about 130 degrees (Ulrich and Scofield, 1897, p. 996); the Gunn material has an apical angle of about 150 degrees. Few other species of Liospira are this large, and none has such a large apical angle. The Gunn material probably represents an undescribed species, but I am most reluctant to erect a new species based on incomplete steinkerns.

? Liospira sp.

Plate 9, figs. 19, 20, 24

Diagnosis.—Minute steinkerns, less than 1 mm in greatest dimension, of one and one-half to two and one-half whorls; apical region planar for first whorl, then sloping gently downward; whorl
periphery usually rounded, but may approach subangular; whorls abruptly expanding in size; external details unknown.

Material and occurrence.--About 50 specimens, all from the lower half of the Gunn Member in the subsurface of North Dakota, have been collected. One specimen is from locality A2600, two from A2603, and the rest are from A2602.

Discussion.--These specimens have, at first blush, the appearance of Raphistoma, until one realizes the scale of these fossils. Raphistoma is commonly planar across the top for several millimetres, not merely for a small fraction of one millimeter. Most of these specimens lack the sharp periphery found in all three genera discussed above under ?Liospira sp. cf. L. americanum. Perhaps that is a development that occurs in subsequent whorls. In any event, I am tentatively assigning these specimens to Liospira, while remaining aware that they may represent more than one genus of low-spired gastropods.

Family Eotomariidae Wenz, 1938
Subfamily Eotomariinae Wenz, 1938
Tribe Eotomarides Wenz, 1938
Genus Eotomaria Ulrich and Scofield, 1897

Type species.--Eotomaria canalifera Ulrich in Ulrich and Scofield, 1897 (subsequent designation by Bassler, 1915, p. 491).

Diagnosis.--"Sublenticular, coeloconoidal, minutely phaneromphalous; deep sinus culminating in short slit that generates a selenizone just above periphery." (Knight et al., 1960, p. 1204).
Discussion.—Ulrich and Scofield (1897, p. 954) wrote, in concluding their description of their new genus Eotomaria: "Type, E. sublaevis n. sp. (Ulrich)." Unfortunately, this was the only mention of Eotomaria sublaevis; nowhere is there a description or illustration. Bassler (1915, p. 491), under Eotomaria, wrote: "Genotype: E. canalifera Ulrich." Bassler's first entry under Eotomaria canalifera Ulrich reads: "Eotomaria canalifera Ulrich, Geol. Minnesota, 3, pt. 2, 1897, p. 1002, pl. 69, figs. 9-14 (E. sublaevis, p. 954, in error)." Knight (1941, p. 112) wrote: "Genotype, by original designation, Eotomaria sublaevis Ulrich, 1897, nomen nudum, lapsus calami for Eotomaria canalifera Ulrich and Scofield, 1897."

Eotomaria sublaevis is certainly a nomen nudum, and it may well have been an inadvertent error; Ulrich and Scofield could have selected a new name for their E. sublaevis, changing it everywhere but on page 954 of their publication. However, as I interpret the Code (ICZN, 1985a), this does not constitute a lapsus calami. That term is mentioned only in Article 32 (c) (ii) (p. 69) and in the Glossary (p. 257), and only in connection with spelling errors. Ulrich and Scofield's (1897, p. 954) designation of Eotomaria sublaevis is simply an invalid designation of type species, as it is based on a nomen nudum. The type species must, therefore, be designated from one of the six species originally included in the genus, and Bassler's (1915, p. 491) designation of Eotomaria canalifera is the earliest such designation I can find.
? Eotomaria sp. cf. E. supracingulata (Billings, 1857)

Plate 9, figs. 11, 30

Diagnosis.—Shell large for genus, height about two-thirds maximum width; early whorls slightly turreted; sides of later whorls almost vertical; periphery sharply rounded; apical angle about 115 degrees; details of apex, umbilicus, aperture, ornamentation unknown.

Material and occurrence.—Eleven specimens may be assigned here with some degree of confidence. All are from outcrop and are in rather poor condition, incomplete and somewhat deformed.

Discussion.—These poorly preserved specimens conform to the generic diagnosis for Eotomaria, but, as they are steinkerns, it is possible that they represent Raphistoma or even Liospira. The turreted appearance of the earlier whorls argues against this, but that effect is known to be more pronounced in steinkerns than in the shells themselves.

The largest specimen is a little larger than the type specimen of E. supracingulata, and has a larger apical angle, but otherwise agrees fairly well with that species. The profiles of the Gunn specimens are closer to that of E. dryope plana Wilson, but that subspecies is a little smaller and has a larger apical angle. Both of these are Middle Ordovician taxa. Few species of Eotomaria have been described from the Cincinnatian, and the Gunn specimens seem more like the two species discussed above than they do to any of the previously described Upper Ordovician species.
Family Lophospiridae Wenz, 1938
Subfamily Lophospirinae Wenz, 1938
Genus Loxoplocus Fischer, 1885

Type species.—Murchisonia tropidophora Whiteaves, 1884 (by monotypy; junior subjective synonym of Murchisonia soluta Whiteaves, 1884, by designation of Whiteaves, 1895, p. 84).

Diagnosis.—"Sinus deep, angular; selenizone or pseudoselenizone convex." (Knight et al., 1960, p. 1208).

Discussion.—Fischer (1885) erected Loxoplocus to accommodate Whiteaves's (1884) Murchisonia tropidophora, not realizing that that species was synonymous with M. soluta. Whiteaves (1895), after studying better-preserved material, concluded that the two species were one, and retained L. soluta as the name. Hence, both names are retained in the type species listing above, as per Recommendation 67B of the Code (ICZN, 1985a, p. 123).

Subgenus Loxoplocus (Lophospira) Whitfield, 1886

Type species.—Murchisonia bicincta Hall, 1847 (subsequent designation by Oehlert, 1888; junior homonym of Murchisonia bicincta M'Coy, 1844, replaced by Murchisonia milleri Hall, 1877).

Diagnosis.—"Turbinate, gradate; whorls mostly contiguous." (Knight et al., 1960, p. 1208).

Discussion.—Whitfield (1886) designated two species as "types" for his new genus Lophospira; Oehlert (1888) rectified that by designating one of the two, Murchisonia bicincta Hall, as the type species. Apparently neither author was aware that M. bicincta Hall,
1847 was a junior homonym of *M. bicincta* M'Coy, 1844, and that Hall (1877) had renamed his species *Murchisonia milleri*.

The subgenera of *Loxoplocus* are referred to as "artificial and intergrading groups" (Knight et al., 1944, p. 449) but their use was retained by Knight et al., (1960). This is obviously a situation that requires attention; I am following the Treatise scheme only for lack of a better classification.

? *Loxoplocus* (Lophospira) sp. cf. *L. (L.) milleri* (Hall, 1877)

Plate 9, fig. 18

[?] *Pleurotomaria bicincta* (Hall) Whiteaves, 1895, p. 122-123;

Dowling, 1900, p. 51f.


Diagnosis.—Shell average-sized for genus; apical angle about 60 degrees; about four whorls on most complete specimen; details of aperture, umbilicus, ornamentation unknown.

Material and occurrence.—About 20 specimens, all from outcrop, may be assigned to this taxon. All are incomplete and somewhat deformed.

Discussion.—Ulrich and Scofield (1897, p. 962, 989, 1046-1047) discussed the difficulties of distinguishing some species of *Lophospira* from species of *Trochonema*, concluding that only the presence or absence of a slit band serves to separate them. My difficulties are exacerbated by having only steinkerns to deal with;
no slit band is in evidence in any specimen. My questionable
assignment of these specimens to *Lophospira* is based on overall
similarity of shape, particularly with respect to the whorl profile.
As I have not seen the specimens (or illustrations thereof) reported
by Whiteaves (1895) and Okulitch (1943), these are only tentatively
placed in synonymy.

The largest specimen is incomplete, but is about 26 mm high and
22 mm wide. The most complete specimen is about 22 mm high and 16 mm
wide. The apical angle, as well as can be determined in these
specimens, is about 60 degrees. There are nine or ten species
described by Ulrich and Scofield (1897), alone, into which these
specimens would fit based on the above measurements. The suggested
comparison with the type species is just that, a suggested comparison.
There is no way of making a species assignment based on the material
at hand.

? *Loxoplocus* (Lophospira) sp.

**Diagnosis.**—Minute steinkerns, medium-spired, with sharp
angulation on whorl periphery; second angulation concealed by
succeeding whorl; external details unknown.

**Material and occurrence.**—Three specimens, two from locality
A2602 and the third from A2603, were collected from near the base of
the Gunn Member in the subsurface of North Dakota. All are phosphatic
steinkerns.

**Discussion.**—These specimens conform to the generic diagnosis of
*Lophospira*, although, as discussed above, the possibility that they
are specimens of Trochonema can not be ruled out. Species-level identification is impossible.

These specimens are not included in the previous taxon because they are an order of magnitude smaller and there is no evidence that they are conspecific.

Superfamily Trochonematacea Zittel, 1895
Family Trochonematidae Zittel, 1895
Genus Trochonema Salter, 1859

Type species.--Pleurotomaria umbilicata Hall, 1847 (by original designation).

Diagnosis.--"Turbiniform to aciculate, with a major spiral angulation having channel within; later whorls disjunct in some forms." (Knight et al., 1960, p. 1225).

Subgenus Trochonema (Trochonema)

Diagnosis.--"Turbiniform; narrowly phaneromphalous; with 4 spiral angulations; sutures channeled." (Knight et al., 1960, p. 1225).

Discussion.--Knight et al. (1944, p. 451) referred to the subgenera of Trochonema as "artificial and intergrading groups," but the classification was retained by Knight et al. (1960, p. 1225).

Trochonema (Trochonema) sp. cf. T. (T.) umbilicata lata
Ulrich and Scofield, 1897
Plate 9, figs. 25, 29

[?] Trochonema umbilicatum Hall Whiteaves, 1895, p. 124; Dowling, 1900, p. 51F; Bassler, 1915, p. 1304 (partim).

[?] Trochonemopsis umbilicatum (Hall) Baillie, 1952, p. 33.
Diagnosis.—Large for genus, exceptionally low-spired; height slightly more than half of width; details of aperture and ornamentation unknown.

Material and occurrence.—About 25 specimens have been collected, all from outcrop. All are incomplete steinkerns, and most are not very well preserved.

Discussion.—These specimens are exceptionally low-spired for *Trochonema*, yet the four distinct carinae on the whorl profile in the best-preserved specimens mark them as belonging to that genus. *Raphistoma*, which may have a similar shape, commonly has only two carinae. It is, of course, possible that some of the more poorly preserved specimens may belong in that genus, but there is no indisputable evidence to support such an assignment.

In both size and shape these specimens closely resemble *Trochonema (Trochonema) umbilicata lata* Ulrich and Scofield, 1897 (p. 1048, pl. 77, figs. 7, 8). The Gunn specimens differ from that subspecies by being slightly lower spired and perhaps in expanding a bit more abruptly. Otherwise, they are closely matched, as far as can be determined from comparing steinkerns with complete body fossils.

I have no idea why Baillie (1952, p. 33) reassigned the type species of *Trochonema* to the later-named *Trochonemopsis*. This may be done only if the earlier genus name is found to be a junior homonym. I am not aware of any such finding.
Trochonema (Trochonema) sp.
Plate 9, fig. 21

**Diagnosis.**—Medium-sized steinkerns having at least three carinae on whorls; details of apex, aperture, umbilicus, ornamentation unknown.

**Material and occurrence.**—Eight poorly preserved specimens are assigned to this taxon. One is from subsurface locality A2602, just below the middle of the Gunn Member, and the rest are from outcrop. All are incomplete; none is well enough preserved to justify even suggesting a species comparison.

**Discussion.**—The discussion above under Lophospira regarding the difficulty of distinguishing that genus from Trochonema is pertinent here also. However, the eight specimens grouped here seem more at home in Trochonema.

Suborder TROCHINA Cox and Knight, 1960
Superfamily Platyceratacea Hall, 1859
Family Platyceratidae Hall, 1859
Genus Cyclonema Hall, 1852

**Type species.**—Pleurotomaria bilix Conrad, 1842 (by original designation).

**Diagnosis.**—"Turbiniform to trochiform, anomphalous, aperture polygonal to auriform, columellar lip lunate and excavated, ornament of three orders of spiral lines cancelled by collabral lirae which thicken into growth wrinkles." (Thompson, 1970, p. 235).

**Discussion.**—Thompson (1970, p. 233-234) discussed the subgenera (Dyeria and Ploconema) assigned to Cyclonema by Bowsher (1955), an
assignment maintained by Knight et al. (1960, p. 1240). Based on her study, Thompson rejected both Dyeria and Ploconema as subgenera of Cyclonema, and regarded that genus as being without subgenera. Her practice is followed here.

*Cyclonema* sp. cf. *C. bilix* (Conrad, 1842)

Plate 9, fig. 9

*Cyclora minuta* Hall Whiteaves, 1895, p. 124; Dowling, 1900, p. 52F; Bassler, 1915, p. 335 (partim); Baillie, 1952, p. 33.

**Diagnosis.**—Trochiform to somewhat turbiniform steinkerns; whorl profile concave to almost straight on upper surface, periphery broadly to sharply rounded; details of aperture, ornamentation unknown.

**Material and occurrence.**—About 50 specimens have been collected from outcrop. One specimen was collected from subsurface locality A2602, near the top of the Gunn Member. Preservation is almost universally poor.

**Discussion.**—The largest of the Gunn specimens are comparable in size and shape to specimens of *Cyclonema bilix* illustrated by Thompson (1970, pl. 31, figs. 1-18). In her description of *C. bilix bilix*, Thompson (1970, p. 237, 239) documented the "highly variable" type species of Cyclonema. In particular, the shell shape is "an unreliable character" (p. 239). Thus, minor differences between the Gunn specimens and those from the Cincinnati area are probably not diagnostically significant.

A number of the Gunn specimens appear to be juveniles, some as small as 5 mm high. It was probably a juvenile that Whiteaves (1895, p. 124) listed as "*Cyclora minuta."
? Cyclonema sp.

Plate 9, fig. 22

Diagnosis.—Minute steinkerns of two or three whorls; whorl profile rounded; third whorl expanding abruptly; anomphalous or with narrow umbilicus; height about two-thirds width; details of aperture, ornamentation unknown.

Material and occurrence.—About 100 specimens, all phosphatic steinkerns, have been collected from the lower half of the Gunn Member in the subsurface of North Dakota. One each is from localities A2600 and A2616, four from A2603, and the rest from A2602.

Discussion.—These are specimens that, in other studies, would be referred to Cyclora minuta. Hall (1845) established Cyclora to accommodate tiny steinkerns of this morphology. Ulrich and Scofield (1897, p. 847) wrote of Cyclora: "the species of which again may be but dwarfed forms of Holopea or Cyclonema and Lophospira, . . . ." Knight (1941, p. 90), apparently rejected the idea of dwarf species of Cyclora and similar genera. He examined "Hall's several hundred syntypes" and wrote:

Having had some experience with nepionic gastropods I am convinced that all [of] Hall's specimens are steinkerns of embryos of some one or possibly more species that may be known as adults under different specific and generic names. Since it is often difficult to assign embryonic shells definitely to a known adult form even when well preserved and since Hall's specimens are mere steinkerns it is impossible to tell with what adult form or forms they should be associated. However, it seems likely that Hall's specimens are simply the young of some species of Cyclonema abundant in the same horizon at Cincinnati.

Thompson (1970, p. 227-228) also discussed the possible relationship between Cyclora and Cyclonema. She noted (p. 227) that
Cyclora minuta "resembles the protoconchs of Cyclonema" and that an acetate peel of Cyclora minuta "compares well with axial thin sections of Cyclonema preserving an apex."

In view of the above arguments, I am assigning the Gunn material, tentatively, to Cyclonema. I do not wish to perpetuate nomenclatorial confusion by assigning the material to what is, essentially, a form genus and species.

Suborder MURCHISONIINA Cox and Knight, 1960
Superfamily Murchisoniacea Koken, 1896
Family Murchisoniidae Koken, 1896
Genus Murchisonia d'Archiac and deVerneuil, 1841

Type species.—Muricites turbinatus Schlotheim, 1820 (subsequent designation by Woodward, 1856; junior homonym of Muricites turbinatus Brocchi, 1814; renamed Turritella bilineata von Dechen, 1832).

Diagnosis.—"With labral sinus culminating at about middle of labrum in shallow slit or notch; commonly without ornament other than margins of selenizone and growth lines." (Knight et al., 1960, p. 1291).

Discussion.—Knight (1941, p. 202) gave an interesting account of the confusion regarding the correct designation of a type species for this genus.

Subgenus Murchisonia (Hormotoma) Salter, 1859

Type species.—Murchisonia gracilis Hall, 1847 (subsequent designation by Donald, 1885).
Diagnosis. — "Whorls rounded, with relatively deep sutures, mid-whorl periphery with slit and selenizone." (Knight et al., 1960, p. 1291).

? *Murchisonia* (Hormotoma) sp. cf. *M. (H.) gracilis* (Hall, 1847)

Plate 9, figs. 6-8

*Murchisonia gracilis* ? Hall Whiteaves, 1880, p. 50C.


*Hormotoma gracilis* (Hall) Dowling, 1900, p. 52F; Bassler, 1915, p. 645 (partim); Okulitch, 1943, p. 61; Baillie, 1952, p. 33.

Diagnosis. — Shell small for genus; apical angle 15 to 25 degrees; at least seven whorls present; details of apex, ornamentation unknown.

Material and occurrence. — About 40 specimens have been collected from outcrop. All are steinkerns; none preserves the apex.

Discussion. — The lack of an apex precludes even an attempt at species identification; the comparison suggested above is just that. *M. (H.) gracilis* is reported as having 10 to 14 whorls, many of them bead-like near the apex. Without apices, it is not possible to determine the number of whorls or true height of these specimens; restoration of incomplete specimens based on the apical angle suggests that as much as a centimetre may be missing from some of the larger specimens.
? Murchisonia (Hormotoma) sp. cf. M. (H.) salteri
Ulrich and Scofield, 1897
Plate 9, figs. 34

Diagnosis.—Shell average-sized for genus; height at least 40 mm, with at least eight whorls; width, apical angle, aperture, ornamentation unknown.

Material and occurrence.—One specimen was collected from subsurface locality A2602, near the top of the Gunn Member. This specimen was cut longitudinally by the coring bit and is exposed in the sidewall of a core.

Discussion.—This specimen does not seem to be conspecific with any of the outcrop specimens of ?Murchisonia (Hormotoma). It is too large to be included in ?M. (H.) gracilis, and its whorls are too delicate for it to be included in either of the next two species. In both size and shape it seems closest to ?M. (H.) salteri.

? Murchisonia (Hormotoma) sp. cf. M. (H.) bellicincta (Hall, 1847)
Plate 9, figs. 4, 5

Diagnosis.—Shell small for genus; apical angle exceptionally large for genus, about 50 degrees; details of apex and ornamentation unknown.

Material and occurrence.—The single specimen, a fairly well-preserved steinkern, was collected from outcrop.

Discussion.—M. (H.) bellicincta has the largest apical angle of any species of Murchisonia (Hormotoma). The size and apical angle of this specimen fall well within the range for M. (H.) bellicincta.
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? Murchisonia (Hormotoma) sp. cf. M. (H.) trentonensis

Ulrich and Scofield, 1897

Murchisonia bellicincta Hall Whiteaves, 1895, p. 123.

Hormotoma bellicincta (Hall) Bassler, 1915, p. 644 (partim); Baillie, 1952, p. 33.

Diagnosis.--Shell medium-sized for genus; apical angle about 30 degrees; more loosely coiled than usual for genus; details of apex, aperture, ornamentation unknown.

Material and occurrence.--About 30 specimens have been collected from outcrop. None is well preserved; all are incomplete and some are distorted.

Discussion.--Ulrich and Scofield (1897, p. 1017), in their discussion of Hormotoma bellicincta, stated that Hall (1847, pl. 39, fig. 1) had illustrated at least two species under his H. bellicincta. They retained the smaller specimens in Hall's original species, and erected Hormotoma trentonensis to accommodate the larger, and more common, forms illustrated by Hall. The larger form is certainly more common in the outcrop of the Gunn Member, and I think it likely that it was M. (H.) cf. M. (H.) trentonensis that constituted Whiteaves's (1895, p. 123) "several very imperfect specimens."

These specimens are close to M. (H.) trentonensis, but the match is not perfect. The height agrees well, as does the style of coiling. But the apical angle is a little smaller in the Gunn specimens, and the width a little less. The Gunn material probably constitutes an undescribed species.
? Murchisonia (Hormotoma) sp. cf. M. (H.) major Hall, 1851

Plate 9, fig. 37

Diagnosis.—Large for genus; apical angle about 35 degrees; not tightly coiled; aperture poorly preserved, but apertural shape similar to that of M. (H.) major; whorls expand abruptly; details of apex, aperture, and ornamentation unknown.

Material and occurrence.—Three very incomplete specimens, all from outcrop, are assigned here. None is composed of more than two whorls; the earlier whorls are missing in all cases.

Discussion.—This material is so poorly preserved that it is with considerable hesitation that I compare it with any previously described species. However, the material present does compare favorably with Ulrich and Scofield’s (1897, p. 1018-1019) description of "Hormotoma (?) major Hall," so I am tentatively making that comparison.

? Murchisonia (Hormotoma) sp.

Plate 9, fig. 26

Diagnosis.—Forms minute, less than 1 mm high; five or more whorls, somewhat loosely coiled; aperture subcircular, slightly produced at base; second and fourth whorls apparently expand abruptly; details of ornamentation unknown.

Material and occurrence.—All specimens are phosphatic steinkerns from the subsurface of North Dakota, from the lower half of the Gunn Member. One is from locality A2600 and the remaining 17 are from A2602.
Discussion.--Similar tiny high-spired gastropods have been referred to *Hormotoma gracilis* in other studies, but there can be no certainty about such an assignment. These specimens could represent protoconchs or juveniles assignable to a variety of species of *Murchisonia* (*Hormotoma*), or even to another genus. Therefore, I am assigning them only tentatively to *M. (Hormotoma).*

Class PELECYPODA Goldfuss, 1820

Subclass PALAEOTAXODONTA Korobkov, 1954

Order NUCULOIDEA Dall, 1889

Superfamily Nuculacea Gray, 1824

Family Praenuculidae McAlester, 1969

Genus *Palaeoconcha* Miller, 1889

*Type species.*--*Palaeoconcha faberi* Miller, 1889 (by original designation).

*Diagnosis.*--"Rounded, small, anterior and posterior teeth similar in size and number." (McAlester, 1969, p. N229).

? *Palaeoconcha* sp. A

Plate 9, fig. 27

*Diagnosis.*--Form minute, about 1 mm high. Subcircular to subovate; higher than long; beaks low, rounded, centrally located; dentition equal-sized; ornamentation unknown.

*Material and occurrence.*--Two specimens, both phosphatic steinkerns, have been collected from subsurface locality A2602.26, about 5 m above the base of the Gunn Member. These are not as well preserved as many of the microscopic gastropods, except that the impression of the dentition is fairly well preserved in one specimen.
Discussion.--The assignment of these specimens to *Palaeoconcha* is not certain, but there are few Ordovician genera capable of accommodating subcircular species. Harrison and Harrison (1975) assigned some of their specimens to *Deceptrix*, but the equal-sized dentition would seem to rule that out for the Gunn material. *Cardiolaria* is another possibility, but the types are poorly preserved and the anterior teeth are larger than the posterior (McAlester, 1968, p. 19) as is the case in *Deceptrix*.

Minute specimens of *Palaeoconcha* from the Maquoketa Formation have been assigned to *P. obliqua* by Ladd (1929) and Snyder and Bretsky (1971). Minute specimens of *Palaeoconcha* from the Brassfield Formation have been assigned to *P. ohioensis* by Harrison and Harrison (1975). Both these species have fairly acute beaks, somewhat higher than is the case with the Gunn material; both, also, are several times larger. Under these circumstances, I do not wish to suggest a comparison with these species.

? *Palaeoconcha* sp. B

Plate 9, figs. 12, 13

**Diagnosis.**--Shell medium-sized for genus, subtrigonal in dorsal portion, subcircular in ventral half; higher than long; beaks low, rounded, central; details of dentition, musculature, ornamentation unknown.

**Material and occurrence.**--Two specimens were recovered from subsurface locality A2602, about 10 m above the base of the Gunn Member. These are the only macroscopic pelecypods collected from the
subsurface, and are very poorly preserved steinkerns composed of argillaceous carbonate matrix.

**Discussion.** Remarks made above under *Palaeoconcha* sp. A apply here also. I am considering these specimens separately because they are significantly larger than those assigned to the previous taxon and the proportions are a little different. However, proportions of some pelecypod species are known to change as they grow, and it is quite possible that all four specimens here assigned to *Palaeoconcha* are conspecific.

**Genus "Palaeoneilo"**

**Diagnosis.** Outline subcircular to subovate, anterior broadly rounded, posterior produced slightly to significantly, narrowly rounded to almost acuminate; height from about two-thirds length to subequal; ornamentation lacking or of weak to strong growth lines crossed by weak radial lines; posterior teeth more numerous than anterior, but may approach equality; teeth apparently equal-sized, but may diminish beneath umbones; beak located subcentrally or displaced anteriorly by as much as one-fourth length.

**Discussion.** "*Palaeoneilo*" has radial ornamentation, lacking in *Palaeoneilo*, and is less produced posteriorly than *Palaeoneilo*. Also, the beaks in *Palaeoneilo* are generally closer to the anterior margin; as a consequence, posterior teeth greatly outnumber anterior teeth in that genus.

Hall (1862, p. 55) illustrated, but did not describe, a species he called *Nucula* (*Tellinomya*) *fecunda*, from Upper Ordovician
strata in Wisconsin. Apparently no one cited this species until Ulrich (1897, p. 595-596, pl. 42, figs. 67-73) described and illustrated it, reassigning it to Ctenodonta. In the meantime, Hall (1870) had named both *Palaeoneilo* and a new species, *Palaeoneilo fecunda*, from the Middle Devonian of New York.

The earliest assignment of *Ctenodonta fecunda* (Hall) to *Palaeoneilo* that I can find is that of Snyder and Bretsky (1971), who tentatively assigned their specimens to *Palaeoneilo* but suggested (p. 237) that their *Palaeoneilo? fecunda* belonged to an undescribed genus and should be "classified as nomen inquirendum." Pojeta (1971) and Harrison and Harrison (1975), however, dropped the interrogation mark and referred their specimens to *Palaeoneilo fecunda* without question (presumably not Hall's Middle Devonian species).

I am doubtful whether there is any basis for assuming the existence of *Palaeoneilo* prior to the Middle Devonian. I find only two lines of evidence supporting a pre-Devonian extension of the range of *Palaeoneilo*. First, there is the questionable assignment of *Ctenodonta fecunda* to the genus, discussed above. Second, there is McAlester's (1969, p. N233) placement of the Late Ordovician genus *Synek*, from Central Europe, in synonymy with *Palaeoneilo*. According to McAlester (1968, p. 54) *Synek* was founded on three steinkerns. McAlester reported that, except for a series of "faint impressions along the hinge line which may have been made by a series of small taxodont teeth," the dentition, hinge features, and ligament were unknown. The details of surface ornamentation ("very fine concentric ridges and very fine radial ridges on the posterior region") conform
to those of "Palaeoneilo" as I have given them above; they are not those of Palaeoneilo, which is commonly strongly ribbed but apparently lacks radial ornamentation. Thus, it would seem that the evidence supporting the synonymy of Synek with Palaeoneilo is hardly overwhelming.

Pojeta (1971, pl. 5, figs. 7-22) reassigned several of Ulrich's (1897) species of Ctenodonta (but not C. fecunda), along with Hall's (1847) Nucula laevata, to Deceptrix. This does not seem entirely satisfactory either. Deceptrix, as defined in the Treatise (McAlester, 1969, p. N229) and as exemplified by the type species, D. carinata (as described by McAlester, 1968, p. 25-26) has anterior teeth that are both significantly fewer and larger than the posterior teeth. The specimens illustrated by Pojeta (1971) have the anterior and posterior teeth approximately equal in size and number. The species assigned to Deceptrix by Pojeta (1971) conform more or less to Ulrich's (1897, p. 581) "C. laevata group," and would, in my opinion, form a reasonable basis for the erection of a new genus. Therefore, I must agree with Snyder and Bretsky (1971), who suggested that a new genus was necessary.

"Palaeoneilo" differs from Ctenodonta in being substantially smaller and in having the beak much closer to the anterior margin. Synek is based on material that is so poorly preserved that the genus is not recognizable.
"Palaeoneilo" sp. A
Plate 10, figs. 5, 6

Diagnosis.--Minute, ovate, beaks subcentral but offset anteriorly; teeth about equal in size, slightly more numerous posterior to beak than anterior to it; umbones somewhat inflated; details of musculature and ornamentation unknown.

Material and occurrence.--The only specimen is a phosphatic steinkern, fairly well preserved, from subsurface locality A2602.

Discussion.--The generic assignment of this specimen was discussed above. This, and the next taxon, represent specimens that other workers might assign to *Palaeoneilo fecunda*. These fossils, however, are much smaller than Ulrich's *Ctenodonta fecunda*, and preserve nothing of the muscle scars and surface details. Therefore, I do not wish to suggest such a comparison.

"Palaeoneilo" sp. B
Plate 10, fig. 1

Diagnosis.--Subovate; posterior portion somewhat produced, narrowly rounded; anterior margin broadly rounded; beak about one-third from anterior margin to posterior; details of dentition, musculature, ornamentation unknown.

Material and occurrence.--A single specimen was collected from subsurface locality A2602.

Discussion.--The concept of "*Palaeoneilo*" is certainly broad enough to accommodate this taxon also. The specimen under consideration seems to differ significantly from "*Palaeoneilo*" sp. A
in its proportions. Harrison and Harrison (1975, p. 213) said of their *Palaeoneilo fecunda*, "Anterior and posterior length is nearly equal in smallest shells, but become markedly unequal as size increases." Here, the smaller of the two specimens assigned to "Palaeoneilo" is the more unequal in its proportions. Consequently, I think it is unlikely that they are conspecific.

Subclass PTERIOMORPHA Beurlen, 1944
Order ARCOIDA Stoliczka, 1871
Superfamily Cyrtodontacea Ulrich, 1894
Family Cyrtodontidae Ulrich, 1894
Genus Matheria Billings, 1858

*Type species.*—*Matheria tenera* Billings, 1858 (by monotypy).

*Diagnosis.*—"Oblong quadrate or suboval; beaks small, anterior; surface with concentric growth lines; LV with 2 small, divergent cardinal teeth beneath beak; RV with 1 cardinal tooth, no lamellar teeth; ligament external; pallial line simple, obscurely defined." (LaRocque, 1969, p. N249).

*Discussion.*—LaRocque (1969, p. N249) stated that *Matheria tenera* is the type species of *Matheria* by original designation ("OD"). I can find no such designation in Billings (1858, p. 188-189); hence, I must regard *M. tenera* as being the type species by monotypy.

The correct suprageneric assignment of *Matheria* is apparently a rather difficult problem. It is listed in the Treatise under both the Cyrtodontidae (LaRocque, 1969, p. N249) and the Astartidae (Chavan, 1969, p. N566). The latter assignment is the one maintained by Vokes (1980, p. 122). *Matheria* would thus be the only known pre-Devonian
genus of the Astartidae. If this assignment were to be accepted, it would mean that this obscure, uncommon genus, known only from eastern and central North America, persisted from the Middle Ordovician into the Devonian and then gave rise to the rest of the Astartidae. Ulrich (1897, p. 486, 563) seemed to have little difficulty accommodating Matheria within the Cyrtodontidae, and it seems to me that until the early record of these families and their genera are better known, it would be best to retain that assignment.

? Matheria sp.

Plate 9, fig. 16

Diagnosis.—Average-sized for genus; subquadrate; beaks anterior; other details unknown.

Material and occurrence.—One specimen, a very poorly preserved and incomplete steinkern, was collected from outcrop.

Discussion.—This poorly preserved specimen is only very tentatively assigned to Matheria. Nevertheless, it is about of a size with previously reported species, and has a very similar outline. Steinkerns of some species of Modiolopsis may have a similar appearance (e.g., Ulrich's, 1890, p. 273, fig. 2a, illustration of a steinkern of M. subelliptica). The Gunn specimen, however, seems to have the beaks placed more anteriorly than those of Modiolopsis.

Whiteaves (1895, p. 122), under "Plethocardia (sp. nov. ?)" reported, "Like P. suberecta, Ulrich, but anterior side too imperfect for certainty. On the other hand, the general aspect is decidedly like that of Whitella megambona, Whitfield, sp.' Ulrich, in letter
dated April 4, 1894." Both Plethocardia suberecta and Whitella
degambona are weakly subquadrate, but otherwise have little in common
with Matheria. Ulrich, who was familiar with all three genera, was
undoubtedly able to distinguish among them. I must, therefore,
conclude that my specimen is not conspecific with the one that
Whiteaves and Ulrich saw, and that I have no examples of their
species.

Order PTEROIDA Newell, 1965
Suborder PTERIINA Newell, 1965
Superfamily Ambonychiacea Miller, 1877
Family Ambonychiidae Miller, 1877
Genus Ambonychia Hall, 1847

Type pseices.—Ambonychia radiata Hall, 1847 (subsequent
designation by Stoliczka, 1871).

Diagnosis.—"Prosocline to slightly opisthocline, orbicular to
ovoid shells without anterior lobation; ornamented equally on both
valves by simple radial costae; byssal gape generally prominent below
beaks; dentition pseudoheterodont, composed of 2 or 3 small radial
cardinal teeth in each valve below beaks and few posterior lateral
elements located at posterior extremity of hinge margin." (Newell and

Discussion.—Most of the species now assignable to Ambonychia
resided comfortably in Byssonychia Ulrich for almost three-quarters of
a century. The belated discovery that Stoliczka (1871) had designated
A. radiata the type species of Ambonychia, as Ulrich (1893) had done
for Byssonychia, necessitated placing the two genera in synonymy and
revising the concept of Ambonychia (Pojeta, 1966, p. 160-161).

Ambonychia sp. aff. A. obesa (Ulrich, 1893)

Plate 10, figs. 3, 4

Byssonychia obesa Ulrich Whiteaves, 1895, p. 122; Dowling, 1900, p. 51F; Bassler, 1915, p. 146 (partim); Baillie, 1952, p. 33.

Diagnosis.—Shell medium-sized for genus; more than 40 costae; umbones rounded; angle gamma (sensu Pojeta, 1962, p. 172-173) about 80 degrees; details of byssal gape, ligament areas, muscle scars, dentition unknown.

Material and occurrence.—Three incomplete specimens were collected from outcrop. All are very poorly preserved steinkerns and are missing parts of the anterior or posterior.

Discussion.—The incompleteness and poor preservation of this material prevent a definite species assignment. Following Pojeta's (1962, p. 199) taxonomic key to the species of Ambonychia found in the Cincinnati region, it seems that A. obesa would best accommodate these specimens. However, the specimens are not well enough preserved to obtain a complete count of the costae. If the Gunn species should prove to have 50 or more costae, it might be referred to A. anticostiana or A. radiata; if, in addition, it had the inflated valves characteristic of A. obesa, it might prove to be an undescribed species. I think it best to suggest the affinity of this form to A. obesa pending the finding and description of more complete material.
Discussion.--This specimen is only very tentatively assigned to Lyrodesma. The antero-dorsal margin appears almost truncate -- perhaps the specimen has been partly weathered away. It is possible that this specimen represents an undescribed genus, but the condition of the material would render such a taxonomic decision irresponsible.

Class ROSTROCONCHIA

Pojeta, Runnegar, Morris, and Newell, 1972

Order RIBEIROIDA Kobayashi, 1933

Family Ribeiriidae Kobayashi, 1933

Genus Pinnocaris Etheridge, 1878

Type species.--Pinnocaris lapworthi Etheridge, 1878 (by monotypy).

Diagnosis.--"Posteriorly elongated compressed ribeiriids with anterior clefts and with posterior end drawn out into a rostrum."
(Pojeta and Runnegar, 1976, p. 54).

? Pinnocaris sp.

Plate 10, fig. 9

Diagnosis.--About 15 to 20 mm long, to 10 mm high; ornamentation of concentric lines parallel to shell margin, about 0.3 mm apart ventrally, becoming closer spaced dorsally; ventral margin almost straight.

Material and occurrence.--Two poorly preserved and incomplete specimens, one each from locality A2614.22, about 3 m above the base of the Gunn Member, and from A2618.4, about 10 m above the base, have been collected. These specimens consist of exterior molds.
Discussion.—The poor preservation of these specimens permits only the most tentative generic assignment. If they are indeed rostroconchs, their lack of radial ornamentation dictates their assignment to the Ribeiriidae. The possibility cannot be excluded, however, that they belong to some group other than rostroconchs (e.g., phyllocarids).

Class CEPHALOPODA Cuvier, 1797
Subclass ACTINOCERATOIDEA Teichert, 1933
Order ACTINOCERIDA Teichert, 1933
Family Actinoceratidae Saemann, 1853
Genus Actinoceras Bronn, 1835

Type species.—Actinoceras bigsbyi Bronn, 1835 (by monotypy).

Diagnosis.—"Large, straight, somewhat fusiform shells, with tendency to decrease in diameter from anterior part of phragmocone toward aperture; cross section subcircular to circular. Siphuncle large, generally somewhat off center, tending to decrease in diameter toward adult portion of phragmocone; septal necks long, brims relatively short; narrow endosiphuncular canal in mature stage with simple radial canals. Cameral deposits common, generally of episeptal and hyposeptal type; circulus present in few species." (Teichert, 1964a, p. K204).
? Actinoceras sp.

Plate 10, fig. 14

Diagnosis.--Siphuncle circular to subcircular; endosiphuncular canal enlarges anteriorly; other structural details obscured; conch unknown.

Material and occurrence.--Two siphuncle fragments have been collected from outcrop. The largest of these consists of 15 segments and is about 185 mm long, and expands anteriorly from 47 to 52 mm in diameter. Both specimens are heavily recrystallized.

Discussion.--As with all the cephalopods from the Gunn member, recrystallization, weathering, fragmentation, and generally poor to abominable preservation, precludes specific, and even confident generic, assignment.

Actinoceras has not been reported previously from the Gunn Member, although it has been reported from the overlying Penitentiary Member and the similar-appearing Armenoceras has been reported from the Gunn (Baillie, 1952, p. 33). The specimens assigned here appear to have the long septal necks characteristic of Actinoceras that serve to distinguish siphuncles of that genus from those of Armenoceras.

Genus Kochoceras Troedsson, 1926

Type species.--Kochoceras cuneiforme Troedsson, 1926 (by original designation).

Diagnosis.--"Similar to Actinoceras but shell ventrally flattened. Siphuncle marginal, in broad contact with ventral area of shell wall." (Teichert, 1964a, p. K206).
Diagnosis.--Siphuncle elliptical in cross section; endosiphonal canal moderately large; conch unknown.

Material and occurrence.--Eight of these depressed siphuncle fragments have been collected from outcrop. The largest of these has eight segments and is about 90 mm long and 30 by 50 mm in diameter. One specimen retains a small portion of the phragmocone.

Discussion.--This constitutes the first report of Kochoceras from the Gunn Member. It is not impossible that these specimens have been secondarily compressed, but only one specimen shows evidence of crushing.

Family Huroniidae Foerste and Teichert, 1930

Genus Huronia Stokes, 1824

Type species.--Huronia bigsbyi Stokes, 1824 (subsequent designation by Bassler, 1915, p. 651).

Diagnosis.--"Shell poorly known. Siphuncle very large, straight; segments long, with long cylindrical posterior part formed by long adnation area; free part of connecting ring short, slightly inflated; septal necks short, brims short and pointing forward and outward; central canal narrow, radial canals in anterior portion of segment, strongly curved." (Teichert, 1964a, p. K210).

Discussion.--Small for genus; sutures with broad lobes and sharper saddles; other details unknown.
Material and occurrence.--Two badly weathered fragments, of two
and three camerae, were collected from outcrop.

Discussion.--These specimens are tentatively assigned to Huronia
on the basis of their segment morphology, which approaches the fairly
distinctive form found in that genus.

Subclass NAUTILOIDEA Agassiz, 1847

Order ORTHOCERIDA Kuhn, 1940

Superfamily Orthocerataceae M'Coy, 1844

Family Orthoceratidae M'Coy, 1844

Subfamily Michelinoceratinae Flower, 1945

Genus Pleurorthoceras Flower, 1962

Type species.--Orthoceras selkirkense Whiteaves, 1892 (by
original designation of Shimuzu and Obata, 1936, p. 21, for
Foersteoceras Shimuzu and Obata, 1936, non Foersteoceras Ruedemann,
1925).

Diagnosis.--"Long, slender, subcylindrical orthocones of circular
section and with long camerae and very long body chamber. Siphuncle
central or eccentric by no more than its own diameter, empty. . . .
[S]iphuncle suborthochoanitic, with somewhat inflated segments.
drawn in part from description of Michelinoceras).

Discussion.--Shimuzu and Obata (1936) erected Foersteoceras "for
shells with annuli and an essentially tubular siphuncle." (Flower,
1962, p. 36). They designated Orthoceras selkirkense Whiteaves the
type species. Unfortunately, Foersteoceras Shimuzu and Obata, 1936 is
a junior homonym of *Foersteoceras* Ruedemann, 1925, a fact first noted by Teichert (1940, p. 592).

Flower (1962, p. 35) erected *Pleurorthoceras* and selected *Orthoceras clarkesvillense* Foerste as the type species. Flower (1962, p. 36) included *Orthoceras selkirkense* Whiteaves, the type species of Shimuzu and Obata's *Foersteoceras*, in his *Pleurorthoceras*. Although Flower wrote "n. gen." after his listing of *Pleurorthoceras*, his inclusion of Shimuzu and Obata's type species renders *Pleurorthoceras* merely a new name, or a junior synonym (and senior available name), rather than a new genus. Flower's calling his *Pleurorthoceras* a new genus does not make it one. This situation was recognized in the Treatise (Sweet, 1964a, p. K226) whose entry under *Pleurorthoceras* reads, in part, "nom. subst. pro *Foersteoceras* Shimuzu and Obata, 1936; non Ruedemann, 1925."

I concur with Sweet that Flower's name was a replacement for that of Shimuzu and Obata. Therefore, I am regarding *Orthoceras selkirkense* Whiteaves, validly designated by Shimuzu and Obata (1936, p. 21) the type species for *Foersteoceras* Shimuzu and Obata, as the type species of *Pleurorthoceras* Flower.

? *Pleurorthoceras* sp. cf. *P. selkirkense* (Whiteaves, 1892)

Plate 10, fig. 2

[?] *Orthoceras Selkirkense* Whiteaves, 1895, p. 125; Dowling, 1900, p. 52F.

[?] *Cycloceras selkirkense* (Whiteaves) Baillie, 1952, p. 33.
Diagnosis.—Shell small, expanding anteriorly; camerae long, length almost equal to thickness; sutures with broad, shallow lobes and saddles; details of body chamber, apex, ornamentation unknown.

Material and occurrence.—Two specimens, one of two camerae and the other of four and a half camerae, have been collected from outcrop. These specimens are internal molds and fine detail has been lost.

Discussion.—These specimens seem to be both smaller and more abruptly expanding than is typical of P. selkirkense. It may be that the Gunn specimens came from near the apex of the animal; it may also be that they are different species. The material at hand is insufficient to determine these questions.

Superfamily Pseudorthocerataceae Flower and Caster, 1935

Family Proteoceratidae Flower, 1962

Genus Ephippiorthoceras Foerste, 1924

Type species.—Orthoceras formosum Billings, 1857 (by original designation).

Diagnosis.—"Uncompressed to slightly compressed orthocones with inconspicuous ornament of transverse or longitudinal lirae, or both, or rather coarse oblique plications. Sutures forming broad lateral lobes and dorsal and ventral saddles; camerae of moderate length. Siphuncle subcentral to subventral, cyrtochoanitic; segments moderately to considerably expanded, occupied in at least some species by circumferentially continuous parietal deposits originating in septal foramina and extending adorally along connecting rings.
Camere of some species with episeptal and mural deposits that are heavier ventrally than dorsally." (Sweet, 1964a, p. K256).

? Ephippiorthoceras sp.
Plate 10, fig. 10

**Diagnosis.**—Moderate-sized for genus, somewhat compressed; sutures with broad, shallow lobes and sharper saddles; details of apex, siphuncle, ornamentation unknown.

**Material and occurrence.**—One specimen, an internal mold of five camerae, was collected from outcrop.

**Discussion.**—This specimen is tentatively assigned to Ephippiorthoceras largely on the basis of its size and nautiloid sutures. Most other Late Ordovician orthocerids are either much larger, have straight transverse sutures, or both.

Genus Gorbyoceras Shimuzu and Obata, 1935

**Type species.**—Orthoceras gorbyi Miller, 1894 (by original designation).

**Diagnosis.**—"Annulated orthocones with longitudinal markings. Siphuncle subcentral, cyrtochoanitic; segments weakly to broadly expanded with small endosiphuncular annuli in septal foramina in early parts of phragmocone. Mural cameral deposits developed much farther anteriorly than endosiphuncular deposits." (Sweet, 1964a, p. K256).

? Gorbyoceras sp.
Plate 10, fig. 12

**Diagnosis.**—Shell average-sized for genus; sutures straight, transverse; other details unknown.
Material and occurrence.--Two poorly preserved internal molds, of two and four camerae, have been collected from outcrop.

Discussion.--The poor condition of the material precludes definite generic or specific assignment. Of the few annulated Late Ordovician genera, the Gunn specimens seem to fit best into Gorbyoceras.

Order ASCOCERIDA Kuhn, 1949

Family Ascoceratidae Barrande, 1867

Subfamily Ascoceratinae Barrande, 1867

Genus Billingsites Hyatt, 1884

Type species.--Ascoceras canadense Billings, 1857 (by original designation).

Diagnosis.--"Ascoceroid stage strongly inflated, depressed, with short, slightly contracted neck; fully mature aperture unknown; shell surface smooth or with moderate transverse sculpture; basal septum absent, ascoceroid septa generally entire, but possible weakly lacunose; 6 ascoceroid septa present in extreme forms, but 3 common at maturity; siphuncle expanded adorally. Deciduous portion unknown."


? Billingsites sp.

Plate 10, fig. 8

Ascoceras Newberryi Billings Whiteaves, 1880, p. 50C.

Ascoceras (species indeterminable) Whiteaves, 1895, p. 125; Dowling, 1900, p. 52F.

Diagnosis.--Small for genus; two ascoceroid septa visible in best-preserved specimen; other details unknown.

Material and occurrence.--Three very incomplete and poorly preserved internal molds have been collected from outcrop.

Discussion.--The poor condition of this material makes it difficult to see any features. It certainly appears that a basal suture is lacking, but that could be due to the poor preservation. If a basal septum had been found to be present, this material should be assigned to Schuchertoceras.

Ascoceras newberryi is tentatively included in the synonymy above. It, too, is a small species, although now assigned to Schuchertoceras. It seems unlikely that the Gunn material seen by Whiteaves was well enough preserved to assign definitely to a species, and the material assigned here is the only ascoceroid material I have seen from outcrop.

Subfamily Probillingsitinae Flower, 1941

Genus Probillingsites Foerste, 1928

Type species.--Probillingsites welleri Foerste, 1928 (by original designation).

Diagnosis.--"Mature portion obese, subcircular in cross section but flattened ventrally, with as many as five camerae; siphuncular segments constricted at septal foramina to less than half maximum diameter; connecting rings adnate above and below septa; first siphuncular segment with almost straight dorsal margin in section, its length approximating that of other adoral segments combined." (Furnish and Glenister, 1964, p. K276).
? Probillingsites sp.
Plate 10, fig. 13

Diagnosis.—Large for genus; four camerae present; other details unknown.

Material and occurrence.—The single specimen was recovered from subsurface locality A2619.11, about 2 m above the base of the Gunn Member. It is embedded in matrix and has been cut by the coring bit; the exterior is not visible.

Discussion.—The portion of the specimen exposed in core is 57 mm long and 59 mm high, but there is no determining how much has been lost. I know of no species of Probillingsites having as great a thickness or height, but this seems the most appropriate genus for this specimen.

Order ONCOCERIDA Flower in Flower and Kunnelly, 1950
Family Oncoceratidae Hyatt, 1884
Genus Digenuoceras Foerste, 1935

Type species.—Oxygonioceras (?) latum Foerste, 1929 (by original designation).

Diagnosis.—"Conch . . . compressed, both venter and dorsum acutely angular in transverse section. Siphuncle cyrtochoanitic; segments subfusiform, probably empty." (Sweet, 1964b, p. K284).

? Digenuoceras sp.
Plate 11, fig. 18

Diagnosis.—Small for genus; dorsal margin angular, ventral margin sharply rounded to angular; other details unknown.
Material and occurrence.--Six fragmentary specimens have been collected from outcrop. The largest of these has seven camerae and part of the body chamber. All are internal molds, but the siphuncle is preserved in one specimen.

Discussion.--Most species assigned to **Digenuoceras** are appreciably larger than the Gunn specimens, but no other Ordovician genus seems to be able to accommodate cyrticones that are as strongly compressed as these.

Order **DISCOSORIDA** Flower in Flower and Kummel, 1950

Family **Cyrtogomphoceratidae** Flower, 1940

Genus **Cyrtogomphoceras** Foerste, 1924

**Type species.**—**Oncoceras magnum** Whiteaves, 1890 (by original designation).

**Diagnosis.**—"Large endogastric brevicones, fusiform in profile, expanding rapidly, gibbous over anterior end of phragmocone or base of body chamber, which contracts conically; aperture with ventral hyponomic sinus; cross section of conch generally strongly compressed, though circular in some forms; sutures with faint lateral lobes, sloping increasingly forward on dorsum in later growth stages; siphuncle large, slightly removed from venter, short segments broadly expanded; septal necks short, with strongly recurved brims; connecting rings thickened, bullettes swollen, but generally poorly seen; cameral deposits absent." (Teichert, 1964b, p. K328).
? Cyrtogomphoceras sp. cf. C. magnum (Whiteaves, 1890)

Plate 11, figs. 15, 20

**Diagnosis.**--Large for genus; apparently compressed fairly strongly; other details unknown.

**Material and occurrence.**--One specimen, a portion of an internal mold exceeding 120 mm in length and containing ten camerae along with, perhaps, a small portion of the body chamber, was collected from outcrop. A second specimen, also from outcrop, is the internal mold of a body chamber.

**Discussion.**--The larger specimen is compared to C. magnum as it is about the same size and seems to show about the same degree of curvature. The second specimen, the body chamber, may not be conspecific; it seems to have belonged to a somewhat smaller specimen.

It is possible that the larger specimen belonged to a large coiled nautiloid; Wilsonoceras has been reported from the Gunn Member (Foerste, 1929, p. 147). However, the sutures seem to be those of Cyrtogomphoceras rather than those of Wilsonoceras.

**Family Westonoceratidae Teichert, 1933**

**Genus Westonoceras Foerste, 1924**

**Type species.**--Cyrtoceras manitobense Whiteaves, 1890 (by original designation).

**Diagnosis.**--"Compressed, humped exogastric cyrtocones; early part of conch slender, gently exogastric to straight, rapidly expanding, convexity of ventral profile increasing; greatest gibbosity along anterior part of phragmocone and posterior part of body chamber; in cross section dorsum broadly rounded, venter narrow; sutures with
lateral lobes; siphuncle close to ventral wall, segments strongly
expanded, box-shaped; septal necks strongly recumbent, rings thick;
parietal deposits initiated at septal foramina, growing forward and
commonly forming continuous lining within siphuncle; cameral deposits

? Westonoceras sp.
Plate 11, fig. 19

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Diagnosis.--Small for genus, slightly curved or straight; sutures
with broad, shallow lobes and saddles; other details unknown.

Material and occurrence.--Two phragmocone fragments have been
collected from outcrop. The largest of these is about 30 mm long and
consists of 12 camerae.

Discussion.--This material is assigned here with much hesitation.
If it is indeed Westonoceras, it must represent the early, posterior
part of the conch. Unfortunately, there doesn't seem to be a better
taxonomic assignment available, and the material is so incomplete that
any diagnostic features have been lost.

Incertae sedis

Genus A

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Diagnosis.--Depressed orthocones, straight or slowly expanding;
lateral margins acute or sharply rounded; sutures transverse,
straight.

Discussion.--The characters given above do not seem to be
combined in any previously described genus, but I wanted to be able to
include the next specimen in the systematics.
Genus A, sp. A
Plate 11, fig. 17

**Diagnosis.**—Shell slightly expanding anteriorly; lateral margins sharply rounded; camerae relatively short; other details unknown.

**Material and occurrence.**—One specimen has been collected from outcrop. This specimen consists of 16 camerae and is about 110 mm long.

**Discussion.**—There does not seem to be an appropriate taxon for this specimen. The Tripteroceratidae are all depressed with fairly sharp lateral margins, but no genus in that family has straight sutures. Other orthoconic genera with straight sutures have circular or subcircular cross sections. However, given the quality and quantity of material available, I am most reluctant to name a new species and genus at this time.

Class HYOLITHA Marek, 1963
Order HYOLITHIDA Matthew, 1899
Suborder HYOLITHINA Matthew, 1899
Family Hyolithidae Nicholson, 1872
Genus Hyolithes Eichwald, 1840

**Type species.**—Hyolithes acutus Eichwald, 1840 (by monotypy).

**Diagnosis.**—"Cross section oval, subtriangular, or subpentagonal. Exterior with growth lines only, no ribs. Dorsal side rounded, ventral side broad. Operculum subcircular to subquadrate to subtrigonal. Usually one pair of large muscle scars on underside of operculum. Rarely with 2 curved 'arms' or 'supports' found attached to other hard parts." (Fisher, 1962, p. W124).
Discussion.—The higher taxonomic affinities of hyolithids are currently being debated. There is considerable support for placing them in their own phylum (e.g., Pojeta, 1985, 1987) but some still feel that they may best be accommodated as a class within the Mollusca (e.g., Yochelson, 1985). Again, I will adopt a conservative approach, retaining the hyolithids within the mollusks until they are better known and some sort of consensus is reached.

_Hyolithes_ sp. aff. _H. versaillesensis_ Miller and Faber, 1894

_Plate 11, figs. 10, 11_

_Diagnosis._—Shells small, not exceeding 8 mm in length; cross section usually subtrigonal, but may become biconvex or planoconvex; dorsal side usually broadly convex, ventral side usually more or less sharply angulated; details of ornamentation, operculum, helens unknown.

_Material and occurrence._—Six fragments of phosphatic steinkerns, all from the lowest quarter of the Gunn Member at subsurface locality A2602, have been collected.

_Discussion._—These specimens conform to the description and illustration of _H. versaillesensis_ Miller and Faber in all particulars. However, as that species was founded on steinkerns, and all external details are unknown, the Gunn specimens are only tentatively assigned to that taxon. _Hyolithes parviusculus_ (Hall, 1862) has never been adequately described, but may prove conspecific with _H. versaillesensis_, in which case Hall's name would have priority. The principal difference seems to be that _H. parviusculus_ is larger.
Phylum ARTHROPODA Siebold and Stannius, 1845

Subphylum TRILOBITOMORPHA Stormer, 1944

Class TRILOBITA Walch, 1771

Order PTYCHOPARIIDA Swinnerton, 1915

Suborder ASAPHINA Salter, 1864

Superfamily Asaphacea Burmeister, 1843

Family Asaphidae Burmeister, 1843

Subfamily Isotelinae Angelin, 1854

Genus Isotelus DeKay, 1824

Type species.--Isotelus gigas DeKay, 1824 (by original designation).

Diagnosis.--"Cephalon and pygidium mostly with poorly defined flattened border. Frontal area moderately long, cephalic axis ill defined, almost obsolete in several species, slightly expanding in front of medium-size eyes situated somewhat behind transverse mid-line of cranidium; no posterior border furrow; genal angles rounded, pointed, or with short genal spines. Hypostoma almost parallel-sided, posterior margin with broad (tr.), deep notch; anterior lobe short. Thoracic axis considerably broader than pleurae. Pygidial axis broad, poorly defined, almost obsolete in several species; pleural fields smooth or very faintly ribbed." (Jaanusson, 1959a, p. 0339).

Isotelus sp. cf. I. maximus Locke, 1838

Plate 11, fig. 12

Diagnosis.--Genal spine large; terraces pronounced on both dorsal and ventral surfaces; other details unknown.
Material and occurrence.--One large genal spine, preserved on a bedding plane, was recovered from subsurface locality A2624.23, about 5 m above the base of the Gunn Member.

Discussion.--With only a genal spine and a small portion of the adjacent free cheek to go on, a species assignment is not possible. A comparison with *Isotelus iowensis* (Owen) could equally well have been suggested; both that species and *I. maximus* Locke are large species possessing pronounced genal spines.

*Isotelus sp. cf. I. gigas* DeKay, 1824
Plate 11, fig. 8

Diagnosis.--Large for genus; cephalon with wide border; border with narrow raised rim; genal angle sharply rounded; eye moderately large; other details unknown.

Material and occurrence.--One cephalic fragment was collected from outcrop. This fragment preserves most of a free cheek, up to and including the eye, and including the genal angle.

Discussion.--The specimen also conforms, morphologically, to descriptions of *Isotelus gigas* DeKay, but not enough has been preserved to positively assign it to that species. Rudkin and Tripp (1985), who examined a plaster cast of the type specimen of *I. gigas*, reported a "raised line" around the cephalic border, a feature also found on the Gunn specimen.

Suborder ILLAENINA Jaanusson, 1959
Superfamily Illaenacea Hawle and Corda, 1847
Family Illaenidae Hawle and Corda, 1847
Subfamily Bumastinae Raymond, 1916
Genus *Bumastus* Murchison, 1839

Type species.—*Bumastus barriensis* Murchison, 1839 (by monotypy).

*Diagnosis.*—"Thorax with 8 to 10 segments; axis very broad, axial furrows poorly defined. Pygidial axial furrows generally not developed." (Jaanusson, 1959b, p. 0374).

? *Bumastus* sp.

Plate 11, figs. 1, 13

*Diagnosis.*—Average-sized for genus; pygidium semicircular to semielliptical, without border; axis undefined; ten thoracic segments present; other details unknown.

*Material and occurrence.*—Seven specimens, all from outcrop, have been collected. The smallest specimen is complete and enrolled, but the cephalon is poorly preserved. The other six specimens are all pygidia, two of which retain some thoracic segments.

*Discussion.*—So little diagnostic material is preserved in these specimens that even the generic assignment is uncertain. Trilobites of the general shape and size of the Gunn specimens may also be assigned to *Bumastoides* Whittington or *Failleana* Chatterton and Ludvigsen, to mention two possibilities. *Bumastoides* is known to be present in the Selkirk Member of the Red River Formation (Westrop, 1983). Generic distinctions among the Bumastinae seem to be made on features such as the rostral shield, strength of the cephalic axial furrows, hypostome, and eyes (Jaanusson, 1959b, p. 0374), features that are all lacking in the Gunn material at hand.
Order PHACOPIDA Salter, 1864

Suborder CHEIRURINA Harrington and Leanza, 1957

Family Cheiruridae Salter, 1864

Subfamily Cheirurinae Salter, 1864

Genus Ceraurus Green, 1832

**Type species.**--*Ceraurus pleurexanthemus* Green, 1832 (by original designation).

**Diagnosis.**--"Glabella expanding forward, with 3 pairs of short lateral furrows; eyes set well away from glabella, opposite 3p; fixigenae with long genal spines. Thoracic segments generally 11. Pygidium with long pair of axially recurved pleural spines from anterior segment. Surface tuberculation coarse." (Henningsmoen, 1959, p. 0433).

*Ceraurus sp. aff. C. tuberosus* Troedsson, 1929

Plate 11, fig. 14

**Diagnosis.**--Entire cranidium coarsely tuberculate; anterior margin narrow, well-defined; eyes close to posterior cephalic margin; other details unknown.

**Material and occurrence.**--A single incomplete cranidium has been collected from outcrop. Most of the glabella is preserved, along with one fixed cheek and one eye.

**Discussion.**--What there is of this specimen agrees in all respects with *Ceraurus tuberosus* Troedsson, but the specimen is too incomplete to be definitely assigned to that species. The Gunn specimen is somewhat smaller than Troedsson's (1929) illustrated specimens, but could represent an immature individual.
Genus *Ceraurinus* Barton, 1913

*Type species.*—*Ceraurinus marginata* Barton, 1913 (by original designation).

*Diagnosis.*—"Like *Ceraurus* but with longer lateral glabellar furrows and finer surface ornamentation." (Henningsmoen, 1959, p. 0432).

*Ceraurinus icarus* (Billings, 1860)

Plate 11, fig. 3

*Cheirurus Icarus* Billings, 1860a, p. 67–68, fig. 11; Billings, 1863, p. 219, fig. 231; Whiteaves, 1880, p. 50C; Whiteaves, 1895, p. 128; Dowling, 1900, p. 53F.

*Ceraurus icarus* (Billings) Meek, 1873, p. 162–165, pl. 14, figs. 11a–11c; Cumings, 1908, pl. 54, figs. 8, 8a.

*Ceraurus meekanus* Miller, 1889, p. 537–538.

*Ceraurus* (Eccoptochile) *icarus* (Billings) Clarke, 1894, p. 738.

Eccoptochile ? *meekanus* (Miller) Slocom, 1913, p. 75–77, pl. 17, figs. 6–9.

*Ceraurinus icarus* (Billings) Barton, 1913, p. 551, unnumbered plate, fig. 7; Bassler, 1915, p. 200 (partim); Barton, 1915, fig. 23; Slocom, 1916, p. 227–229, pl. 18, figs. 6–9; Foerste, 1924, pl. 44, figs. 3a, 3b; Walter, 1925, p. 251–254, pl. 20, figs. 10–13; Twenhofel, 1928, p. 334; Troedsson, 1929, p. 73–74, pl. 18, figs. 10–15, pl. 19, figs. 1–3; Shimer and Shrock, 1944, fig. 272–14; Baillie, 1952, p. 33; Ludvigsen, 1977, p. 966–970, pl. 2, figs. 3–10, text-fig. 2B; Ludvigsen, 1978, pl. 6, fig. 59;
Ross et al., 1980, figs. 4s, 4z; Bolton, 1981, pl. 6, fig. 3
(non fig. 2).

*Ceraurinus marginatus* Foerste, 1924, p. 248-249, pl. 46, figs. 6a, 6b
(non *Barton*, 1913).

*Ceraurinus elongatus* Cooper, 1930, p. 384-385, pl. 5, figs. 13-14.

? *Ceraurinus icarus* (Billings) Cox, 1933, p. 366, pl. 20, figs. 7-9.


*Remipyga icarus* (Billings) Whittington, 1954, p. 130; Bolton, 1972, pl. 2, fig. 4.

*Ceraurinella elongatus* (Cooper) Lesperance, 1968, p. 815.

*Xylabion* ? *elongatum* (Cooper) Lane, 1971, p. 41.

*Ceraurinus cf. icarus* (Billings) Westrop and Ludvigsen, 1983, p. 21, pl. 7, figs. 1-4, 6, 8, 11.

**Diagnosis.**—Posterior glabellar furrows intersect occipital furrow, isolating posterior glabellar lobes; pygidial spines all extend about an equal distance posteriorly.

**Material and occurrence.**—One complete enrolled specimen, somewhat encrusted by matrix, and a complete glabella with a fixed cheek attached have been collected from outcrop. A third specimen, also from outcrop, is a pygidial fragment.

**Discussion.**—The diagnostic glabella and pygidium makes this Richmondian guide fossil easy to identify. The Gunn material agrees in all respects with other descriptions and illustrations.

**Suborder CALYemenina Swinnerton, 1915**

**Family Calymenidae Burmeister, 1843**

**Subfamily Calymeninae Burmeister, 1843**
Genus Flexicalymene Shirley, 1936

**Type species.**—*Calymene caractaci* Salter, 1865 (by original designation).

**Diagnosis.**—"Glabella with 3 pairs of lateral lobes; axial furrows contracted slightly opposite 1p and 2p lateral furrows; preglabellar furrows broad (*sag.*, *exsag.*); eye lobes opposite, ahead, or behind 2p glabellar lobes. Hypostoma without raised area in center of anterior lobe of middle body. Thorax with 12 or 13 segments. Pygidium with deep pleural furrows and shallow interpleural grooves extending close to margins of pleural regions." (Whittington, 1959, p. 0452).

**Flexicalymene sp.**

Plate 11, figs. 4, 5, 7

[?] *Calymene Blumenbachii* Billings Whiteaves, 1880, p. 50C.

[?] *Calymene callicephala* Green Whiteaves, 1895, p. 128; Dowling, 1900, p. 53F.

**Diagnosis.**—Thorax with 13 segments; pygidium with five distinct rings and suggestions of two more; cephalic details unknown.

**Material and occurrence.**—A single, almost complete, enrolled specimen has been collected from outcrop.

**Discussion.**—Unfortunately, the cephalon, and particularly the glabella, has been eroded and partially obscured by matrix. Thus, the diagnostic details of these structures are not observable, and it is not possible to suggest a species comparison.
Suborder PHACOPINA Struze, 1959
Superfamily Dalmanitacea Vogdes, 1890
Family Pterygometopidae Reed, 1905
Subfamily Pterygometopinae Reed, 1905
Genus Calyptaulax Cooper, 1930

**Type species.**—Calyptaulax glabella Cooper, 1930 (by original designation).

**Diagnosis.**—"Cephalon highly vaulted; frontal lobe of glabella may be prolonged sideward in sickle-shaped elevations of genae that embrace eyes anteriorly and are cut off from frontal lobe by facial sutures; 3p lateral glabellar lobes distinctly triangular, large, protruding sideward a little less than frontal lobe, 2p lobes smaller than in *Eomonorachus*; central area more or less arched, never depressed; longitudinal furrows may be present; 2p lateral glabellar furrows distinctly oblique in anteromesial direction, 1p furrows subparallel to 2p furrows; genal spines present or absent. Pygidium highly vaulted, generally subtriangular; posterior margins of rings undulating (narrow curve laterally, flat broad curve mesially)." (Struve, 1959, p. 0492).

Subgenus Calliops Delo, 1935

**Type species.**—Phacops callicephalus Hall, 1847 (by original designation).

**Diagnosis.**—"Glabella with 1p lateral lobes detached; 2p lateral glabellar furrows narrower and shallower than 1p and 3p furrows but reaching axial furrows; eyes very large, close to glabella and posterior border furrows. Pygidium with 8 to 11 axial rings and 4 to
8 pairs of ribs, pleural furrows distinct, interpleural furrows distinct or obsolescent."

*Calyptaulax* (Calliops) sp.

Plate 11, figs. 2, 6, 9

[?] *Pterygometopus callicephalus* (Hall) Dowling, 1900, p. 53F.

[?] *Pterygometopus callicephalus* Baillie, 1952, p. 33.

[?] *Calyptaulax* sp. A Westrop and Ludvigsen, 1983, p. 25, pl. 7, fig. 7.

**Diagnosis.**—Glabella tuberculose; pygidium with about nine axial rings and six pairs of ribs; interpleural furrows distinct; pleural furrows extend almost to border; other details unknown.

**Material and occurrence.**—One weathered and partly matrix-encrusted glabella, and two pygidia have been collected from outcrop. A third pygidium was recovered from subsurface locality A2600.02, about 6 m above the base of the Gunn Member.

**Discussion.**—One of the two pygidia from outcrop is very well preserved, and appears almost identical with the pygidium illustrated by Westrop and Ludvigsen (1983, pl. 7, fig. 7). The Gunn material is assigned to *Calyptaulax* (Calliops) on the basis of the glabellar furrows, which seem more like those of *Calyptaulax* (Calliops) than they do those of *C. (Calyptaulax)*. The three pygidia are assigned here also, although it is possible that more than one taxon is represented. The material is too sparse and poorly preserved to attempt species identification.
Diagnosis.--Medium-sized ?phyllocarids, subtrapezoidal; no ornamentation apparent; other details unknown.

Material and occurrence.--Several specimens of thin dark brown or black shiny films, preserved on bedding planes, have been collected from subsurface locality A2603, in the lower half of the Gunn Member. Fragments of similar material were seen, but not collected, in core from other wells in central and western North Dakota.

Discussion.--Insufficient material has been preserved to attempt a classification of these specimens; even their status as phyllocarids is uncertain. The material has been preserved as thin, dark films that appear to be organic, but that may be collophane; Rolfe (1969, p. R298) stated that many Paleozoic phyllocarids seem to be preserved as collophane.

It may seem pointless to include material like this in the systematics, but I have seen nothing like this reported from the Gunn Member in the literature, and I wanted to report this in the hope that others might be encouraged to hunt for better-preserved material.
Plate 1. Corals of the Gunn Member, Stony Mountain Formation

All figures Xl unless otherwise indicated.


Figs. 9, 14, 15, 19. Lobocorallium trilobatum (Whiteaves). 9. Negative print of acetate peel taken 20.5 mm from apex, cardinal side down. UND 6396., locality A2600.10. 14, 15. UND 13587., locality A583. 14. Calical view, cardinal side down. 15. Alar view, cardinal side left. 19. Alar view, cardinal side right. This specimen resembles L. haysi, found in the underlying Red River Formation, but was collected in situ only two or three metres below the top of the Gunn Member. UND 6397., locality A417.

Fig. 13. Protaraea tenuis (Billings). One of the better-preserved colonies of this thin, encrusting, and usually poorly preserved species. UND 6391., locality A417. X2.2.

Fig. 16. Paleofavosites okulitchi Stearn. A small but complete colony, with significantly larger corallites as compared to those of P. prolificus (Billings), fig. 17. UND 6399., locality A2569.

Figs. 17, 18, 20. Paleofavosites prolificus (Billings). 17, 20. UND 856., locality A417. 17. Corallites, natural size. Compare with P. okulitchi Stearn, fig. 16. 18. An entire small, nodular colony, the most common colony size. UND 6468., locality A2572. 20. A complete moderate-sized colony. Brachiopods here and in fig. 17 are Diceromyonia storeya (Okulitch). X0.5.
Plate 2. Bryozoans and corals of the Gunn Member, Stony Mountain Formation

Figs. 1-15. Arthroclema brevis n. sp. All figures X16 unless otherwise noted. 1-4. Primary segments. 1. UND 6213., locality A2603.20., holotype. 2. UND 6215., locality A2603.18, paratype. 3. UND 6214., locality A2603.181, paratype. 4. UND 6219., locality A2603.17, paratype. 5-7. Secondary segments. 5. An exceptionally long segment. UND 6218., locality A2603.18, paratype. 6. UND 6222., locality A2603.201, paratype. 7. UND 6220., locality A2603.183, paratype. 8, 9. Tertiary segments. 8. UND 6223., locality A2603.20, paratype. 9. UND 6221., locality A2603.201, paratype. 10. Transverse section, primary segment; note large proportion of extrazoecial skeleton (light areas) to zooecial volume (dark areas), characteristic of primary segments of Arthroclema; UND 6382., locality A2603, paratype. 11. Longitudinal section, primary segment. Black areas are pyrite filling zooecia. UND 6381., locality A2603, paratype. 12. Transverse section, secondary segment, showing seven sides and seven zooecial ranges. UND 6380., locality A2603, paratype, X22. 13. Longitudinal section, secondary segment. UND 6383., locality A2603, paratype. 14, 15. Unusually short, stubby segments, interpreted to be aberrant primary segments. 14. UND 6216., locality A2603.19, paratype. 15. UND 6217., locality A2603.18, paratype.


Figs. 24-36. *Arthroclema pentagonalis* n. sp. All figures X16 unless otherwise indicated. 24. Longitudinal section, primary segment. UND 6377., locality A2602.29, paratype. 25. Primary segment showing distal termination and lateral articulation socket. UND 6228., locality A2602.29, paratype. 26. Primary segment showing proximal termination and indistinct lateral socket on left side just above the middle. UND 6229., locality A2602.29, paratype. 27. Secondary segment, showing slightly flaring distal end and zooecial apertures with the proximal portions of their peristomes produced into spine-like processes, characteristic of this species. UND 6230., locality A2602.28, paratype. 28. Secondary? segment, with two lateral sockets. UND 6226., locality A2602.32, holotype. 29. Secondary segment. UND 6227., locality A2602.29, paratype. 30. Fragments of two secondary segments joined at their ends. UND 6225., locality A2602.29, paratype. 31. Secondary? segment, with lateral socket near top. UND 6231., locality A2602.29, paratype. 32. Secondary segment preserving flared distal termination. UND 6232., locality A2602.28, paratype. 33. Transverse section, primary segment. UND 6373., locality A2602.29, paratype. X23. 34. Transverse section, secondary segment, showing five ranges of zooecia. UND 6374., locality A2602.29, paratype. X22. 35. Tertiary? segment. UND 6233., locality A2602.29, paratype. 36. Longitudinal section, secondary segment. UND 6376., locality A2602.29, paratype.

Fig. 38. *Paleofavosites manitobensis* n. sp. Note abundant wall pores in this natural section. UND 13757., locality A841.1. Holotype. X2.7.

Fig. 39. *Tubulotrypa auloporoides* (Nicholson) encrusting pedicle exterior of *Megamyonia nitens* (Billings). Note that in the upper left portion, the colony has the form of "Proboscina" *auloporoides*, whereas on the right side it has the form of "P." *frondosa*. UND 6307., locality A2602.18. X13.3.
Plate 3. Arthrostylid bryozoans of the Gunn Member, Stony Mountain Formation

Figs. 1-5, 28. Nematoporella ulrichi n. gen., n. sp. All specimens are from locality A2602.183. 1. Longitudinal section. UND 6379., paratype. X28.7. 2. Transverse section. Only three zooecia reflect the alternating positions of zooecia in adjacent ranges. UND 6378., paratype. X28.7. 3. Fragment preserving the distal termination. UND 6235., paratype. X28.7. 4. Fragment showing zooecial arrangement and sinuous longitudinal ridges. UND 6236., paratype. X28.7. 5. Fragment preserving the proximal end. UND 6234., holotype. X28.7. 28. Detail of figure 4, UND 6236. X100.


Figs. 30-34. Ulrichostylus costatus n. sp. All figures X18.

30. Longitudinal section. UND 6387., locality A2602.183, paratype. 31-33. Three segments, showing variability within species. 31. UND 6352., locality A2602.183, paratype. 32. UND 6353., locality A2602.183, holotype. 33. UND 6354., locality A2602.32, paratype. 34. Transverse section, showing eight zooecial ranges and pronounced longitudinal ridges between the ranges; UND 6388., locality A2602.32, paratype.
Plate 4. Ptilodictyoid bryozoans of the Gunn Member, Stony Mountain Formation

Fig. 1. Ptilodictya sulcata Billings. Transverse section, X16. UND 14325., locality A2569.

4. Longitudinal section, showing wide endozone characteristic of this genus. UND 6485., locality A2602.17, paratype.
5. Tangential section, showing subrectangular zooecia in endozone and (at top) subcircular zooecia in exozone. UND 6488., locality A2602.183, paratype.
6. Bifurcate segment. UND 6479., locality A2603.18, holotype. 7. Unbranched segment. UND 6482., locality A2603.201, paratype. 8. Transverse section, showing aligned zooecial ranges across mesotheca. UND 14326., locality A2603.18, paratype.


Figs. 29-33. Pachydictya hexagonalis Ulrich. UND 14577., locality A2569. 29. Shallow tangential section, showing monticule (top center) composed of smaller zooecia, X10. 30. Transverse section, X10. 31. Detail of tangential section, showing mural styles delineating zooecia and zooecial ranges, X16. 32. Longitudinal section, showing common diaphragms, X16. Mesotheca is vertical structure on right. 33. Detail of longitudinal section, showing phosphatic globules in living chambers, X16.
Plate 5. Bryozoans of the Gunn Member, Stony Mountain Formation


Figs. 7, 15, 16. *Platydictya renvillensis* n. gen., n. sp. UND 6470., locality A2628.1, holotype. All figures X16. 7. Transverse section, showing alternating zooecial ranges across mesotheca. 15. Longitudinal section. 16. Tangential section, showing longitudinally arranged subrectangular zooecia in endozone (bottom) and subcircular zooecia in exozone (top) in a weak diagonal arrangement.

Figs. 8, 9. *Dekayia micropora* n. sp. UND 14660., locality A417, holotype. Both figures are positive prints of acetate peels, X10. 8. Tangential section. Ring-like pattern is due to zoarium having a raised rim and depressed center, like *Dekayia gregaria* (Ulrich). 9. Longitudinal section. Substrate is *Dinorthis (Dinorthis) carletona* Twenhofel.

Figs. 10-12. *Lioclemella subfusiformis* (James). UND 14731., locality A2602.29. All figures are positive prints of acetate peels, X10. 10. Transverse section, showing wide exozone and large, closely tabulated mesozooecia. 11. Tangential section. Lighter elliptical areas are zooecia, darker areas between are mesozooecia. 12. Longitudinal section, also showing abundant, large, closely tabulated mesozooecia.

Figs. 13, 14, 19. *?Stigmatella* sp. UND 14973., locality A2569. All figures are positive prints of acetate peels, X10. 13. Transverse section. 14. Tangential section. 19. Longitudinal section, showing two closely tabulated mesozooecia in upper left.
Figs. 17, 18, 21, 22. *Tarphophragma clinopora* n. sp. All figures are positive prints of acetate peels, X10. 17. Longitudinal section, showing abundant diaphragms throughout zoarium and two small mesozooecia in upper right. UND 14664., locality A2616.051, paratype. 18. Tangential section. UND 14663., locality A2569, holotype. 21. Transverse section. UND 14664., locality A2616.051, paratype. 22. Longitudinal section. UND 14664., locality A2616.051 paratype.

Figs. 20, 23, 24. *Dekayia aequalis* n. sp. UND 14661., locality A417, holotype. All figures are positive prints of acetate peels, X10. 20. Longitudinal section, showing thin, crenulated walls and sparse diaphragms in endozone, and irregularly thickened walls and common diaphragms in exozone. 23. Tangential section. Light-colored dots are abundant large acanthopores, some showing small lumens. 24. Transverse section.
Plate 6. Trepostome bryozoans of the Gunn Member, Stony Mountain Formation

All figures are positive prints of acetate peels, X10.

Figs. 1, 2. Bythopora striata Ulrich. UNO 14772., locality A2602.29. 1. Transverse section. 2. Longitudinal section, showing zooecia opening to the surface at very low angles.

Figs. 3, 4. Parvohallopora sp. aff. P. subplana (Ulrich). UND 14682., locality A2603.181. 3. Tangential section, showing thick-walled zooecia and abundant thinner-walled mesozooecia. 4. Longitudinal section, showing abundant closely-tabulated mesozooecia.

Figs. 5, 6. Batostoma sp. cf. B. ovata (Ulrich). UND 14976., locality A417. 5. Longitudinal section, showing common diaphragms, some intersecting. Substrate is Salvadorea selecta (Billings). 6. Tangential section, showing thickened walls near surface.


Figs. 9-11. Eridotrypa nitida (Ulrich). UND 14805., locality A2602.29. 9. Transverse section. 10. Deep tangential section. 11. Longitudinal section, showing almost total lack of diaphragms in zooecia and short, closely tabulated mesozooecia.


Figs. 15, 16, 19. Batostoma manitobense Ulrich. UND 14715., locality A2602.21. 15. Tangential section, showing abundant mesozooecia (dark areas) and acanthopores (light dots). Maculae are in upper left and lower right. 16. Transverse section. 19. Longitudinal section, showing common closely tabulated mesozooecia and virtual absence of diaphragms in endozone.

Figs. 17, 18. Monticulipora parasitica Ulrich. 17. Tangential section. Macula is darker area on right. UND 14880., locality A2602.183. 18. Longitudinal section, showing abundant cystiphragms and occasional diaphragms. Substrate is Dinorthis (Dinorthis) carletona Twenhofel. UND 14876., locality A579.
Figs. 20, 22, 23. Homotrypa oligophragma n. sp. 20. Transverse section. UND 14931., locality A2603.301, paratype.
22. Longitudinal section, showing common diaphragms in distal endozone and a macula just above right center. UND 14928., locality A2603.301, holotype. 23. Tangential section, showing common mesozooecia. UND 14928., locality A2603.301, holotype.

Figs. 21, 25, 27, 28. Homotrypa glabra Cumings and Galloway.
21. Transverse section. UND 14907., locality A2602.22.
25. Tangential section. Macula is near top. UND 14907., locality A2602.22. 27. Longitudinal section, showing common cystiphragms and occasional diaphragms. UND 14903., locality A2602.19. 28. Longitudinal section, with cystiphragms less common than in preceding section. UND 14907., locality A2602.22.

Plate 7. Bryozoans and brachiopods of the Gunn Member,
Stony Mountain Formation

All bryozoans are positive prints of acetate peels, X10.

Figs. 1, 5, 9. Homotrypa astrovae n. sp. UND 14932., locality A2603.171, holotype. 1. Transverse section, showing wide exozone, abundant mesozooecia with very closely spaced diaphragms, and abundant diaphragms in zooecia. 5. Tangential section, showing abundant mesozooecia and maculae at upper left, upper right, and lower left center. 9. Longitudinal section, showing common diaphragms in the endozone, including curved and cystiphragmoid diaphragms.

Figs. 2-4. Homotrypa tabulata n. sp. 2. Tangential section, showing common mesozooecia and macula just above center. UND 14924., locality A2602.192, paratype. 3. Longitudinal section, showing abundant diaphragms throughout zooarium, including some curved and cystiphragmoid diaphragms. UND 14927., locality A2603.18, paratype. 4. Longitudinal section, with fewer diaphragms than preceding section and abundant overlapping cystiphragms in exozone. UND 14925., locality A2569, holotype.

Figs. 6, 7. Rhombotrypa quadrata (Rominger). UND 14957., locality A2620.07. 6. Transverse section. 7. Longitudinal section, showing sparse diaphragms in endozone.

Figs. 8, 12, 13. Rhombotrypa multitabulata Utgaard and Perry. 8. Tangential section. UND 14955., locality A2616.07. 12. Longitudinal section, with two zooecia (lower left) more closely tabulated than usual. UND 14955., locality A2616.07. 13. Longitudinal section, showing abundant endozonal diaphragms. UND 14945., locality A2569.


Fig. 21. ?Lingula sp. cf. L. narrawayi Wilson. Mold of exterior. X2. UND 14977., locality A2621.2.
Plate 8. Brachiopods and mollusks of the Gunn Member,
Stony Mountain Formation

All figures X1 unless otherwise noted.

Figs. 1, 2, 9, 10. Hebertella occidentalis montoyensis Howe.
1, 2. Pedicle valve interior. UND 15033., locality A2602.30.


Fig. 12. Strophomena planocorrugata Twenhofel. Pedicle valve exterior. UND 15132.-1, locality A417.


42. Brachial valve exterior. 43. Pedicle valve exterior.

50. Lateral view.

Fig. 51. Sinuites sp. Apertural view. UND 6246., locality A2602.183. X66.7.

Fig. 52. ?Plagioglypta sp. cf. P. iowaensis (James). UND 6237., locality A2602.25. X53.3.
Plate 9. Mollusks of the Gunn Member, Stony Mountain Formation

Figs. 1, 23. Phragmolites sp. A. UND 6241., locality A2569.

  2. Apertural view.  3. Lateral view.

  5. Adapertural view.

Figs. 6-8. ?Murchisonia (Hormotoma) sp. cf. M. (H.) gracilis (Hall).
  X1.  6. Adapertural view. UND 6286., locality A2573.
  UND 6287., locality A2569.

Fig. 9. Cyclonema sp. cf. C. bilix (Conrad). Apertural view, X1.
  UND 6275., locality A2572.


Figs. 12, 13. ?Palaeoconcha sp. B. X2. UND 6293., locality A2602.23.

Figs. 14, 15, 17. ?Lyrodesma sp. X1. UND 6299., locality A2569.

Fig. 16. ?Matheria sp. Lateral view, X1. UND 6296., locality A417.

Fig. 18. ?Loxoplocus (Lophospira) sp. cf. L. (L.) milleri (Hall).
  Apertural view, X1. UND 6263., locality A2569.


Fig. 21. ?Trochonema (Trochonema) sp. Adapertural view, X1. UND 6270., locality A2602.20.


Fig. 26. ?Murchisonia (Hormotoma) sp. Apertural view, X40. UND 6290., locality A2602.243.

Fig. 27. ?Palaeoconcha sp. A. Lateral view, X33.3. UND 6291., locality A2602.26.


Fig. 34. ?Murchisonia (Hormotoma) sp. cf. M. (H.) salteri Ulrich and Scofield. Section exposed in sidewall of core, Xl. Uncoated. UND 6280., locality A2602.061.

Fig. 36. ?Sinuites sp. Lateral view, X66.7. UND 6247., locality A2602.183.

Fig. 37. ?Murchisonia (Hormotoma) sp. cf. M. (H.) major Hall. Apertural view, Xl. UND 6282., locality A2569.

Fig. 38. ?Loxoplocus (Lophospira) sp. Apertural view, X66.7. UND 6265., locality A2602.311.
Plate 10. Mollusks of the Gunn Member, Stony Mountain Formation.

All figures X1 unless otherwise noted.

Fig. 1. "Palaeoneilo" sp. B. Lateral view, X66.7. UND 6295., locality A2602.

Fig. 2. ?Pleurorthoceras sp. cf. P. selkirkense (Whiteaves). Ventral (?) view. UND 15461., locality A583.


Fig. 7. ?Huronia sp. Lateral (?) view. UND 15459., locality A2569.

Fig. 8. ?Billingsites sp. Lateral (?) view. UND 15467., locality A2572.

Fig. 9. ?Pinnocaris sp. Exterior mold (?). UND 15496., locality A2618.4.

Fig. 10. ?Ephippiorthoceras sp. Lateral (?) view. UND 15463., locality A417.

Fig. 11. ?Kochoceras sp. Ventral (?) view. UND 15455., locality A417.

Fig. 12. ?Gorbyoceras sp. Lateral (?) view. UND 15464., locality A417.

Fig. 13. ?Probillingsites sp. Lateral (?) view of vertical (?) section. Uncoated core slab. UND 15469., locality A2619.11.

Fig. 14. ?Actinoceras sp. Ventral (?) view. UND 15454., locality A417.
Plate 11. Mollusks and arthropods of the Gunn Member, Stony Mountain Formation


Fig. 3. Caraurinus icarus (Billings). Partial cranidium, Xl. UND 15488., locality A417.

Figs. 4, 5, 7. Flexicalymene sp. Enrolled specimen. UND 15490., locality A417. 4. Pygidium, Xl. 5. Thorax, Xl. 7. Cephalon, X2.

Fig. 8. Isotelus sp. cf. I. gigas DeKay. Partial free cheek, encrusted by matrix, Xl. UND 15479., locality A1989.


Fig. 12. Isotelus sp. cf. I. maximus Locke. Genal spine, preserved on bedding plane in core, Xl. UND 15478., locality A6242.23.

Fig. 14. Ceraurus sp. aff. C. tuberosus Troedsson. Partial cephalon in matrix, X2. UND 15486., locality A1990.


Fig. 16. Phyllocarid gen. et sp. indet. Uncoated specimen, Xl. UND 15497., locality A2603.241.

Fig. 17. Gen. A, sp. A. Xl. Unidentified orthoconic cephalopod. Ventral (?) view. UND 15476., locality A969.

Fig. 18. ?Digenuoceras sp. Xl. Lateral view. UND 15470., locality A417.

Fig. 19. ?Westonoceras sp. Xl. Ventral (?) view. UND 15475., locality A417.
APPENDIX A

LOCALITY REGISTER

The University of North Dakota Department of Geology paleontology collection has a system of accession numbers ("A" numbers) that may be used as locality numbers. In many instances, a given locality has more than one "A" number; the number may represent different collectors, different horizons, or different dates of collection. For subsurface localities, I have given each well core from which I collected specimens a separate "A" number. Within each well, individual horizons or intervals have been indicated by a decimal number appended to the "A" number; these are listed below the locality description. A brief description of outcrop localities is given below; core descriptions are given in Appendix B.

Outcrop Localities


Municipality of Winnipeg Aggregate Plant, west quarry, S 1/2, sec. 14, T. 13 N., R. 2 E., approximately 1 km (0.6 mi.) NNW of the center of Stony Mountain, Manitoba. Approximately 5 m of Gunn Member exposed at this location, overlain by about 3 m of Penitentiary Member, overlain by about 5 m of Gunton Member.

A583, A2569

Municipality of Winnipeg Aggregate Plant, east quarry, NE 1/4, sec. 11, NW 1/4, sec. 12, SW 1/4, sec. 13, SE 1/4, sec. 14, T. 13 N., R. 2 E., approximately 0.5 km (0.3 mi.) NE of the center of Stony Mountain, Manitoba. Approximately 3 m of Gunn Member overlain by 3 m of Penitentiary Member.

A2570

East side of north-south road, 30 m south of intersection with Deprez Rd., Stony Mountain, Manitoba. Float on weathered surface.

A2571


A2572

West- to northwest-facing slope on a NW-SE trending ridge on the southeast corner of the Manitoba Provincial Penitentiary grounds, NE 1/4 NE 1/4 sec. 2, T. 13 N., R. 2 E., Stony Mountain, Manitoba.
West-facing slope, about 400 m south of intersection of School Rd. with northeast corner of athletic field, NE 1/4 SE 1/4 sec. 11, T. 13 N., R. 2 E., Stony Mountain, Manitoba.

**Subsurface Localities**

**A2600**

Union Oil Co. of California Restad #1 (NDGS Well #37), 1980 FNL, 660 FWL, SW 1/4 NW 1/4 sec. 26, T. 162 N., R. 64 W., Cavalier Co., N. D.

NOTE: Footages are rough approximations; the core boxes are not individually marked as to depth. The entire 30-foot interval between 2845 ft. and 2875 ft. below KB is marked on each of the 11 boxes containing the core.

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### A2617

Texaco Schank #2 (NDGS Well #4182), 1320 FSL, 1420 FWL, E 1/2 SW 1/4 sec. 23, T. 137 N., R. 92 W., Stark Co., N. D.

<table>
<thead>
<tr>
<th>Number</th>
<th>Interval or Horizon (ft below KB)</th>
<th>Number</th>
<th>Interval or Horizon (ft below KB)</th>
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<tbody>
<tr>
<td>A2617.1</td>
<td>10150.0-10153.0</td>
<td>A2617.5</td>
<td>10156.5-10159.5</td>
</tr>
<tr>
<td>A2617.2</td>
<td>10154.3</td>
<td>A2617.6</td>
<td>10161.0</td>
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<td>A2617.3</td>
<td>10154.8</td>
<td>A2617.7</td>
<td>10159.5-10162.0</td>
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<tr>
<td>A2617.4</td>
<td>10153.0-10156.5</td>
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</tr>
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</table>

### A2618

Socony Vacuum Oil Co. Jacobs #Fl4-24-P (NDGS Well #511), 660 FSL, 660 FWL, SW 1/4 SW 1/4 sec. 24, T. 134 N., R. 96 W., Hettinger Co., N. D.

<table>
<thead>
<tr>
<th>Number</th>
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<th>Interval or Horizon (ft below KB)</th>
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<tbody>
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<td>A2618.1</td>
<td>10145-10151</td>
<td>A2618.3</td>
<td>10157-10162</td>
</tr>
<tr>
<td>A2618.2</td>
<td>10151-10157</td>
<td>A2618.4</td>
<td>10162-10168</td>
</tr>
</tbody>
</table>
A. J. Hodges Industries, Inc. Hestekin #1 (NDGS Well #4143), 660 FNL, 660 FEL, NE 1/4 NE 1/4 sec. 15, T. 130 N., R. 104 W., Bowman Co., N. D.

<table>
<thead>
<tr>
<th>Number</th>
<th>Interval or Horizon (ft below KB)</th>
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<tbody>
<tr>
<td>A2619.01</td>
<td>9422-9424.5</td>
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<tr>
<td>A2619.02</td>
<td>9424.5-9427</td>
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<tr>
<td>A2619.03</td>
<td>9427-9429.5</td>
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<tr>
<td>A2619.04</td>
<td>9429.5-9432</td>
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<td>A2619.05</td>
<td>9432-9434.5</td>
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<td>A2619.06</td>
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</tr>
<tr>
<td>A2619.07</td>
<td>9434.7</td>
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A2620

Socony Vacuum Oil Co. Dvorak #F-42-6-P (NDGS Well #505), 660 FEL, 1980 FNL, SE 1/4 NE 1/4 sec. 6, T. 141 N., R. 94 W., Dunn Co., N. D.

<table>
<thead>
<tr>
<th>Number</th>
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<tbody>
<tr>
<td>A2620.01</td>
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<td>A2620.02</td>
<td>12224-12230</td>
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<td>A2620.03</td>
<td>12230-12236</td>
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<td>A2620.04</td>
<td>12236-12242</td>
</tr>
<tr>
<td>A2620.05</td>
<td>12242-12246</td>
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</tbody>
</table>

A2621

Union Oil Co. of California Kudrna #1 (NDGS Well #4311), 1830 FSL, 2030 FWL, NE 1/4 SW 1/4 sec. 20, T. 139 N., R. 97 W., Stark Co., N. D.

<table>
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<tr>
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<th>Interval or Horizon (ft below KB)</th>
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<tbody>
<tr>
<td>A2621.1</td>
<td>11928-11940</td>
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<td>A2621.2</td>
<td>11937.5</td>
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<tr>
<td>A2621.3</td>
<td>11940-11952</td>
</tr>
<tr>
<td>A2621.4</td>
<td>11952-11964</td>
</tr>
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### A2622

Amoco Production Co. Federal "B" #1 (NDGS Well #7501), 1380 FSL, 660 FEL, NE 1/4 SE 1/4 sec. 25, T. 145 N., R. 100 W., McKenzie Co., N. D.

<table>
<thead>
<tr>
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<td>A2622.06</td>
<td>13355.7-13359</td>
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<tr>
<td>A2622.02</td>
<td>13342.5-13345.5</td>
<td>A2622.07</td>
<td>13359-13361.7</td>
</tr>
<tr>
<td>A2622.03</td>
<td>13348.3-13350.5</td>
<td>A2622.08</td>
<td>13361.7-13364.5</td>
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<tr>
<td>A2622.04</td>
<td>13350.5-13353</td>
<td>A2622.09</td>
<td>13364.5-13367.5</td>
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<td>A2622.05</td>
<td>13353-13355.7</td>
<td>A2622.10</td>
<td>13367.5-13370</td>
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### A2623

Amerada Petroleum Corp. Antelope Unit "A" #1 (NDGS Well #2373), 2100 FSL, 1000 FEL, NE 1/4 SE 1/4 sec. 1, T. 152 N., R. 95 W., McKenzie Co., N. D.

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<tr>
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<td>A2623.4</td>
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<td>A2623.5</td>
<td>13095-13109</td>
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### A2624

Amerada Petroleum Corp. Boe-Olson Unit #1 (NDGS Well #1403), 1650 FNL, 1650 FEL, SW 1/4 NE 1/4 sec. 15, T. 155 N., R. 96 W., Williams Co., N. D.

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<td>A2624.02</td>
<td>12594.5-12596.5</td>
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<tr>
<td>A2624.03</td>
<td>12596.5-12599</td>
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<tr>
<td>A2624.04</td>
<td>12599-12601.5</td>
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<td>A2624.05</td>
<td>12601.5-12604</td>
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<td>A2624.06</td>
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<td>A2624.08</td>
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<td>A2624.11</td>
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<td>A2624.13</td>
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<td>12621.5-12624</td>
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<tr>
<td>A2624.15</td>
<td>12624-12626.5</td>
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### A2625

Shell Oil Co. U. S. A. #43-11 (NDGS Well #6839), 790 FEL, 1850 FSL, NE 1/4 SE 1/4 sec. 11, T. 150 N., R. 104 W., McKenzie Co., N. D.

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<th>Interval (ft below KB)</th>
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<td>A2625.5</td>
<td>12707-12715.5</td>
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<td>A2625.2</td>
<td>12681.5-12690</td>
<td>A2625.6</td>
<td>12715.5-12722.7</td>
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<td>A2625.3</td>
<td>12690-12698.3</td>
<td>A2625.7</td>
<td>12722.7-12731.2</td>
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<td>A2625.4</td>
<td>12698.3-12707</td>
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### A2626


<table>
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<td>A2626.1</td>
<td>13797-13813</td>
<td>A2626.5</td>
<td>13844</td>
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<td>A2626.2</td>
<td>13803</td>
<td>A2626.6</td>
<td>13830-13846</td>
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<td>A2626.3</td>
<td>13829</td>
<td>A2626.7</td>
<td>13846-13864</td>
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<tr>
<td>A2626.4</td>
<td>13813-13830</td>
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</table>

### A2627

Arco Oil & Gas Co. Simpson #1 (NDGS Well #9800), 1980 FEL, 1980 FSL, NW 1/4 SE 1/4 sec. 27, T. 158 N., R. 97 W., Williams Co., N. D.

<table>
<thead>
<tr>
<th>Number</th>
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<th>Number</th>
<th>Interval (ft below KB)</th>
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<tbody>
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<td>A2627.2</td>
<td>13263-13266.7</td>
<td>A2627.4</td>
<td>13269.8-13273</td>
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</table>

### A2628

Shell Oil Co. Larson #23X-9 (NDGS Well #6296), 1873 FWL, 1829 FSL, NE 1/4 SW 1/4 sec. 9, T. 163 N., R. 87 W., Renville Co., N. D.

<table>
<thead>
<tr>
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<th>Number</th>
<th>Interval or Horizon (ft below KB)</th>
</tr>
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<tbody>
<tr>
<td>A2628.1</td>
<td>8682</td>
<td>A2628.5</td>
<td>8704.5-8712</td>
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<tr>
<td>A2628.2</td>
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<td>A2628.6</td>
<td>8712-8720.5</td>
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<td>A2628.3</td>
<td>8688-8696</td>
<td>A2628.7</td>
<td>8720.5-8729</td>
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<tr>
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<td>8696-8704.5</td>
<td>A2628.8</td>
<td>8729-8737.5</td>
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</table>
A2629

Kerr-McGee Oil Industries, Inc. Johnson #1 (NDGS Well #1546), 660 FNL, 1975 FWL, NE 1/4 NW 1/4 sec. 34, T. 162 N., R. 101 W., Divide Co., N. D.

Core was unmarked "representative" core, in very poor condition. No collection was made. The Gunn Member was present from 11098 ft. to 11135 ft. below KB in this well.
Core descriptions are arranged alphabetically by county and in numerical order by North Dakota Geological Survey (NDGS) well number within each county. Depths are given in feet below Kelly bushing (KB) and were taken from labels on core boxes stored at the Wilson M. Laird Core and Sample Library of the NDGS, located on the campus of the University of North Dakota in Grand Forks.

Core description format is rock name followed by color, allochems (except that fossils are indicated separately in the right column), and other features. Colors were described for dry specimens. Colors, with their alpha-numeric designations, are from the Rack Color Chart (Goddard et al., 1948).

Fossils are identified to the lowest taxonomic level possible given the available material. To save space, fossil material is abbreviated as follows: b=brachiopod, bo=orthide brachiopod, Bp=Bighornia patella, br=small rhynchonellide brachiopod, bs=strophomenide brachiopod, bt=trepostome bryozoan, c=coral, Dc=Dinorthis (Dinarthis) carletona, Ds=Diceromyonia storeya, g=gastropod, Ho=Hebertella occidentalis montoyensis, Ht=Murchisonia (Hormotoma) trentonensis, Lt=Lobocorallium trilobatum, Mn=Megamyonia nitens, Os=Oepikina pergibbosa, P=Paleofavosites sp., Rg=Rhynchotrema gigas, Ss=Salvadorea selecta, t=trilobite material.

### Bowman County

<table>
<thead>
<tr>
<th>NDGS Well #4143 (A2619)</th>
<th>sec. 15, T. 130 N., R. 104 W.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Depth</strong></td>
<td><strong>Description</strong></td>
</tr>
<tr>
<td>9422-9448</td>
<td>Limestone, dolomitic, argillaceous, dark greenish gray (5GY4/1) to medium bluish gray (5B6/1) sparsely fossiliferous in thin &quot;hash&quot; beds, otherwise largely barren.</td>
</tr>
<tr>
<td>9448-9455</td>
<td>Limestone, as above; some pyritization, preferentially in burrows.</td>
</tr>
<tr>
<td>9455</td>
<td>Contact (?) with Red River Formation; karsted surface infilled with mottled yellowish gray (5Y7.5/1), light bluish gray (5B7/1) and olive gray (5Y5/1) argillaceous limestone.</td>
</tr>
</tbody>
</table>
### Cavalier County

#### NDGS Well #27 (A2601)

<table>
<thead>
<tr>
<th>Depth</th>
<th>Description</th>
<th>Fossils</th>
</tr>
</thead>
<tbody>
<tr>
<td>2590-2593</td>
<td>Limestone, dolomitic, argillaceous, mottled, burrowed, light greenish gray (5GY7/1) and grayish red purple (5RP5/2).</td>
<td>b, c, Dc</td>
</tr>
<tr>
<td>2593-2603</td>
<td>Limestone, as above, interbedded with thin pale bluish purple (5P87.5/3) limestones; mottling less pronounced, burrows less abundant.</td>
<td>b, br, bs bt, c, Dc Ds, g, Ho Rg, Ss, t</td>
</tr>
<tr>
<td>2603</td>
<td>End core</td>
<td></td>
</tr>
</tbody>
</table>

#### NDGS Well #37 (A2600)

<table>
<thead>
<tr>
<th>Depth</th>
<th>Description</th>
<th>Fossils</th>
</tr>
</thead>
<tbody>
<tr>
<td>2845-2864</td>
<td>Mudstone, olive gray (5Y4/1) to light olive gray (5Y6/1), with zones of fossil &quot;hash&quot;, shell debris, and thin light bluish gray (5B8/1) bioclastic limestones, burrowed in part.</td>
<td>b, bc, br bs, bt, c Da, Dc Ds, g, Ho Lt, Mn Op, Rg Ss, t</td>
</tr>
<tr>
<td>2864</td>
<td>Top Red River Formation</td>
<td></td>
</tr>
</tbody>
</table>

### Divide County

#### NDGS Well #1546 (A2629)

Core was "representative" core, unmarked, with 8 to 14 feet in a 2.5 foot core box. Depths are, therefore, very imprecise.

<table>
<thead>
<tr>
<th>Depth</th>
<th>Description</th>
<th>Fossils</th>
</tr>
</thead>
<tbody>
<tr>
<td>11098</td>
<td>Top Gunn Member</td>
<td>Dc, Ds</td>
</tr>
<tr>
<td>11098-11103</td>
<td>Dolostone, argillaceous, calcareous, medium gray (N5) to gark greenish gray (5GY4/1), burrowed, laminated near base.</td>
<td></td>
</tr>
<tr>
<td>11103-11120</td>
<td>Dolostone, as above, dark greenish gray (5GY4/1) Dc, Ds</td>
<td></td>
</tr>
<tr>
<td>11120-11135</td>
<td>Dolostone, as above, becoming olive gray (5Y4/1) Bp, br toward base; sparse fossil &quot;hash&quot; throughout.</td>
<td>bt, c, Dc Rg</td>
</tr>
<tr>
<td>11135</td>
<td>Top Red River.</td>
<td></td>
</tr>
</tbody>
</table>
Dunn County

NDGS Well #505 (A2620)  sec. 6, T. 141 N., R. 94 W.

12224  Top Gunn Member

12224-12236 Limestone, argillaceous, dolomitic, dark greenish gray (5GY4.5/1), sparsely fossiliferous near top, abundantly fossiliferous toward base, "hash" zones common near base.

12236-12246 Limestone, as above, dark greenish gray (5GY3.5/1), interbedded with bioclastic limestones, pale blue (5B7/2), burrowed in part, abundantly fossiliferous.

12246-12298 Limestone, dolomitic, argillaceous, dark greenish gray (5GY2.5/1) interbedded with light bluish gray (5B6/1) bioclastic limestone; bryozoan boundstone near middle of interval; only 6 feet of core preserved in interval.

12298-12304 Dolostone, calcareous, argillaceous, dark greenish gray (5G4.5/1) to medium gray (N4.5), largely barren with few thin fossil zones.

12304-12310 Dolostone, as above; sparse trilobite fragments, otherwise barren.

12310-12313 Limestone, dolomitic, argillaceous, dark greenish gray (5G3/1) to dark gray (N3), fossiliferous near top.

12313  Top Red River Formation.

Hettinger County

NDGS Well #511 (A2618)  sec. 24, T. 134 N., R. 96 W.

Core from this well was 5 cm in diameter, 5 to 6 feet per box. It was not possible to determine the order of the core fragments or which direction was originally up.

10145-10168 Limestone, bioclastic, medium bluish gray (5B5.5/1) interbedded with olive gray (5Y4/1) dolomitic mudstone, abundantly fossiliferous; brachiopods relatively rare.
McHenry County

NDGS Well #8803 (A2603)  
sec. 22, T. 151 N., R. 80 W.

7602  Top Gunn Member.

7602-7607  Dolostone, argillaceous, greenish gray (5GY6/1) burrows in greenish (5GY5/1) matrix; body fossils absent.

7607-7611  Dolostone, as above; thin light bluish gray (5B6.5/1) bioclastic limestone interbeds.

7611-7681  Limestone, dolomitic, argillaceous, greenish gray (5GY5/1) with light bluish gray (5B6.5/1) bioclastic limestone interbeds; abundantly fossiliferous throughout.

7681-7688  Limestone, as above; fossils sparse.

7688  Top Red River Formation.

McKenzie County

NDGS Well #2373 (A2623)  
sec. 1, T. 152 N., R. 95 W.

13053-13098  Limestone, dolomitic, argillaceous, dark gray (N3) to dark greenish gray (5GY3/1) interbedded with thin light bluish gray (5B6/1) bioclastic limestones and thin fossil "hash" zones; brachiopods commonly decorticated.

13098  Top Red River Formation.

NDGS Well #6839 (A2625)  
sec. 11, T. 150 N., R. 104 W.

12679  Top Gunn Member.

12679-12731  Limestone, argillaceous, light greenish gray (5GY5/1), interbedded with light bluish gray (5B7.5/1) limestones; abundantly fossiliferous.

12731  Top Red River Formation.
341

**NDGS Well #7501 (A2622)**

sec. 25, T. 145 N., R. 100 W.

13340-13345 Limestone, dolomitic, argillaceous, dark gray (N3); fossiliferous zones alternating with barren zones.

13345-13348 Core missing.

13348-13367 Limestone, dolomitic, argillaceous, dark gray (N3 to N4) interbedded with light bluish gray (5B6.5/1) bioclastic limestone; fossils moderately abundant.

13367 Top Red River Formation.

**McLean County**

**NDGS Well #8711 (A2615)**

sec. 31, T. 146 N., R. 80 W.

7715-7721 Dolostone, argillaceous, greenish gray (5GY5/1) to light bluish gray (5B8/1) bioclastic limestone; fossils moderately abundant.

7721 Top Red River Formation.

**NDGS Well #8993 (A2614)**

sec. 26, T. 149 N., R. 80 W.

7713-7727 Limestone, dolomitic, very argillaceous, grayish green (5G5/2) with thin interbeds of light bluish gray (5B6/1) bioclastic limestone; fossils moderately abundant; locally pyritized.

7727 Top Red River Formation.

**Morton County**

**NDGS Well #7340 (A2616)**

sec. 26, T. 140 N., R. 88 W.

9770-9826 Limestone, dolomitic, argillaceous, greenish gray (5GY4.5/1 to 5GY5.5/1) with interbeds of light bluish gray (5B7.5/1) bioclastic limestone; locally burrowed; locally pyritized.

9826 End core.
Ramsey County

NDGS Well #20 (A2602)  sec. 29, T. 158 N., R. 62 W.

2389  Top Gunn Member.

2389-2398  Limestone, argillaceous, grayish purple (5P4.5/2) with interbeds of light purplish gray (5P7.5/1) limestone, very fossiliferous.  c, Dc, Lt b, bs, bt c, Dc, Lt Op, Ss

2398-2407  Limestone, argillaceous, burrowed, mottled, pale reddish gray (5R6.5/1), greenish gray (5GY5.5/1), and light olive gray (5Y6/1) with light purplish gray (5P8/1) bioclastic limestone; fossils less abundant than in above interval.  b, bt, c Ds, g, Ss t

2407-2422  Limestone, as above; fossils, especially brachiopods, abundant.  b, br, bs bt, c, Ds g, Mn, Op Ss, t

2422-2453  Limestone, argillaceous, light brownish gray (5YR6/1), purplish gray (5P4/1), and some dusky yellow green (5GY4.5/2) and olive gray (5Y4/1) with interbeds of light bluish gray (5B7/1) limestone.  b, Bp, br bs, bt, c Dc, Ds, g Ho, Mn Op, Rg Ss, t

2453-2480  Limestone, very argillaceous, and calcareous mudstone, reddish gray (5R6/1), dusky red (5R3/3), and greenish gray (5GY6/1) with interbeds of light bluish gray (5B7/1) limestone; fossils, especially brachiopods, very abundant.  b, Bp, br bs, bt, c Dc, Ds Ho, Mn Op, Rg Ss, t

2480  Top Red River Formation.

Renville County

NDGS Well #6296 (A2628)  sec. 9, T. 163 N., R. 87 W.

8675  Top Gunn Member

8675-8683  Dolostone, calcareous, argillaceous, greenish gray (5GY5/1); styloilite swarms, zones of fossil "hash"; fossils abundant.  b, bc, bt c, Dc, g Rg, Ss, t

8683-8731  Limestone, dolomitic, argillaceous, greenish gray (5GY5/1) with interbeds of light bluish gray (5B6/1) bioclastic limestone; fossils sparse to common; some thin barren zones.  b, br, bs bt, c, Dc Ds, Lt Rg, Ss, t
8731 Top Red River Formation.

Stark County

NDGS Well #4182 (A2617) sec. 23, T. 137 N., R. 92 W.

10150-10162 Dolostone, calcareous, argillaceous, olive gray (5Y3.5/1) with light bluish gray (5B6.5/1) limestone interbeds; fossils moderately common; thin barren zones and "hash" zones; locally pyritized.

10162 Top Red River Formation.

NDGS Well #4311 (A2621) sec. 20, T. 139 N., R. 97 W.

11928-11931 Limestone, dolomitic, argillaceous, olive gray (5Y4/1) to greenish gray (5GY5/1) to greenish black (5G2/1) with interbeds of light bluish gray (5B6.5/1) to medium bluish gray (5B5.5/1) limestone; fossils and "hash" zones moderately abundant.

11931-11968 Mudstone, calcareous, greenish gray (5G5/1), failtly laminated in part, with light bluish gray (5B7/1) limestone interbeds; fossils sparse, brachiopods decorticated; large barren zones.

11968-11970 Mudstone, as above; brachiopods relatively abundant.

11970 Top Red River Formation.

Williams County

NDGS Well #999 (A2626) sec. 23, T. 154 N., R. 100 W.

Core is intermittent -- only "representative samples" were retained.

13802 Top Gunn Member.

13802-13811 Limestone, dolomitic, argillaceous, olive gray (5Y4/1) to olive black (5Y2/1); sparsely fossiliferous.
13811-13854 Limestone, as above; thin interbeds of light bluish gray (5B8/1) bioclastic limestone; fossils common to abundant.

13854-13863 Limestone, as above; trepostome bryozoans common, other fossils uncommon.

13863 Top Red River Formation.

NDGS Well #1403 (A2624) sec. 15, T. 155 N., R. 96 W.

12593 Top Gunn Member.

12593-12597 Dolostone, calcareous, argillaceous, mottled medium gray (N5.5) and medium dark gray (N4.5), grading downward to dark greenish gray (5GY3/1); fossils sparse.

12597-12609 Dolostone, calcareous, argillaceous, dark greenish gray (5GY3.5/1); small light gray (N7.5) blebs and nodules of anhydrite; fossils abundant.

12609-12659 Dolostone, calcareous, argillaceous, dark greenish gray (5GY4/1) interbedded with light bluish gray (5B6.5/1) limestone; rare anhydrite blebs; thin "hash" zones; abundantly fossiliferous.

12659 Top Red River Formation.

NDGS Well #9800 (A2627) sec. 27, T. 158 N., R. 97 W.

13260-13273 Dolostone, calcareous, argillaceous, dark olive gray (5Y3/1) with interbeds of light bluish gray (5B7/1) limestone; abundantly fossiliferous.

13273 Top Red River Formation.
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