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Ostracoda of the upper Clays Ferry, Kope and lower Fairview Formations (Middle and Upper Ordovician) at Moffett Road, northern Kentucky

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Edited by John Pojeta, Jr.

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Illustrations

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Abstract.--The highly fossiliferous Moffett Road section, in Kenton County, Kentucky, spans the Middle-Late Ordovician boundary and includes all of the Late Ordovician Edenian Stage. Ostracodes are one of the more common elements in a fauna which also contains brachiopods, bryozoans, pelecypods, gastropods, trilobites, conodonts, scolecodonts and crinoids; they are present in 182 of the 229 samples collected from this section. There are at least 36 species of 22 genera present in the collections, of which five species are new. These are briefly described in open nomenclature and the other species are described or discussed. No distinct difference was found between ostracode assemblages from collections made from shales and those from limestones, but there is a noticeable faunal change between the Middle Ordovician (Shermanian) Point Pleasant Tongue of the Clays Ferry Formation and the Upper Ordovician (Edenian) Kope Formation, marked by the appearance of species of Jonesella, Pseudulrichia, Cincinnaticoncha and Edenopsis in the Kope. No such distinct change occurs in the ostracodes at the boundary between the Kope and the overlying Fairview Formation, but this may be partly because few well-preserved ostracodes were found in the lower Fairview. The ranges of all the ostracode taxa are shown on Plate 1, and the lithology and general faunal content of all the collections from the Moffett Road section are described in Appendix A.

Introduction

The tristate region of Ohio, Kentucky and Indiana, approximately centered on Cincinnati, Ohio, has been considered the classical area of Upper Ordovician rocks in the United States since Meek and Worthen (1865) proposed the Cincinnati Group. Rocks of this group are considered to belong to the Cinncinnatian Provincial Series, which, in ascending order, is divided into the Edenian, Maysvillian and Richmondian Stages. The oldest of these, the Edenian, is co-extensive with the Kope Formation of Weiss and Sweet (1964) in the Cincinnati area, but unfortunately the contact of the Kope with the underlying Shermanian Point Pleasant Tongue of the Clays Ferry Formation, and thus the boundary between the Upper and Middle Ordovician, is no longer exposed at Cincinnati. To obviate this, Pojeta (1981) proposed to designate a stratotype for the Edenian Stage at a section along Moffett Road, in the De Mossville 7 1/2 minute quadrangle, Kentucky, about 17 miles south of Cincinnati (fig. 1). At this locality, the contacts of the Kope with both the underlying Point Pleasant and the overlying Fairview Formation are exposed. The Fairview is not well exposed and only about 30 feet are present. Pojeta (written commun.) now prefers to use the Moffett Road section only as a Middle-Upper Ordovician boundary stratotype. The section was measured by A. B. Gibson and S. J. Luft in 1967. In 1969 John Pojeta Jr., R. J. Ross, Jr., and O. L. Karklins of the U. S. Geological Survey, and W. T. Dean, then of the Geological Survey of Canada, remeasured the section and collected 229 samples for biostratigraphic analysis, concentrating on the boundaries between the formations and especially the lower boundary (Middle-Upper Ordovician) between the Kope and Point Pleasant. These collections were prepared and two papers have been based on them, one by Karklins (1983) on the bryozoa, and one by

Sweet (1984) on the conodonts. This paper on the ostracodes continues the project of defining the ranges of species of various faunal groups in the Moffett Road section to make them more useful for biostratigraphic correlation. The ranges of ostracode taxa are shown on pl. 1, and brief comments and descriptions of the species are given in the text.

Acknowledgements.-- We are most grateful to Steven M. Warshauer, who not only made his unpublished doctoral dissertation on the Kope ostracodes available to us, but also loaned us his specimens for study. We also received valuable help from John Pojeta, Jr., who originated the project of having each group of fossils in the Moffett Road section studied by specialists in that group, and who has provided information on the position of collections in the section. Samples were prepared by David Oldham, L. W. Ward and Robin Bell.

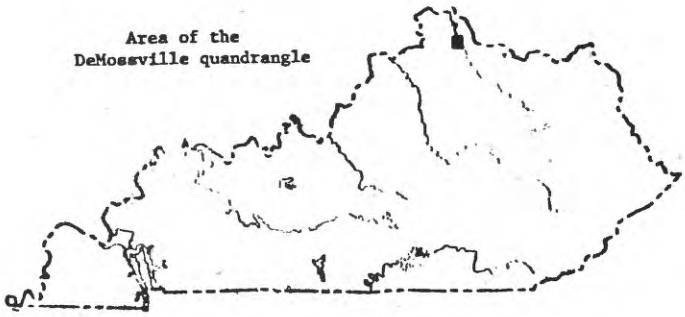
Previous work

Because the Ordovician formations in the vicinity of Cincinnati, Ohio and adjacent parts of Kentucky are richly fossiliferous, they were collected and studied by some of the first American paleontologists, who described many species of all elements of the fauna. As early as the middle of the 19th century, Emmons (1855) included ostracodes from this region as characteristic American fossils in his textbook on American Geology. Other authors who described ostracodes from this area were Hall (1871, 1872), Miller (1874a,b), Jones (1890) and especially Ulrich (1879, 1890). Bassler and Kellett (1934, p. 52) listed 20 species from beds that would now be considered equivalent to the Kope Formation of Edenian age; all were described before 1900. For the next 50 years very little was done with ostracodes of the Middle and lower Upper Ordovician of the Cincinnati area and Kentucky. Levinson (1951, p. 69-70) described the hingement of Ceratopsis chambersi (Miller, 1874) from the Edenian of Ohio, and Keenan (1951, pl. 78, figs. 1-7) figured but did not describe some of the typical species from the early Edenian. However, in 1972 S. M. Warshauer completed a Ph.D. dissertation on the taxonomy, ontogeny, biostratigraphy and paleoecology of the Edenian (Late Ordovician) ostracodes of the Ohio Valley, and subsequently Warshauer (1975, 1981) published short papers on Ceratopsis chambersi and on three new genera from the Edenian Stage. Ostracodes from older formations were described by Warshauer and Berdan (1982), who were able to provide a more modern taxonomy for some of the species named in the 19th century. The studies by Warshauer (1972) and Warshauer and Berdan (1982) have provided a contemporary basis for the present paper.

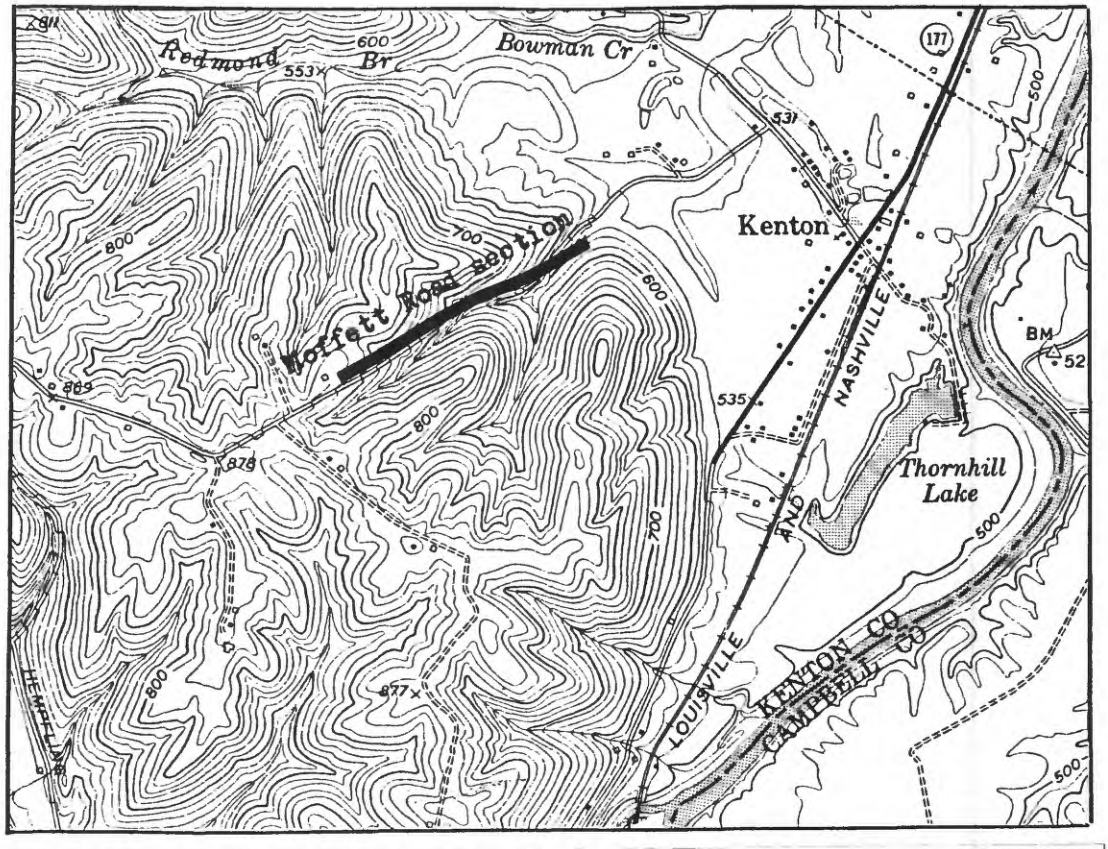
Locality and description of section

The base of the Moffett Road section is approximately 0.5 miles west of Kenton, Kenton County, Kentucky, in the De Mossville, Ky. 7 1/2 minute quadrangle, which was mapped geologically by Luft (1970). The base of the section is 118.5 mm east and 547 mm north of the lower left, or southwest, corner of this map in the bed of an unnamed creek; the lower 22 feet of the section are exposed in the creek bed and the remainder of the section is in road cuts along Moffett Road (fig. 1). The section is about 0.6 miles long and about 342 feet thick (Karklins, 1983, p. 5). When measured in 1969 by John Pojeta, Jr., A. B. Gibson and S. J. Luft the rocks were well exposed, but as the formations in this section tend to slump, the section is now partly covered (Sweet, 1984, p. 4). In 1969, the lowest 54 feet of the section were

assigned to the Point Pleasant Tongue of the Clays Ferry Formation, the overlying 257 feet to the Kope Formation, and above that, the upper 31 feet were assigned to the Fairview Formation. According to Weir, Peterson and Swadley (1984), the Clays Ferry consists of subequal amounts of limestone and shale (30-60 percent each) and minor siltstone 5-10 percent), the Kope is 60 to 80 percent shale and 20 to 40 percent limestone, and the Fairview is about 40 percent limestone to 60 percent shale and siltstone at its type area in Cincinnati. The Kope is thus somewhat shalier than either the Point Pleasant or the Fairview and tends to weather back and slump and be poorly exposed. Descriptions of the lithology and fossil content of all 229 samples collected from the Point Pleasant, Kope and Fairview are given in Appendix A, fossils being listed in order of their abundance in the samples.



INDEX MAP OF KENTUCKY



SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

Figure 1. Location of the Moffett Road section in the northwestern part of the De Mossville 7 1/2 minute quadrangle, Kentucky, and index map of Kentucky showing location of the De Mossville quadrangle.

Materials and methods

Ostracodes are one of the common components of the fauna of the Moffett Road section. They have been found in 182 out of 229 collections, those collections from which ostracodes have been recovered are shown on pl. 1. The specimens were obtained by three techniques; (1) boiling, washing and picking the clay shales, (2) dissolving collections in either acetic or hydrochloric acid and picking the residues, or (3) extracting specimens from limestone blocks and chips by heating and quenching and using a vibratool and needles. Because of these differences in manner of preparation and because the samples varied in size, no valid conclusions can be drawn by comparing the number of specimens from one collection to another; for example, the time-consuming process of preparing specimens from limestone produced far fewer individuals than would have been obtained from a collection of washed shale of comparable size because not every specimen of every taxon was extracted. Consequently, rather than giving the numbers of specimens on pl. 1, abundances have been indicated only by rare (r) = 1-5, common (c) = 6-20, abundant (a) = 21-50, and very abundant (va) = more than 50 specimens. In some collections, specimens are preserved only as steinkerns or are so badly corroded that they are unidentifiable; taxa from these collections have not been plotted on pl. 1. In general, specimens from limestone collections and from the rare etched collections are well preserved, as are some of those from the washed samples. Unfortunately, many of the specimens from washed samples are corroded and pocked with casts of dolomite crystals. One collection, USGS colln. 8396-CO (field no. M-1-69) from 0.5 foot above the base of the section, was not plotted on pl. 1 because it contains, in addition to steinkerns of Ceratopsis intermedia and Laccoprimitia sp., seven silicified specimens of taxa which do not occur elsewhere in the Clays Ferry Formation nor have they been found elsewhere in the Ordovician of the Cincinnati area. They almost certainly represent contamination in the laboratory, and as the succeeding collection, USGS colln. 8397-CO, is 0.5 to 1.1 feet above the base, the lower collection has been omitted. The lithologic column and the formation boundaries shown on pl. 1 are based on an unpublished section measured in 1967 by A. B. Gibbons and S. J. Luft, both of the U.S. Geological Survey.

Biostratigraphy

In the Moffett Road section, 48 of the 142 useable ostracode-bearing collections are from the Point Pleasant Tongue of the Clays Ferry Formation; in contrast, only 10 are from the Fairview Formation and the ostracodes in most of these are not well preserved. Consequently, biostratigraphic control is much better at the lower rather than the upper boundary of the Kope. As might be expected, the ranges of certain taxa overlap. Some species are less useful for zonation and correlation than others, either because they are long-ranging or because they are so rare that their ranges cannot be determined with certainty. For example, the distinctive species Warthinia nodosa (Ulrich, 1890) and Quasibollia persulcata (Ulrich, 1879) range through the Lexington Limestone, the Clays Ferry Formation, the Kope Formation and into the Fairview Formation. On the other hand, forms such as those listed on pl. 1 as "Primitia" gibbera Ulrich, 1894, Aechmina sp., Leperditella spp., and Ectoprimitia? sp. are sufficiently rare or poorly known that they are of little value for biostratigraphic zonation. A third group of species of doubtful utility includes most of the species of Laccoprimitia as well as

Phelobythocypris, Shenandoia? and Elliptocyprites, because these forms are difficult to identify unless well preserved. However, I have separated Phelobythocypris sp. from P. cylindrica (Hall, 1871) because there appears to be a change in lateral outline in the higher parts of the section. Distinctive taxa that seem to be of zonal value are the species of Ceratopsis, Ctenobolbina, Jonesella and Pseudoprimitiella, as well as Pseudulrichia byrnesi (Miller, 1874), Cincinnaticoncha pedigera (Ulrich, 1890) and Edenopsis bicava (Ulrich and Bassler, 1923). The species of Ceratopsis are particularly valuable because they can be discriminated by the character of the speral process, which in some collections is the only part of the ostracode that is preserved.

On this basis, three, and possibly four, informal assemblage zones can be proposed for the Moffett Road section. The oldest of these is the Ceratopsis intermedia zone, which is essentially coextensive with the exposed upper part of the Point Pleasant Tongue of the Clays Ferry Formation. In addition to C. intermedia Ulrich, 1894, the zone also contains Ceratopsis asymmetrica Warshauer and Berdan, 1982, C. fimbriata Warshauer and Berdan, 1982, Milleratia perminima (Ulrich, 1890), Laccoprimitia rudis (Ulrich, 1890) and Laccoprimitia claysferryensis Warshauer and Berdan, 1982. None of these species cross the Point Pleasant-Kope contact and all are typical of the fauna of the Clays Ferry Formation and Lexington Limestone (Warshauer and Berdan, 1982). Some species such as Ningulella paupera Warshauer and Berdan, 1982, Schmidtella brevis Ulrich, 1894, Phelobythocypris cylindrica (Hall, 1871) and Laccoprimitia cryptomorphologica Warshauer and Berdan, 1982, which occur in this zone, come up from older beds and range into the Kope. Other taxa, such as Pseudoprimitiella unicornis (Ulrich, 1879), Jonesella n. sp. B and Parenthatia n. sp., which are more common in higher beds, appear rarely in this zone.

The Edenopsis bicava zone succeeds the Ceratopsis intermedia zone rather abruptly, less than ten feet above the Point Pleasant-Kope Boundary. Species such as Pseudulrichia byrnesi (Miller, 1874) appear just above the contact, and the name-giver of the zone, Edenopsis bicava (Ulrich and Bassler, 1923) is abundant seven feet above the contact. Other species characteristic of this zone are Cincinnaticoncha pedigera (Ulrich, 1890), Laccoprimitia centralis Ulrich, 1890, Jonesella n. sp. A and Ningulella? sp. aff. N.? claypolei (Jones, 1890), as well as Pseudoprimitiella unicornis and Jonesella n. sp. B. With the exception of the last two taxa, none of the other species are known to occur in the Point Pleasant Tongue in the Moffett Road section or in the undifferentiated Clays Ferry Formation elsewhere. Although Ceratopsis sp. aff. C. chambersi ranges into this zone, it is present in only two of 39 collections considered to belong in the zone, which is also characterized by the scarcity of species of Ceratopsis.

The boundary between the succeeding Ceratopsis chambersi zone and the Edenopsis bicava zone is not as sharp as that between the two older zones. The name-giving species, Ceratopsis chambersi (Miller, 1874), appears 47 feet above the base of the Kope Formation and ranges to about ten feet below its top. Many of the species of the older Edenopsis bicava zone also occur in the lower part of the Ceratopsis chambersi zone; for example, Cincinnaticoncha pedigera, Pseudoprimitiella unicornis, Laccoprimitia centralis, Ningulella? sp. aff. N.? claypolei, Jonesella n. sp. B, and even Edenopsis bicava. However, these species are not as abundant in the Ceratopsis chambersi zone, and new species appear, such as Jonesella crepidiformis (Ulrich, 1879) and Pseudoprimitiella n. sp. Above the part of the section where the two zones overlap, the Ceratopsis

chambersi zone is characterized by C. chambersi, Phelobythocypris sp. and other podocopes, the ubiquitous long-ranging species Warthinia nodosa and Quasibollia persulcata, and Ctenobolbina ciliata (Emmons, 1855), which first appears in the lower Kope in the Edenopsis bicava zone and ranges through the Kope into the Fairview Formation.

A possible fourth zone marked by the appearance of Laccoprimitia n. sp., a punctate species, may be present in the upper 35 feet of the Kope Formation and possibly the lower part of the Fairview Formation at Moffett Road. This zone includes the taxa noted as typical for the Ceratopsis chambersi zone, as well as a greater abundance of Ctenobolbina alata Ulrich, 1890, which, although present in older horizons, is commoner near the top of the Kope. These occurrences hardly seem sufficient to justify proposing a zone. Unfortunately, the ostracode collections from the poorly exposed Fairview Formation in the Moffett Road section are poor and consist largely of long-ranging species, so the upward extent of zones in the upper part of the Kope cannot be surely determined.

To suggest the use of zones on the basis of only one measured section is a highly risky proposition. However, Warshauer (1972) studied ostracodes from 12 localities in the Kope Formation, 11 of which were measured sections. His sections included only one, the Moffett Road section, which exposed the contacts of the Kope Formation with the Point Pleasant below and the Fairview above; of his other sections, three contained the Point Pleasant-Kope contact and seven contained the Kope-Fairview contact. Warshauer (1972, p. 23-44) analyzed the ostracode assemblages in his samples by binary (presence-absence) Q-mode cluster analysis; dendrograms constructed using the Range method showed three Range Zones in the Kope. These appear to correspond to the assemblage zones of the Kope used in this report, his lowest zone (A) being the approximate equivalent of the Edenopsis bicava zone, his middle zone (B) being the Ceratopsis chambersi zone, and his highest zone (C) representing the unnamed zone marked by the appearance of Laccoprimitia n. sp. As Warshauer studied only ostracodes from the Kope, he did not have the Ceratopsis intermedia zone of the Point Pleasant. Warshauer's measured sections span an east-west distance of nearly 70 miles and a north-south distance of more than 26 miles, with the Moffett Road section being nearly in the middle of the area studied. All of his sections which show the Point Pleasant-Kope contact are east of the Moffett Road section. The most easterly of these, Kope Hollow, is a little more than 30 miles from Moffett Road and exposes 200 feet of the Kope Formation at its type section, but not the contact with the overlying Fairview (Warshauer, 1972, p. 17-18). In this section, Pseudulrichia byrnesi and Edenopsis bicava, together with Ceratopsis sp. aff. C. chambersi, occur 3 feet 3 inches above the base of the Kope; P. byrnesi is found only at this horizon, but E. bicava extends to 63 feet 3 inches above the base, where it is associated with C. chambersi s.s. These ranges are similar to those of the same taxa at Moffett Road except that P. byrnesi ranges to 56.3 feet above the base of the Kope in the Moffett Road section. The same general relationships appear to be maintained in the other two sections which include the Point Pleasant-Kope contact; in the Twelve Mile Creek section of Warshauer (1972, p. 16), P. byrnesi may range up to 30 feet above the base of the section, and is associated with C. chambersi. It appears likely that the Edenopsis bicava zone of the lower part of the Kope will prove to be a useful biostratigraphic unit, at least locally.

Warshauer's seven sections which include the Kope-Fairview contact provide better stratigraphic control for the upper part of the Kope than can be obtained

from our collections from the Moffett Road section. His samples from the Moffett Road section show Ctenobolbina alata and Laccoprimitia n. sp. in the uppermost 20 feet of the Kope; in our samples, Laccoprimitia n. sp. occurs through the upper 35 feet and C. alata is common about 30 feet below the top, but also occurs rarely about 185 feet below the top. Warshauer (1972, fig. 11) apparently did not sample the highest Kope in three of the other six sections which include the Kope-Fairview contact; unfortunately, two of these are his most westerly sections. The other three sections, of which two are close to Cincinnati and one is about 27 miles east of Moffett Road, all contain C. alata and Laccoprimitia n. sp. in the highest samples. However, all the other taxa in the upper part of the Kope also occur in the Ceratopsis chambersi zone and Ctenobolbina alata is known to occur rarely in this zone as well, so that Laccoprimitia n. sp. is the only form that appears to be restricted to the uppermost Kope and possibly the lowermost Fairview. This evidence does not appear to warrant proposing a distinct zone above the Ceratopsis chambersi Zone at this time, although it may prove to be desirable at some future date.

Warshauer did not collect samples from the Fairview Formation, and as noted previously, ostracodes in our samples from the poorly exposed Fairview in the Moffett Road section are sparse and poorly preserved. The single specimen of Laccoprimitia n.sp. is only questionably identified. Consequently, it is not possible to suggest any zonation for the Fairview from the material at hand. However, there is no indication that Ceratopsis chambersi ranges into the Fairview.

The ostracodes of the Maysvillian Stage, of which the Fairview is the oldest formation in northern Kentucky and adjacent southwestern Ohio, have not been critically studied for more than 50 years. Bassler and Kellett (1934, p. 53) listed ostracodes from the Maysvillian "Corryville Beds" and "Mount Auburn Beds" in southwestern Ohio; of 12 taxa listed, one is not an ostracode, five are also reported from the underlying Edenian, and six appear for the first time in the "Corryville". Of the six new species from Maysvillian beds, one, Americoncha marginata (Ulrich, 1890), although not reported from the Edenian by Bassler and Kellett (1934, p. 52), has been found by Warshauer (1972, p. 135-138) in the Kope Formation, and two, Elpezoe cincinnatiensis (Meek, 1872) and E. irregularis (Miller, 1878) are rare entomoconchids of doubtful stratigraphic value. The three remaining species, Ceratopsis oculifera (Hall, 1871), Ctenobolbina duryi (Miller, 1874) and Eridoconcha rugosa Ulrich and Bassler, 1923, may prove to be stratigraphically useful. However, it should be noted that the "Corryville Beds" would now be considered a part of the Bull Fork Formation, which is younger than the Fairview Formation (Weir, Peterson and Swadley, 1984, p. E-24). Although the ostracodes from the Fairview are essentially unstudied, the five taxa listed from both the Edenian and the Maysvillian "Corryville Beds" by Bassler and Kellett (1934, p. 52-53) might be expected in the Fairview, and in fact two of them, Quasibollia persulcata and Warthinia nodosa, have been found in the Fairview of the Moffett Road Section.

The ostracode zonation suggested for the Moffett Road section appears to be valid for north-central Kentucky and adjacent parts of southwestern Ohio, based on the evidence presented here and from Warshauer's measured sections. Whether it can be extended beyond this area remains to be seen. Some ostracodes from the Clays Ferry Formation were described by Warshauer and Berdan (1982) and were listed by Weir, Peterson and Swadley (1984, p. E67); no ostracodes were listed for the Kope because they were unstudied at the time the 1984 report was

prepared. With the exception of six collections from the upper part of section 192, Sadieville C of Cressman (1973), all the collections from which ostracodes were described and listed from the Clays Ferry were from the lower part of the formation and the species in them are either long-ranging or are typical of the Ceratopsis intermedia Zone. The Edenopsis bicava Zone has not has not been recognized in the Sadieville C section, but five collections from the upper part of the section, starting at 97 feet above the base, contain Ceratopsis chambersi. However, the Sadieville C section, in Scott County, Ky., although further south than any of the other sections discussed in this paper, is considered to be in north-central Kentucky by Weir, Peterson and Swadley (1984); without more data on the Kope and Clays Ferry ostracodes in central and east-central Kentucky it is not possible to determine how far the Edenian ostracode zones extend southward.

It should be noted that Ruedemann (1926, p. 140, pl. 23, figs. 13-15) described and figured specimens of Cincinnaticoncha pedigera (as Jonesella) from the Whetstone Gulf Formation from his station 6 in the Lorraine Gulf section in New York. According to Sweet and Bergstrom (1976, text-fig. 3), the Whetstone Gulf is Maysvillian in age, but apparently this is based on its stratigraphic position above the Utica Shale and partly equivalent Hillier Limestone, as they reported no conodonts from the Whetstone Gulf (Sweet and Bergstrom, 1976, p. 149). It is not possible to determine whether the occurrence of Cincinnaticoncha pedigera in the Whetstone Gulf represents a recurrence of the species in the Maysvillian or whether its presence indicates an Edenian age for the lower part of the Whetstone Gulf without a careful study of the Maysvillian ostracodes from the Cincinnati region, which is beyond the scope of this paper.

In summary, the most conspicuous faunal break in the ostracodes of the Moffett Road section occurs at the Point Pleasant-Kope boundary, where a number of new and distinctive taxa are added to the fauna. With the exception of Jonesella n. sp. B, no species of Jonesella are known in the Point Pleasant, and the addition of Edenopsis bicava, Cincinnaticoncha pedigera and Pseudulrichia byrnesi in the lower part of the Kope is striking. Other zones in the Kope are not as distinct, but Ceratopsis chambersi first appears 54 feet above the base of the formation. The upper part of the Kope and possibly the lower Fairview may constitute a third Late Ordovician zone characterized by Laccoprimitia n. sp. and species of Ctenobolbina, but the data are not adequate to be certain of this.

Comparison of the ranges of ostracode taxa with those of bryozoans and conodonts suggests that the ostracodes may prove more useful than the other two groups in discriminating the Middle-Late Ordovician boundary. Karklins (1983, p. 12) proposed the bryozoan Stictoporella interstincta assemblage zone and considered that it extended from the upper Point Pleasant into the lower 44 feet of the Kope Formation, thus including the boundary. Sweet (1984) and Pojeta (in Weir, Peterson and Swadley, 1984, fig. 51) indicated that the conodont Amorphognathus superbus zone also straddled the boundary. In contrast, the ostracode Edenopsis bicava zone first appears essentially at the boundary with the addition of Pseudulrichia byrnesi, a distinctive element of the zone, to the ostracode fauna. The relative position of this zone in relation to those above and below it extends through the area of the sections studied by Warshauer (1972); further work is required to determine whether it can be traced further.

Paleoecology

Living marine ostracodes inhabit environments ranging in depth from intertidal to bathyal and may be either pelagic or benthic; most are the latter. Benthic forms are found on all varieties of substrate, including sand (Barker, 1983), flocculent mud (Abe, 1983) and algae (Whatley and Wall, 1975). According to Benson (1961, p. Q58), most fossil marine ostracodes were crawlers, burrowers, and near-bottom swimmers. Although quite a bit of work has been done on the paleoecology of Tertiary and Mesozoic ostracodes (Oertli, 1971), which are more comparable to the living forms, the paleoecology of the Paleozoic species has been less thoroughly studied. Most of the papers on the Paleozoic are concerned with the Carboniferous and Devonian (Becker, 1971; Becker and others, 1974; Berdan, 1981; Bless, 1982, 1983; Le Fevre, 1971; among many others), but Lundin (1971) and Siemann-Gartmann (1983) have provided some information on the paleoecology of Silurian ostracodes. Very little has been published on the paleoecology of Ordovician ostracodes; Berdan (1984) summarized previous studies and discussed the environment in which leperditicopes lived, but this is only one specialized Order. Warshauer (in Warshauer and Berdan 1982) analyzed the ostracode faunas from the Lexington Limestone and the lower Clays Ferry Formation (Middle and Upper Ordovician) paleoecologically.

According to Weir, Peterson and Swadley (1984, p. E98), northcentral Kentucky was part of a shelf that sloped gently northward and was covered by marine waters of shallow to moderate depth during late Middle and Late Ordovician time. Sediments deposited in this sea were muds, lime muds and lime sands, which eventually formed lithofacies B (Clays Ferry and Fairview Formations) and D (Kope Formation) of Weir, Peterson and Swadley (1984, p. E84). Both the Point Pleasant Tongue of the Clays Ferry Formation and the Fairview Formation have a higher percentage of limestone than the Kope, and were presumably deposited in shallower and more frequently agitated water. The Kope formation is thought to have been deposited at depths of from 66 to 100 feet (Weir, Peterson and Swadley, 1984, p. E96).

The ostracodes of the Moffett Road section were probably transported after death, but also probably were not moved far from the environment in which they lived. Weir, Peterson and Swadley, (1984, p. E96) indicated the presence of ripple marks in their lithofacies B and D, which suggests that some of the fossils, especially in the limestone beds, may have been gently winnowed. Ostracodes, being small, may have been especially susceptible to movement by weak wave or current action. Specimens on chips of shale or shaly limestone are commonly concentrated on bedding planes, whereas those in bioclastic limestone may be at any angle to the bedding surfaces. I have not been able to detect any significant difference between the types of taxa in limestones or shales; possibly the species in limestone were washed into that environment. Most specimens are dissociated valves; complete carapaces are not common. Adamczak (1981) studied the orientation of ostracode valves on bedding surfaces and inferred that a predominance of valves oriented with the concave side up indicated settling from suspension whereas a predominance of valves with the convex side up indicated movement by currents without suspension. In most of the collections from Moffett Road in which the bedding surfaces can be determined the ostracodes are oriented with the convex side up, but in a few, notably USGS 8790-CO, from the Kope Formation 103 feet above the base of the section, most specimens are concave side up. Adamczak (1981, p. 2) also suggested that beds with a predominance of valves oriented vertically with respect to the bedding might indicate bioturbation; possibly some of the

limestone beds in the Moffett Road section have been disturbed by burrowing animals but in general the ostracode-bearing samples are too small to determine this by means of the texture, and the random orientation of the ostracodes could have been the result of other processes.

Benson (1961, p. Q60) summarized the functional morphology of ostracode shells and concluded that smooth, elongate forms were more apt to be burrowers in soft sediment and more highly ornamented forms probably crawled on the surface of the sediment or on algae; swimmers were smooth but with relatively short, thin shells. On these bases, genera such as Phelobythocypris, Shenandoia and Elliptocyprites, and possibly also Ningulella, Pseudoprimitiella and some species of Laccoprimitia may have burrowed in the substrate, whereas Warthinia, Quasibollia and Ctenobolbina crawled on the surface of the sediment or on algae, bryozoans or crinoids. The presence of algae is inferred, as none were preserved, but both bryozoans and crinoid columnals are common elements in the faunas of the formations in the Moffett Road section, and may have provided good microenvironments for ostracodes. Spinose forms such as Aechmina and Pseudulrichia were almost certainly not burrowers. The mode of life of the genus Ceratopsis is still uncertain. Warshauer and Berdan (1982, p. H36) speculated on possible functions of the speral process but were unable to arrive at any firm conclusions. One possible use of the speral process which was considered unlikely by Warshauer and Berdan was that the process served as a support for the animal when resting on its back while feeding. This hypothesis now seems somewhat more attractive because there seems to be a correlation between the length of the speral process and the type of sediment in which the animal lived. Species of Ceratopsis from limier formations, for example, C. intermedia and C. asymmetrica from the Point Pleasant and C. oculifera from the Fairview, have fairly short, rounded processes, whereas species from shalier formations, such as C. chambersi from the Kope and C. robusta from the Richmondian, have long, spike-like processes. This tendency can be seen in the form here discussed as Ceratopsis sp. aff. C. chambersi, which is basically a Ceratopsis intermedia with a more elongate speral process. This form appears as the section becomes shalier near the top of the Point Pleasant, and ranges into the lower Kope. Higher in the Kope it is replaced by C. chambersi s.s. Adamczak (1969) suggested that palaeocope ostracodes, of which Ceratopsis is one, might have been filter feeders. If Ceratopsis did feed in this manner, it is possible that the speral processes served more as an anchor to hold the animal on its back close to the bottom and in proper alignment with food bearing currents, with the longer speral process being a more effective anchor on a muddy bottom. However, this explanation does not solve the problem of why the speral process has a fimbriate margin and must be considered as hypothetical.

At some horizons, ostracodes are very abundant and one species may be present in disproportionate numbers. For example, in USGS colln. 8485-CO and 8486-CO from the Kope Formation, 98.8 and 99.3 feet above the base of the section, respectively, Warthinia nodosa is represented by 644 and 141 specimens, as opposed to 71 and 25 specimens of Quasibollia persulcata and smaller numbers of other taxa. Of the 644 specimens of W. nodosa in USGS colln. 8485-CO, only two are carapaces, the others are all single valves. All are about the same size and are believed to be adults. The abundance of W. nodosa is not due to size sorting because Q. persulcata and other less common taxa are about the same size as W. nodosa and a few specimens of much larger species such as Ctenobolbina ciliata are present in the same collection. One other sample, USGS colln. 8482-CO, 97.0 feet above the base of the section, also contains a disproportionately large number (85) of W. nodosa in relation to the other

ostracodes present in the assemblage; this suggests that the unusually large number of specimens of W. nodosa in USGS colln. 8485-CO does not represent a seasonal "bloom," as the species is highly abundant through more than two feet of beds, which probably would have accumulated through more than one season. Warshauer's collections are not sufficiently closely spaced to determine whether the influx of Warthinia has any stratigraphic significance or whether it is a local occurrence.

The relatively abrupt appearance of Pseudulrichia byrnesi, Cincinnaticoncha pedigera, Edenopsis bicava and Jonesella n. sp. A shortly above the Point Pleasant-Kope boundary does not appear to be related to the paleoenvironment. Possible ancestors for P. byrnesi, C. pedigera and E. bicava may occur in the Point Pleasant; P. byrnesi may have evolved from "Primitia" gibbera, Cincinnaticoncha from Pseudoprimitiella or Ningulella, and Edenopsis from a species of Laccoprimitia. Jonesella crepidiformis and Jonesella n. sp. A may have been derived from Jonesella n. sp. B, which occurs rarely in the upper part of the Point Pleasant, and which in turn may be a descendant of J. gonyloba Warshauer and Berdan, 1982. Jonesella gonyloba was described from the Curdsville and Logana Members of the Lexington Limestone, which are Kirkfieldian to Shermanian (Middle Ordovician) in age.

Systematic paleontology

In this part of the paper, taxa which have recently been described and figured by Warshauer (1975, 1981) and Warshauer and Berdan (1982) are not redescribed. Five new species are described in open nomenclature because adequate description is beyond the primarily stratigraphic scope of this paper, and other taxa are described because they are poorly known. The terminology used is based on Moore (1961, p. Q47-Q56), and the cartoons used to illustrate taxa on pl. 1 were mostly made from tracings of photographs and reduced; they are not to scale. The broken dotted lines on pl. 1 are to connect the names of taxa with their occurrences in the section; continuous dotted lines show the ranges of taxa. All specimens are deposited in the collections of the U.S. Geological Survey; they are on faunal slides designated by USGS collection numbers. Occurrence and range data given under the systematic descriptions are for the Moffett Road section only. Under "Occurrence", collections are listed in stratigraphic rather than numerical order.

Class OSTRACODA Latreille, 1804
Order PALAEOCOPIDA Henningsmoen, 1953
Suborder BEYRICHICOPINA Scott, 1961
Superfamily DREPANELLACEA Ulrich and Bassler, 1923
Family BOLLIIDAE Bouček, 1936
Genus QUASIBOLLIA Warshauer and Berdan, 1982

Type species.--Bollia persulcata Ulrich, 1879

Quasibollia persulcata (Ulrich, 1879)

Remarks.--This species has been redescribed and figured by Warshauer and Berdan (1982, p. H20-H22, pl. 1, figs. 2, 4-10). The lectotype and paralectotypes are from the Kope Formation at Covington, Ky.; it has also been found in the Grier, Millersburg, Strodes Creek and Tanglewood Members of the Lexington Limestone and in the Clays Ferry Formation. It occurs in the Moffett Road section from the Point Pleasant Tongue of the Clays Ferry Formation to the Fairview Formation.

Occurrence.--USGS colln. 8397-CO, 8398-CO, 8406-CO, 8413-CO, 8419-CO, 8421-CO, 8423-CO, 8426-CO, 8430-CO, 8437-CO, 8449-CO, from the Point Pleasant; 8451-CO, 8453-CO, 8456-CO, 8457-CO, 8460-CO, 8461-CO, 8466-CO, 8467-CO, 8468-CO, 8469-CO, 8470-CO, 8471-CO, 8472-CO, 8474-CO, 8480-CO, 8482-CO, 8483-CO, 8485-CO, 8486-CO, 8491-CO, 8492-CO, 8494-CO, 8499-CO, 8647-CO, 8506-CO, 8508-CO, 8510-CO, 8512-CO, 8537-CO, 8541-CO, 8544-CO, 8552-CO, 8554-CO, 8581-CO, 8585-CO, 8595-CO, 8598-CO, 8604-CO, from the Kope; 8611-CO, from the Fairview Formation.

Range.--From 0.5 to 317.9 feet above the base of the section. Although long-ranging, it is not usually abundant at any one horizon.

Genus WARTHINIA Spivey, 1939

Type species.--Primitia nodosa Ulrich, 1890

Warthinia nodosa (Ulrich, 1890)

Remarks.--This distinctive species has most recently been redescribed by Warshauer and Berdan (1982, p. H23-H26, pl. 1, figs. 12-21, pl. 2, figs. 9-11), who noted that the lectotype and paralectotypes came from the "Eden Group", Cincinnati, Ohio, but recorded hypotypes from the Curdsville, Grier, Millersburg and Tanglewood Members of the Lexington Limestone and the Clays Ferry Formation, in rocks of Kirkfieldian to Edenian age. The species occurs from the Point Pleasant to the Fairview in the Moffett Road section and in some collections is exceedingly abundant, one collection (USGS colln. 8485-CO) contained more than 600 specimens.

Occurrence.--USGS colln. 8397-CO, 8398-CO, 8399-CO, 8403-CO, 8405-CO, 8406-CO, 8407-CO, 8409-CO, 8413-CO, 8419-CO, 8425-CO, 8430-CO, 8437-CO, 8446-CO, 8449-CO, from the Point Pleasant; 8451-CO, 8453-CO, 8454-CO, 8456-CO, 8457-CO, 8458-CO, 8460-CO, 8461-CO, 8462-CO, 8465-CO, 8466-CO, 8467-CO, 8468-CO, 8469-CO, 8470-CO, 8471-CO, 8472-CO, 8474-CO, 8476-CO, 8477-CO, 8479-CO, 8480-CO, 8482-CO, 8483-CO, 8485-CO, 8486-CO, 8490-CO, 8491-CO, 8492-CO, 8494-CO, 8495-CO, 8496-CO, 8647-CO, 8508-CO, 8509-CO, 8512-CO, 8514-CO, 8517-CO, 8521-CO, 8520-CO, 8532-CO, 8535-CO, 8541-CO, 8540-CO, 8544-CO, 8548-CO, 8554-CO, 8559-CO, 8579-CO, 8583-CO, 8581-CO, 8595-CO, 8598-CO, 8603-CO, 8604-CO, from the Kope; 8621-CO, from the Fairview Formation.

Range.--From 0.5 to 333.4 feet above the base of the section.

Genus PARENTHATIA Kay, 1940

Type species.--Moorea punctata Ulrich, 1894

Parenthatia n. sp. A

Description.--Lateral outline amplete, subrectangular to oval; hingeline straight, anterior and posterior margins smoothly curved, ventral margin very gently curved to nearly straight, cardinal angles obtuse. Lateral surface of valve completely surrounded by velar ridge. Valve surface inside ridge punctate except for raised Y-shaped area in center of valve, Y-shaped area is horizontal, with arms of Y directed posteriorly.

Remarks.--This species is most closely related to Parenthatia sadievillensis Warshauer and Berdan, 1982, but differs from it in having the

central ridge Y-shaped, rather than a horizontal bar as in P. sadievillensis. This species is rare in the Moffett Road section; one specimen was found in the upper part of the Point Pleasant and three were found in two collections from the Kope.

Occurrence.--USGS collns. 8449-CO, from the Point Pleasant; 8552-CO, 8554-CO, from the Kope Formation.

Range.--From 53.6 to 212.8 feet above the base of the section.

Family AECHMINIDAE Bouček, 1936
Genus AECHMINA Jones and Holl, 1869
Type species.--Aechmina cuspidata Jones and Holl, 1869
Aechmina sp.

Description.--Lateral outline preplete; hinge line straight, anterior margin smoothly curved, ventral margin gently curved, rounding into more smoothly curved posterior margin. Spine on anterior half of valve, shorter than maximum length of valve, making angle of about 60° with plane of valves. Shell surface smooth.

Remarks.--The above description is based on six specimens from five collections (an additional specimen was lost in preparation) and several of the specimens are not complete. It is possible that more than one species is involved, as two specimens from the Point Pleasant Formation seem to have wider spine bases than those from the Kope, but the material is not adequate to determine whether this represents interspecific variation or a specific difference. However, the specimens from the Moffett Road section cannot be assigned to Aechmina richmondensis Ulrich and Bassler, 1923 because their spines are longer and more acute, and on the same basis are excluded from A. ionensis Kay, 1940, and A. kolihai Schmidt, 1941. In addition to having a shorter spine, A. maquoketensis Keenan, 1951 has a granular surface and a depression just anterior to the spine, and A. taurea Keenan, 1951 has a fimbriate free margin; none of these features has been observed in our Moffett Road material. The form most closely resembling the specimens from Moffett Road is Aechmina sp. of Copeland, (1965, p. 7, pl. 5, figs. 10-12) from the Middle Ordovician Bucke Formation of Ontario, but the spines on our specimens do not appear to be recurved posteriorly. All but one of the specimens recovered were from limestone samples.

Occurrence.--USGS collns. 8423-CO, 8431-CO, Point Pleasant Tongue of the Clays Ferry Formation; 8492-CO (specimen lost), 8495-CO, 8512-CO, 8535-CO, Kope Formation.

Range.--From 28.9 to 143.9 feet above the base of the section.

Family RICHINIDAE Scott, 1961

Genus JONESELLA Ulrich, 1980

Type species.--Jonesella crepidiformis Ulrich, 1890 (by original designation, = Leperditia crepiformis Ulrich, 1879, nomen oblitum).

Jonesella crepidiformis (Ulrich, 1879)

Leperditia crepiformis Ulrich, 1879, p. 2, pl. 7, figs. 3, 3a.

Jonesella crepidiformis Ulrich, 1890, p. 121-122, pl. 7, figs. 8a, b. c.

Jonesella crepidiformis (Ulrich). Bassler and Kellett, 1934, p. 343 (see for synonymy prior to 1934).

Description.--Lateral outline amplete; hingeline straight, anterior and posterior margins smoothly curved, ventral margin gently curved. Cardinal angles obtuse. Anterior half of valve occupied by U-shaped ridge which is reflected internally as groove. Ends of ridge may protrude above hingeline in lateral view. S2 enclosed by ridge, widest ventrally, small anterodorsal node between dorsal end of S2 and anterior limb of ridge. Valve slopes smoothly to free margins, no marginal or velar structures. Surface of valves very finely granulose.

Remarks.--Ulrich (1890, p. 121), in describing his new genus Jonesella, stated "Type, J. CREPIDIFORMIS (Leperditia crepiformis, Ulrich, Jour. Cin. Soc. Nat. Hist., Vol. II, p. 10, Pl. VII, Fig. 3, 3a, 1879)". Most subsequent authors have given the type of Jonesella as Leperditia crepidiformis (see Bassler and Kellett, 1934, p. 343). This binomen does not exist in Ulrich's original papers and L. crepiformis should be considered a nomen oblitum. Only one right valve of J. crepidiformis was found in the Moffett Road section, although the syntype lot USNM 41,359 consists of nine specimens from the "Utica gr., Covington, Ky.", from beds that should be the equivalent of the lower Kope Formation.

Occurrence.--USGS colln. 8535-CO, from the Kope Formation.

Range.--143.9 feet above base of section.

Jonesella n. sp. A

Description.--Lateral outline amplete; hingeline straight, anterior, ventral and posterior margins all smoothly curved, cardinal angles obtuse. Anterior two-thirds of valve occupied by broad U-shaped ridge, both limbs of ridge protrude above hingeline. S2 widest ventrally so that anterodorsal part of anterior limb appears wider and knob-like. Posteroventral part of U-shaped ridge sharply angular, protrudes posteriorly. Ridge involves entire thickness of valve, appears as groove in internal view. No marginal structures. Shell surface very finely granulose.

Remarks.--This species is most like Jonesella crepidiformis, but differs from that species in having a wider U-shaped ridge which occupies more of the valve surface and in the posteriorly directed posteroventral angulation or projection of the ridge. Unlike J. crepidiformis, it is quite common in some collections from the Moffett Road section, in the lower part of the Kope Formation.

Occurrence.--USGS collns. 8460-CO, 8462-CO, 8465-CO, 8466-CO, 8467-CO, 8468-CO, all in the Kope Formation.

Range.--From 68.0 to 82.2 feet above the base of the section.

Jonesella n. sp. B

Description.--Lateral outline amplete to preplete; hingeline straight, anterior and posterior margins smoothly curved, ventral margin gently curved, cardinal angles obtuse. Anterior half to two-thirds of valve occupied by disjunct U-shaped ridge which is skewed anteroventrally. S2 moderately deep, slanted anteriorly. Anterodorsal part of anterior limb of U-shaped ridge knob-like, may protrude above hingeline. Ventral part of U-shaped ridge has a sag or furrow dividing it from posterior limb. Posterior limb ends dorsally in posterodorsally directed spine. No marginal structures. Shell surface finely granulose.

Remarks.--This species is easily distinguished from Jonesella crepidiformis and Jonesella n. sp. A by the oblique nature of the U-shaped ridge and the posterodorsal spine. It is superficially similar to Pseudulrichia byrnesi (Miller, 1874), but the anterior limb of the U-shaped ridge is more prominent than the anterior lobe of P. byrnesi and more distinctly set off from the valve surface. Jonesella n. sp. B is fairly common in the lower part of the Kope Formation and is rare in the upper part of the Point Pleasant.

Occurrence.--USGS colIns. 8430-CO, 8437-CO, from the Point Pleasant; 8451-CO, 8456-CO, 8458-CO, 8460-CO, 8461-CO, 8462-CO, 8465-CO, 8466-CO, 8467-CO, 8468-CO, 8469-CO, 8470-CO, 8471-CO, 8472-CO, 8475-CO, 8474-CO, 8476-CO, 8477-CO, 8478-CO, 8479-CO, 8480-CO, 8482-CO, 8483-CO, 8485-CO, 8491-CO, 8492-CO, 8494-CO, 8495-CO, 8498-CO, 8650-CO, 8531-CO, from the Kope Formation.

Range.--From 34.8 to 139.9 feet above the base of the section.

Genus PSEUDULRICHIA Schmidt, 1941

Type species.--Leperditia byrnesi Miller, 1874, senior subjective synonym of Leperditia bivertex Ulrich, 1879.

Pseudulrichia byrnesi (Miller, 1874)

Description.--Lateral outline amplete; hingeline straight, anterior and posterior margins smoothly rounded, ventral margin gently curved, cardinal angles obtuse. Ll close to anterior margin, rounded, bulbous, does not extend above hingeline in lateral view. L2 posterior to midpoint of valve, posterodorsally directed horn which may or may not extend above hingeline in lateral view. S2 wide, at or anterior to midlength of valve, above midheight of valve, poorly defined by lobes. Weak marginal rim anterior of Ll, otherwise no marginal structures. Shell surface smooth.

Remarks.--Warshauer (1972) examined the syntypes of Leperditia byrnesi Miller, 1874 and the holotype of Leperditia bivertex Ulrich, 1879 and found them to be conspecific. Consequently, the type species of the genus Pseudulrichia, for which Schmidt (1941, p. 59) designated L. bivertex as type, should be L. byrnesi. According to Bassler and Kellett (1934, p. 286), the types of both species came from the "Trenton" in the vicinity of Cincinnati, Ohio and Covington, Ky., that is, probably from the Point Pleasant Tongue of

the Clays Ferry Formation. Warshauer (1972) found P. byrnesi in nine samples from the Kope Formation. In the Moffett Road section, P. byrnesi was found in four and possibly five collections from the lower part of the Kope.

Occurrence.--USGS collns. 8451-CO, 8453-CO, 8456-CO, ?8457-CO, 8494-CO, from the Kope.

Range.--From 54.7 to 110.3 feet above the base of the section.

Family INDETERMINATE
Genus CINCINNATICONCHA Warshauer, 1981

Type species.--Jonesella pedigera Ulrich, 1890
Cincinnaticoncha pedigera (Ulrich, 1890)

Remarks.--Warshauer (1981, p. 886-888) proposed the genus Cincinnaticoncha and redescribed the type species, C. pedigera, on the basis of the holotype and 30 hypotypes. The holotype (USNM 41,360) is from the "Utica Group, Covington, Ky." (Warshauer, 1981, p. 886) and the hypotypes are from the Kope Formation at several localities in northcentral Kentucky. The specimens from Moffett Road are in the lower part of the Kope Formation.

Occurrence.--USGS collns. 8460-CO, 8462-CO, 8466-CO, 8467-CO, 8468-CO, 8469-CO, 8471-CO, 8474-CO, 8475-CO, 8531-CO, from the Kope Formation.

Range.--From 68.0 to 139.9 feet above the base of the section.

Superfamily HOLLINACEA Swartz, 1936
Family HOLLINIDAE Swartz, 1936
Subfamily GUBERELLINAE Schallreuter, 1976
Genus CTENOBOLBINA Ulrich, 1890

Type species.--Beyrichia ciliata Emmons, 1855
Ctenobolbina ciliata (Emmons, 1855)

Beyrichia ciliata Emmons, 1855, v. 1, pt. 2, p. 219, tf. 74c.
Ctenobolbina ciliata (Emmons). Ulrich, 1890, p. 108-109, pl. 7, figs. 1a,b; Bassler and Kellett, 1934, p. 249-250 (see for synonymy before 1934).
Not Ctenobolbina cf. ciliata (Emmons). Wade, 1911, v. 67, pt. 3, no. 267, p. 452, pl. 36, fig. 6.
Ctenobolbina bispinosa Ulrich, 1890, v. 13, p. 110-111, pl. 7, fig. 6; Keenan, 1951, v. 25, no. 5, p. 572, pl. 78, fig. 1.

Description.--Lateral outline amplete; hingeline straight, anterior and posterior margins smoothly curved, ventral margin gently curved to straight, subparallel to hingeline. Cardinal angles obtuse but distinct, hingeline about four-fifths maximum length of valve. L1 large, inflated; L2 indistinct, nearly obsolete, merges with L1 at midheight; L3 narrower than L1; L4 low, occupies posterior quarter of valve. S1 shallow, indistinct, separates L2 from L1; S2 wide, deep, curved anteriorly, extends from hingeline to ventral margin of domicilium; S3 shallow, curved anteriorly, does not extend to either dorsal or ventral margin of domicilium. In adults, tecnomorphic velum extends from about midheight anteriorly to about midheight posteriorly; heteromorphic velum extends from above midheight anteriorly to midheight or below posteriorly, curves outward and downward anteriorly to form a frill funnel. Vela of both forms radially striate, may be fringed with spinelets. Juvenile specimens lack vela but may have row of spines in that position. Heteromorphic velum higher on valve than

tecnomorphic velum. All growth stages have row of rather coarse spinelets along free margins of both valves. All stages have more or less well developed hollow spine at ventral end of L3, juveniles may also have smaller spine at dorsal end of L3. Valve surface coarsely papillose except for S2 and velum.

Remarks.--Warshauer (1972) redescribed Ctenobolbina ciliata and demonstrated that the species is trimorphic by studying its ontogeny. This condition has also been observed in some hollinid genera, and together with the velar dimorphism and restricted velum of adults, suggests that C. ciliata, and therefore the genus Ctenobolbina of which it is the type species, belongs in the family Hollinidae. Ctenobolbina was only questionably placed in the Hollinidae in the Treatise on Invertebrate Paleontology (Moore, 1961, p. Q135) because at that time the species was not known to be dimorphic. Schallreuter (1976, p. 163, 210-211) considered Ctenobolbina to belong in the family Ctenonotellidae Schmidt, 1941 because it lacked either a histiovelum or a histium. However, it appears to have more characters in common with the hollinids than the ctenonotellids. Schallreuter (1976, p. 210) included Ctenobolbina in his new subfamily Guberellinae. Ctenobolbina ciliata is fairly abundant throughout the Kope and extends into the Fairview Formation in the Moffett Road section.

Occurrence.--USGS collns. 8459-CO, ?8474-CO, 8482-CO, 8484-CO, 8485-CO, 8493-CO, 8506-CO, 8529-CO, 8541-CO, 8544-CO, 8552-CO, ?8554-CO, ?8555-CO, 8559-CO, 8565-CO, ?8566-CO, 8569-CO, 8571-CO, 8574-CO, ?8576-CO, 8581-CO, 8587-CO, ?8590-CO, 8592-CO, 8594-CO, 8595-CO, 8597-CO, 8598-CO, 8603-CO, 8604-CO, from the Kope Formation; 8612-CO, ?8611-CO, 8616-CO, 8618-CO, ?8620-CO, from the Fairview Formation.

Range.--From 67.4 to 326.7 feet and possibly to 332.4 feet above the base of the section.

Ctenobolbina alata Ulrich, 1890

Description.--Lateral outline amplete to slightly preplete; hingeline straight, anterior and posterior margins smoothly curved, ventral margin gently curved to straight, cardinal angles obtuse. L1 and L2 merged, S1 a shallow, short indentation separating L1 and L2. S2 long, deep, curved anteriorly, extends from hingeline nearly to velum. L3 distinct, narrow, curved anteriorly, with strong alate spine at ventral end just above velum. S3 shallow, poorly defined but long, curved anteriorly; L4 smoothly curved. Small spine may be present at dorsal end of L3. Velum extends from above midheight anteriorly to below midheight posteriorly on heteromorphs. Wide antral channel below velum, marginal structure consists of small spinelets. Valve surface granulose.

Remarks.--The above description is based on the six syntypes (USNM 41,489) from "Utica gr., Cincinnati, Ohio" and about 10 fragmentary specimens from the Kope Formation in the Moffett Road section. Not enough specimens are available to determine much about the tecnomorphs of C. alata or whether the species is trimorphic like C. ciliata. The two species are very similar, the principal difference being the ventral spine on L3, which in C. ciliata is spike-like and has a circular cross-section when broken, whereas in C. alata the spine is flattened and alate, so that a broken spine has an elliptical cross-section. The spines of both species are hollow, but apparently do not

connect with the inner surface of the valve except under unusual types of preservation, so that they do not appear on steinkerns or valve interiors and the species cannot be discriminated from such material. Unfortunately, as noted by Schallreuter (1966, p. 856), Emmons (1855, p. 219, fig. 74c) figured only the interior of a valve of C. ciliata, so it is not possible to tell whether the specimen figured by Ulrich (1890, pl. 7, fig. 1) actually represents C. ciliata of Emmons. As C. ciliata of Ulrich appears to be much more common than C. alata, it probably does, and I have assigned indeterminable specimens of Ctenobolbina to C. ciliata because it is more abundant. The alate spine of C. alata is larger on the left valve than on the right valve. In addition to the differences in the spine, the ornamentation of C. alata is not as coarse as that of C. ciliata, but this distinction also requires the exterior of the valve.

Occurrence.--USGS colIns. 8485-CO, ?8512-CO, 8581-CO, all from the Kope Formation.

Range.--From 98.8 to 275.0 feet above the base of the section.

Family TETRADELLIDAE Swartz, 1936
Genus CERATOPSIS Ulrich, 1894

Type species.--Beyrichia chambersi Miller, 1874
Ceratopsis chambersi (Miller, 1874)

Remarks.--This species was redescribed by Warshauer (1975), who demonstrated that C. chambersi was dimorphic and developed a histial structure in adults only. The combination of the histial structure and the extremely long speral process of C. chambersi makes it possible to identify this species in collections even when the specimens are broken, as are many of those in the Moffett Road section. It is quite common in the Kope Formation.

Occurrence.--USGS colIns. 8485-CO, 8495-CO, 8498-CO, 8499-CO, 8648-CO, 8650-CO, 8506-CO, 8508-CO, ?8509-CO, 8510-CO, 8512-CO, 8513-CO, 8514-CO, 8516-CO, 8517-CO, 8518-CO, 8520-CO, 8521-CO, 8522-CO, 8525-CO, 8532-CO, 8535-CO, 8537-CO, 8538-CO, 8539-CO, 8541-CO, 8544-CO, 8548-CO, 8552-CO, 8554-CO, 8556-CO, 8574-CO, ?8576-CO, 8579-CO, 8580-CO, 8581-CO, 8582-CO, 8585-CO, 8587-CO, ?8588-CO, 8589-CO, 8590-CO, 8591-CO, 8592-CO, 8594-CO, 8595-CO, 8597-CO, all from the Kope Formation.

Range.--From 98.8 to 298.1 feet above the base of the section.

Ceratopsis intermedia Ulrich, 1894

Remarks.--This species was redescribed and illustrated for the first time by Warshauer and Berdan (1982, p. H36-H40, pl. 5, figs. 6-12, pl. 6, figs. 4, 7-10, pl. 7, figs. 6-9, 17, pl. 8, figs. 6, 7). Ceratopsis intermedia is characterized by a subtriangular palmate speral process directed anterolaterally and deep, wide sulci. It shows no development of a histial structure, unlike C. chambersi. In the Moffett Road section, it is considered to be confined to the Point Pleasant Tongue of the Clays Ferry Formation.

Occurrence.--USGS colIns. 8397-CO, 8398-CO, 8399-CO, 8402-CO, 8403-CO, 8404-CO, 8405-CO, 8406-CO, 8407-CO, 8409-CO, 8413-CO, 8415-CO, 8419-CO,

8422-CO, 8423-CO, 8426-CO, ?8429-CO, from the Point Pleasant Tongue of the Clays Ferry Formation.

Range.--From 0.5 to ?32.5 feet above the base of the section.

Ceratopsis asymmetrica Warshauer and Berdan, 1982

Remarks.--This species was proposed by Warshauer and Berdan (1982, p. H40-H42, pl. 6, figs. 1-3, 6, pl. 7, figs. 10-12, pl. 8, fig. 8) for specimens of Ceratopsis which have a wider subvelar area on the right than on the left valve and which have a subtriangular palmate speral process oblique to the surface of the valve, so that it appears to be tipped posteriorly. Ceratopsis asymmetrica occurs with C. intermedia and unless the specimens are well preserved it is not possible to tell the two species apart. C. asymmetrica occurs in the Point Pleasant in the lower part of the Moffett Road section.

Occurrence.--USGS colln. 8397-CO, 8398-CO, 8399-CO, 8402-CO, 8403-CO, 8404-CO, 8405-CO, 8406-CO, 8415-CO, from the Point Pleasant Tongue of the Clays Ferry Formation.

Range.--From 0.5 to 20.0 feet above the base of the section.

Ceratopsis fimbriata Warshauer and Berdan, 1982

Remarks.--This species was described by Warshauer and Berdan (1982, p. H43-H44, pl. 7, figs. 13-15) for specimens of Ceratopsis with a low, lanceolate speral process that is prolonged ventrally and is fimbriate along its entire distal edge. Only one specimen referable to C. fimbriata has been found in the Point Pleasant in the Moffett Road section.

Occurrence.--USGS colln. 8398-CO from the Point Pleasant Tongue of the Clays Ferry Formation.

Range.--From 2.1 to 2.8 feet above the base of the section.

Ceratopsis sp. aff. C. chambersi (Miller, 1874)

Description.--Lateral outline preplete; hingeline straight, anterior margin smoothly curved, ventral and posterior margins merge into each other in even curve; anterior cardinal angle distinct, posterior cardinal angle obtuse. Quadrilobate, lobes narrow, sulci wide and deep. Speral process erect, long, ovate face directed anteriorly. No distinct histial structure. Extent of velum not known.

Remarks.--Unfortunately, the material on which the above description is based is fragmentary or poorly preserved; the most complete specimen, from the Kope Formation, lacks the posterodorsal third of the valve. The lobation of this form is like that of Ceratopsis intermedia, but the speral process is longer and more erect, and approaches that of C. chambersi. This form appears to be intermediate between C. chambersi and C. intermedia, and is also intermediate in stratigraphic position. In the Moffett Road section, the lower part of its range, in the Point Pleasant, overlaps that of C. intermedia, and it extends upward into the lower part of the Kope, where C. intermedia is absent. The material is not adequate to determine whether

this form is a variation of C. intermedia, C. chambersi, or a new species.

Occurrence.--USGS colIns. 8398-CO, 8419-CO, 8421-CO, 8430-CO, 8431-CO, 8437-CO, from the Point Pleasant Tongue of the Clays Ferry Formation; 8453-CO, 8485-CO, from the Kope Formation.

Range.--From 2.1 to 98.8 feet above the base of the section.

Suborder KLOEDENELLOCOPINA Scott, 1961
Superfamily LEPERDITELLACEA Ulrich and Bassler, 1906
Family LEPERDITELLIDAE Ulrich and Bassler, 1906
Genus PSEUDOPRIMITIELLA Warshauer, 1981

Type species.--Leperditia unicornis Ulrich, 1879
Pseudoprimitiella unicornis (Ulrich, 1879)

Remarks.--Warshauer (1981, p. 889-890) proposed the genus Pseudoprimitiella and redescribed the type species P. unicornis on the basis of the syntypes (USNM 41,467) and 14 hypotypes from the Kope Formation. He also (Warshauer, 1981, p. 890, pl. 1, fig. 10) designated and figured a lectotype (USNM 41,467d). To judge from the specimens from the Moffett Road section, the lateral outline of this species is quite variable, many of them being more elongate than the lectotype. There does not appear to be any stratigraphic significance in this variability.

Occurrence.--USGS colIns. 8432-CO from the Point Pleasant; 8451-CO, 8453-CO, 8457-CO, 8458-CO, 8461-CO, 8466-CO, 8467-CO, 8468-CO, 8469-CO, 8470-CO, 8471-CO, 8472-CO, 8474-CO, 8475-CO, 8476-CO, 8477-CO, 8480-CO, 8482-CO, 8485-CO, 8486-CO, 8487-CO, 8489-CO, 8490-CO, 8492-CO, 8531-CO, 8554-CO, 8581-CO, ?8590-CO, from the Kope Formation.

Range.--From 37.8 to ?285.5 feet above the base of the section.

Pseudoprimitiella n. sp. A

Description.--Lateral outline amplete, elongate ovate; hingeline straight, anterior and posterior margins smoothly curved, ventral margin gently curved to straight, subparallel to dorsal margin, cardinal angles obtuse. Anterior and dorsal parts of valve slightly inflated so that valve surface slopes from dorsum to ventral margin. Short, stout, posteriorly directed spine on posterior of valve below midheight. Lateral surface of valve punctate.

Remarks.--The principal difference between this species and Pseudoprimitiella unicornis (Ulrich, 1879) is the punctate lateral surface of the new species. Pseudoprimitiella huilensis (Copeland, 1970), as described by Copeland (1970, p. 22-23, pl. 4, figs. 24, 27) from the Vaureal Formation of Anticosti Island, Quebec, is also punctate but is papillose as well and has a slight S2. Although Warshauer (1972) reported Pseudoprimitiella n. sp. A from eight collections from the lower part of the Kope in the Moffett Road section, I have definitely identified it in only one of our collections from the Kope, but this may be because the punctae cannot always be recognized on poorly preserved specimens.

Occurrence.--USGS colln. 8487-CO from the Kope Formation.

Range.--At 101.6 feet above the base of the section.

Genus NINGULELLA Warshauer and Berdan, 1982

Type species.--Ningulella paupera Warshauer and Berdan, 1982

Ningulella paupera Warshauer and Berdan, 1982

Remarks.--This species was described by Warshauer and Berdan (1982, p. H63-H64, pl. 15, figs. 10-18) from the Clays Ferry Formation and the Millersburg and Strodes Creek Members (Edenian) of the Lexington Limestone and questionably from the Grier Member (Shermanian) of the Lexington Limestone. In the Moffett Road section it occurs in the Point Pleasant and the lower half of the Kope Formation.

Occurrence.--USGS collns. 8397-CO, 8398-CO, 8399-CO, 8402-CO, 8404-CO, 8405-CO, 8406-CO, 8407-CO, ?8408-CO, 8409-CO, 8413-CO, 8415-CO, 8423-CO, 8426-CO, 8429-CO, 8445-CO, from the Point Pleasant; 8451-CO, 8453-CO, 8456-CO, 8457-CO, 8458-CO, ?8459-CO, 8460-CO, 8461-CO, 8462-CO, 8465-CO, 8466-CO, 8467-CO, 8468-CO, 8469-CO, 8470-CO, 8471-CO, 8473-CO, 8475-CO, 8478-CO, 8479-CO, ?8484-CO, 8485-CO, 8486-CO, ?8487-CO, 8490-CO, 8494-CO, 8495-CO, 8496-CO, ?8498-CO, 8506-CO, ?8548-CO, from the Kope Formation.

Range.--From 0.5 to 123.6 and questionably 198.5 feet above the base of the section.

Ningulella? sp. aff. N.? claypolei (Jones, 1890)

Leperditia claypolei Jones, 1890, p. 25, pl. 3, fig. 17.

Primitiella claypolei (Jones). Bassler, 1915, p. 1033; Bassler and Kellett, 1934, p. 461.

?Aparchites minutissimus (Hall). Warshauer, 1972, p. 128-134, pl. 6, figs. 9-13.

Not Schmidtella claypolei (Jones). Warshauer, 1972, p. 162-164, pl. 6, fig. 16.

Description.--Lateral outline slightly postplete to amplete; hingeline straight, about two-thirds length of valve, anterior margin sharply curved, rounding smoothly into gently curved ventral margin, posterior margin evenly curved. Hinge not incised, cardinal angles obtuse. Height of valve about half maximum length. No structures around free margins; valves meet evenly, overlap not determined. In end view, outline sharply curved in dorsal third of valve, sloping gently to ventral margin. Shell surface smooth.

Remarks.--This undistinguished species tends to have a leperditellid outline, and resembles Leperditella? canalis Ulrich, 1894 in lateral view. However, it lacks the posterodorsal inflation and incised hinge of Leperditella, nor does it have the marginal structure of L.? canalis. Warshauer (1972) assigned it to Aparchites? minutissimus (Hall, 1871), and stated that some of his pyritized specimens had the central swelling or node characteristic of A.? minutissimus. None of our specimens from Moffett Road show such a swelling, and it seems probable that more than one species is present. In any case, this species cannot be assigned to Aparchites, because Swartz (1969) demonstrated that the type species, A. whiteavesi Jones, 1889

had thickened free margins, a feature which is lacking in our material. Although relatively shorter and higher than the type species of Ningulella, N. paupera Warshauer and Berdan, 1982, the Moffett Road specimens otherwise agree with the characters of Ningulella. However, no carapaces have been found so the type of overlap cannot be determined, therefore this species is only questionably assigned to Ningulella. It may be related to the form described by Jones (1890, p. 25, pl. 3, fig. 17) as Leperditia claypolei, which is here also questionably assigned to Ningulella. Jones' species was described as coming from the vicinity of Cincinnati, Ohio and being associated with Ctenobolbina ciliata, which has not been found in formations older than the Kope. Warshauer (1972, p. 162-164, pl. 6, fig. 16) considered Jones' species to belong to Schmidtella and identified the specimens here assigned to S. brevis as S. claypolei (Jones). However, Jones (1890, p. 25, fig. 17) showed S. claypolei with a straight hingeline and the greatest width in the ventral half of the valve; this indicates that it does not belong in Schmidtella, which is umbonate and has the greatest width in the dorsal half of the valve. Unfortunately, the location of the types of "Leperditia" claypolei Jones, 1890 and "Leperditia (Isochilina)" minutissima Hall, 1871 is not known; until the types are restudied, neither species can be unequivocally assigned on the generic level.

Occurrence.--USGS collns. 8458-CO, 8461-CO, 8465-CO, 8466-CO, 8485-CO, ?8495-CO (3 larger specimens in limestone), from the Kope Formation.

Range.--From 66.8 to ?111.0 feet above the base of the section.

Genus SCHMIDTELLA Ulrich, 1892

Type species.--Schmidtella crassimarginata Ulrich, 1892
Schmidtella brevis Ulrich, 1894

Remarks.--Warshauer and Berdan (1982, p. H55, pl. 12, figs. 11-16) redescribed and refigured this species, including the holotype (USNM 41,299). As currently interpreted, this is a long-ranging species; the holotype is from the Decorah Shale (Rocklandian) near Fountain, Minn., and it has been found in the Millersburg and Strodes Creek (Edenian) Members of the Lexington Limestone and in the Clays Ferry Formation, also Edenian. In the Moffett Road section, it occurs in the Point Pleasant and ranges nearly to the top of the Kope Formation.

Occurrence.--USGS collns. 8419-CO, 8423-CO, 8429-CO, 8438-CO, 8445-CO, from the Point Pleasant; 8451-CO, ?8456-CO, 8457-CO, 8458-CO, 8461-CO, 8468-CO, 8471-CO, 8472-CO, 8474-CO, 8475-CO, 8476-CO, 8477-CO, 8482-CO, 8483-CO, 8485-CO, 8486-CO, 8487-CO, 8490-CO, 8491-CO, 8492-CO, 8493-CO, 8494-CO, 8497-CO, 8499-CO, 8647-CO, 8506-CO, 8507-CO, 8508-CO, 8510-CO, 8512-CO, ?8513-CO, 8520-CO, 8521-CO, 8531-CO, 8537-CO, 8538-CO, 8554-CO, 8570-CO, 8585-CO, 8590-CO, 8595-CO, from the Kope Formation.

Range.--From 25.6 to 293.5 feet above the base of the section.

Genus MILLERATIA Swartz, 1936

Type species.--Beyrichia cincinnatiensis Miller, 1875
Milleratia perminima (Ulrich, 1890)

Remarks.--Warshauer and Berdan (1982, p. H61-H62, pl. 14, figs. 1-5) redescribed and illustrated this species and concluded that the syntypes (USNM 41,436) came from the Point Pleasant Tongue of the Clays Ferry Formation. They also figured two specimens from the Point Pleasant at the Moffett Road section (Warshauer and Berdan, 1982, pl. 14, figs. 4, 5). In the more extensive collections from the Moffett Road section reported in this paper, M. perminima has been found in the lower part of the exposed Point Pleasant, and disappears about 15 feet below the Kope-Point Pleasant contact. It has not been found in the Kope.

Occurrence.--USGS collns. ?8398-CO, 8404-CO, 8405-CO, 8406-CO, 8409-CO, 8413-CO, 8415-CO, 8419-CO, ?8420-CO, 8421-CO, 8422-CO, 8423-CO, ?8424-CO, 8425-CO, 8426-CO, 8429-CO, 8431-CO, all from the Point Pleasant Tongue of the Ferry Formation.

Range.--From ?2.1 to 35.4 feet above the base of the section.

Genus LACCOPRIMITIA Ulrich and Bassler, 1923

Type species.--Primitia centralis Ulrich, 1890
Laccoprimitia centralis (Ulrich, 1890)

Remarks.--Warshauer and Berdan (1982, p. H57-H58, pl. 14, fig. 8) redescribed this species from the holotype only, and noted that although Ulrich (1890, p. 130-131) had stated that L. centralis occurred in beds which would now be considered the lower part of the Kope Formation, the label with the holotype suggested that it might have come from the Point Pleasant. A large number of specimens from the lower part of the Kope Formation in the Moffett Road section have characters which would put them in L. centralis rather than in the very similar species Laccoprimitis rudis (Ulrich, 1890), although they do not agree with the type of L. centralis in all respects. In particular, the size of the adductorial node appears to be quite variable, although it is small in the holotype. The criterion used here to discriminate between L. centralis and L. rudis is the development of the velar bend, which in L. centralis is obscure and not distinctly set off from the main part of the valve, rather than being distinctly set off and shelf-like as it is in L. rudis.

Occurrence.--USGS collns. 8453-CO, 8456-CO, 8457-CO, 8458-CO, 8460-CO, 8461-CO, ?8462-CO, 8465-CO, 8466-CO, 8467-CO, 8468-CO, 8469-CO, 8470-CO, 8471-CO, 8472-CO, 8474-CO, ?8484-CO, 8487-CO, ?8509-CO, ?8510-CO, 8531-CO, ?8594-CO, all in the Kope Formation.

Range.--From 60.8 feet to ?293.0 feet above the base of the section.

Laccoprimitia rudis [Ulrich, 1890)

Remarks.--This species was redescribed and refigured by Warshauer and Berdan (1982, p. H58-H59, pl. 14, figs. 9-19) on the basis of the holotype and 20 measured specimens. As noted by Warshauer and Berdan (1982, p. H58), the types apparently came from the Kope Formation, but approximately 470 specimens referable to this species were found in the Lexington Limestone and Clays Ferry Formation. As mentioned previously, the principal difference between L. rudis and L. centralis is in the degree of development of the velar bend,

which in L. rudis is distinctly set off from the domicilium by a groove approximately parallel to the free margin, so that it appears as a shelf in end view. Specimens from the Moffett Road section are quite variable in lateral outline, and not all of them show the pits in the velar groove mentioned by Warshauer and Berdan (1982, p. H58), but all are considered to belong to L. rudis.

Occurrence.--USGS collns. 8406-CO, 8419-CO, 8421-CO, 8422-CO, 8423-CO, 8424-CO, ?8425-CO, 8426-CO, 8429-CO, 8431-CO, 8432-CO, 8435-CO, 8437-CO, 8438-CO, ?8439-CO, 8440-CO, all from the Point Pleasant Tongue of the Clays Ferry Formation.

Range.--From 10.3 feet to 42.9 feet above the base of the section.

Laccoprimitia cryptomorphologica Warshauer and Berdan, 1982

Remarks.--This undistinguished species was proposed by Warshauer and Berdan (1982, p. H59-H60) for specimens of Laccoprimitia in which the generic characters are poorly developed and subdued. It was originally described from the Millersburg Member of the Lexington Limestone and the Clays Ferry Formation, both of Edenian age.

Occurrence.--USGS collns. 8397-CO, 8398-CO, 8399-CO, 8402-CO, 8404-CO, 8405-CO, 8406-CO, 8409-CO, ?8411-CO, ?8413-CO, 8415-CO, from the Point Pleasant Tongue of the Clays Ferry Formation; 8482-CO, 8483-CO, 8485-CO, 8486-CO, 8489-CO, 8490-CO, 8491-CO, 8492-CO, 8506-CO, 8508-CO, 8541-CO, 8544-CO, from the Kope Formation.

Range.--From 0.5 feet to 169.0 feet above the base of the section.

Laccoprimitia claysferryensis Warshauer and Berdan, 1982

Remarks.--This species was described by Warshauer and Berdan (1982, p. H60-H61, pl. 13, figs. 7, 8, pl. 14, figs. 28-32) from the Clays Ferry Formation at its supplemental type section in the Ford 7.5 minute quadrangle, Madison County, Kentucky. Four specimens in two collections from the Moffett Road section show the distinct groove separating the velar bend from the domicilium which is characteristic of Laccoprimitia claysferryensis. These specimens were extracted from a bioclastic limestone, some of which is fairly fine grained.

Occurrence.--USGS collns. 8423-CO, 8440-CO, from the Point Pleasant Tongue of the Clays Ferry Formation.

Range.--From 28.9 to 42.9 feet above the base of the section.

Laccoprimitia n. sp. A

Description.--Lateral outline amplete to slightly postplete; dorsal margin irregularly curved in lateral view because of posterodorsal swelling, hingeline straight, incised below swelling. Anterior margin sharply curved ventrally, ventral margin gently curved to straight, posterior margin smoothly curved. Marginal rim distinct, extending from anterior to posterior cardinal angles. Velar bend distinct, shelf-like. Adductorial node large, distinct,

subcentral to just anterior of midlength, bordered laterally by very narrow sulci which join above it to form weak S2. Surface of valves punctate except for adductorial node and velar bend.

Remarks.--This species is distinguished from other described species of Laccoprimitia in the Moffett Road section by its punctate ornamentation. It is similar to Laccoprimitia mica (Copeland, 1965) from the Middle Ordovician Liskeard Formation of Ontario, which is also punctate, but differs in having a more distinctly defined, shelf-like velar bend. It appears to be confined to the upper part of the Kope Formation, and questionably the lower part of the Fairview Formation.

Occurrence.--USGS collns. 8585-CO, ?8587-CO, 8592-CO, 8595-CO, 8597-CO, 8598-CO, 8603-CO, 8604-CO, from the Kope Formation; ?8622-CO, from the Fairview Formation.

Range.--From 276.6 feet to ?338.4 feet above the base of the section.

Genus EDENOPSIS Warshauer, 1981

Type species.--Octonaria bicava Ulrich and Bassler, 1923
Edenopsis bicava (Ulrich and Bassler, 1923)

Remarks.--Warshauer (1981, p. 891-892, pl. 1, figs. 1-8) proposed Edenopsis and redescribed and refigured E. bicava (Ulrich and Bassler, 1923), suggesting that the new genus might be related to Schmidtella Ulrich, 1892. It seems more probable that Edenopsis is related to Laccoprimitia, because the two characteristic sulci of Edenopsis could be derived from the bifurcating S2 that surrounds the adductorial node of some species of Laccoprimitia, such as L. rudis (Ulrich, 1890). According to Warshauer (1981, p. 892), it occurs in the lower two-thirds of the Kope Formation and is only known from the Edenian of the Cincinnati area. In the Moffett Road section, it is found in about the same stratigraphic position but is generally rare; none have been found in the Point Pleasant.

Occurrence.--USGS collns. 8457-CO, 8468-CO, 8474-CO, 8647-CO, 8506-CO, 8508-CO, 8509-CO, 8539-CO, 8540-CO, 8544-CO, 8585-CO, all from the Kope Formation.

Range.--From 62.8 to 276.6 feet above the base of the section.

Genus ECTOPRIMITIA Bouček, 1936

Type species.--Primitia corrugata Krause, 1892
Ectoprimitia? sp.

Description.--Lateral outline amplete to preplete; hingeline straight, nearly as long as maximum length, anterior and posterior margins smoothly curved, ventral margin very gently curved, anterior cardinal angle more acute than posterior. Unisulcate, sulcus just anterior of midlength of valve, extends from dorsal margin to midheight of valve, deepens ventrally and curves anteriorly. Valves appear to meet equally without distinct overlap, no velar structure but a very narrow marginal structure extends around free margins, widest posteriorly. Shell surface very finely reticulate.

Remarks.--The above description is based on two carapaces, one partly

corroded and the other badly corroded, from one collection. The specimens are most like the Chazyan species Ectoprimitia? diminucarina Kraft, 1962, but the marginal rims appear to meet evenly with no space between them. Also, the specimens are relatively shorter and are punctate rather than smooth. The specimens are too poorly preserved to identify even as to genus with any certainty, and may be juveniles.

Occurrence.--USGS colln. 8496-CO from the Kope Formation.

Range.--111.5 feet above the base of the section.

Genus LEPERDITELLA Ulrich, 1894

Type species.--Leperditella rex Coryell and Schenck, 1941

Leperditella spp.

Remarks.--Two, and possibly three, species of Leperditella are present in the Moffett Road section, but in most collections they are represented by only one single valve, which is not adequate for specific determination in this genus. The lowest specimen, a single right valve from the Point Pleasant 7.7 feet above the base of the section (USGS colln. 8404-CO), may belong to the species described as Leperditella? perplexa by Warshauer and Berdan (1982, p. H53, pl. 11, figs. 1-4). However, since neither the overlap nor the degree of incisement of the hinge can be determined, no firm identification is possible. One poorly preserved corroded carapace of a rather short Leperditella? occurs in the Kope Formation 94.6 feet above the base of the section (USGS colln. 8480-CO); this specimen is so poor that it can only questionably be assigned to the genus. Higher in the section, three collections from the Kope, USGS collns. 8512-CO, 8517-CO and 8521-CO from 127.1, 130.4 and 131.5 feet above the base of the section, respectively, each contain one specimen of a Leperditella. These specimens are probably conspecific, although the highest one is larger than the others. All have a characteristic postplete leperditellid outline in lateral view, a posterodorsal swelling in both valves between which the hinge is incised, and a weak, indistinct sag in the dorsal part of the shell anterior to the posterodorsal swelling. A carapace from USGS colln. 8517-CO shows leperditellid left valve over right overlap. These specimens from the Kope resemble the form described as Leperditella sp. aff. L. tumida (Ulrich, 1892) by Warshauer and Berdan (1982, p. H52, pl. 11, figs. 10-14) from the Clays Ferry Formation and Lexington Limestone, but the Kope specimens are relatively shorter. The material is inadequate for specific identification.

Occurrence.--USGS collns. 8404-CO from the Point Pleasant, ?8480-CO, 8512-CO, 8517-CO, 8521-CO from the Kope.

Range.--From 7.7 feet to 131.5 feet above the base of the section.

Genus PRIMITIA Jones and Holl, 1865

Type species.--Beyrichia mundula Jones, 1855

"Primitia" gibbera Ulrich, 1894

Primitia gibbera Ulrich, 1894, p. 655-656, pl. 43, figs. 57-59; Bassler, 1915, p. 1030; Ladd, 1929, p. 395; Bassler and Kellett, 1934, p. 444.

Not Primitia gibbera Ulrich. Spivey, 1939, p. 166, pl. 21, figs. 7, 8.

Description.--Lateral outline amplete; hinge line short, straight,

anterior, ventral and posterior margins smoothly curved to form nearly circular outline. Shallow sulcus in dorsal half of valve, slightly anterior of midlength, separates two low indistinct nodes. In end view, shell surface slopes from nodes to free margin. No marginal structures. Shell surface smooth.

Remarks.--The above description is based on eight specimens from the Point Pleasant, which show some variability in the distinctness of the nodes. The Moffett Road specimens are very similar to Ulrich's syntypes (USNM 41,341) of Primitia gibbera from the Maquoketa Shale three miles north of Spring Valley, Minnesota, except that Ulrich's specimens are more elongate. Unfortunately, the syntypes are on a chip of dolomitic shale and are not well preserved. Primitia tumidula Ulrich, 1894 is also similar, but has a marginal bend, as noted by Ulrich (1894, p. 655). Primitia mammata Ulrich, 1894 is more elongate and has a distinct posterior cardinal angle. The specimens which Spivey (1939, p. 166, pl. 21, figs. 7, 8) assigned to P. gibbera are here excluded from the species because they have a marginal structure. The generic name Primitia is placed in quotes because Jones (1855, p. 90, pl. 6, fig. 29b) showed that Primitia mundula, the type species, has a narrow marginal rim. Of the eight specimens studied, only one is from a limestone sample.

Occurrence.--USGS collns. 8397-CO, 8398-CO, 8402-CO, 8409-CO, 8419-CO, from the Point Pleasant Tongue of the Clays Ferry Formation.

Range.--From 0.5 to 25.6 feet above the base of the section.

Suborder ERIDOSTRACA Adamczak, 1961
Family ERIDOCONCHIDAE Henningsmoen, 1953
Genus AMERICONCHA Schallreuter, 1968

Type species.--Eridoconcha multiannulata Levinson, 1951
Americoncha dubia Warshauer and Berdan, 1982

Remarks.--Specimens of Americoncha from the Kope Formation in the Moffett Road section appear to belong in A. dubia, which was described by Warshauer and Berdan (1982, p. H66-H67, pl. 17, figs. 13-29) from the Edenian Millersburg and Tanglewood Limestone Members of the Lexington Limestone and the Clays Ferry Formation, also Edenian.

Occurrence.--USGS collns. 8470-CO, 8471-CO, 8474-CO, from the Kope Formation.

Range.--From 83.5 to 86.8 feet above the base of the section.

Order PODOCOPIDA Muller, 1884
Suborder METACOPINA Sylvester-Bradley, 1961
Superfamily HEALDIACEA Harlton, 1933
Family BAIRDIOCYPRIDIDAE Shaver, 1961
Genus PHELOBYTHOCYPRIS Warshauer and Berdan, 1982

Type species.--Bythocypris cylindrica (Hall). Ulrich, 1894
Phelobythocypris cylindrica (Hall, 1871)

Remarks.--This species has been redescribed and refigured by Warshauer and Berdan (1982, p. H68-H69, pl. 18, figs. 8-18), who considered it

characterized by its inflated posterior third and the long, nearly straight slope from the greatest height to the anterior margin. It occurs in the Point Pleasant Tongue of the Clays Ferry Formation and ranges into the Kope. It is also found throughout the Lexington Limestone, (Curdsville, Grier, Perryville, Tanglewood, Devils Hollow, Millersburg and Strodes Creek Members).

Occurrence.--USGS collns. 8397-CO, 8398-CO, 8399-CO, 8404-CO, ?8409-CO, ?8411-CO, 8421-CO, 8422-CO, 8423-CO, ?8424-CO, 8426-CO, 8431-CO, ?8432-CO, 8440-CO, ?8445-CO, 8448-CO, 8449-CO, from the Point Pleasant; 8451-CO, 8453-CO, 8456-CO, ?8457-CO, 8475-CO, 8491-CO, 8492-CO, 8535-CO, from the Kope Formation.

Range.--From 0.5 to 143.9 feet above the base of the section.

Phelobythocypris sp.

Description.--Lateral outline elongated subreniform; dorsal margin asymmetrically curved with gently curved anterior slope and steeply curved posterior slope, anterior margin sharply curved, posterior margin semicircular, ventral margin concave to straight. Left valve overlaps right around free margins and may overreach dorsally. Greatest height and width in posterior half of carapace. Dorsal outline subelliptical, tapering gradually toward anterior. Hinge with groove in anterodorsal part of left valve, and apparently also in right valve. Muscle scar not seen. Shell surface smooth.

Remarks.--This form is very similar to Phelobythocypris cylindrica (Hall, 1871) and may represent intraspecific variation of that species. It differs from P. cylindrica in having a very gently curved rather than almost straight anterodorsal margin and in lacking the conspicuous inflation of the posterior third of the carapace characteristic of P. cylindrica. Although the ranges of the two forms overlap, they are rarely found in the same collection, and Phelobythocypris sp. is the dominant form in the Kope. Consequently, it seems desirable to keep the two morphotypes separate, even though they may be variants of the same species. Phelobythocypris sp. commonly occurs as complete carapaces, which suggests a strong hingement, but this has impeded the study of the interiors of the valves.

Occurrence.--USGS collns. ?8409-CO, ?8411-CO, ?8424-CO,?8432-CO, 8437-CO, ?8438-CO, from the Point Pleasant; 8453-CO, 8461-CO, 8462-CO, 8467-CO, 8468-CO, 8469-CO, 8471-CO, 8472-CO, 8474-CO, 8476-CO, 8477-CO, 8478-CO, 8479-CO, 8480-CO, ?8481-CO, 8482-CO, 8483-CO, 8485-CO, 8486-CO, 8487-CO, 8489-CO, 8490-CO, 8493-CO, 8494-CO, 8495-CO, 8496-CO, 8497-CO, 8498-CO, 8499-CO, 8647-CO, 8648-CO, 8650-CO, 8506-CO, 8507-CO, 8508-CO, 8509-CO, 8510-CO, 8512-CO, 8513-CO, 8514-CO, 8516-CO, 8517-CO, 8518-CO, 8520-CO, 8521-CO, 8531-CO, 8537-CO, 8538-CO, 8539-CO, 8541-CO, 8542-CO, 8544-CO, 8547-CO, 8548-CO, 8549-CO, 8552-CO, 8554-CO, 8556-CO, ?8565-CO, ?8566-CO, 8570-CO, 8571-CO, ?8574-CO, ?8575-CO, ?8576-CO, 8581-CO, 8590-CO, 8591-CO, 8592-CO, 8594-CO, 8595-CO, 8597-CO, 8598-CO, 8603-CO, 8604-CO from the Kope Formation; 8611-CO, 8612-CO, from the Fairview Formation.

Range.--From ?13.3 to 319.4 feet above the base of the section.

Genus SHENANDOIA Kraft, 1962

Type species.--Shenandoia acuminulata Kraft, 1962

Shenandoia? sp.

Description.--Lateral outline subovate; dorsal margin curved, anterior margin sharply rounded, ventral margin nearly straight, posterior margin rounded. Left valve overlaps right on free margins, overreaches slightly on dorsal margin. Hinge very weakly incised, ventral contact margin slightly sinuous. Shell surface smooth.

Remarks.--This form is very close to Shenandoia? sp. described by Warshauer and Berdan (1982, p. H70, pl. 18, figs. 1-4) from the Strodes Creek Member of the Lexington Limestone, but its posterior margin is more smoothly rounded. The generic assignment is queried because, like the Lexington specimens, the Moffett Road specimens appear to lack the anterodorsal incisure considered diagnostic for Shenandoia by Kraft (1962, p. 73-74). Much of the material is poorly preserved and consists of corroded steinkerns; identifications have been based largely on the lateral outline of carapaces. More than one species may be included under this taxon; some of the specimens from the lower part of the Moffett Road section in the Point Pleasant appear to be shorter and wider than those from higher in the section, but I am not certain that this is a valid difference.

Occurrence.--USGS collns. 8397-CO, 8398-CO, 8399-CO, 8404-CO, 8405-CO, 8406-CO, 8407-CO, 8411-CO, 8415-CO, 8421-CO, 8422-CO, 8426-CO, 8430-CO, 8436-CO, 8437-CO, 8445-CO, 8448-CO, from the Point Pleasant; 8456-CO, 8466-CO, 8467-CO, 8468-CO, 8469-CO, 8470-CO, 8471-CO, 8472-CO, 8474-CO, 8475-CO, 8476-CO, 8477-CO, 8480-CO, 8482-CO, 8483-CO, 8485-CO, 8486-CO, 8487-CO, 8489-CO, 8490-CO, 8491-CO, 8492-CO, 8493-CO, 8494-CO, 8495-CO, 8496-CO, 8497-CO, 8498-CO, 8499-CO, 8647-CO, 8648-CO, 8650-CO, 8506-CO, 8507-CO, 8508-CO, 8514-CO, 8516-CO, 8517-CO, 8520-CO, 8521-CO, 8531-CO, 8535-CO, 8537-CO, 8539-CO, 8541-CO, 8544-CO, 8548-CO, 8552-CO, 8554-CO, 8556-CO, 8566-CO, 8567-CO, 8574-CO, 8581-CO, 8595-CO, 8603-CO, from the Kope Formation; 8616-CO, from the Fairview Formation.

Range.--From 0.5 to 326.7 feet above the base of the section.

Genus ELLIPTOCYPRITES Swain, 1962

Type species.--Elliptocyprites parallela Swain, 1962

Elliptocyprites sp.

Description.--Lateral outline elliptical; dorsal margin straight to slightly convex, ventral margin straight to slightly concave, subparallel to dorsal margin, anterior and posterior margins nearly equally curved, anterior may be slightly more sharply curved. Left valve overlaps right around free margins, valves meet evenly at hingeline. Carapace elongate, length twice or more greater than height. Dorsal outline elongate elliptical. Shell surface smooth.

Remarks.--This form was described and illustrated by Warshauer and Berdan (1982, p. H70, pl. 18, figs. 5-7). Although long ranging, it is not common in most collections and is usually represented by corroded carapaces or steinkerns which have been recognized by their characteristic elongated elliptical outline. Specimens from the upper part of the Moffett Road section appear to be somewhat more elongate than those from the lower part; more than one species may be present but the material is too sparse and poorly preserved

to be certain. In addition to its occurrence in the Kope, it has also been found in the Clays Ferry Formation and the Lexington Limestone (Curdsville, Grier, Millersburg and Strodes Creek Members) as reported by Warshauer and Berdan (1982, p. H70).

Occurrence.--USGS colIns. 8397-CO, ?8398-CO, 8399-CO, 8404-CO, 8405-CO, 8406-CO, 8407-CO, 8415-CO, 8421-CO, 8422-CO, 8430-CO, ?8439-CO, from the Point Pleasant; ?8451-CO, 8458-CO, 8468-CO, 8469-CO, ?8475-CO, 8476-CO, ?8535-CO, ?8548-CO, ?8566-CO, 8581-CO, 8597-CO, from the Kope Formation.

Range.--From 0.5 to 298.1 feet above the base of the section.

APPENDIX A
Description of samples.

POINT PLEASANT FORMATION

USGS No.	Field No.	Ft. above base of section

8396-CO M-1-69 0.0' - 0.5'
Limestone
From fossiliferous packstone to wackestone. Large fossils oriented parallel to the bedding. There is some silicification.
Fossils include: flat brachiopods, bryozoans, gastropods, trilobites, ostracodes, conodonts.
Color: olive gray 5YR 4/1

8397-CO M-1a-69 0.5' - 1.1'
Shale with thin bedded limestone.
Calcareous, platy, silty, minor micas.
Fossils include: flat brachiopods, bryozoans, ostracodes, conodonts, gastropods, pelecypods, scolecodonts.
Color: light olive gray 5Y 6/1.
Limestone - argillaceous.
Fossiliferous packstone to wackestone.
Color: medium gray N5.

8068-CO M-1B-69 1.1' - 2.1'
Limestone
Fossiliferous packstone.
Fossils include: flat brachiopods, conodonts, gastropods, bryozoans, crinoids, few trilobite fragments, ostracodes.
Color: medium gray N5.

8398-CO M-2-69 2.1' - 2.8'
Limestone interbedded with shale.
Fossiliferous packstone with minor interclasts.
Fossils include: flat brachiopods, ostracodes, gastropods, conodonts, bryozoans.
Color: light olive gray 5Y 6/1.
Shale
Poorly fissile, calcareous, silty.
Color: moderate yellowish brown 10YR 5/4.

8399-CO M-3-69 2.8' - 3.5'
Shale with very thin limestone lenses.
Poorly fissile, calcareous, silty, fossiliferous.
Fossils include: flat brachiopods, bryozoans, ostracodes, pelecypods, trilobites, conodonts, scolecodonts, gastropods.
Color: light olive gray 5Y 6/1.

8400-CO M-4-69 3.5' - 4.7'
Limestone
Fossiliferous packstone.
Fossils include: flat brachiopods, conodonts, bryozoans, gastropods, trilobites, crinoids debris, - slight silicification of fossils.

8400-CO cont'd.
Color: medium gray N5.

8401-CO M-5-69 4.7' - 5.7'
Limestone
Fossiliferous mudstone with fossil bearing burrows.
Fossils include: flat brachiopods, bryozoans, conodonts, trilobites, pelecypods, gastropods, ostracodes, scolecodonts.
Color: olive gray 5Y 4/1.

8402-CO M-6-69 7.7'
Limestone interbedded with shale.
Fossiliferous packstone - wackestone.
Fossils include: flat brachiopods, conodonts, trilobites, bryozoans, silicified ostracodes, gastropods, scolecodonts.
Color: medium gray N5.
Shale
Very calcareous, poorly fissile, very fossiliferous.
Color: medium gray N5.

8403-CO M-6(1)-69 7.7'
Shale
Calcareous, fissile, silty.
Fossils include: ostracodes, pelecypods, flat brachiopods, trilobites, conodonts, bryozoans.
Color: dark yellowish brown 10YR 4/2.

8404-CO M-6(2)-69 7.7'
Argillaceous limestone interbedded with shale.
Very fossiliferous wackestone - packstone.
Fossils include: flat brachiopods, ostracodes, trilobites, bryozoans.
Color: medium gray N6.
Shale
Calcareous, fissile, fossiliferous, silty.
Fossils include: flat brachiopods, gastropods, trilobites, pelecypods, crinoids.
Color: light olive gray 5Y 6/1.

8405-CO M-6(3)-69 7.7'
Shale
Very calcareous, silty, fossiliferous.
Fossils include: flat brachiopods, trilobites, ostracodes, conodonts, pelecypods, gastropods, scolecodonts.
Color: light olive gray 5Y 5/2.

8406-CO M-7(1+2)-69 10.3'
Shale
Very calcareous, fossiliferous, silty.
Fossils include: ostracodes, bryozoans, conodonts, trilobites, flat brachiopods, pelecypods, scolecodonts.
Color: light gray N7

8407-CO M-7(3)-69 10.3'
Limestone interbedded with shale.

8407-CO cont'd.
Fossiliferous mudstone, laminated, with pellets.
Fossils include: trilobites, gastropods, pelecypods, bryozoans, conodonts, scolecodonts, crinoids, ostracodes.
Color: light olive brown 5Y 5/6.
Shale
Calcareous, fossiliferous.
Color: light olive brown 5Y 5/6

8408-CO M-8-69 12.3'
Limestone
Fossiliferous packstone with fairly large interclasts.
Fossils include: trilobites, flat brachiopods, conodonts, gastropods, pelecypods, ostracodes,-silicified material.
Color: medium gray N5.

8409-CO M-9-69 13.3'
Limestone
Fossiliferous wackstone, partially dolomitized.
Fossils include: trilobites, flat brachiopods, ostracodes, bryozoans, conodonts, scolecodonts, pelecypods, gastropods.
Color: medium light gray N6.

8410-CO M-10-69 13.8'
Limestone
Fossiliferous wackestone, partially dolomitized.
Fossils include: trilobites, flat brachiopods, conodonts, gastropods, pelecypods, bryozoans, scolecodonts.
Color: medium light gray N6.

8411-CO M-11-69 14.4'
Shale with very thin limestone layers.
Calcareous, silty, fossiliferous, poorly fissile.
Fossils include: bryozoans, flat brachiopods, conodonts, gastropods, ostracodes, pelecypods, trilobites, scolecodonts, conodonts, crinoids.
Color: medium gray N5.
Fossiliferous wackestone - packstone with very fine fossil debris.
Dolomitized.
Color: medium gray N5.

8412-CO M-12-69 14.9'
Limestone
Fossiliferous wackestone - packstone, some silicification.
Fossils include: bryozoans, trilobites, flat brachiopods, gastropods, pelecypods, ostracodes, scolecodonts.
Color: medium light gray N6.

8413-CO M-13-69 15.9'
Shale
Calcareous, silty, fissile, fossiliferous.
Fossils include: bryozoans, flat brachiopods, trilobites, ostracodes, gastropods, conodonts, scolecodonts.
Color: medium light gray N6.

8414-CO M-14-69 16.9'
Limestone
Fossiliferous packstone with pyrite, interclasts, minor silicification.
Fossils include: flat brachiopods, trilobites, bryozoans, conodonts, gastropods, pelecypods, ostracodes, scolecodonts.
Color: medium light gray N6.

8415-CO M-15-69 20'
Shale
Calcareous, fissile, fossiliferous, silty.
Fossils include: trilobites, flat brachiopods, ostracodes, bryozoans, gastropods, pelecypods, conodonts, scolecodonts, crinoids, graptolites.
Color: pale yellowish brown 10YR 6/2.

8416-CO M-16-69 21.8'
Limestone
Fossiliferous packstone with some interclasts and some silicification.
Fossils include: trilobites, flat brachiopods, conodonts, gastropods, bryozoans, crinoids.
Color: medium gray N5.

8417-CO M-17-69 22.8'
Shale
Calcareous, fissile, fossiliferous, silty.
Fossils include: conodonts, gastropods, flat brachiopods, pelecypods, scolecodonts.
Color: yellowish gray 5Y 7/2.

8418-CO M-18-69 23.3'
Limestone
Fossiliferous packstone with some silicification.
Fossils include: flat brachiopods, conodonts, bryozoans, trilobites, gastropods, scolecodonts.
Color: medium light gray N6.

8419-CO M-18A-69 25.6'
Shale with thin limestone lenses.
Calcareous, fossiliferous, fissile, silty.
Fossils include: flat brachiopods, bryozoans, trilobites, gastropods, conodonts, ostracodes.
Color: yellowish gray 5Y 7/2.

8420-CO M-19-69 26.6'
Limestone
Very fossiliferous packstone to wackestone-packstone with mud-filled burrows.
Fossils include: flat brachiopods, trilobites, conodonts, gastropods, bryozoans, ostracodes, scolecodonts, crinoids.
Color: medium light gray N6.

8421-CO M-20A-69 28.0'
Shale with thin limestone beds.
Calcareous, fissile, silty, fossiliferous.
Fossils include: ostracodes, gastropods, bryozoans, pelecypods, flat brachiopods, conodonts, trilobites, crinoids, scolecodonts.

8421-CO cont'd.
Poorly fossiliferous mudstone with some interclasts.
Color: pale yellowish brown 10YR 6/2.

8422-CO M-21A-69 28.2'
Limestone - shale
Fossiliferous packstone interbedded with shale. Fossils oriented parallel to the bedding. Some silicification.
Fossils include: flat brachiopods, bryozoans, ostracodes, trilobites, conodonts, gastropods, pelecypods, scolecodonts, crinoids.
Color: medium light gray N6
Shale
Calcareous, silty, fossiliferous, poorly fissile.
Color: moderate yellowish brown 10YR 5/4.

8423-CO M-21-69 28.9'
Limestone
Fossiliferous packstone with muddy interclasts. Fossils oriented parallel to the bedding. Laminated.
Fossils include: bryozoans, gastropods, ostracodes, flat brachiopods, conodonts, scolecodonts, pelecypods.
Color: medium light gray N6.

8424-CO M-22a-69 29.4'
Limestone
Fossiliferous packstone with some silicification.
Fossils include: gastropods, bryozoans, flat brachiopods, ostracodes, conodonts, pelecypods, trilobites, scolecodonts, crinoids.
Color: medium light gray N6.

8425-CO M-22-69 29.9'
Shale
Calcareous, silty, and very fossiliferous, fissile.
Fossils include: ostracodes, flat brachiopods, bryozoans, conodonts, gastropods, scolecodonts.
Color: pale yellowish brown 10YR 6/2.

8426-CO M-20-69 30'
Shale
Calcareous, poorly fissile, silty, fossiliferous.
Fossils include: gastropods, pelecypods, bryozoans, ostracodes, flat brachiopods, conodonts, trilobites, crinoids, scolecodonts.
Color: yellowish gray 5Y 7/2.

8427-CO M-23a-69 31.5'
Limestone
Fossiliferous packstone with some interclasts. Some silicification.
Fossils include: bryozoans, flat brachiopods, trilobites, gastropods, pelecypods, ostracodes, scolecodonts, crinoids.
Color: medium light gray N6.

8428-CO M-23-69 31.9'
Shale
Calcareous, soft, fossiliferous, very poorly fissile.

8428-CO cont'd.
Fossils include: bryozoans, flat brachiopods, gastropods, pelecypods, crinoids, trilobite fragments.
Color: moderate yellowish brown 10YR 5/4.

8429-CO M-24-69 32.5'
Limestone
Fossiliferous packstone with finer fossil debris.
Fossils include: conodonts, flat brachiopods, bryozoans, gastropods, ostracodes, scolecodonts, crinoids.
Color: medium light gray N6.

8430-CO M-25-69 34.8'
Shale with limestone lenses.
Calcareous, very fossiliferous, fissile, silty.
Fossils include: bryozoans, flat brachiopods, trilobites, ostracodes, conodonts, crinoids, gastropods, hyolithids, pelecypods, scolecodonts.
Color: pale yellowish brown 10YR 6/2.
Fossiliferous packstone.
Color: medium light gray N6.

8431-CO M-26-69 35.4'
Limestone
Fossiliferous packstone with very fine fossil debris.
Fossils include: bryozoans, conodonts, ostracodes, flat brachiopods, trilobites, gastropods, scolecodonts, crinoids.
Color: medium light gray N6.

8432-CO M-26a-69 37.8'
Shaly mudstone mixed with fossiliferous packstone.
Calcareous, poorly fissile, poorly fossiliferous, silty.
Fossils include: flat brachiopods, trilobites, bryozoans, gastropods, pelecypods, conodonts, ostracodes, scolecodonts, crinoids.
Color: pale yellowish brown 10YR 6/2.

8433-CO M-27-69 38.1'
Limestone
Fossiliferous packstone with finely crushed debris.
Fossils include: conodonts, ostracodes, some bryozoans, gastropods, pelecypods, scolecodonts, crinoids.
Color: medium light gray N6.

8434-CO M-28-69 38.6'
Limestone
Fossiliferous packstone with coarse fossil debris.
Fossils include: gastropods, hyolithids, pelecypods, bryozoans, trilobites, flat brachiopods, conodonts, ostracodes, scolecodonts, crinoids, worms.
Color: medium light gray N6.

8435-CO M-29-69 40.8'
Limestone
Fossiliferous wackestone to packstone with interclasts and very fine fossil debris. Dolomitic, very burrowed.
Fossils include: flat brachiopods, bryozoans, gastropods, pelecypods,

8435-CO cont'd.
hyolithids, ostracodes, scolecodonts.
Color: medium light gray N6.

8436-CO M-30-69 41.5'
Limestone
Fossiliferous packstone with some silicification.
Fossils include: bryozoans, flat brachiopods, gastropods, hyolithids, pelecypods, conodonts, trilobites, ostracodes, scolecodonts, crinoids.
Color: Medium light gray N6

8437-CO M-30a-69 41.9'
Shale interbedded with limestone.
Calcareous, fissile, fossiliferous, silty.
Fossils include: flat brachiopods, ostracodes, trilobites, conodonts, gastropods, crinoids.
Color: pale yellowish brown 10YR 6/2.
Fossiliferous packstone to wackestone with fine fossil debris. Dolomitic, burrowed.
Color: medium light gray N6.

8438-CO M-31-69 42.2'
Limestone
Fossiliferous packstone to grainstone.
Fossils include: bryozoans, flat brachiopods, gastropods, pelecypods, hyolithids, trilobites, ostracodes, scolecodonts, conodonts, crinoids, sponges.
Color: medium light gray N6.

8439-CO M-31a-69 42.7'
Limestone - shale.
Fossiliferous packstone - wackestone, fine fossil debris oriented parallel to the bedding.
Fossils include: gastropods, bryozoans, flat brachiopods, trilobites, conodonts, pelecypods, hyolithids, ostracodes, scolecodonts, crinoids.
Color: light brownish gray 5YR 6/1.
Shale
Calcareous, fossiliferous, poorly fissile, silty.
Color: light brownish gray 5YR 6/1.

8440-CO M-32-69 42.9'
Limestone
Fossiliferous packstone, fairly horizontal fossil debris.
Fossils include: gastropods, conodonts, flat brachiopods, pelecypods, bryozoans, trilobites, ostracodes, scolecodonts, crinoids.
Color: medium gray N5.

8441-CO M-32A-69 43.2'
Limestone
Fossiliferous packstone with fine weathered fossil debris.
Fossils include: bryozoans, gastropods, conodonts, pelecypods, hyolithids, ostracodes, crinoids.
Color: medium gray N5.

8442-CO M-33-69 44.4'
Shale interbedded with limestone.
Calcareous, poorly fissile, fossiliferous.
Fossils include: flat brachiopods, bryozoans, gastropods, pelecypods, trilobites, conodonts, ostracodes, scolecodonts, crinoids.
Color: pale yellowish brown 10YR 6/2.
Fossiliferous packstone-wackestone with fine fossil debris and very burrowed.
Color: medium light gray N6.

8443-CO M-33A-69 45.0'
Limestone
Fossiliferous packstone with interclasts.
Fossils include: bryozoans, flat brachiopods, gastropods, trilobites, pelecypods, conodonts, ostracodes, hyolithids, crinoids.
Color: medium gray N5.

8444-CO M-34-69 46.7'
Shale with limestone nodules.
Muddy, calcareous, not fissile, fossiliferous.
Fossils include: bryozoans, gastropods, pelecypods, flat brachiopods, conodonts, trilobites, ostracodes, scolecodonts, crinoids.
Color: moderate yellowish brown 10YR 5/4.
Fossiliferous packstone with interclasts.
Color: moderate yellowish brown 10YR 5/4.

8445-CO M-35-69 47.3'
Limestone
Fossiliferous packstone with predominantly crinoid debris.
Fossils include: crinoids, gastropods, bryozoans, trilobites, flat brachiopods, conodonts, ostracodes, pelecypods, scolecodonts.
Color: medium light gray N6.

8446-CO M-36A-69 49.6'
Shale with limestone lenses.
Calcareous, poorly fissile, fossiliferous, silty.
Fossils include: gastropods, bryozoans, flat brachiopods, pelecypods, ostracodes, trilobites, conodonts, scolecodonts, crinoids.
Fossiliferous packstone to wackestone with pellets, dolomitic, burrowed, with very fine fossil debris.
Color: pale olive 10Y 6/2.

8447-CO M-36-69 50.3'
Limestone
Fossiliferous packstone to grainstone with minor interclasts and plenty of crinoid debris.
Fossils include: crinoids, bryozoans, flat brachiopods, conodonts, gastropods, pelecypods, hyolithids, trilobites, scolecodonts, ostracodes, ?algae, ?sponges.
Color: medium gray N5.

8448-CO M-37-69 52.4'
Limestone
Fossiliferous packstone to grainstone with some interclasts.
Fossils include: bryozoans, flat brachiopods, gastropods, conodonts,

8448-CO cont'd.
pelecypods, ostracodes, hyolithids, trilobites, crinoids, sponges.
Color: light olive gray 5Y 6/1.

8449-CO M-37B-69 53.6'
Shale with thin limestone layers.
Calcareous, poorly fissile, fossiliferous, silty.
Fossils include: conodonts, bryozoans, gastropods, ostracodes, crinoids, flat brachiopods, pelecypods.
Color: yellowish gray 5Y 7/2.
Fossiliferous packstone to grainstone.
Color: light gray N7

8450-CO M-37a-69 54.0'
Limestone
Fossiliferous packstone.
Fossils include: bryozoans, crinoids, conodonts, flat brachiopods, trilobites, gastropods, scolecodonts, ?worms.
Color: light olive gray 5Y 6/1.

KOPE FORMATION
8451-CO M-38-69 54.7'
Limestone
Varies from fossiliferous packstone to packstone-wackestone.
Fossils include: bryozoans, flat brachiopods, trilobites, crinoids, gastropods, ostracodes, scolecodonts.
Color: medium gray N5.

8452-CO M-39-69 55.9'
Limestone
Fossiliferous packstone to grainstone with interclasts and pyrite.
Fossils include: gastropods, bryozoans, flat brachiopods, crinoids, trilobites, conodonts, pelecypods, ostracodes, hyolithids, scolecodonts.
Color: medium gray N5.

8453-CO M-40-69 57.2'
Shale with limestone lenses.
Calcareous, fossiliferous, fissile, silty.
Fossils include: ostracodes, trilobites, flat brachiopods, bryozoans, scolecodonts, crinoids, conodonts.
Color: pale yellowish brown 10YR 6/2.
Fossiliferous packstone.
Color: medium gray N5.

8454-CO M-41-69 59.2'
Shale
Non-calcareous, fossiliferous, poorly fissile, silty.
Fossils include: trilobites, flat brachiopods, bryozoans, gastropods, conodonts, pelecypods, ostracodes, scolecodonts, crinoids.
Color: yellowish gray 5Y 7/2.

8455-CO M-42-69 59.8'
Limestone
Fossiliferous packstone to grainstone with pyrite.

8455-CO cont'd.
Fossils include: bryozoans, gastropods, trilobites, flat brachiopods, conodonts, crinoids.
Color: medium light gray N6.

8456-CO M-43-69 60.8'
Limestone
Fossiliferous packstone with peloids and pyrite. Finer grained, with mud-filled worm burrows.
Fossils include: flat brachiopods, bryozoans, conodonts, gastropods, trilobites, ostracodes, crinoids, pelecypods, scolecodonts.
Color: medium gray N5.

8457-CO M-44-69 62.8'
Shale
Calcareous, not fissile, fossiliferous, silty.
Fossils include: bryozoans, ostracodes, trilobites, flat brachiopods, conodonts, crinoids, scolecodonts.
Color: yellowish gray 5Y 7/2.

8458-CO M-45-69 66.8'
Limestone - shale
Fossiliferous packstone with pyrite and peloids.
Fossils include: flat brachiopods, gastropods, ostracodes, conodonts, pelecypods, bryozoans, hyolithids, crinoids.
Color: medium dark gray N4
Shale
Calcareous, poorly fissile, fossiliferous, silty.
Color: light olive gray 5Y 5/2.

8459-CO M-46-69 67.4'
Limestone
Fossiliferous packstone with peloids or interclasts.
Fossils include: flat brachiopods, conodonts, gastropods, pelecypods, crinoids, trilobites, ostracodes, scolecodonts.
Color: medium gray N5.

8460-CO M-47-69 68.0'
Limestone
Fossiliferous packstone.
Fossils include: flat brachiopods, crinoids, gastropods, pelecypods, ostracodes, trilobites, conodonts, hyolithids, bryozoans, scolecodonts, ?worm tubes.
Color: medium gray N5.

8461-CO M-48-69 69.0'
Shale with burrows.
Calcareous, poorly fissile, muddy, fossiliferous, silty.
Fossils include: flat brachiopods, scolecodonts, ostracodes, trilobites, bryozoans, crinoids, conodonts.
Color: yellowish gray 5Y 7/2.

8462-CO M-49-69 70.0'
Shale

8462=CO cont'd.
Slightly calcareous, fissile, fossiliferous, silty, muddy.
Fossils include: flat brachiopods, ostracodes, crinoids, trilobites, bryozoans, conodonts.
Color: yellowish gray 5Y 7/2.

8463=CO M=50=69 72.0'
Limestone
Poorly fossiliferous mudstone, slightly recrystallized.
Fossils include: few scolecodonts.
Color: medium dark gray N4.

8464=CO M=51=69 73.0'
Shale, finely laminated.
Calcareous, poorly fossiliferous, fissile, silty.
Fossils include: flat brachiopods, bryozoans, trilobites, scolecodonts, conodonts.
Color: yellowish gray 5Y 7/2.

8465=CO M=52=69 75.0'
Shale
Calcareous, fissile, poorly fossiliferous, silty.
Fossils include: flat brachiopods, ostracodes, trilobites, crinoids, bryozoans, scolecodonts, conodonts.
Color: light olive gray 5Y 6/1.

8466=CO M=53=69 77.0'
Shaly limestone
Very fossiliferous packstone, thin bedded.
Fossils include: flat brachiopods, pelecypods, ostracodes, crinoids, gastropods, bryozoans, trilobites, conodonts, scolecodonts.
Color: medium gray N5.
Shale
Calcareous, fissile, fossiliferous, silty.
Color: light olive gray 5Y 6/1.

8467=CO M=54=69 77.2'
Limestone
Fossiliferous packstone with very small fossils oriented parallel to the bedding.
Fossils include: flat brachiopods, ostracodes, crinoids, bryozoans, conodonts, gastropods, scolecodonts.
Color: medium gray N6.

8468=CO M-55-69 82.2'
Shale
Calcareous, poorly fissile, fossiliferous, silty, laminated.
Fossils include: trilobites, ostracodes, flat brachiopods, bryozoans, crinoids, gastropods, scolecodonts, ?worm tubes.
Color: light olive gray 5Y 6/1.

8469-CO M-55A-69 83.0'
Shale
Calcareous, poorly fissile, fossiliferous, silty.

8469-CO cont'd.
Fossils include: flat brachiopods, ostracodes, trilobites, crinoids, bryozoans, pelecypods, scolecodonts.
Color: light olive gray 5Y 6/1.

8470-CO M-55B-69 83.5'
Shale
Calcareous, poorly fissile, fossiliferous, silty.
Fossils include: flat brachiopods, ostracodes, trilobites, bryozoans, crinoids.
Color: light olive gray 5Y 6/1.

8471-CO M-55C-69 84.5'
Shale
Calcareous, poorly fissile, fossiliferous, silty.
Fossils include: trilobites, ostracodes, flat brachiopods, bryozoans, conodonts, scolecodonts.
Color: dusky yellow 5Y 6/4.

8472-CO M-55D-69 85.0'
Shale, slightly burrowed, laminated.
Calcareous, poorly fissile, fossiliferous, silty.
Fossils include: trilobites, flat brachiopods, bryozoans, ostracodes, crinoids, scolecodonts, conodonts.
Color: dusky yellow 5Y 6/4.

8473-CO M-55E-69 87.0'
Limestone
Very poorly fossiliferous mudstone with burrows.
Fossils include: ostracodes, few crinoids.
Color: light olive gray 5Y 6/1.

8474-CO M-57-69 86.8'
Shale - limestone.
Calcareous, poorly fissile, fossiliferous, silty.
Fossils include: flat brachiopods, trilobites, bryozoans, ostracodes, crinoids, scolecodonts, ?worms.
Color: yellowish gray 5Y 7/2
Fossiliferous mudstone with worm trails.
Color: light olive gray 5Y 6/1.

8475-CO M-56-69 88.2'
Limestone
Fossiliferous packstone and unfossiliferous mudstone with worm trails.
Fossils include: bryozoans, flat brachiopods, trilobites, ostracodes, gastropods, conodonts, few cephalopods, crinoids, scolecodonts.
Color: medium gray N5.

8476-CO M-58-69 90.1'
Shale interbedded with limestone.
Calcareous, poorly fissile, fossiliferous.
Fossils include : trilobites, flat brachiopods, bryozoans, ostracodes, crinoids, scolecodonts, worms.
Color: dusky yellow 5Y 6/4.

8476-CO cont'd.
Unfossiliferous mudstone, burrowed and laminated.
Color: light olive gray 5Y 6/1.

8477-CO M-59-69 91.1'
Shale with limestone.
Calcareous, poorly fissile, fossiliferous, silty.
Fossils include: flat brachiopods, ostracodes trilobites, bryozoans, crinoids, scolecodonts, conodonts.
Color: yellowish gray 5Y 7/2.
Poorly fossiliferous mudstone, laminated, abundant crinoids.
Color: medium light gray N6.

8478-CO M-60-69 93.2'
Limestone
Fossiliferous packstone to wackestone.
Fossils include: bryozoans, crinoids, flat brachiopods, conodonts, trilobites, ostracodes.
Color: medium light gray N6.

8479-CO M-61-69 94.0'
Limestone
Fossiliferous wackestone to packstone.
Fossils include: bryozoans, flat brachiopods, conodonts, trilobites, crinoids, gastropods, ostracodes, scolecodonts.
Color: medium light gray N6.

8480-CO M-62-69 94.6'
Shale
Calcareous, poorly fissile, fossiliferous, silty, fine laminated.
Fossils include: cornulites, trilobites, flat brachiopods, bryozoans, ostracodes, crinoids, gastropods.
Color: light olive gray 5Y 6/1.

8481-CO M-63-69 95.7'
Limestone
Fossiliferous packstone with pyrite.
Fossils include: bryozoans, flat brachiopods, gastropods, conodonts, pelecypods, hyolithids, ostracodes, crinoids.
Color: medium gray N5.

8482-CO M-64-69 97.0'
Limestone and shale
Fossiliferous wackestone to packstone.
Fossils include: bryozoans, trilobites, flat brachiopods, conodonts, ostracodes, gastropods, crinoids, worms.
Color: medium light gray N6.
Shale
Calcareous, fissile, fossiliferous, silty, fine laminated.
Color: moderate yellowish brown 10YR 5/4.

8483-CO M-65-69 97.8'
Limestone and shale
Fossiliferous packstone.

8483-CO cont'd.
Fossils include: bryozoans, flat brachiopods, trilobites, conodonts, ostracodes, gastropods, pelecypods, hyolithids, crinoids, worms.
Color: medium gray N5.
Shale
Calcareous, fissile, fossiliferous, silty.
Color: moderate yellowish brown 10YR 5/4.

8484-CO M-66-69 98.3'
Limestone
Fossiliferous packstone to grainstone,calcite spar, pyrite here and there.
Fossils include: bryozoans, flat brachiopods, gastropods, conodonts, trilobites, pelecypods, hyolithids, crinoids, ostracodes.
Color: medium gray N5.

8485-CO M-67-69 98.8'
Limestone and shale
Very fossiliferous packstone.
Fossils include: bryozoans, flat brachiopods, trilobites, ostracodes, gastropods, pelecypods, hyolithids, conodonts, crinoids.
Color: medium gray N6.
Shale with thin mudstone layers.
Calcareous, fissile, fossiliferous, silty.
Color: dusky yellow 5Y 6/4.
Mudstone
Color: light olive gray 5Y 6/1.

8486-CO M-68-69 99.3'
Shale with limestone lenses
Calcareous, poorly fissile, fossiliferous, silty.
Fossils include: flat brachiopods, trilobites, bryozoans, ostracodes, conodonts, scolecodonts, crinoids.
Color: yellowish gray 5Y 7/2.
Fossiliferous packstone, fossils horizontally oriented.
Color: medium gray N5.

8487-CO M-69-69 101.6'
Limestone
Fossiliferous wackestone to packstone and mudstone.
Fossils include: bryozoans, conodonts, flat brachiopods, trilobites, ostracodes, crinoids, gastropods, hyolithids, scolecodonts.
Color: medium gray N5.

8488-CO M-70-69 101.6'
Limestone
Fossiliferous packstone
Fossils include: bryozoans, flat brachiopods, conodonts, trilobites, crinoids, gastropods, hyolithids, scolecodonts.
Color: medium gray N5.

8489-CO M-71-69 102.6'
Limestone
Fossiliferous wackestone to packstone.
Fossils include: flat brachiopods, bryozoans, trilobites, ostracodes,

8489-CO cont'd.
conodonts, crinoids, scolecodonts, gastropods, pelecypods.
Color: medium gray N5.

8490-CO M-72-69 103.0'
Shale with limestone lenses.
Calcareous, fissile, very fossiliferous, silty.
Fossils include: flat brachiopods, trilobites, bryozoans, ostracodes, crinoids, conodonts, worms, scolecodonts.
Color: yellowish gray 5Y 7/2.
Very fossiliferous wackestone to packstone.
Color: light olive gray 5Y 6/1.

8491-CO M-73-69 104.0'
Shale
Calcareous, fissile, fossiliferous, silty.
Fossils include: flat brachiopods, trilobites, bryozoans, ostracodes, crinoids, scolecodonts, worms, conodonts.
Color: light olive gray 5Y 6/1.

8492-CO M-74-69 106.3'
Limestone
Fossiliferous packstone.
Fossils include: flat brachiopods, conodonts, trilobites, bryozoans, ostracodes, gastropods, pelecypods, hyolithids, crinoids, scolecodonts.
Color: medium gray N5.

8493-CO M-75-69 108.3'
Limestone
Fossiliferous packstone.
Fossils include: bryozoans, conodonts, flat brachiopods, gastropods, trilobites, ostracodes, crinoids.
Color: medium gray N5.

8494-CO M-76-69 110.3'
Shale
Calcareous, fissile, fossiliferous, silty.
Fossils include: flat brachiopods, trilobites, bryozoans, ostracodes, crinoids, worms.
Color: yellowish gray 5Y 7/2.

8495-CO M-77-69 111.0'
Limestone
Fossiliferous wackestone to packstone, ?burrowed?
Fossils include: conodonts, bryozoans, flat brachiopods, trilobites, ostracodes, scolecodonts, crinoids, pelecypods.
Color: medium dark gray N4.

8496-CO M-78-69 111.5'
Shale
Calcareous, not fissile, fossiliferous, silty.
Fossils include: crinoids, bryozoans, flat brachiopods, ostracodes, trilobites, conodonts, worms.
Color: yellowish gray 5Y 7/2.

8497-CO M-79-69 114.8'
Limestone
Unfossiliferous mudstone with burrows, slightly laminated.
Color: pale olive 10Y 6/2.
Fossiliferous wackestone
Fossils include: bryozoans, conodonts, flat brachiopods, trilobites, ostracodes, crinoids.
Color: medium gray N5.

8498-CO M-80-69 116.1'
Shale
Calcareous, poorly fissile, in places very fossiliferous, silty.
Fossils include: bryozoans, flat brachiopods, trilobites, ostracodes, crinoids.
Color: yellowish gray 5Y 7/2.

8499-CO M-81-69 116.5'
Limestone
Fossiliferous packstone
Fossils include: bryozoans, conodonts, flat brachiopods, trilobites, ostracodes, crinoids, gastropods, scolecodonts.
Color: medium gray N5.

8647-CO M-82-69 118.0'
Shale with limestone lenses
Calcareous, poorly fissile, fossiliferous, silty.
Fossils include: flat brachiopods, trilobites, bryozoans, conodonts, ostracodes, crinoids, scolecodonts.
Color: yellowish gray 5Y 7/2
Fossiliferous wackestone to packstone
Color: medium light gray N6.

8648-CO M-83-69 118.5'
Limestone
Fossiliferous packstone
Fossils include: flat brachiopods, conodonts, trilobites, bryozoans, pelecypods, ostracodes, crinoids, scolecodonts.
Color: medium gray N5.

8649-CO M-84-69 120.8'
Limestone
Fossiliferous packstone with interclasts.
Fossils include: flat brachiopods, bryozoans, conodonts, trilobites, gastropods, scolecodonts, crinoids.
Color: medium gray N5.

8650-CO M-85-69 121.0'
Shale
Calcareous, poorly fissile, fossiliferous, silty.
Fossils include: bryozoans, flat brachiopods, ostracodes, trilobites, scolecodonts.
Color: yellowish gray 5Y 7/2.

8651-CO M-86-69 121.3'
Limestone
Fossiliferous packstone with fine fossil debris.
Fossiliferous packstone to wackestone.
Fossils include: bryozoans, flat brachiopods, trilobites, crinoids, conodonts, gastropods, scolecodonts, ?pelecypod?
Color: light olive gray 5Y 6/1.

8652-CO M-87-69 122.0'
Limestone
Fossiliferous wackestone to packstone, thin beds.
Fossils include: flat brachiopods, bryozoans, conodonts, trilobites, gastropods, pelecypods, crinoids, scolecodonts, hyolithids.
Color: light olive gray 5Y 6/1.

8506-CO M-88-69 123.6'
Shale
Very fossiliferous, calcareous, poorly fissile, silty.
Fossils include: flat brachiopods, bryozoans, ostracodes, trilobites, crinoids, pelecypods, scolecodonts, conodonts.
Color: yellowish gray 5Y 7/2.

8507-CO M-99-69 124.2'
Limestone
Fossiliferous packstone with fine fossil debris and peloids.
Fossils include: bryozoans, flat brachiopods, conodonts, ostracodes, trilobites, gastropods, scolecodonts.
Color: medium gray N5.

8508-CO M-89-69 124.6'
Shale
Very calcareous, poorly fissile, fossiliferous, silty.
Fossils include: flat brachiopods, trilobites, bryozoans, ostracodes, gastropods, pelecypods, conodonts, scolecodonts, crinoids.
Color: pale olive 10Y 6/2.

8509-CO M-90-69 125.9'
Shale with thin limestone - packstone layers.
Calcareous, poorly fissile, fossiliferous, silty.
Fossils include: flat brachiopods, bryozoans, trilobites, ostracodes, gastropods, crinoids, scolecodonts, conodonts.
Color: pale olive 10Y 6/2.

8510-CO M-91-69 126.4'
Limestone
Fossiliferous packstone with peloids and lime clasts.
Fossils include: flat brachiopods, conodonts, gastropods, bryozoans, trilobites, ostracodes, crinoids, scolecodonts.
Color: medium gray N5.

8511-CO M-92-69 126.4'
Limestone
Fossiliferous packstone to wackestone.
Fossils include: flat brachiopods, conodonts, bryozoans, trilobites,

8511-CO cont'd.
gastropods, crinoids, scolecodonts, ostracodes.
Color: medium gray N5.

8512-CO M-93-69 127.1'
Limestone
Fossiliferous packstone to wackestone
Fossils include: bryozoans, flat brachiopods, ostracodes, conodonts, trilobites, crinoids, scolecodonts.
Color: medium gray N5.
1 tray of shale
Calcareous, poorly fissile, silty, ?fossiliferous.
Color: yellowish gray 5Y 8/1

8513-CO M-94-69 128.1'
Limestone
Poorly fossiliferous mudstone, very clayey, laminated.
Fossils include: flat brachiopods, ostracodes, conodonts.
Color: light olive gray 5Y 6/1.

8514-CO M-95-69 128.7'
Limestone
Fossiliferous mudstone, clayey, laminated, burrowed.
Fossils include: flat brachiopods, gastropods, ostracodes, bryozoans, scolecodonts.
Color: light olive gray 5Y 6/1.

8515-CO M-100-69 128.8'
Limestone
Mostly barren, dolomitic mudstone, finely laminated.
Top layer has some brachiopods, crinoids, conodonts, few ostracodes.
Color: medium gray N5.

8516-CO M-101-69 129.2'
Shale with packstone lenses.
Calcareous, poorly fissile, very fossiliferous, silty.
Fossils include: bryozoans, flat brachiopods, trilobites, crinoids, ostracodes, gastropods, scolecodonts, cephalopod, conodonts.
Color: yellowish gray 5Y 7/2.

8517-CO M-96-69 130.4'
Shale
Calcareous, poorly fissile, fossiliferous, silty.
Fossils include: flat brachiopods, trilobites, bryozoans, ostracodes, crinoids, gastropods, scolecodonts, conodonts.
Color: yellowish gray 5Y 7/2.

8518-CO M-97-69 131.0'
Limestone
Fossiliferous wackestone to mudstone.
Fossils include: bryozoans, flat brachiopods, crinoids, conodonts, trilobites, scolecodonts, ostracodes, cephalopods.
Color: medium light gray N6.

8519-CO M-106-69 131.0'
Shale with packstone to wackestone lenses.
Calcareous, poorly fissile, fossiliferous, silty.
Fossils include: bryozoans, flat brachiopods, gastropods, pelecypods, crinoids, conodonts.
Color: yellowish gray 5Y 7/2.

8520-CO M-102-69 131.2'
Shale
Calcareous, fissile, fossiliferous, silty.
Fossils include: flat brachiopods, bryozoans, trilobites, ostracodes, gastropods, crinoids, scolecodonts.
Color: yellowish gray 5Y 7/2.

8521-CO M-98-69 131.5'
Shale with mudstone lenses.
Calcareous, poorly fissile, fossiliferous.
Fossils include: flat brachiopods, bryozoans, ostracodes, conodonts, trilobites, scolecodonts, crinoids.
Color: dusky yellow 5Y 6/4.

8522-CO M-105-69 131.5'
Limestone and shale
Fossiliferous packstone to wackestone.
Fossils include: gastropods, bryozoans, flat brachiopods, conodonts, trilobites, pelecypods, crinoids, scolecodonts, ostracodes.
Color: medium gray N5.
Shale
Calcareous, poorly fissile, fossiliferous, silty.
Color: yellowish gray 5Y 7/2.

8523-CO M-103-69 132.2'
Limestone
Fossiliferous packstone with minor interclasts.
Fossils include: flat brachiopods, crinoids, bryozoans, conodonts, gastropods, trilobites, pelecypods, scolecodonts.
Color: medium gray N5.

8524-CO M-107-69 133.3'
Limestone
Fossiliferous packstone.
Fossils include: flat brachiopods, bryozoans, conodonts, trilobites, crinoids, gastropods, hyolithids, scolecodonts.
Color: medium gray N5.

8525-CO M-108-69 134.3'
Shale with small packstone lenses.
Calcareous, poorly fissile, fossiliferous, silty.
Fossils include: bryozoans, flat brachiopods, gastropods, crinoids, trilobites, scolecodonts, conodonts, ostracodes.
Color: moderate yellowish brown 10YR 5/4.

8526-CO M-104-69 134.9'
Limestone

8526-CO cont'd.
Fossiliferous packstone, fossils tend to be oriented parallel to the bedding.
Fossils include: gastropods, flat brachiopods, bryozoans, pelecypods, conodonts, trilobites, crinoids, ostracodes, scolecodonts.
Color: medium gray N5.

8528-CO M-110-69 136.9'
Limestone
Fossiliferous packstone to wackestone, abundant peloids.
Fossils include: bryozoans, gastropods, conodonts, flat brachiopods, crinoids, trilobites, scolecodonts.
Color: medium light gray N6.

8529-CO M-111-69 138.1'
Limestone and shale
Fossiliferous packstone
Fossils include: bryozoans, crinoids, conodonts, flat brachiopods, gastropods, trilobites, ostracodes, scolecodonts.
Color: medium gray N5.
Shale
Noncalcareous, poorly fissile, fossiliferous.
Color: yellowish gray 5Y 7/2.

8530-CO M-112-69 139.4'
Shale with very thin layers of packstone to wackestone.
Calcareous, fissile, fossiliferous.
Fossils include: bryozoans, gastropods, flat brachiopods, trilobites, conodonts, crinoids, scolecodonts.
Color: yellowish gray 5Y 7/2.

8531-CO M-113-69 139.9'
Limestone
Fossiliferous packstone with peloids. Fine fossil debris is oriented parallel to the bedding.
Fossils include: conodonts, gastropods, flat brachiopods, crinoids, ostracodes, trilobites, pelecypods, scolecodonts.
Color: medium gray N5.

8532-CO M-115-69 141.2'
Shale with burrows.
Calcareous, fissile, fossiliferous, silty.
Fossils include: bryozoans, flat brachiopods, crinoids, trilobites, ostracodes, conodonts.
Color: yellowish gray 5Y 7/2.

8533-CO M-117-69 141.6'
Limestone
Fossiliferous packstone.
Fossils include: bryozoans, trilobites, flat brachiopods, conodonts, gastropods, scolecodonts, crinoids, pelecypods.
Color: medium light gray N6.

8534-CO M-114-69 142.2'
Shale

8534-CO cont'd.
Calcareous, fissile, fossiliferous, silty.
Fossils include: gastropods, bryozoans, flat brachiopods, crinoids, trilobites, pelecypods, conodonts.
Color: grayish orange 10YR 7/4.

8535-CO M-116-69 143.9'
Shaly limestone
Fossiliferous packstone, argillaceous.
Fossils include: bryozoans, crinoids, graptolites, ostracodes, trilobites, flat brachiopods, conodonts.
Color: yellowish gray 5Y 7/2.

8536-CO M-120-69 145.1'
Shale with fossiliferous mudstone to wackestone, laminated.
Calcareous, poorly fissile, fossiliferous, silty.
Fossils include: bryozoans, flat brachiopods, trilobites, crinoids, gastropods.
Color: yellowish gray 5Y 7/2.

8537-CO M-119-69 145.2'
Shale with some layers of mudstone.
Calcareous, fissile, fossiliferous, silty.
Fossils include: bryozoans, flat brachiopods, trilobites, ostracodes, gastropods, conodonts.
Color: light olive gray 5Y 6/1.

8538-CO M-121-69 147.1'
Limestone
Fossiliferous wackestone to packstone with burrows, less fossiliferous mudstone, very finely laminated.
Fossils include: trilobites, flat brachiopods, crinoids, bryozoans, conodonts, ostracodes, pelecypods, gastropods, ?graptolites.
Color: light olive gray 5Y 6/1.

8539-CO M-122-69 149.0'
Shale
Calcareous, fissile, fossiliferous, silty.
Fossils include: bryozoans, flat brachiopods, crinoids, trilobites, ostracodes, gastropods, conodonts.
Color: yellowish gray 5Y 7/2.

8540-CO M-124-69 152.5'
Shale with layers of mudstone with burrows.
Calcareous, fissile, fossiliferous, silty.
Fossils include: trilobites, flat brachiopods, bryozoans, crinoids, gastropods, pelecypods, scolecodonts, ostracodes, conodonts.
Color: yellowish gray 5Y 7/2.

8541-CO M-123-69 153.5'
Shale with layers of mudstone, burrowed, very fine laminated.
Calcareous, fissile, fossiliferous, silty.
Fossils include: gastropods, flat brachiopods, bryozoans, ostracodes, trilobites, pelecypods, conodonts.

8541-CO cont'd.
Color: yellowish gray 5Y 7/2.

8542-CO M-125-69 154.5'
Limestone
Fossiliferous packstone.
Fossils include: gastropods, pelecypods, conodonts, bryozoans, flat brachiopods, ostracodes, crinoids, trilobites, ?worms, hyolithids.
Color: medium gray N5.

8543-CO M-126-69 168.0'
Limestone
Fossiliferous grainstone.
Fossils include: gastropods, pelecypods, flat brachiopods, conodonts, crinoids, bryozoans, scolecodonts, ostracodes, hyolithids.
Color: medium gray N5.

8544-CO M-128-69 169.0'
Shale
Calcareous, fissile, fossiliferous, silty.
Fossils include: flat brachiopods, bryozoans, trilobites, ostracodes, crinoids, gastropods, pelecypods, scolecodonts, conodonts.
Color: yellowish gray 5Y 7/2.

8545-CO M-127-69 169.5'
Limestone
Fossiliferous packstone with fine fossil debris.
Fossils include: flat brachiopods, trilobites, conodonts, gastropods, bryozoans, crinoids, pelecypods, scolecodonts, ?worm tubes, ?sponges.
Color: medium gray N5.

8546-CO M-129-69 177.5'
Limestone
Fossiliferous packstone.
Fossils include: gastropods, pelecypods, flat brachiopods, conodonts, trilobites, bryozoans, crinoids.
Color: medium gray N5.

8547-CO M-130-69 184.5'
Limestone
Fossiliferous packstone, fossils oriented parallel to the bedding.
Fossils include: gastropods, pelecypods, hyolithids, flat brachiopods, conodonts, crinoids, trilobites, scolecodonts, bryozoans, ostracodes, ?worms.
Color: light medium gray N6.

8548-CO M-131-69 198.5'
Shale with fossiliferous packstone.
Calcareous, poorly fissile, fossiliferous, silty.
Fossils include: flat brachiopods, bryozoans, ostracodes, crinoids, gastropods, trilobites, conodonts.
Color: yellowish gray 5Y 7/2.

8549-CO M-132-69 199.5'
Limestone

8549-CO cont'd.
Fossiliferous packstone with fossils oriented parallel to the bedding.
Fossils include: gastropods, conodonts, flat brachiopods, trilobites, pelecypods, bryozoans, crinoids, ostracodes, graptolites, scolecodonts.
Color: light medium gray N6.

8550-CO M-133-69 202.5'
Shale with mudstone.
Calcareous, poorly fissile, fossiliferous, ?laminated.
Fossils include: gastropods, flat brachiopods, pelecypods, scolecodonts.
Color: yellowish gray 5Y 7/2.

8551-CO M-134-69 210.9'
Limestone
Fossiliferous packstone to grainstone with very fine fossil debris.
Fossils include: gastropods, flat brachiopods, small bryozoans, conodonts, pelecypods, crinoids, ostracodes, trilobites, scolecodonts, ?sponges.
Color: medium gray N5.

8552-CO M-135-69 211.9'
Shale with burrows
Non calcareous, poorly fissile, fossiliferous, laminated.
Fossils include: flat brachiopods, bryozoans, gastropods, pelecypods, ostracodes, scolecodonts, conodonts.
Color: yellowish gray 5Y 7/2.

8553-CO M-136-69 212.3'
Limestone
Fossiliferous packstone with fine fossil debris.
Fossils include: flat brachiopods, bryozoans, gastropods, trilobites, conodonts,pelecypods, crinoids, scolecodonts.
Color: medium gray N5.

8554-CO M-137-69 212.8'
Shale with fine layers of packstone. Fine fossil debris.
Calcareous, poorly fissile, fossiliferous, silty.
Fossils include: flat brachiopods, bryozoans, gastropods, ostracodes, crinoids, conodonts, trilobites, scolecodonts.
Color: yellowish gray 5Y 7/2.

8555-CO M-138-69 215.0'
Shale
Noncalcareous, fissile, poorly fossiliferous, silty.
Fossils include: flat brachiopods, crinoids, bryozoans, gastropods, pelecypods, ostracodes, conodonts.
Color: yellowish gray 5Y 7/2.

8556-CO M-139-69 216.9'
Shale with very thin layers of very fine packstone.
Poorly calcareous, poorly fissile, fossiliferous, silty.
Fossils include: bryozoans, flat brachiopods, crinoids, ostracodes, gastropods, conodonts, pelecypods, trilobites.
Color: yellowish gray 5Y 7/2.

8557-CO M-140-69 235.6'
Limestone
Fossiliferous packstone.
Fossils include: flat brachiopods, bryozoans, conodonts, crinoids, trilobites, gastropods, pelecypods, scolecodonts, ostracodes.
Color: light medium gray N6.

8558-CO M-141-69 237.0'
Limestone
Fossiliferous packstone with fine fossil debris.
Fossils include: flat brachiopods, bryozoans, conodonts, trilobites, gastropods, pelecypods, ?hyolithids, crinoids, scolecodonts, ostracodes.
Color: medium gray N5.

8559-CO M-142-69 238.0'
Shale with very thin layers of packstone.
Calcareous, poorly fissile, fossiliferous, silty.
Fossils include: bryozoans, flat brachiopods, gastropods, pelecypods, trilobites, crinoids, ostracodes, scolecodonts, conodonts.
Color: yellowish gray 5Y 7/2.

8560-CO M-143-69 248.0'
Shale with layers of mudstone, burrows.
Slightly calcareous, poorly fissile, fossiliferous, silty.
Fossils include: few flat brachiopods, few bryozoans, gastropods.
Color: yellowish gray 5Y 7/2.

8561-CO M-144-69 250.6'
Limestone
Fossiliferous packstone.
Fossils include: bryozoans, gastropods, conodonts, flat brachiopods, pelecypods, crinoids.
Color: medium light gray N6.

8562-CO M-146-69 250.6'
Limestone
Fossiliferous packstone, weathered.
Fossils include: bryozoans, gastropods, pelecypods, conodonts, flat brachiopods, hyolithids, ostracodes, ?sponges, ?worms.
Color: light gray N7.

8563-CO M-145-69- 252.0'
Shale
Slightly calcareous, poorly fissile, poorly fossiliferous, silty.
Fossils include: bryozoans, flat brachiopods, crinoids.
Color: yellowish gray 5Y 7/2.

8564-CO M-147-69 252.6'
Limestone
Fossiliferous packstone.
Fossils include: flat brachiopods, bryozoans, conodonts, gastropods, pelecypods, scolecodonts, ostracodes.
Color: medium gray N6.

8565-CO M-148-69 253.6'
Shale with minor mudstone layers, laminated.
Calcareous, poorly fissile, fossiliferous, silty.
Fossils include: bryozoans, flat brachiopods, gastropods, pelecypods, ostracodes, conodonts, scolecodonts, crinoids.
Color: yellowish gray 5Y 7/2.

8566-CO M-149-69 255.6'
Shale with minor mudstone layers, laminated.
Poorly calcareous, poorly fissile, fossiliferous, silty.
Fossils include: bryozoans, flat brachiopods, trilobites, ostracodes, conodonts, scolecodonts, crinoids.
Color: yellowish gray 5Y 7/2.

8567-CO M-150-69 257.1'
Shale with lenses of packstone or packstone to wackestone.
Slightly calcareous, poorly fissile, fossiliferous, silty.
Fossils include: flat brachiopods, bryozoans, gastropods, pelecypods, trilobites, crinoids, scolecodonts, ostracodes, conodonts.
Color: yellowish gray 5Y 7/2.

8568-CO M-151-69 258.4'
Limestone
Fossiliferous packstone with fine fossil debris.
Fossils include: bryozoans, flat brachiopods, trilobites, conodonts, gastropods, scolecodonts, graptolites, crinoids.
Color: medium gray N5.

8569-CO M-152-69 259.1'
Shale with burrows
Noncalcareous, poorly fissile, poorly fossiliferous, silty.
Fossils include: flat brachiopods, gastropods, pelecypods, bryozoans, scolecodonts, conodonts, ostracodes.
Color: yellowish gray 5Y 7/2.

8570-CO M-153-69 260.7'
Limestone
Fossiliferous packstone with coarse fossil debris.
Fossils include: bryozoans, gastropods, flat brachiopods, conodonts, pelecypods, trilobites, crinoids, ostracodes, scolecodonts.
Color: medium gray N5.

8571-CO M-154-69 262.0'
Shale with burrows.
Slightly calcareous, fissile, fossiliferous, silty.
Fossils include: bryozoans, flat brachiopods, ostracodes, gastropods, conodonts.
Color: yellowish gray 5Y 7/2.

8572-CO M-155-69 263.3'
Shale
Calcareous, poorly fissile, fossiliferous, slightly silty.
Fossils include: flat brachiopods, bryozoans, crinoids, gastropods.
Color: yellowish gray 5Y 7/2.

8573-CO M-156-69 263.6'
Limestone
Fossiliferous packstone with coarse fossil debris.
Fossils include: bryozoans, flat brachiopods, gastropods, conodonts, trilobites, scolecodonts.
Color: light medium gray N6.

8574-CO M-157-69 267.4'
Shale with thin layers of packstone.
Calcareous, fissile, fossiliferous, silty.
Fossils include: bryozoans, flat brachiopods, crinoids, gastropods, ostracodes, pelecypods, conodonts, scolecodonts.
Color: yellowish gray 5Y 7/2.

8575-CO M-158-69 267.7'
Limestone
Fossiliferous packstone
Fossils include: flat brachiopods, bryozoans, conodonts, trilobites, gastropods, pelecypods, scolecodonts, ostracodes, crinoids.
Color: medium gray N5.

8576-CO M-159-69 267.8'
Limestone, somewhat argillaceous.
Fossiliferous packstone.
Fossils include: flat brachiopods, bryozoans, gastropods, conodonts, pelecypods, crinoids, trilobites, ostracodes, scolecodonts.
Color: light gray N7.

8577-CO M-160-69 271.1'
Limestone, argillaceous.
Fossiliferous wackestone to packstone, fossils oriented parallel to the bedding.
Fossils include: flat brachiopods, bryozoans, conodonts, scolecodonts, crinoids, gastropods, pelecypods.
Color: dusky yellow 5Y 6/4.

8578-CO M-163-69 271.1'
Limestone - shaly
Fossiliferous packstone to wackestone, many fossils oriented parallel to the bedding.
Fossils include: flat brachiopods, bryozoans, crinoids, conodonts, gastropods, pelecypods, ostracodes.
Color: light olive brown 5Y 5/6.

8579-CO M-165-69 273.0'
Shale with very thin limestone layers, burrowed.
Slightly calcareous, poorly fossiliferous, very finely laminated.
Fossils include: gastropods, flat brachiopods, conodonts, bryozoans, pelecypods, scolecodonts, ostracodes, crinoids.
Color: pale olive 10Y 6/2.

8580-CO M-164-69 273.6'
Limestone
Fossiliferous packstone to grainstone with some interclasts.

8580-CO cont'd.
Fossils include: gastropods, pelecypods, conodonts, flat brachiopodsscolecodonts, bryozoans, ostracodes, trilobites, crinoids
Color: medium gray N6.

8581-CO M-167-69 275.0'
Shale mixed with fossiliferous packstone.
Calcareous, fossiliferous.
Fossils include: bryozoans, ostracodes, flat brachiopods, trilobites, gastropods, pelecypods, conodonts, crinoids.
Color: yellowish gray 5Y 7/2.

8582-CO M-161-69 275.1'
Limestone
Fossiliferous wackestone to packstone.
Fossils include: flat brachiopods, bryozoans, gastropods, conodonts, crinoids, scolecodonts, ostracodes, pelecypods, ?trilobite, ?hyolithid.
Color: grayish yellow green 5GY 7/2.

8583-CO M-166-69 275.8'
Limestone
Fossiliferous packstone with pellets.
Fossils include: flat brachiopods, bryozoans, trilobites, scolecodonts, conodonts, gastropods, pelecypods, ostracodes, crinoids, hyolithid, ?sponges.
Color: medium light gray N6.

8584-CO M-168-69 276.0'
Limestone
Fossiliferous packstone with fine fossil debris.
Fossils include: flat brachiopods, bryozoans, conodonts, crinoids, gastropods, pelecypods, ostracodes, scolecodonts, ?sponges.
Color: medium gray N5.

8585-CO M-169-69 276.6'
Shale
Calcareous, fissile, fossiliferous, silty.
Fossils include: flat brachiopods, bryozoans, ostracodes, crinoids, gastropods, pelecypods, conodonts.
Color: yellowish gray 5Y 7/2.

8586-CO M-162-69 277.1'
Limestone
Fossiliferous packstone.
Fossils include: flat brachiopods, bryozoans, gastropods, trilobites, crinoids.
Color: light gray N7.

8587-CO M-170-69 279.0'
Shale
Calcareous, fissile, fossiliferous, silty.
Fossils include: flat brachiopods, bryozoans, ostracodes, trilobites, gastropods, crinoids, conodonts.
Color: yellowish gray 5Y 7/2.

8588-CO M-171-69 281.3'
Shale
Slightly calcareous, fissile, fossiliferous, silty.
Fossils include: flat brachiopods, bryozoans, crinoids, gastropods, ostracodes, conodonts.
Color: yellowish gray 5Y 7/2

8589-CO M-173-69 284.8'
Shale
Calcareous, fissile, fossiliferous, silty, laminated.
Fossils include: bryozoans, flat brachiopods, crinoids, trilobites, ostracodes, gastropods, pelecypods, conodonts.
Color: dusky yellow 5Y 6/4.

8590-CO M-172-69 285.5'
Limestone
Fossiliferous packstone to wackestone.
Fossils include: bryozoans, flat brachiopods, conodonts, gastropods, trilobites, ostracodes, scolecodonts, crinoids, ?graptolites.
Color: medium light gray N6.

8591-CO M-174-69 286.3'
Shale with fossiliferous packstone to wackestone layers. Some pellets.
Calcareous, poorly fissile, fossiliferous, silty.
Fossils include: bryozoans, flat brachiopods, crinoids, ostracodes, gastropods, pelecypods, conodonts.
Color: yellowish gray 5Y 7/2.

8592-CO M-175-69 288.3'
Limestone and shale
Fossiliferous packstone with fine fossil debris.
Fossils include: flat brachiopods, bryozoans, conodonts, gastropods, crinoids, ostracodes, pelecypods, scolecodonts, trilobites.
Color: medium light gray N6.
Shale
Calcareous, poorly fissile, fossiliferous, silty.
Color: yellowish gray 5Y 7/2

8593-CO M-176-69 292.5'
Limestone and shale
Fossiliferous packstone
Fossils include: bryozoans, flat brachiopods, conodonts, trilobites, gastropods, pelecypods, scolecodonts, crinoids.
Color: medium light gray N6.
Shale
Calcareous, fissile, fossiliferous, silty.
Color: grayish orange 10YR 7/4

8594-CO M-177-69 293.0'
Limestone
Fossiliferous wackestone and packstone.
Fossils include: bryozoans, flat brachiopods, conodonts, trilobites, graptolites?, scolecodonts, ostracodes, crinoids.
Color: light olive gray 5Y 6/1 - medium gray N6.

8595-CO M-178-69 293.5'
Limestone and shale
Fossiliferous packstone.
Fossils include: flat brachiopods, bryozoans, ostracodes, gastropods, pelecypods, conodonts, trilobites, scolecodonts.
Color: light gray N7.
Shale
Calcareous, fissile, fossiliferous, silty.
Color: light brownish gray 5YR 6/1

8596-CO M-179-69 296.8'
Shale with some laminated mudstone.
Calcareous, fissile, fossiliferous, silty.
Fossils include: flat brachiopods, trilobites, crinoids, gastropods.
Color: light olive brown 5Y 5/6

8597-CO M-180-69 298.1'
Shale with laminated, burrowed mudstone.
Calcareous, fissile, fossiliferous, silty.
Fossils include: flat brachiopods, bryozoans, gastropods, ostracodes, crinoids.
Color: grayish orange 10YR 7/4.

8598-CO M-181-69 301.6'
Shale
Calcareous, poorly fissile, fossiliferous, silty.
Fossils include: flat brachiopods, bryozoans, ostracodes, gastropods, conodonts, pelecypods, crinoids, ?trilobites.
Color: grayish orange 10YR 7/4.

8599-CO M-182-69 303.1'
Shale with pieces of noncalcareous mudstone.
Calcareous, fossiliferous, fissile, silty.
Fossils include: flat brachiopods, bryozoans, trilobites, gastropods, crinoids, conodonts.
Color: grayish orange 10YR 7/4.

8600-CO M-183-69 306.4'
Shale with burrowed, laminated mudstone.
Calcareous, fissile, fossiliferous, silty.
Fossils include: flat brachiopods, gastropods, bryozoans, pelecypods, trilobites, crinoids.
Color: grayish orange 10YR 7/4.

8601-CO M-191-69 307.6'
Limestone
Less fossiliferous mudstone.
Fossils include: flat brachiopods, bryozoans, crinoids.
Color: light olive gray 5Y 6/1.

8602-CO M-184-69 308.7'
Shale with thin layers of laminated mudstone.
Calcareous, fissile, fossiliferous, silty.
Fossils include: flat brachiopods, gastropods, bryozoans, pelecypods,

8602-CO cont'd.
conodonts, ostracodes.
Color: grayish orange 10YR 7/4.

8603-CO M-185-69 308.9'
Shale with layers of limestone, burrowed.
Calcareous, fossiliferous, poorly fissile, silty.
Fossils include: flat brachiopods, bryozoans, gastropods, pelecypods, ostracodes, crinoids, trilobites, conodonts, hyolithids.
Color: grayish orange 10YR 7/4.

8604-CO M-186-69 309.4'
Limestone and shale, burrowed.
Fossiliferous packstone with fine fossil debris.
Fossils include: flat brachiopods, bryozoans, gastropods,pelecypods, ostracodes, crinoids.
Color: moderate yellowish brown 10 YR 5/4.

8605-CO M-187-69 310.1'
Limestone
Fossiliferous packstone, weathered, laminated.
Fossils include: flat brachiopods, bryozoans, trilobites, crinoids.
Color: medium gray N5.

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8606-CO M-187A-69 311.0'
Limestone
Fossiliferous packstone to wackestone
Fossils include: flat brachiopods, bryozoans, conodonts, gastropods, pelecypods, trilobites, crinoids, ?hyolithid.
Color: medium light gray N6.

8607-CO M-188-69 312.4'
Shale
Calcareous, poorly fissile, fossiliferous, silty.
Fossils include: flat brachiopods, bryozoans, gastropods, conodonts.
Color: grayish orange 10YR 7/4

8608-CO M-192-69 312.6'
Limestone
Fossiliferous packstone.
Fossils include: flat brachiopods, gastropods, bryozoans, pelecypods, conodonts, scolecodonts, crinoids, ostracodes.
Color: medium gray N5.

8609-CO M-189-69 314.7'
Shale
Calcareous, poorly fissile, fossiliferous, silty.
Fossils include: flat brachiopods, bryozoans, crinoids, gastropods, pelecypods, conodonts.
Color: grayish orange 10YR 7/4.

8610-CO M-193-69 315.6'
Shale
Calcareous, poorly fissile, less fossiliferous, silty.
Fossils include: gastropod, crinoids.
Color: yellowish gray 5Y 7/2.

8611-CO M-194-69 317.9'
Limestone
Fossiliferous packstone.
Fossils include: gastropods, flat brachiopods, bryozoans, pelecypods, hyolithids, ostracodes, scolecodonts, conodonts, crinoids, worm tubes, sponges.
Color: medium gray N5.

8612-CO M-190-69 319.4'
Limestone
Fossiliferous packstone.
Fossils include: flat brachiopods, bryozoans, gastropods, conodonts, pelecypods, ostracodes, scolecodonts, crinoids, hyolithids, ?worms, ?sponges.
Color: medium gray N5.

8613-CO M-195-69 319.9'
Limestone
Fossiliferous packstone.
Fossils include: gastropods, flat brachiopods, conodonts, pelecypods, bryozoans, scolecodonts.
Color: medium gray N5.

8614-CO M-196-69 323.1'
Limestone
Fossiliferous packstone.
Fossils include: flat brachiopods, bryozoans, gastropods, conodonts, pelecypods, scolecodonts, crinoids, ostracodes.
Color: medium gray N5.

8615-CO M-197-69 324.4'
Limestone
Fossiliferous packstone.
Fossils include: flat brachiopods, bryozoans, conodonts, gastropods, pelecypods, scolecodonts, crinoids, ?trilobites, ?hyolithids.
Color: medium gray N5.

8616-CO M-198-69 326.7'
Limestone and shale, weathered.
Fossiliferous packstone to wackestone. Fossils oriented parallel to the bedding.
Fossils include: flat brachiopods, bryozoans, gastropods, ostracodes, pelecypods, ?trilobites.
Color: medium light gray N6.

8617-CO M-200-69 326.9'
Shale
Calcareous, less fossiliferous, poorly fissile, silty.
Fossils include: flat brachiopods, gastropods, pelecypods, bryozoans,

8617-CO cont'd.
conodonts.
Color: yellowish gray 5Y 7/2.

8618-CO M-199-69 327.2'
Shale
Calcareous, fissile, fossiliferous, silty.
Fossils include: flat brachiopods, gastropods, bryozoans, pelecypods, conodonts, ostracodes.
Color: grayish orange 10YR 7/4.

8619-CO M-201-69 328.1'
Limestone
Fossiliferous packstone.
Fossils include: flat brachiopods, bryozoans, conodonts, gastropods, pelecypods, crinoids, ostracodes, scolecodonts, ?trilobites, sponges, worm tubes.
Color; medium gray N5.

8620-CO M-202-69 332.4'
Limestone
Fossiliferous mudstone
Fossils include: flat brachiopods, bryozoans, crinoids, gastropods, scolecodonts, conodonts, ostracodes, ?trilobites.
Color: medium light gray N6 - weathered.

8621-CO M-203-69 333.4'
Shale
Calcareous, fissile, fossiliferous, silty, burrowed.
Fossils include: flat brachiopods, gastropods, pelecypods, bryozoans, conodonts, ostracodes, ?crinoids.
Color: yellowish gray 5Y 7/2.

8622-CO M-204-69 338.4'
Shale
Calcareous, fissile, fossiliferous, silty.
Fossils include: bryozoans, flat brachiopods, conodonts, gastropods, crinoids, pelecypods, scolecodonts, ?trilobites, sponges, hyolithids, ostracodes.
Color: grayish orange 10YR 7/4.

8623-CO M-205-69 341.4'
Limestone
Fossiliferous packstone
Fossils include: bryozoans, flat brachiopods, gastropods, pelecypods, conodonts, sponges, crinoids, scolecodonts, ?trilobites.
Color: medium gray N5.

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