Pennsylvania Brachiopods of Nevada

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Geology

by

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June 1972
ABSTRACT

Highly fossiliferous Pennsylvanian rocks crop out extensively in mountain ranges of eastern Nevada. Brachiopods and corals are uniformly distributed in these rocks in contrast to erratic lateral distribution of fusulinids. Correlation of the Pennsylvanian System in this area is better served by using megafaunal elements and a biostratigraphical scheme is presented. Faunal elements of the basal Moleen and Ely Formations in northeastern and east-central Nevada respectively, and extreme upper units of BSb member of the Bird Spring Group in southern Nevada have close affinity to the early Morrowan fauna from other areas in Nevada, Utah and the mid-continent region. These basal units also represent the upper range limit of brachiopods, Rhipidomella nevadensis and Diaphragmus fasciculatus which are primarily upper Mississippian species. The presence of these two late Mississippian species and Ovatia aff. O. elongata, Spirifer occiduus, S. opimus, Hustedia miser, Antiquatonia lintzi n. sp., and other early Pennsylvanian fauna in the basal units is indicative of an early Morrowan age. A widespread unconformity indicating local orogenies and epirogenic upwarping is evident for late middle and upper Pennsylvanian time in northeastern and east-central Nevada.
In southern Nevada, uninterrupted faunal and lithologic sequences indicate continuous deposition. Faunal analysis revealed that 9 taxa are index fossils, 27 taxa have short vertical range but poor to moderate lateral distribution, 8 have poor vertical distribution, but good lateral distribution and the rest are stratigraphically unimportant.

More than 60 taxa of brachiopods are described. Nine brachiopods Wellerella dekalbensis var. elkoensis n. var., Composita nevadensis n. sp., Composita elongata var. elyensis n. var., Cleiothyridina orbicularis var. brogani n. var., Antiquatonia lintzi n. sp., Antiquatonia lintzi var. costatus n. var., Linoproductus firbyi n. sp., Desmoinesia muricatina var. nevadensis n. var., and Retichonetes larsoni n. sp. are described for the first time.
# TABLE OF CONTENTS

**ABSTRACT**

<table>
<thead>
<tr>
<th>INTRODUCTION</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>1</td>
</tr>
<tr>
<td>Purpose, scope, and limitations of this investigation</td>
<td>3</td>
</tr>
<tr>
<td>Method of investigation</td>
<td>6</td>
</tr>
<tr>
<td>Previous investigations</td>
<td>6</td>
</tr>
<tr>
<td>Acknowledgment</td>
<td>9</td>
</tr>
</tbody>
</table>

**STRATIGRAPHY AND GEOLOGIC HISTORY**

| Formational nomenclature | 11 |

**AGE AND CORRELATION**

| Lower Pennsylvanian, Morrowan | 17 |
| Lower Pennsylvanian, Atokan | 19 |
| Middle Pennsylvanian, Desmoinesian | 24 |
| Upper Pennsylvanian, Missourian-Virgilian | 25 |

**SUMMARY**

| 28 |

**SYSTEMATIC PALEONTOLOGY**

| 35 |

**BIBLIOGRAPHY**

| 115 |
TABLES

1. Correlation chart of Pennsylvanian Formations in eastern Nevada ........ 18
2. Stratigraphic significance and relative abundance of selected Pennsylvanian megafauna in eastern Nevada .......... 20
3. Stratigraphic ranges of selected fossils in eastern Nevada .................. 27
4. Measured section at Shingle Pass area, Lincoln County, Nevada ............ 34

FIGURES

1. Upper Paleozoic outcrops in eastern Nevada .... 2
2. Location Map .......... 4
3. Paleogeographic framework during early Pennsylvanian time and isopach map of Morrowan-Atokan sediments ............. 12

PLATES

1. Lingulida, orthida, terebratulida, rhynchonellida, spiriferida .... 126
2. Spiriferida ........ 128
3. Spiriferida .......... 130
4. Strophomenida ........ 132
5. Strophomenida .......... 134
INTRODUCTION

Pennsylvanian sediments, locally thicker than 2,500 feet, were deposited in a very large area in the miogeosyncline of the Cordilleran Geosyncline. Outcrops of these rocks are exposed extensively in the mountain ranges in eastern Nevada. These discontinuous exposures are limited to long thin bands in the mountain ranges (fig. 1). These rocks are predominantly gray limestones of variable thickness with chert pebbles and sandstones, and are highly fossiliferous. During the last two decades, these rocks have attracted considerable investigation in regard to problems of stratigraphy, sedimentation and paleontology. However, very few investigations were conducted on the megafaunal elements of these rocks.

Eastern Nevada lies in the Basin and Range physiographic province. Alternating mountain ranges and valleys, trending roughly north-south, are typical of the entire region. Mountain ranges are relatively narrow and the valleys are broad. Mountainous relief is typical throughout the area of investigation. A combination of external and internal drainage systems is characteristic of the area of investigation. Most tributaries in southern Nevada discharge into the Colorado River system, whereas those in northeastern Nevada drain into
the Humboldt River system which subsequently discharges in the Carson and Humboldt Sinks.

Vegetation in the area includes pinon pines (Pinus monophylla) and junipers (Junipersus monosperma, J. osteosperma) in the mountains and higher elevations and sagebrush (Artemisia tridenta, A. nova, A. arbuscula) in the valleys and lower elevations.

Location

The area of investigation lies in parts of Elko, Eureka, White Pine, Nye, Lincoln and Clark counties in Nevada. Areas of fossil collections and stratigraphical section measurements are shown in Figure 2.

Purpose, Scope and Limitations of this Investigation

Most studies of Pennsylvanian rocks in eastern Nevada have been local in nature. Most of the investigations of the Pennsylvanian fauna deal generally with one phylum, and the areal extent of the fossil localities is usually limited. The purpose of this investigation, therefore, is two-fold: the first objective is to describe megafaunal assemblages in these rocks together with their regional and spatial distribution, the second is to provide a stratigraphic interpretation based on faunal distribution. This study will aid
FIGURE 2
Location Map
in understanding regional distribution of megafaunal elements in the Pennsylvanian System of the Cordilleran region.

Most earlier publications on Pennsylvanian rocks of Nevada have dealt with fusulinids and their regional distribution. Biostratigraphical correlation of the Pennsylvanian System in eastern Nevada is difficult because fusulinids, by far the best index fossils for upper Paleozoic rocks elsewhere, in the Basin and Range province of Nevada have a very uneven lateral distribution. Fusulinids are quite abundant in southern Nevada but are either absent or nearly so in central and northern Nevada. A correlation based primarily on fusulinids appeared doomed to failure. Hence, the correlation was achieved primarily on the basis of megafaunal elements such as brachiopods and corals which are found to be widely distributed in the Cordilleran region. Because of the longer geologic ranges of these taxa, a correlation based on brachiopod and coral distribution could not be as refined as that achieved through fusulinid distribution. At those localities where fusulinids were associated with the megafaunal elements their distribution was noted to provide a tie-in with fusulinid biostratigraphical zonation.
Method of Investigation

Every major invertebrate fossil group is represented in the Pennsylvanian rocks of eastern Nevada. Extensive fossil collections were made during the summers of 1968 and 1969 from outcrops of Pennsylvanian rocks in Elko, White Pine, Eureka, Nye, Lincoln and Clark Counties in Nevada. Fossil collections and earlier measured stratigraphic sections from several localities in northeastern Nevada were made available to the author by Dr. Joseph Lintz, Jr., Professor of Geology, University of Nevada. As stratigraphic sections at most of the fossil localities were already measured, stratigraphic horizons of fossils were carefully plotted within the section. In the Shingle Pass area of Lincoln County the stratigraphic section was measured by the author.

Previous Investigations

Until 1950, studies concerning biostratigraphy and paleontology of Pennsylvanian rocks have been generalized in nature. Geological investigations of the 40th Parallel Survey (King, 1878; Hauge & Emmons, 1877; Meek, 1877 and others) are surprisingly accurate but generalized. Upper Paleozoic rocks in several ranges in southern Nevada were first discussed by Spurr (1903). Later Hewett (1931) introduced the name Bird Spring Formation for upper Paleozoic
carbonates in the Goodsprings District. Longwell and Dunbar (1936), however, later recognized Permian rocks and Chesterian rocks within Hewett's Bird Spring Formation and defined a separate member, the Indian Springs member for the Chesterian portion.

Dott (1955) published a comprehensive study on Pennsylvanian stratigraphy in northeastern Nevada including faunal assemblages and their stratigraphic significance. He elevated the Ely Formation of Lawson (1906) to Group rank which included the newly established formations, the Moleen (below) and Tomera, and recognized a widespread unconformity separating Des Moines and Wolfcampian sediments. Welsh (1959) described the biostratigraphy of Pennsylvanian-Permian rocks in southern Nevada. He made a distinction between the basinal and shelf facies of the Bird Spring Formation, and assigned the shelf rocks to the Callville limestone and Pakoon Formation and the basinal sequence to the Bird Spring Formation (Pennsylvanian) and the unpublished Apex Formation (Permian).

Steele (1960) in his study of Pennsylvanian-Permian stratigraphy in the Great Basin, separated the Wolfcampian-age carbonate of the Ely Limestone in the Robinson Mining District and proposed a new name, Riepe Spring Limestone for
this coralline and fusulinid-bearing limestone. He also proposed a reference section for Ely Limestone in the Moorman Ranch area near U. S. Highway 50. Earlier workers had not designated a type area for the Ely Limestone.

Lane (1962) conducted a detailed faunal study of the Ely Group in the Illipah Quadrangle, and described a total of 49 genera, of which 4 are fusulinids and 21 are brachiopods. On the basis of these faunal elements, he assigned these sediments to Atokan age.

Bissell (1962) published a comprehensive summary of various investigations on Pennsylvanian-Permian stratigraphy in the Cordilleran region. Langenheim et al. (1962) made a detailed study of the Pennsylvanian stratigraphy and fusulinid zonation in the Arrow Canyon Range in southern Nevada, and subdivided the Bird Spring Formation into 5 members (BSa to BSe) ranging in age from late Mississippian to early Permian. Brill (1963) presented a correlation scheme of the Pennsylvanian rocks in the Great Basin and the Colorado Plateau Province. Coogan (1964) discussed the early Pennsylvanian history of the Ely basin and compared it with the Bird Spring basin in southern Nevada. In this study, he recognized a significant thickening of early Pennsylvanian sediments toward a depositional center at Ward Mountain, near Ely, Nevada.
Paleontological investigation of the megafaunal elements are as follows: Tabulate Corals in the Ward Mountain, near Ely by Wilson (1963); Pennsylvanian megafauna in the Arrow Canyon Range by Langenheim (1964); Late Paleozoic spiriferid brachiopods, crinoides and bryozoans from southern Nevada by Lane (1963, 1964); and conodonts from southern Nevada by Dunn (1965) and Webster (1966).

Major emphasis of these earlier investigations have been on the physical stratigraphy and the microfaunal elements of Pennsylvanian rocks in Nevada. Surprisingly only a few, (Lane, 1962; Lane, 1963, 1964; Wilson, 1963; and Langenheim, 1964) of these publications have delt with the megafaunal elements in the Pennsylvanian rocks of Nevada.

Acknowledgment

The author is greatly indebted to Dr. Joseph Lintz, Jr., Professor of Geology at the University of Nevada for originally suggesting the problem and continued guidance throughout the preparation of this manuscript. The author is indebted to Dr. James R. Firby, Asst. Professor of Geology for his help in the preparation of plates. Partial financial support for this project was attained through the help of Dr. Arthur Baker, III, Associate Director, Nevada
Bureau of Mines and this is duly acknowledged. Part of the financial support was received through the Mackay School of Mines Research Fund.
Rocks of Pennsylvanian age crop out extensively in eastern Nevada. Bissell (1962, 1964) summarized the stratigraphic correlation of the Pennsylvanian System and included measured sections from several localities in eastern Nevada.

The Pennsylvanian Period generally represents an abrupt change from the depositional conditions which existed through most of the Mississippian Period. Depositional basins which received essentially clastic material (conglomerate, sandstone, and shale) from the orogenic highlands of the Antler Orogeny became the site of cyclic carbonate deposition. The early Pennsylvanian framework of paleogeographic conditions is illustrated in Fig. 3. Carbonate deposition was centered in the Ely basin and unstable shelf areas of southern Nevada. These depositional centers were bounded on the west by positive areas of the Antler orogenic belt; on the northeast by the northeast Nevada high?; on the east by western Utah high and on the southeast by the Callville shelf. Various sections measured by Langenheim (1964), Bissell (1964), Coogan (1964), and this author reveal an almost two-fold increase in thickness of early Pennsylvanian sediments basinward. This author concurs with Coogan's (1964)
FIGURE 3

Paleogeographic framework during early Pennsylvanian time and isopach map of Morrowan-Atokan sediments

Contour Interval
600 Feet

Miles

Modified after Coogan (1964)

Antler Orogenic Belt
Northeast Nevada High?
Carlin Canyon
Ely
Western Utah High
Callville Shelf

[Map showing geographic features and contours]

A gradual increase in the amount of bituminous coal and petroleum is observed. The thickness and quality of the bituminous coal vary widely throughout the region. In the northern part of the area, where the coal seams are more persistent, the thickness of the coal is greater.

Carbonate sediments in the southern Nevada area are less persistent, and carbonate stimulation of a sequence observed in this author's studies. Changes in the thickness and quality of sediments, their color, and their distribution are compared from the Arrow Canyon to the Lee Canyon regions of southern Nevada. It is seen that basin conditions existed in the Spring Mountains and the Lee Canyon regions of southern Nevada during early Pennsylvanian time.

Observations that along with increased temperature, there was increase in the amount of humic substances (i.e., the total material, those which were more than 50 percent of the surface of the coal seam, where the bituminous coal was more persistent.)
observation that along with basinward increase in the thickness of sediments, there is an increase in the amount of bituminous (i.e., insoluble, fetid, and organic) material in the sediments. Coogan (1964, p. 488) states:

A gradual increase in the amount of bituminous limestone occurs between Arrow Canyon and Sunnyside: then there is a sharp increase to 29 percent of the section in the Burbank Hills, and to more than 50 percent of the section at Ward Mountain, where basinal environmental conditions were more persistent.

Carbonate sedimentation in southern Nevada took place on an unstable shelf area as no significant basinward thickening of sediments was observed by this author. Changes in the thickness of sediments, their color, and their bituminous content from the Arrow Canyon to the Lee Canyon in southern Nevada is not as critical as those from the Arrow Canyon to the Ward Mountain region. Hence, this author disagrees with Welsh's suggestion made in 1955 that basinal conditions existed in the Spring Mountains and the Lee Canyon regions of southern Nevada.

Sediments to the northeast in the Elko region are generally oxidized, and occasionally chert beds are interbedded with limestone and intermittent conglomerates. Interbedded clastic sediments are indicative of local tectonic disturbances. However, basinward intermittent euxinic conditions are apparent in sediments further south in the
Illipah Quadrangle as sediments become more gray and bituminous. These same conditions are reflected in the sediments of the Pancake Range and Shingle Pass region.

Carbonate sediments of the Pennsylvanian System in eastern Nevada are often associated with chert nodules and interbedded chert units, which contain the same fossils as the surrounding carbonates. On the basis of field observations, this author concurs with Dott's (1955) suggestion that most of the silica in the Pennsylvanian sediments of the area was deposited with carbonate mud and was concentrated during diagenesis. Dott (1955, p. 2236) states:

Sharp change to reducing conditions made mineral associations which are stable at the depositional interface become unstable upon burial. Extensive replacements, including chert formation, between minerals of lower and higher oxidation states would occur, especially during early stages of compaction, when maximum mobility of ions and colloids could occur.

Carbonate sediments during the Pennsylvanian Period were deposited in shallow water, with frequent agitation, winnowing and redeposition. Alternating with these conditions were periods of less intense stirring of accumulating sediments, producing a cyclic pattern. This cyclic pattern was described by Dott (1958) in northeastern Nevada and was observed to be typical of Pennsylvanian sediments throughout most of eastern Nevada.
Paleogeographic conditions changed considerably in eastern Nevada during middle Pennsylvanian time. The Ely basin subsidence of the Morrowan and Atokan epochs ceased, as attested by the uniform thickness of Desmoinesian sediments in east-central Nevada. The Desmoinesian sediments in the Illipah Quadrangle, Pancake Range, Shingle Pass region, and other areas in east-central Nevada are more arenaceous; indicating regional instability in the northeast and east-central Nevada. This instability resulted in local orogenic movements in the northeast (Dott, 1955) so that conglomerates were deposited in the Elko area. Epeirogenic upwarping occurred in east-central Nevada (Ely basin depositional area) and this resulted in, generally, uniform thickness of Desmoinesian sediments throughout the region.

This regional instability in the northeast and east-central Nevada resulted in a widespread unconformity (generally Wolfcampian on Desmoinesian). Nowhere is this unconformity more apparent than in Carlin Canyon where Post-Desmoinesian sediments rest with distinct angularity over Desmoinesian and older Pennsylvanian sediments. In eastern Nevada, the effect of this epeirogenic upwarping was a gradual westward shift of Utah high to encompass parts of eastern Nevada in middle and late Pennsylvanian times.
In southern Nevada, in the Arrow Canyon Range, Lee Canyon, and Spring Mountains regions, the prevailing conditions of deposition of Morrowan and Atokan times continued without any apparent hiatus in the faunal or lithologic sequence. The thickness of Desmoinesian sediments in southern Nevada ranging in thickness from 450 feet to 750 feet is comparable to those in east-central and northeastern Nevada.

Because of epeirogenic upwarping and orogenic movements in east-central and northeastern Nevada respectively, Missourian-Virgilian sediments are poorly represented in those areas. In most of these localities Desmoinesian sediments are directly overlain by carbonates of Wolfcampian-age. This relationship is true in the Illipah region, Butte and Ward Mountains, Pancake Range, Shingle Pass region, and adjoining areas in east-central Nevada. Upper Pennsylvanian sediments (Missourian-Virgilian) are therefore, found only in the Elko area (Strathern Formation), Battle Mountain region (Antler Peak Limestone), and southern Nevada (upper part of BSc, and Bsd units of Bird Spring Group). Playford (1961) reported Desmoinesian and Virgilian fusulinids from the upper Ely Limestone near Lund. Faunal evidence from the Shingle Pass region, 30 miles south of Lund, indicates an absence of upper Pennsylvanian sediments in the area.
Formational Nomenclature

Pennsylvanian sediments have been designated by various names in eastern and southern Nevada. In northeastern Nevada, Dott (1955) elevated the Ely Formation to group rank and subdivided it into Moleen (below) and Tomera Formations. The Strathern Limestone consists of sediments deposited during upper Pennsylvanian-Permian times. Elsewhere, Pennsylvanian sediments have been called the Ely Limestone and the Hogan Formation in the Pancake Range, Illipah and Shingle Pass region; Bailey Spring Limestone in the Fairview Range; Tippipah Limestone at Nevada test site and as the Bird Spring Group in southern Nevada. Table 1 is a correlation chart of Pennsylvanian formations in eastern and southern Nevada.

AGE AND CORRELATION

Correlation of Pennsylvanian rocks in the Great Basin is difficult because comparatively few fossils of short geological (temporal) range and wide lateral distribution have been recognized. Fusulinids are widely distributed at several localities in southern and eastern Nevada, but are absent or nearly so at other localities. Correlation is achieved by establishing the temporal range and lateral distribution of megafaunal elements of the Pennsylvanian System. Where fusulinids were already described, their distribution was
TABLE 1

Correlation Chart of Pennsylvanian Formations in Eastern Nevada

<table>
<thead>
<tr>
<th>PERMIAN</th>
<th>WOLFCAMPAN</th>
<th>Elko Area</th>
<th>Illipah Area</th>
<th>Pancake Range</th>
<th>Shingle Pass</th>
<th>Southern</th>
<th>Arrow Canyon</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Arcturus Gr.</td>
<td>Riepe Spring Fm.</td>
<td>Riepe Spring Fm.</td>
<td>Riepe Spring Fm.</td>
<td>Arcturus Gr. Rib Hill ss</td>
<td>BSe</td>
</tr>
<tr>
<td>VIRGILIAN</td>
<td></td>
<td>Strathern Formation</td>
<td>Ely Group</td>
<td>Hogan Fm</td>
<td>Hogan Fm</td>
<td>Hogan Fm</td>
<td>BSc</td>
</tr>
<tr>
<td>MISSOURIAN</td>
<td></td>
<td>Tomera</td>
<td>Ely Group</td>
<td>Ely Limestone</td>
<td>Ely Limestone</td>
<td>Ely Limestone</td>
<td>BSd</td>
</tr>
<tr>
<td>DESMOINESIAN</td>
<td></td>
<td>Ely Group</td>
<td>Moleen</td>
<td>Hogan Fm</td>
<td>Hogan Fm</td>
<td>Hogan Fm</td>
<td>BSc</td>
</tr>
<tr>
<td>ATOKAN</td>
<td></td>
<td>Ely Group</td>
<td>Hogan Fm</td>
<td>Ely Group</td>
<td>Ely Group</td>
<td>Ely Group</td>
<td>BSb</td>
</tr>
<tr>
<td>MORROWAN</td>
<td></td>
<td>Ely Group</td>
<td>Ely Group</td>
<td>Ely Group</td>
<td>Ely Group</td>
<td>Ely Group</td>
<td></td>
</tr>
<tr>
<td>SPRINGERAN</td>
<td></td>
<td>Ely Group</td>
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<td>Ely Group</td>
<td>Ely Group</td>
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</tr>
<tr>
<td>MISS.</td>
<td>CHESTERIAN</td>
<td></td>
<td>Tonka Fm.</td>
<td>Chainman Shale</td>
<td>Chainman Shale</td>
<td>Chainman Shale</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>White Pine Shale</td>
<td>Chainman Shale</td>
<td>Chainman Shale</td>
<td>Chainman Shale</td>
<td>Chainman Shale</td>
<td></td>
</tr>
</tbody>
</table>

Modified after Dott (1955) and Bissell (1964).
noted and was incorporated in the correlation scheme. Relative abundance and stratigraphic importance of megafauna in the Pennsylvanian System in eastern Nevada is shown in Table 2.

Lower Pennsylvanian, Morrowan

Beds of Morrowan-age have been regionally recognized in northeastern, east-central and southern Nevada. Morrowan-age sediments include lower and middle parts of the Moleen Formation in northeastern Nevada, lower and middle parts of the Ely Limestone in east-central Nevada, and extreme upper parts of BSb and lower parts of BSc units of the Bird Spring Group in southern Nevada. That sediments at these localities are of Morrowan-age is indicated by the presence of the following taxa of brachiopods: *Rhipidomella nevadensis*, *Cleiothyridina orbicularis*, *Diaphragmus* cf. *D. fasciculatus*, *Antiquatonia hermosana*, *A. lintzi* n. sp., *Anthracospirifer occiduus*, *Spirifer opimus*, *Ovatia* aff. *O. elongata*, *Composita subtilita*, *Hustedia miserii*, and *Linoproductus prattenianus* and a fusulinid, *Millerella* sp. *Neospirifer cameratus* was collected from upper Morrowan rocks. Elements of this faunal assemblage has been referred to *Rhipidomella nevadensis* Zone by Dott (1955) and Sadlick (1960). This author recognized *Rhipidomella nevadensis* in the basal Pennsylvanian sediments (up to 50' from the base) at most of the localities in east-central
### Table 2

Stratigraphic Significance and Relative Abundance of Selected Pennsylvanian Megafauna in Eastern Nevada

<table>
<thead>
<tr>
<th>Stratigraphic Significance</th>
<th>Relative Abundance</th>
</tr>
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<tbody>
<tr>
<td>1. Springerian</td>
<td>a = abundant</td>
</tr>
<tr>
<td>2. Norwalkian</td>
<td>c = common</td>
</tr>
<tr>
<td>3. Atokan</td>
<td>r = rare</td>
</tr>
<tr>
<td>4. Desmoinesian</td>
<td>rr = very rare</td>
</tr>
<tr>
<td>5. Missourian-Virgilian</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Taxon</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chaetetes favosus Moore &amp; Jeffords</td>
<td></td>
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<tr>
<td>Springeria sp.</td>
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<tr>
<td>Locephovillidium aff. L. proliferum (McChesney)</td>
<td>c</td>
<td>c</td>
<td>c</td>
<td>c</td>
<td>c</td>
<td>c</td>
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<tr>
<td>Locephovillidium aff. L. protractum (M-E &amp; P)</td>
<td>r</td>
<td>r</td>
<td>r</td>
<td>r</td>
<td>u</td>
<td>u</td>
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<tr>
<td>Caminia terauna (Owen)</td>
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<tr>
<td>Linea tenuiseta (Price)</td>
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<tr>
<td>Eusphytonella carinaria (Swallow)</td>
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<tr>
<td>Eusphytonella nevadensis (Shephard)</td>
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<td>Beecheria brevifrons (Norton)</td>
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<td>Girtyeila aff. G. woodworthi Clark</td>
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<tr>
<td>Welleteria aff. W. osakensis (Swallow)</td>
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<tr>
<td>Composita argentea (Shephard)</td>
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<tr>
<td>Composita evans Matzer</td>
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<tr>
<td>Composita aff. L. elvensis var.</td>
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<tr>
<td>Composita elongata var. elvensis n. var.</td>
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<tr>
<td>Composita triloba Dunbar &amp; Condra</td>
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<td>Composita nevadensis n. sp.</td>
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and northeastern Nevada. *Rhipidomella nevadensis* was reported from Arrow Canyon by Welsh (1959) but it is not represented in the present collection from Arrow Canyon. Its presence in the basal Pennsylvanian sediments represents the upper range limit of this species. This author considers this occurrence to be of considerable stratigraphic significance. The occurrence of Morrowan fauna in association with *Rhipidomella nevadensis* and *Diaphragmus* cf. *D. fasciculatus* in the basal units of the Ely and Moleen Formations and upper units of BSb of the Bird Spring Group indicates an early Morrowan age. *Ovatia aff. O. elongata*, heretofore, has been described from late Mississippian rocks. However, its range is being extended to encompass Morrowan times. This author considers this species to be of considerable stratigraphic significance for Morrowan age rocks in eastern Nevada.

The faunal assemblage described here compares favorably with the described Morrowan fauna of northeastern and southern Nevada and the mid-continent.

Lane (1962) suggested that the Ely fauna of the Illipah region are of Atokan age as they do not contain fossils clearly indicative of either Springeran or Morrowan age. This author, on the other hand, feels that the fauna of the
basal Ely in east-central Nevada are comparable to that of basal Moleen in northeastern Nevada and the extreme upper member of BSb unit of the Bird Spring Group in southern Nevada. Many faunal elements at these geographically separated localities are identical or nearly so, and are clearly indicative of a lower Morrowan age for the basal Ely Limestone.

Dott (1955) considers basal Moleen units in the Carlin Canyon Range to be Springeran-Morrowan in age. On the basis of the presence of such Morrowan species as Ovatia aff. O. elongata, Anthracospirifer occiduus, Spirifer opimus, Hustedia miseri, Linoproductus magnispinus, Antiquatonia lintzi n. sp. in association with Rhipidomella nevadensis and Diaphragmus cf. D. fasciculatus, this author considers these units to be early Morrowan in age.

On the basis of fusulinids, Cassity and Langenheim (1965) assigned the entire BSb unit of Bird Spring Group at Arrow Canyon Range to the Springeran. In the present investigation, the fauna from the extreme upper unit of BSb member at Arrow Canyon compares favorably with the lower Morrowan fauna from other localities in eastern Nevada. The Arrow Canyon BSb fauna also compares favorably with Lane's (1963) lower Morrowan fauna from southern Nevada.
In this correlation scheme, basal units of the Ely and Moleen Formations, and the extreme upper units of the BSb member of the Bird Spring Group are considered to be of early Morrowan-age. This conclusion is derived on the basis of the occurrence of early Morrowan fauna in these units. The presence of *Rhipidomella nevadensis* and *Diaphragmamus fasciculatus* represents the upper range limit of these species. Gordon and Poole (1968) reported that *Rhipidomella nevadensis*, although a characteristic of late Mississippian fauna, ranges locally into the Pennsylvanian.

The underlying units (Chainman Shale and its stratigraphic equivalent) are considered to be late Mississippian in age. However, Gordon and Poole (1968) reported Mississippian-Pennsylvanian boundary to be coincident with the disconformable contact between the Eleana Formation (late Mississippian) and Tippipah Limestone (late Morrowan) in southwestern Nevada and California. Faunal elements of the Chainman Shale and its stratigraphic equivalents in northeastern and east-central Nevada should be reexamined to determine if either a hiatus exists at the Mississippian-Pennsylvanian boundary or that the upper units of Chainman Shale are of Springeran age.
Lower Pennsylvanian, Atokan (Derryan)


This assemblage represents continued presence of some elements of Morrowan fauna, but there is a marked absence of Rhipidomella nevadensis, Diaphragmus cf. D. fasciculatus, Ovatia aff. O. elongata, Hustedia miseri, and Spirifer opimus. There is, also, a considerable decline in the abundance of Cleiothyridina orbicularis, Anthracospirifer occiduus, Antiquatonia hermosana, and Linoproductus prattenianus.

Corals are a significant part of the Atokan fauna in eastern Nevada. The Chaetetes-Profusulinella zone is widely
distributed and can be recognized in Atokan units at many localities in Nevada.

**Middle Pennsylvanian, Desmoinesian**

Beds of Desmoinesian age consist of the middle and upper parts of the Tomera Formation in the northeast, the Hogan Formation in east-central Nevada, and the BSc unit of the Bird Spring Group in southern Nevada. The middle Pennsylvanian time displays a continued decrease in the abundance of megafaunal elements, especially brachiopods. The Desmoinesian fauna is represented by: brachiopods, *Desmoinesia muricatina*, *Hustedia mormoni*, *Antiquatonia hermosana*, *Neospirifer dunbari* and *N. cameratus*; corals, *Syringopora* sp., *Chaetetes* sp. and *Caninia torqua* and fusulinid, *Fusulinella* sp.

The Desmoinesian fauna also contains relicts of some Morrowan-Atokan brachiopod faunule and displays considerable decrease in the number and diversity of megafaunal elements in contrast to their earlier abundance in rocks of Morrowan-Atokan age.

**Upper Pennsylvanian, Missourian-Virgilian**

Sediments of Missourian-Virgilian age are poorly represented in eastern Nevada. Upper Pennsylvanian fauna
are represented by the Antler Peak Limestone in the Battle Mountain region, the Strathern Formation in northeastern Nevada and by the upper part of BSc and BSD units in southern Nevada. Because of widespread unconformity, Missourian-Virgilian sediments are missing from east-central Nevada where Wolfcampian sediments directly overlie the Desmoinesian. Thus, faunal elements of Missourian-Virgilian are neither widespread nor diversified. Missourian-Virgilian fauna include: brachiopods, *Crurithyris planoconvexa*, *C. expansa*, *Wellerella dekalbensis var. elkoensis* n. var., *W. osagensis*, *Juresania aff. J. nebrascensis*, *Composita* sp. indet. A, *Neospirifer* sp., *Derbyia* sp. and corals, *Syringopora* sp. and *Caninia* sp.

Dott (1955) lists the following genera of brachiopods from upper Pennsylvanian rocks in the Elko area: *Echinoconchus*, *Schizopohoria*, *Beecheria*, *Chonetina*, *Chonetes*, *Phricodothyris*, *Antiquatonia* and *Hustedia*.

Megafaunal elements of Missourian-Virgilian age are poorly represented in the present collection which is attributable to the scarcity of Missourian-Virgilian sediments in eastern Nevada.

Table 3 shows ranges of selected fossils in eastern Nevada.
<table>
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<tr>
<th>MISSISSIPPIAN</th>
<th>PENNSYLVANIAN</th>
<th>PERMIAN</th>
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<tr>
<td>Chazyian</td>
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<td>Springerian</td>
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<td>Deimosian</td>
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<td>Missourian</td>
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<td>Virgilian</td>
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<td>Wolfcampian</td>
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**Table 3**

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<tr>
<th>STRATIGRAPHIC RANGE OF SELECTED FOSSILS IN NORTHERN NEVADA</th>
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**MISSISSIPPIAN**
- *Millerella sp. (M. Marbleensis)*
- *Wendelinella sp.*
- *Propusulinella sp.*
- *Fusulinella sp.*
- *Fusulina sp.*
- *Pseudopunculina sp.*

**PENNYSYLVANIAN**
- *Paramillerella sp.*
- *Stafella sp.*
- *Pseudostafella sp.*
- *Eoschertella sp.*
- *Trifolites sp.*

**PERMIAN**
- *Diaphagmus cf. D. Fasciculatus*
- *Cleipomorpha Orbicularis*
- *Rhipidomella Nevadensis*
- *Chaetites Favous*
- *Ovatia aff. O. Elongata*
- *Caninia Torqua*
- *Neospirifer sp.*
- *Curithyrhis Flandconvexa*
- *Curithyrhis Expansa*
- *Antispuriform Spirifer Oecidus*
- *Hustedlia Miseri*
- *Spirifer Opinus*
- *Linoprocessus Macispinus*
- *Linoprocessus Macispinus*
- *Linoprocessus Macispinus*
- *Linoprocessus Macispinus*

**H暨osis of selected taxa & branching points**
SUMMARY

Pennsylvanian rocks locally thicker than 2500 feet crop out extensively in mountain ranges of eastern Nevada. These rocks were deposited in a very large area of the miogeosyncline of the Cordilleran geosyncline. These rocks are predominantly gray limestone of variable thickness with chert pebbles and sandstones, and are highly fossiliferous.

The Pennsylvanian Period represents an abrupt change from the depositional conditions which existed through most of the Mississippian Period. Depositional basins which received essentially clastic material from the orogenic highlands of the Antler Orogeny became the site of cyclic carbonate deposition. Carbonate sediments were deposited in shallow water, with frequent agitation winnowing and re-deposition. Alternating with these conditions were periods of less intense stirring of accumulating sediments, producing a cyclic pattern.

In the early Pennsylvanian (Morrowan and Atokan) sediments are almost twice as thick as those in northeastern and southern Nevada, indicating the presence of a depositional center near Ely. However, middle Pennsylvanian (Desmoinesian) sediments are of almost uniform thickness throughout eastern Nevada, indicating cessation in the existence of an earlier
depositional center near Ely. This change in the paleogeographic conditions is the result of regional instability in eastern Nevada which resulted in deposition of conglomerates in the Elko area (northeast) and epierogenic upwarping in east-central Nevada. The effect of this episode of epierogenic upwarping was a gradual westward shift of the Utah high to encompass parts of eastern Nevada during middle and late Pennsylvanian times.

In southern Nevada (Arrow Canyon and Lee Canyon Ranges, Spring Mountains) prevailing conditions of deposition of Morrowan and Atokan times continued without any apparent hiatus in lithologic or faunal sequences.

Upper Pennsylvanian (Missourian-Virgilian) sediments are poorly represented in eastern Nevada. In most of the area, Wolfcampian sediments directly overlie Desmoinesian sediments. Upper Pennsylvanian sediments are limited to exposures in the Elko area (Strathern Formation) and in southern Nevada.

Faunal assemblages from the basal units of Moleen and Ely Formations and upper units of BSb member of the Bird Spring Group are comparable to early Morrowan fauna from southern Nevada, Utah, and the mid-continent. The occurrence of *Rhipidomella nevadensis* and *Diaphragmus cf. D. fasciculatus*
in association with such early Morrowan fauna as *Hustedia miseri*, *Ovatia aff. O. elongata*, *Spirifer opimus*, *Anthracospirifer occiduus*, *Linoproductus magnispinus*, *Antiquatonia lintzi* n. sp. in the basal units of the above mentioned formations is of considerable stratigraphic significance. This faunal assemblage is indicative of early Morrowan age for these units. Hence, this author disagrees with Lane's (1962) suggestion that the Ely fauna in the Illipah region is indicative of Atokan age.

Atokan fauna is characterized by the presence of *Chaetetes-Profusulinella* faunizone which can be easily recognized at most localities in eastern Nevada. Atokan assemblage represents continued presence of some elements of Morrowan fauna, but there is a noticeable absence of *Diaphragmus cf. D. fasciculatus*, *Rhipidomella nevadensis* *Ovatia aff. O. elongata*, *Hustedia miseri*, *Spirifer opimus* and a considerable decline in the abundance of *Cleiothyridina orbicularis*, *Anthracospirifer occiduus*, and *Antiquatonia hermosana*. Corals form a significant part of Atokan fauna in eastern Nevada.

Faunal assemblages of Desmoinesian age display a decrease in the megafaunal elements, especially brachiopods. Desmoinesian fauna is represented by *Desmoinesia muricatina*,
Hustedia mormoni, Neospirifer cameratus, Syringopora and Chaetetes sp.

Missourian-Virgilian fauna are poorly represented in eastern Nevada. This is attributed to the scarcity of Missourian-Virgilian sediments in eastern Nevada. Missourian-Virgilian fauna are: Crurithyris planoconvexa, C. expansa, Wellerella osagensis, W. dekalbensis var. elkoensis n. var., Neospirifer sp. and Caninia sp.

Sixty taxa belonging to 29 genera of brachiopods are described. Sixteen genera are represented by one taxon each, 6 genera by 2 taxa, 2 genera by 3 taxa, 3 genera by 4 taxa, 1 genus by 6 taxa, and 1 by 9 taxa.

Inarticulate brachiopods are poorly represented in the Pennsylvanian rocks of eastern Nevada. Several poorly preserved specimens of the genus Lingula were collected.

The order Orthida is represented by four different species of the genus Rhipidomella, of which Rhipidomella nevadensis is widely distributed and is of considerable stratigraphic significance. Its occurrence in the early Morrowan rocks represents the upper range limit.

The order Terebratulida is represented by two genera, Beecheria and Girtyella. They are rare in occurrence in the Pennsylvanian rocks of eastern Nevada.
One Rhynchonellid genus Wellerella is represented by 2 taxa which are common in distribution in upper Pennsylvanian rocks.

The order Spiriferida is widely represented in the Pennsylvanian of eastern Nevada. The following genera of this order are represented in the present collection: Composita, Cleiothyridina, Anthracospirifer, Spirifer, Neospirifer, Punctospirifer, Hustedia, Phricodothyris, Crurithyris, and Martinia. Genus Composita is widely distributed, but has poor vertical distribution. Spirifer occiduus, S. opimus, and Hustedia miser are considered to be of stratigraphic significance for early Pennsylvanian rocks and Hustedia rotunda, Neospirifer cameratus and Neospirifer dunbari are common in middle Pennsylvanian.

Taxa belonging to the order Strophomenida are most abundant in the Pennsylvanian of eastern Nevada. The following genera of Strophomenida are represented in the present collection: Antiquatonia, Diaphragmus, Juresania, Reticulatia, Eomarginifera, Hystriculina, Kozlowskia, Desmoinesia, Linoproductus, Ovatia, Derbyia, Neochonetes, Rugosochonetes and Retichonetes. Ovatia, Antiquatonia, Diaphragmus, Hystriculina, and Retichonetes are found mainly in early Pennsylvanian rocks whereas Desmoinesia, Neochonetes
and Kozlowskia are mainly present in middle Pennsylvanian rocks.

Along with the above mentioned group, other groups of invertebrates are widely represented. Fusulinids, although common, have erratic lateral distribution. Corals are widely distributed especially in the middle and upper Pennsylvanian rocks. Specimens belonging to at least ten different genera are represented in the present collection. Gastropod and pelecypod shells belonging to several genera were collected, but the preservation is very poor. Trilobites, cephalopods, echinoderms and conodonts have been reported from Pennsylvanian rocks in eastern Nevada.

Nine new taxa, Wellerella dekalbensis var. elkoensis n. var., Composita nevadensis n. sp., Composita elongata var. elyensis n. var., Cleiothyridina orbicularis var. brogani n. var., Antiquatonia lintzi n. sp., Antiquatonia lintzi var. costatus n. var., Linoproductus firbyi n. sp., Desmoinesia muricatina var. nevadensis n. var., and Retichonetes larsoni n. sp. are described for the first time.
**Contact in the area is faulted, hence extreme upper Desmoinesian units are not observed in the area.**

Ridge-forming, platy and sandy limestone, crystalline, occasionally cherty, brachiopods (*Composita*, *Linoproductus*, *Desmoinesia*), corals and bryozoans are common.

**Massive to platy limestone, light gray, irregular chert nodules occasionally bedded, corals (*Sprincopora*, *Caninia*), bryozoans, *Neo-spirifer* and *Composita* are common.**

268' **Massive to bedded limestone, occasionally platy, ridge and slope-forming, medium-grained, secondary calcite crystals, moderately fossiliferous, corals, bryozoans and a few brachiopods.**

330' **Massive to bedded, occasionally platy limestone, ridge and slope-forming, fine to medium-grained limestone, crystalline, moderately fossiliferous, crinoides, spiriferids, and productid type brachiopods and corals are common.**

208' **Orthoquartzite, crystalline, clean sandstone**

1½' **Massive limestone with bedded chert, chert layers abundant, 4-5" thick, occasionally irregular nodules, *Chaetetes-Profusulinella* zone.**

68' **Massive to bedded limestone, fine to medium-grained, irregular chert nodules, occasionally bedded chert, 3-4" thick, slightly fossiliferous, crinoides, *Spirifer*, productid brachiopods**

255' **Massive to bedded limestone occasionally platted, ridge and slope-forming, medium to fine-grained, light to dark gray, irregular chert nodules occasionally bedded, rarely fossiliferous.**

239' **Massive, bedded chert-limestone, medium-grained, gray.**

19' **Cover not exposed (slope forming)**

200' **Coarse to fine-grained limestone, irregular chert, highly fossiliferous, ridge and slope-forming, light to dark gray, crystalline, probably oscillatory environment; chert in the lower part occasionally rounded, highly fossiliferous (*Antiquatonia*, *Spirifer*, *Anthracospirifer* are dominant).**

152' **Cherty limestone, with chert layers 6 to 8" thick, bedded and nodular, massive, medium to fine-grained, yellowish gray, occasionally ridge forming, fossils abundant productid, spiriferids by far the dominant type, bryozoans and crinoid are also seen.**

55' **Massive calcarenite, medium-grained, slightly oxidized, with medium-grained sandstone about 3-4" thick, slightly brownish, *Anthracospirifer*, *Cloiochvridina*, *Composita*, *Antiquatonia* are abundant; nodules are irregular shaped.**

106' **Limestone, massive, slope and ridge-forming, cherty at the top, medium-grained, gray to yellow, occasionally pitted surface, fossiliferous (crinoides, spiriferids, few productid type brachiopods).**

110' **Base-contact with Scotty Wash quartzite (Springeran ? or Chesterian).**
Almost all major invertebrate phyla are represented in Pennsylvanian rocks of eastern Nevada. Systematic description includes only brachiopods.

Classification, in general, follows the classification described in Treatise on Invertebrate Paleontology. However, any subsequent changes in the Treatise's classification have been incorporated.

Description of abundance of fossils follows this scheme:

- **Very rare** (rr): 1-2 specimens
- **Rare** (r): 2-5 specimens
- **Common** (c): 5-15 specimens
- **Abundant** (a): over 20 specimens

Locality numbers refer to the following locality:

1a Jake Creek area
1 Ferguson Mountain
2 Elko area
3 Illipah region
4 Pancake Range
5 Shingle Pass area
6 Lee Canyon Range
7 Arrow Canyon Range
8 Battle Mountain area
Phylum BRACHIOPODA Dumeril, 1806
Class INARTICULATA Huxley, 1869
Order LINGULIDA Waagen, 1885
Superfamily LINGULACEA Menke, 1828
Family LINGULIDAE Menke, 1828
Genus LINGULIDA Bruguiere, 1797
LINGULA LEMNISCATA ? Price, 1916

Pl. I, fig. 1

Lingula lemniscata Price, 1916, p. 691, pl. 30, fig. 3;
Dunbar & Condra, 1932, p. 33, 34, pl. 1, fig. 3;
Sturgeon & Hoare, 1968, p. 21, pl. 1, fig. 4

Description. - Shell small, thin, subtriangular to elliptical, greatest width anterior to middle, posterolateral margins converge at an acute angle, anterolateral margins subrounded to rounded, lateral margins gently convex, surface marked by very faint growth lines; specimen is about 1.4 cm. long and 0.8 cm. wide.

Discussion. - Two incomplete specimens are present in the author's collection. The diagnostic criteria of this species are convergence of its posterolateral margins
at an acute angle and subrounded to rounded margins in
the anterolateral region. The present specimens resemble
the description of this species by Dunbar and Condra
(1932) and Sturgeon and Hoare (1968). However, a limited
number of specimens and poor preservations preclude a
definite species identification.

Occurrence. - The specimens were collected from
rocks of Morrowan age. However, the distribution of
this species is far from restricted as it has been
reported from Atokan and younger stages elsewhere in
the United States.

Locality. - 3

Class ARTICULATA Huxley, 1869
Order ORTHIDA Schuchert & Cooper, 1932
Superfamily ENTELETACEA Waagen, 1884
Family RHIPIDOMELLIDAE, Schuchert, 1913
Genus RHIPIDOMELLA Oehlert, 1890
RHIPIDOMELLA CARBONARIA (Swallow), 1858

Pl. I, figs. 2, 3
Rhipidomella carbonaria (Swallow), Dunbar & Condra, 1932, p. 52-54, pl. 2, figs. 1-4; Sturgeon & Hoare, 1968, p. 25, pl. 2, figs. 13-4.

Description. - Shell small, subovate, subequal, biconvex, greatest width near mid-length, greatest thickness just anterior to the hinge; pedicle valve with a high beak arched over low triangular interarea, surface of the valve marked by fine costae and growth lines and a shallow, broad sulcus; brachial valve with slightly greater convexity than the pedicle valve, marked by costae and growth lines.

Measurement. -

<table>
<thead>
<tr>
<th></th>
<th>Length</th>
<th>Width</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>1.2 cm.</td>
<td>1.4 cm.</td>
<td>1.1 cm.</td>
</tr>
</tbody>
</table>

Discussion. - The specimens (only 2) described here as R. carbonaria resemble closely the description of this species by Dunbar and Condra (1932) and Sturgeon and Hoare (1968). The ornamentation and the shape are almost identical but the present specimens are slightly larger.

Occurrence. - Atokan rocks of the Pennsylvanian System.
Locality. - 4, 5.

RHIPIDOMELLA aff. R. ELYENSIS Lane, 1962

Rhipidomella elyensis Lane, 1962, p. 897, 898, pl. 125, figs. 10-16.

Description. - Shell small, biconvex, subequal, sub-ovate, greatest thickness just anterior to the mid-length, maximum thickness just anterior to the hinge; pedicle valve convex but flattens in the anterior region, beak relatively small and arched over subtriangular cardinal area, brachial valve evenly convex; surface of both valves marked by numerous faint lirae which increase in number in the anterior region through intercalation.

Dimension. -

<table>
<thead>
<tr>
<th>Length</th>
<th>Width</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.7 cm.</td>
<td>1.6 cm.</td>
<td>0.8 cm.?</td>
</tr>
</tbody>
</table>

Discussion. - Only two incomplete specimens are included in the present collection. These specimen resemble *R. elyensis* in shape and ornamentation but are slightly larger than those described by Lane (1962). As the present specimens were collected from nearly the same horizon where they were first collected by Lane (1962), they are being described as *Rhipidomella* aff. *R. elyensis*. 
Occurrence. - Atokan rocks of the Pennsylvanian System.

Locality. - 3, 5.

**Rhipidomella nevadensis** (Meek), 1877

*Pl. I, figs. 4, 5*

*Orthis michelini* var. *nevadensis* Meek, 1877, p. 63, 64, pl. 7, figs. 1, la-c.

*Rhipidomella nevadensis* (Meek), Gordon & Poole, 1968, pl. 1, figs. 1-3 (no description)

**Description.** - Shell moderately large, gibbous, sub-rounded to suboval, biconvex, greatest width near mid-length, greatest thickness just posterior to mid-length; pedicle valve moderately convex, beak relatively small, incurved and arched over a narrow interarea, sulcus weak and developed only in mature specimens; brachial valve evenly convex, beak very small and incurved; surface of both valves marked by conspicuous, faint lirae which increase in number through intercalation.

**Dimensions.**

<table>
<thead>
<tr>
<th></th>
<th>Length</th>
<th>Width</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large</td>
<td>2.6 cm.</td>
<td>2.4 cm.</td>
<td>1.5 cm.</td>
</tr>
<tr>
<td>Average</td>
<td>2.1 cm.</td>
<td>1.8 cm.</td>
<td>0.9 cm.</td>
</tr>
</tbody>
</table>
Discussion. - The specimens described here match closely with the original description of this species by Meek (1877) where he referred to this species as a variety or a new species of O. michelini. Dott (1955), Sadlick (1958), and Welsh (1959) subsequently referred to this species as Rhipidomella nevadensis (Meek). This species can be differentiated from other described Pennsylvanian Rhipidomella species on the basis of its relatively large size and more gibbous shell. The specimens of this species are from different localities and although varying in size are otherwise comparable.

Occurrence. - This species has been reported from upper Mississippian to basal Pennsylvanian rocks in the cordillera. It is considered to be primarily an upper Mississippian fauna and its presence in the basal Pennsylvanian is considered to be residual in nature. However, its association with Morrowan fauna in eastern Nevada is considered to be of extreme stratigraphic significance for basal Pennsylvanian sediments.

Locality. - 2, 4, 5.

Rhipidomella sp. indet.

Description. - Shell small, biconvex, subequal, greatest width anterior to mid-length, greatest thickness posterior to
mid-length; pedicle valve moderately convex with a narrow sulcus, beak small, incurved and arched over a small inter-area; brachial valve convex, beak small, incurved; surface of both valves marked by fine costae.

**Discussion.** - The specimen described here resembles closely the characters of the genus *Rhipidomella*, but does not correspond with any of the described Pennsylvanian species of *Rhipidomella*. However, since the present collection includes only one incomplete specimen, species identification could not be accurately determined.

**Occurrence.** - Atokan rocks of the Pennsylvanian System.

**Locality.** - 3.

Order TEREBRATULIDA Waagen, 1883

Superfamily DIALASMATACEA Schuchert, 1913

Family HETERELASMINIDAE Likhareu, 1956

Genus BEECHERIA Hall & Clark, 1893

BEECHERIA BOVIDENS (Morton), 1836

Pl. I, fig. 6

_Terebratula bovidens_ Morton, 1836, p. 150, pl. 2, fig. 4; Meek, 1872, p. 187, pl. 1, fig. 7; pl. 2, fig. 4

_Dialesma bovidens_ (Morton), Dunbar & Condra, 1932, p. 304-306, pl. 37, figs. 33, 34; Lane, 1962, p. 898, pl. 127, fig. 15.

Description. - Shell moderate, elongate, biconvex, maximum width anterior to mid-length, greatest thickness posterior to mid-length; pedicle valve with a prominent incurved beak arching over the hinge, foramen large, sulcus not preserved; brachial valve convex with a rather small beak, partially covered by the beak of the pedicle valve.

Dimension. -

<table>
<thead>
<tr>
<th></th>
<th>Length</th>
<th>Width</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.7 cm.</td>
<td>1.9 cm.</td>
<td>1.3 cm.</td>
</tr>
</tbody>
</table>

Discussion. - The specimen described here as B. bovidens matches closely with those described by Dunbar and Condra (1932), and Lane (1962). Sturgeon and Hoare (1968) described immature specimens of this species. The present specimen, although resembling B. bovidens in shape, is one and one-half times larger. The anterior portion of the specimen is deformed; hence, the sulcus and the anterior margin are not preserved.

Occurrence. - Morrowan rocks. Very rare.

Locality. - 5.
Family CRANAENIDAE Cloud, 1942

Genus GIRTYELLA Weller, 1911

GIRTYELLA aff. G. WOODWORTHI Clark, 1917

_Girtyella woodworthi_ Clark, Easton, 1962, p. 87, 88, pl. 12, figs. 1-7.

**Description.** - Shell elongate, biconvex, greatest thickness near mid-length, greatest width slightly anterior to mid-length; pedicle valve, convex, beak small, incurved, arched over the hinge; brachial valve convex; surface of both valves apparently smooth.

**Discussion.** - The specimens described as _Girtyella aff. G. woodworthi_ are poorly preserved. The shell shape matches closely with the description of this species by Easton (1962). However, the anterior region in the present specimens is not preserved; hence, identification is not definitive.

**Occurrence.** - Atokan-age rocks. Rare.

**Locality.** - 3.

Order RHYNCHONELLIDA Kuhn, 1949

Superfamily RHYNCHONELLACEA Gray, 1848

Family WELLERELLIDAE Likhareu, 1956

Genus WELLERELLA Dunbar & Condra, 1932

_Wellerella osagensis_ (Swallow), 1858
Rhynchosella (Camarophoria) osagensis Swallow, 1858, p. 219; Meek, 1872, p. 179, pl. 1, figs. 9a-b; pl. 6, figs. 2a-b.
Wellerella osagensis (Swallow), Dunbar & Condra, 1932, p. 288, 289, pl. 37, figs. 1-4; Sturgeon & Hoare, 1968, p. 53, pl. 10, figs. 1-6.

Description. - Shell small, subequal, biconvex, subtriangular to suboval, greatest width near mid-length, greatest thickness near the anterior margin; pedicle valve convex, sulcus moderately pronounced having 2-3 plications, lateral slopes bearing 3-4 plicae, beak small, suberect; brachial valve moderately convex, beak very weak, fold bearing 2-3 plicae, lateral slopes bearing 3-4 plicae.

Measurement. -

<table>
<thead>
<tr>
<th>Length</th>
<th>Width</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.82 cm.</td>
<td>1.0 cm.</td>
<td>0.55 cm.</td>
</tr>
</tbody>
</table>

Discussion. - The specimens described here as Wellerella osagensis resemble those described by Dunbar & Condra (1932) and Sturgeon & Hoare (1968). The shape, size, and ornamentation are similar. Sturgeon & Hoare (1968) state that this species can be differentiated from W. tetrahedra (Dunbar & Condra) on the basis of its less pronounced fold and sulcus.

Locality. - 2.
WELLERELLA DEKALBENSIS var. EIKOENSIS n. var.

Pl. I, figs. 7-8

Description. - Shell, small, triangular to subtriangular, greatest width and thickness near the anterior margin; pedicle valve slightly convex with an extremely pronounced tongue-shaped sulcus, plicae numbering 3 in the sulcus and 4 on the lateral slopes, beak small, erect and pointed with a small foramen; brachial valve with 4 plicae each on the fold and the lateral slopes. The specimen is 1.1 cm. long, 1.3 cm. wide, and 0.7 cm. thick.

Discussion. - The specimen described here resembles _W. dekalbensis_ Dunbar and Condra (1932) by having a distinctly triangular outline, and an erect and pointed beak but differs by having only 3 plicae in the sulcus and 4 on the fold in contrast to 5 plicae in the sulcus and 6 on the fold in _W. dekalbensis_. The width in _W. dekalbensis_ is equal to length whereas in the present specimen it is slightly greater than the length. On the basis of these differences, this specimen is designated as a new variety. This variety can be easily distinguished from other described species of _Wellerella_ on the basis of its distinctive triangular outline.


Locality. - 2.
Order SPIRIFERIDA Waagen, 1883
Superfamily ATHYRIDACEA M'Coy, 1884
Family ATHYRIDIDAE M'Coy, 1884
Genus COMPOSITA Brown, 1845

COMPOSITA ARGENTEA (Shepard), 1838

PI. I, figs. 9, 10

Terebratula argentea Shepard, 1838, p. 152, fig. 8
Composita argentea (Shepard), Dunbar & Condra, 1932, p. 367-369, pl. 43, figs. 1-6; Lane, 1962, p. 907, pl. 127, figs. 31-33; Stevens, 1962, p. 620, pl. 91, fig. 4; Grinnell & Andrews, 1964, p. 235, pl. 37, figs. 1, 2, 8, 9; Sturgeon & Hoare, 1968, p. 58, pl. 18, figs. 19-24.

Description. - Shell oval to subcircular, moderately biconvex, greatest width at mid-length; pedicle valve marked by a narrow median sulcus which widens in the anterior region, subcircular growth lines prominent in the anteromedian region, beak short and slightly curved; brachial valve with an unpronounced fold and widespread but faint growth lines, beak not prominent.

Dimensions -

<table>
<thead>
<tr>
<th></th>
<th>Length</th>
<th>Width</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Largest</td>
<td>1.76 cm.</td>
<td>1.64 cm.</td>
<td>1.14 cm.</td>
</tr>
<tr>
<td>Median</td>
<td>1.48 cm.</td>
<td>1.30 cm.</td>
<td>1.00 cm.</td>
</tr>
</tbody>
</table>
Discussion. - This species is common in distribution at several localities and matches closely with the description of C. argentea by Dunbar & Condra (1932) and Lane (1962). C. argentea as redefined by Dunbar and Condra is a distinct species and can be distinguished from closely related C. ovata Mather and C. subtilita (Hall) on the basis of its generally smaller size, broadly ovate to subcircular outline with greatest width being mid-way through the specimen. The fold and sulcus is of intermediate size between C. ovata and C. subtilita. This writer agrees with Dunbar and Condra's delineation of C. argentea as a distinct species.

Occurrence. - Although C. argentea is more commonly restricted to Desmoinesian rocks in the mid-continent region, in Nevada the distribution does appear to be less restricted. In the Ely Limestone in Illipah and Shingle Pass area the species appears in the basal section (Morrowan) and continues through upper part of the section (Desmoinesian). In the Pancake and Arrow Canyon Ranges, it was collected from rocks of Desmoinesian age. Hence, the distribution of this species in the Cordilleran region is not restricted as has been suggested by Grinnell & Andrews (1964). Common.

Localities. - 1a, 1, 3, 4, 5, 6.
Description. - Shell oval to subcircular in outline, size quite variable depending on the maturity of the specimen, moderately biconvex, length slightly more than width, greatest width in the posteromedian region; pedicle valve convex, marked by several growth lines, beak narrow; brachial valve convex with faint growth lines; fold and sulcus either not prominent or apparently absent.

Dimensions.-

<table>
<thead>
<tr>
<th></th>
<th>Length</th>
<th>Width</th>
<th>Thickness</th>
<th>L/W</th>
<th>W/T</th>
<th>L/T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Largest</td>
<td>2.00 cm.</td>
<td>1.50 cm.</td>
<td>1.1 cm.</td>
<td>1.33</td>
<td>1.36</td>
<td>1.82</td>
</tr>
<tr>
<td>Median</td>
<td>1.8 cm.</td>
<td>1.4 cm.</td>
<td>1.1 cm.</td>
<td>1.29</td>
<td>1.27</td>
<td>1.64</td>
</tr>
<tr>
<td>Smallest</td>
<td>1.2 cm.</td>
<td>1.00 cm.</td>
<td>0.7 cm.</td>
<td>1.20</td>
<td>1.43</td>
<td>1.71</td>
</tr>
</tbody>
</table>

Discussion. - Species described here is quite common in distribution and matches well with the description of this
species by Dunbar and Condra (1932) in size, shape, ornamentation and measurements. *C. ovata* and *C. argentea* although intergradational to *C. subtilita*, are not directly intergradational to each other (Grinnell & Andrews, 1964, p. 235).

**Occurrence.** - In eastern Nevada *C. ovata* is common in rocks of Morrowan to Des Moines age. It has been reported from Morrowan to Missourian Stages of the Pennsylvanian Period in the midcontinent region (Dunbar & Condra, 1932). It was not collected from Upper Pennsylvanian rocks which could be attributed to scarcity of Upper Pennsylvanian rocks in Nevada. Common.

**Locality.** - 4, 5.

**COMPOSITA SUBTILITA (Hall), 1852**

Pl. I, fig. 14

*Terebratula subtilita* Hall, 1852, p. 409, pl. 4, figs. 1a, 1b, 2a-c.

*Composita subtilita* (Hall), Girty, 1915, p. 96-101, pl. 5, fig. 7, pl. 6, fig. 13; Dunbar & Condra, 1932, p. 363, pl. 43, figs. 7-13; Stevens, 1962, pl. 91, fig. 6, (no description); Lane, 1962, p. 907, pl. 128, fig. 8; Grinnell & Andrews, 1964, pl. 39, figs. 9-10, (no
description); Langenheim, 1964, p. 91-93, pl. 5, figs. 11-15; Sutherland & Harow, 1967, p. 1079-1080, pl. 136, figs. 9-12; Sturgeon & Hoare, 1968, p. 57, pl. 18, figs. 5-10.

Description. - Shell suboval to subpentagonal, biconvex, greatest width in the anteromedian region, posterolateral margins generally converging at an acute angle, pedicle valve moderately convex, maximum convexity in the posterior region, beak pronounced and curved, sulcus prominent in the pedicle valve, growth lines pronounced and distinct in the anterior region, brachial valve with a pronounced fold and growth lines.

Measurements.

<table>
<thead>
<tr>
<th>Length</th>
<th>Width</th>
<th>Thickness</th>
<th>L/W</th>
<th>W/T</th>
<th>L/T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Largest</td>
<td>2.3 cm.</td>
<td>1.85 cm.</td>
<td>1.5 cm.</td>
<td>1.28</td>
<td>1.23</td>
</tr>
<tr>
<td>Median</td>
<td>2.1 cm.</td>
<td>1.85 cm.</td>
<td>1.50 cm.</td>
<td>1.16</td>
<td>1.23</td>
</tr>
</tbody>
</table>

Discussion. - C. subtilita described here matches closely the description of this species by Dunbar and Condra (1932), Lane (1962), Langenheim (1964). C. subtilita can be differentiated from C. argentea and C. ovata in generally being bigger in size, having greatest width in the anteromedian region, generally acute angled posterolateral margins and a more pronounced fold and sulcus.
Occurrence. - In Nevada, *C. subtilita* is commonly distributed in rocks of Morrowan to Desmoinesian age. In the midcontinent this species is reported from rocks covering the entire Pennsylvanian Period. Common.

Locality. - 1a, 2, 3, 4, 5, 6.

**COMPOSITA TRILOBITA** Dunbar & Condra, 1932

Pl. I, figs. 15-17


**Description.** - Shell subtriangular to suboval, greatest width only 1/4th the distance from the anterior margin, posterolateral margins gradually tapering toward the posterior region; pedicle valve moderately convex with a pronounced median sulcus, narrow in the posterior region but wide and tongue-shaped in the anterior region, beak pronounced, moderately curved with a wide foramen, growth lines few but prominent; brachial valve moderately convex with a subtriangular fold, beak not prominent.
Dimensions. -

<table>
<thead>
<tr>
<th></th>
<th>Length</th>
<th>Width</th>
<th>Thickness</th>
<th>Ratio L/W</th>
<th>Ratio W/T</th>
<th>Ratio L/T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Largest</td>
<td>2.6 cm.</td>
<td>2.3 cm.</td>
<td>2.00 cm.</td>
<td>1.13</td>
<td>1.15</td>
<td>1.4</td>
</tr>
<tr>
<td>Large</td>
<td>2.4 cm.</td>
<td>2.1 cm.</td>
<td>1.8 cm.</td>
<td>1.14</td>
<td>1.16</td>
<td>1.33</td>
</tr>
<tr>
<td>Median</td>
<td>2.2 cm.</td>
<td>2.1 cm.</td>
<td>1.1 cm.?</td>
<td>1.04</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Smallest</td>
<td>1.6 cm.</td>
<td>1.5 cm.</td>
<td>1.1 cm.</td>
<td>1.06</td>
<td>1.36</td>
<td>1.45</td>
</tr>
</tbody>
</table>

Discussion. - The specimens of *C. trilobita* described here match closely the description of this species by Dunbar and Condra (1932). *C. trilobita* can be distinguished from *C. subtillita* by the presence of a pronounced sulcus and fold in the anterior region giving the species a trilobed appearance. Its greatest width immediately near the anterior margin and subtriangular form are very distinctive. Contrary to Grinnell and Andrews (1964) it appears to be closely related to *C. trinuclea* a Mississippian species similar in appearance.

Occurrence. - This species was collected from late Morrowan to Desmoinesian rocks. Grinnell and Andrews (1964) stated that this species is abundant only in upper Pennsylvanian rocks. The range of *C. trilobita* is being extended to include lower Pennsylvanian. Common.

Locality. - 3, 4, 5.
COMPOSITA ELONGATA var. ELYENSIS n. var.

Pl. II, figs. 1-3

Description. - Shell subelongate, strongly biconvex, greatest width near mid-length; pedicle valve strongly convex, near the umbo, than sloping moderately in anterolateral region, beak pronounced, slightly curved with a large umbonal region and than gradually sloping toward anterolateral margin, fold and sulcus apparently present but obscured in specimen.

Dimension. -

<table>
<thead>
<tr>
<th></th>
<th>Length</th>
<th>Width</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median</td>
<td>1.6 cm.</td>
<td>1.15 cm.</td>
<td>1.1 cm.</td>
</tr>
</tbody>
</table>

Discussion. - The species described here, suggests agreement with the description of *C. elongata* by Dunbar and Condra (1932). However, several differences also suggest that it should be designated as a new variety of *C. elongata*. Although shell shape matches *C. elongata*, the umbonal region and beak are more pronounced in this specimen. The angle of posterolateral margin convergence is also slightly smaller than those of *C. elongata*. Although similar in many respects, these differences justify designation of a new variety name for these specimens.
Occurrence. - *C. elongata* Dunbar and Condra (1932) has a rather limited geologic range and is reported from upper Pennsylvanian-Permian rocks. *C. elongata* var. *elyensis* n. var. was collected from Morrowan rocks in Shingle Pass area. Only four specimens were collected and quality of preservation is rather poor.

Locality. 5.

**COMPOSITA NEVADENSIS** n. sp.

Pl. II, figs. 4-7

Description. - Shell subtriangular to suboval, moderately biconvex; greatest width anterior to mid-length, maximum thickness posterior to mid-length, beak strongly incurved and quite pronounced, sulcus tongue-shaped, shallow and disappears before reaching mid-length, anterolateral margin subcircular, posterolateral margin meeting at slightly greater than right angle, surface of pedicle valve marked by numerous, faint growth lines; brachial valve convex with an inflated but unpronounced beak and a faint fold in the anterior region, surface of the valve marked by faint growth lines.
Dimensions.

<table>
<thead>
<tr>
<th></th>
<th>Length</th>
<th>Width</th>
<th>Thickness</th>
<th>Ratio L/W</th>
<th>Ratio W/T</th>
<th>Ratio L/T</th>
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<tbody>
<tr>
<td>Largest</td>
<td>1.9 cm.</td>
<td>2.1 cm.</td>
<td>1.6 cm.</td>
<td>0.9</td>
<td>1.31</td>
<td>1.2</td>
</tr>
<tr>
<td>Median</td>
<td>1.8 cm.</td>
<td>2.0 cm.</td>
<td>1.3 cm.</td>
<td>0.9</td>
<td>1.54</td>
<td>1.38</td>
</tr>
</tbody>
</table>

Discussion. - *C. nevadensis* n. sp. can be distinguished from *C. subtilita*, *C. trilobita*, *C. argentea*, and *C. ovata* by consistently being wider than long, by having suboval to subtriangular outline and by having a more pronounced umbonal region. It can be distinguished from *C. ohioense* (Sturgeon and Hoare) by having a more pronounced umbonal region and less pronounced sulcus. Posterior margins in *C. nevadensis* n. sp. converge at a lesser angle than those of *C. ohioense*.

Occurrence. - Rare to common in rocks of Morrowan age.

Locality. - la, 5.

COMPOSITA aff. *C. OHIOENSE* Sturgeon & Hoare, 1968


Description. - Shell small, subrounded, biconvex, maximum width anterior to the mid-length and maximum
thickens just posterior to mid-length, posterolateral margins converging at obtuse angles; pedicle valve convex, beak weakly developed and incurved and arched over the interarea, sulcus broad, subtriangular and continues beyond the mid-length; brachial valve convex, fold prominent in the anterior region; surface of both valves marked by faint growth lines.

**Discussion.** - The specimens described here as *C. aff. C. ohioense* match closely with the description of *C. ohioense* Sturgeon and Hoare (1968) but are less convex and have a less pronounced umbonal region. This species differs from *C. nevadensis* n. sp. in having a less pronounced umbonal region, and a more pronounced sulcus. Only two incomplete specimens are in the present collection, hence it has been described as *Composita aff. C. ohioense*.

**Occurrence.** - Morrowan rocks. Very rare.

**Locality.** - 5.

**COMPOSITA SP. INDET. A**

**Description.** - Shell moderate-sized, subtriangular, very thin shelled, biconvex, posterolateral margins converging at acute angles, anterolateral margins broadly subrounded; pedicle valve convex, beak pronounced, incurved and arched over a narrow interarea, sulcus beginning in the extreme posterior region as a narrow depression, subsequently
broadening, and becoming tongue-shaped in the anterior region; brachial valve convex with a very weak beak, fold moderately pronounced in the anterior region; surface of both valves marked by concentric growth lines. Measurement of an average specimen is: Length - 1.9 cm., Width - 2.0 cm., and Thickness - 1.2 cm.

Discussion. - One partially incomplete and three very poorly preserved specimens are present in this collection. All specimens are highly deformed; hence, species identification could not be ascertained. These specimens resemble C. subtilita in size but the outline and the sulcus are considerably different. It is possible that these specimens belong to a new species. However, poor preservation and a limited number of specimens prevent establishing a new species for these specimens.

Occurrence. - Missourian rocks. Rare

Locality. - 2.

COMPOSITA SP. INDET. B

Description. - Shell subcircular, relatively large, greatest width anterior to mid-length, biconvex; pedicle valve with a narrow slightly incurved beak, surface marked by faint growth lines, sulcus prominent in the anterior margin becoming considerably narrower in the posterior
region; brachial valve convex, beak short and unpronounced, surface marked by faint growth lines and a fairly pronounced fold.

Discussion. - Specimens described here as C. _sp. indet._ resemble description of genus Composita. However, quality of preservation is too poor to correctly identify specimen to species rank. Internal characters are not preserved in the specimen but a nearly identical specimen from a different location revealed a characteristic spiral brachidia.


Locality. - 4, 7.

Genus CLEIOTHYRIDINA Buckman, 1906

CLEIOTHYRIDINA ORBICULARIS (McChesney), 1860

Pl. II, fig. 8

Athyris orbicularis McChesney, 1860, p. 47

Cleiothyridina orbicularis (McChesney), Girty, 1915, p. 101, pl. 12, figs. 2-2c; Dunbar & Condra, 1932, p. 359, pl. 42, figs. 1-4; Hoare, 1961, p. 87, 88, pl. 11, figs. 15-19; Lane, 1962, p. 906, pl. 127, figs. 36-37; Stevens, 1962, p. 620, pl. 91, fig. 10; Langenheim, 1964, p. 89-91, pl. 6, figs. 18-21; Sturgeon & Hoare, 1968, p. 55,56, pl. 10, figs. 14-16.
Description. - Shell small, subcircular, subequal, biconvex, greatest width near hinge; pedicle valve with a small slightly curving beak, and foramen small, lamellae subcircular and pronounced with fine spines in the anterior region; brachial valve convex with a small unpronounced beak and fine subcircular lamellae; fold and sulcus either absent or not prominent.

Dimensions. -

<table>
<thead>
<tr>
<th></th>
<th>Length</th>
<th>Width</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large</td>
<td>1.3 cm</td>
<td>1.35 cm</td>
<td>1.00 cm</td>
</tr>
<tr>
<td>Median</td>
<td>1.2 cm</td>
<td>1.22 cm</td>
<td>0.90 cm</td>
</tr>
</tbody>
</table>

Discussion. - Specimens described here as *C. orbicularis* (McChesney) resemble quite well the description of this species by Dunbar and Condra (1932) and Lane (1962). Dunbar and Condra (1932) in their discussion mentioned that this species can easily be confused with *Squamularia perplexa* especially when shells are crushed. However, if specimens are well preserved they can easily be distinguished on the basis of a curved and tight beak in contrast to *S. perplexa* which has a relatively large beak and a modest interarea.

Occurrence. - *C. orbicularis* is abundant in Morrowan-Atokan Stages of Lower Pennsylvanian. Distribution is rather restricted as it was not found in higher beds. Abundant.
Locality. - 1a, 1, 3, 5, 7.

**CLEIOTHYRIDINA ORBICULARIS var. BROGANI* n. var.**

Pl. II, figs. 9, 10

**Description.** - Shell small, subcircular, subequal, greatest width near mid-length, greatest thickness slightly posterior to middle; pedicle valve with a small slightly curving beak, lamellae subcircular, having fine spines in the anterior region, fold and sulcus distinctive in mature specimen.

**Dimensions.**

<table>
<thead>
<tr>
<th></th>
<th>Length</th>
<th>Width</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Largest</td>
<td>1.6 cm.</td>
<td>1.7 cm.</td>
<td>1.0 cm.</td>
</tr>
<tr>
<td>Median</td>
<td>1.3 cm.</td>
<td>1.3 cm.</td>
<td>0.8 cm.</td>
</tr>
<tr>
<td>Smallest</td>
<td>1.0 cm.</td>
<td>1.1 cm.</td>
<td>0.6 cm.</td>
</tr>
</tbody>
</table>

**Discussion.** - Posterolateral margins in *C. orbicularis var. brogani* converge at approximately right angles and thus differs from *C. orbicularis* whose margins converge at greater than 150°. Greatest width in *C. orbicularis var. brogani* is near the mid-length whereas in *C. orbicularis* it is near the hinge. Shell size and ornamentation are

*This variety is named in honor of George Brogan, a fellow graduate student at the University of Nevada.*
comparable. On the basis of these differences these specimens are designated as a new var. of *C. orbicularis*.

**Occurrence.** - Morrowan rocks of the Pennsylvanian System. Common.

**Locality.** - 5.

**CLEIOTHYRIDINA ? aff. C. ORBICULARIS var. CRASSALAMELLOSA**

Sturgeon & Hoare, 1968

*Cleiothyridina orbicularis var. crassalamellosa* Sturgeon & Hoare, 1968, p. 56, 57, pl. 10, figs. 17, 18; pl. 18, figs. 1-4.

**Description.** - Shell relatively large, biconvex, subequal, greatest width at mid-length, maximum thickness posterior to mid-length; pedicle valve with low incurved beak, foramen very small, sulcus broad and tongue-shaped; brachial valve with a small unpronounced beak and a gentle corresponding fold; surface of both valves marked by concentric lamellae with fine spine like projections.

**Dimensions.** -

<table>
<thead>
<tr>
<th></th>
<th>Length</th>
<th>Width</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specimen 1</td>
<td>3.0 cm.</td>
<td>3.7 cm.</td>
<td>2.3 cm.</td>
</tr>
<tr>
<td>Specimen 2</td>
<td>2.9 cm.</td>
<td>3.2 cm.</td>
<td>1.1 cm.</td>
</tr>
<tr>
<td>(deformed)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Discussion. - Only 2-3 specimens are described here as Cleiothyridina ? aff. C. orbicularis var. crassalamellosa. They differ from those described by Sturgeon & Hoare in being twice as large and more robust in appearance. The sulcus in the present specimens is more sharply defined. Internal structures were not observed because of quality of preservation. General shape resembles those described by Sturgeon and Hoare (1968); hence, these specimens are designated as Cleiothyridina ? C. orbicularis var. crassalamellosa.

Occurrence. - Morrowan Stage of Pennsylvanian System. Rare.

Locality. - 1a.

Superfamily SPIRIFERACEA King, 1846

Family SPIRIFERIDAE King, 1846

Genus ANTHRACOSPIRIFER Lane, 1963

ANTHRACOSPIRIFER OCCIDUUS (Sadlick), 1960

Pl. II, figs. 11-14

Spirifer opimus var. occidentalis Girty, 1927, p. 433, pl. 27, figs. 21-25.

Spirifer occidentalis (Girty), Dunbar & Condra, 1932, p. 322, pl. 41, figs. 12-16.
Spirifer occiduus Sadlick, 1960, p. 1210-14; Lane, 1962, p. 904, pl. 128, figs. 3-7.

Anthraco spirifer occiduus (Sadlick), Lane, 1963, p. 388

Spirifer occiduus (Sadlick), Langenheim, 1964, p. 87-88, pl. 6, figs. 10-14; Spencer, 1967, p. 18-20, figs. 9, 3, 12.

Anthracospirifer occiduus (Sadlick), Sturgeon & Hoare, 1968, p. 62, pl. 20, figs. 1-7.

**Description.** - Shell spiriferoid, moderately large, biconvex, transverse, greatest width at hinge; pedicle valve strongly convex, greatest convexity near mid-length, beak pronounced incurved over a moderately large interarea, sulcus pronounced, subrounded with 4-5 plications, lateral slopes containing 11-12 plications on each side of the fold and sulcus; beak of brachial valve not prominent, strongly incurved and arched, fold begins as a simple plication which bifurcates immediately behind the beak attaining 4-5 plications.

**Dimension.** - Length - 4.0 cm., 4.2 cm., and 2.4 cm.

**Discussion.** - Specimens described as *A. occiduus* match very well with those described by Girty (1927), Dunbar and Condra (1932), Langenheim (1964) and Spencer (1967). Sadlick (1960) determined that Girty's new variety is a homonym for *S. occidentalis* (Kindle) and hence proposed a new name
S. occiduus. Lane (1963) included S. occiduus (Sadlick) in his new genus Anthracospirifer and this author agrees with this designation. S. occiduus is invariably wider than long and lateral costae are angular to subrounded and thus meets the general characters of Anthracospirifer.

According to Dunbar and Condra (1932, p. 325) S. occidentalis (Girty) closely resembles S. matheri but the latter has finer and angular plications and has 7-9 plications in sulcus and fold instead of 3-5 as in A. occiduus.

Occurrence. - This species is common in Morrowan to Atokan Stages of the Pennsylvanian System. Common.

Locality. - 1, 3, 4, 5, 7.

ANTHRACOSPIRIFER aff. A. BIRDSPRINGENSIS Lane, 1963

Anthracospirifer birdspringensis Lane, 1963, p. 388-389, pl. 44, figs. 4, 7, 10-18; pl. 45, fig. 3.

Description. - Shell elongate, biconvex, greatest width at the hinge, twice as wide as long; pedicle valve moderately convex, beak not prominent sulcus obscured, costae coarse and subrounded, innermost lateral costae originating from the beak and splitting anteriorly, lateral costae coarse and widely spaced, extreme outer costae originating at the hinge; brachial valve not seen.
Discussion. - The two specimens described here agree with the description of *A. birdspringensis* in shape and ornamentation but are considerably larger (about twice in size) than the specimen figured and described by Lane (1963). As only two fragmentary specimens are in the collection the species identification could not be positively ascertained.

Occurrence. - Upper Morrowan-Atokan rocks. Rare.

Locality. - 4, 5.

Genus SPIRIFER Sowerby, 1814

SPIRIFER OPIMUS Hall, 1858

Pl. III, fig. 1

*Spirifer opimus* Hall, 1858, p. 711, pl. 28, figs. 1a-b;

Mather, 1915, p. 185, pl. 12, figs. 7-7c; Dunbar & Condra, 1932, p. 320-322, pl. 9, figs. 13-20; Spencer, 1967, p. 16-18, figs. 9, l;11.

*Anthracospirifer opimus* (Hall), Lane, 1963, p. 387, 388;


Description. - Shell small, biconvex, length nearly equal to width, greatest width at hinge, cardinal extremities subrounded to slightly subangular; beak of the pedicle valve strongly arched and incurved over narrow, subtriangular interarea, near the beak sulcus is unplicated but splitting immediately anterior to beak gives rise to 4 plications; beak
of brachial valve narrow and incurved over interarea, fold subrounded, beginning as a simple plication but almost immediately bifurcates and gives rise to 4 plications, middle 2 plicae being stronger than lateral plicae and separated by well defined grooves; lateral slopes bearing 8-10 rounded plicae on each side of fold and sulcus, coalesced near the beak but radiating outwards.

**Dimensions.**

<table>
<thead>
<tr>
<th></th>
<th>Length</th>
<th>Width</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median</td>
<td>1.9 cm.</td>
<td>1.9 cm.</td>
<td>1.3 cm.</td>
</tr>
<tr>
<td>Average</td>
<td>1.7 cm.</td>
<td>1.73 cm.</td>
<td>1.3 cm.</td>
</tr>
</tbody>
</table>

**Discussion.** - The specimens described here match closely with the description of *S. opimus*. It can be easily distinguished from *Anthracospirifer occiduus* in being more rounder and having a subtriangular interarea. *S. opimus* can be distinguished from *S. rockymontanus* on the basis of coarser plications.

This author disagrees with Lane's (1963) assignment of this species to the genus *Anthracospirifer*, and the statement that all Pennsylvanian species of *Spirifer* should be placed in a different genus. On examination of descriptive characters it is realized that specimens of *S. opimus* are closer to the description of genus *Spirifer* than
**Anthracospirifer.** *S. opimus* is as wide as it is long, and has a pronounced subtriangular interarea. In this author's opinion, *S. opimus* along with *S. rockymontanus* should remain under genus *Spirifer.*

**Occurrence.** - Morrowan rocks. Common.

**Locality.** - 3, 4, 5, 7.

**SPIRIFER ROCKYMONTANUS** Marcou, 1858

Pl. III, figs. 2-4

*Spirifer rockymontanus* Marcou, Girty, 1903, p. 383, pl. 8, figs. 5-7c; Dunbar & Condra, 1932, p. 318, pl. 41, figs. 7-9; Spencer, 1967, p. 15, 16, figs. 5-7c.

**Anthracospirifer rockymontanus** (Marcou), Sturgeon & Hoare, 1968, p. 61, pl. 19, figs. 26-29.

**Description.** - Shell small, biconvex, width nearly equal to length, width greatest at hinge, cardinal extremities somewhat rounded; pedicle valve moderately convex, beak strongly arched and incurved over slightly concave subtriangular interarea, sulcus unplicated and narrow near beak; beak of brachial valve not prominent, slightly elevated and incurved over the interarea, fold well defined becoming subtriangular toward the anterior region, begins as a simple plication which bifurcates almost immediately approximately
3-4 mm. anterior to beak, and attains a total of 6 plications; lateral slopes bear 9-10 subangular plications on each side of the fold and the sulcus.

**Dimensions.**

<table>
<thead>
<tr>
<th></th>
<th>Length</th>
<th>Width</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Largest</td>
<td>1.95 cm.</td>
<td>1.96 cm.</td>
<td>1.4 cm.</td>
</tr>
<tr>
<td>Median</td>
<td>1.8 cm.</td>
<td>1.82 cm.</td>
<td>1.3 cm.</td>
</tr>
<tr>
<td>Average</td>
<td>1.75 cm.</td>
<td>1.79 cm.</td>
<td>1.26 cm.</td>
</tr>
</tbody>
</table>

**Discussion.** - The specimens described here match closely with the description of this species by Girty (1903), Spencer (1967) and Sturgeon & Hoare (1968). Apparently Marcou's original description and figures included two distinct species and Girty designated the smaller one as the type species. Mather (1915) overlooked Girty's choice and invalidly designated Marcou's larger specimen as type. Since Girty has priority over Mather (12 years), his designation must be accepted.

**Occurrence.** - Late Morrowan-Virgilian. This species is prevalent throughout the Pennsylvanian rocks. Common.

**Locality.** - 3, 4, 5, 6, 8.

**Genus NEOSPIRIFER Fredericks, 1919**

NEOSPIRIFER CAMERATUS (Morton), 1836

Pl. III, figs. 5-7

Spirifer cameratus Morton, 1836, p. 150, pl. 2, fig. 3; Girty, 1915, p. 87-89, pl. 9, figs. 4-4b; Girty, 1927, p. 434,
Neospirifer cameratus (Morton), Dunbar & Condra, 1932, 
p. 334-336, pl. 39, figs. 4, 6-9b; Hoare & Burgess, 
1960, p. 714, pl. 91, fig. 9; Langenheim, 1964, p. 85-87, 
pl. 6, figs. 15-17; Spencer, 1967, p. 25, 26, figs. 9, 
4, 17; Sturgeon & Hoare, 1968, p. 64-66, pl. 21, 
figs. 5-8.

Description. - Shell large, biconvex, subrounded to 
subelliptical, greatest width at hinge, cardinal extremities 
acutely angular; beak of pedicle valve prominent, strongly 
incurved and arched over high, linear interarea, sulcus low 
and rounded, beginning as a simple plication near the beak, 
becoming wider and deeper and with several plications in the 
anterior region, lateral slopes with over 20 low, rounded, 
moderately prominent plications, surface ornamentation also 
consists of fine concentric growth lines, especially notice­
able in the anterior region; brachial fold beginning near 
the beak and splitting to 6 plications in the anterior region; 
internal features not observed.

Dimensions.-

<table>
<thead>
<tr>
<th></th>
<th>Length</th>
<th>Width</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>3.2 cm.</td>
<td>4.8 cm.</td>
<td>1.8 cm.</td>
</tr>
<tr>
<td>Median</td>
<td>3.5 cm.</td>
<td>5.2 cm.</td>
<td>2.1 cm.</td>
</tr>
</tbody>
</table>
Discussion. - *N. cameratus* can be distinguished from *N. dunbari* King on the basis of its angular and acute cardinal extremities and more rounded and less stronger plications. Girty suggested that *N. goreii* (Mather) may be identical to *N. cameratus*. However, according to Spencer (1967) *N. cameratus* can be distinguished from *N. goreii* by having 7 plicae per cm. on inner parts of lateral slopes in contrast to 12 plicae per cm. in *N. goreii*.

Occurrence. - This species was collected from rocks of Upper Morrowan to Desmoinesian age. It is common in distribution in the Desmoinesian-age rocks but rare in rocks of Atokan and Upper Morrowan age. The Upper limit of this species in eastern Nevada corresponds with its distribution in the mid-continent.

Locality. - 1a 3, 4, 5, 7.

**NEOSPIRIFER DUNBARI** King, 1933

Pl. III, fig. 8

*Spirifer triplicata* Hall, 1852, p. 410; Girty, 1920, p. 655, pl. 54, fig. 22.

*Neospirifer triplicatus* Dunbar & Condra, 1932, p. 328-332, pl. 39, fig. 5; pl. 41, figs. 1-6; Lane, 1962, p. 905, pl. 128, figs. 9-11.

*Neospirifer dunbari* King, 1933, p. 441.


Description. - Shell relatively large, biconvex, subtriangular, greatest width at the hinge, cardinal extremities sharply defined; pedicle valve convex, beak prominent, strongly arched, and incurved over a linear interarea, a narrow sulcus bounded by two strong plicae starts at the umbo and fans out into a broad depression near the anterior margin, plicae splitting just anterior to umbo and increasing thereafter by bifurcation, lateral plicae over 20, those near the sulcus more pronounced than the rest, giving a slightly uneven appearance on the surface, surface marked by growth lines and lirae which are prominent in the anterior region; beak of brachial valve not prominent, incurved over interarea, fold high, starting as a simple plication, eventually giving rise to over 10 plications in the anterior region.

Dimension. - Length - 4 cm., Width - 7.5 cm.

Discussion. - Specimens described here as N. dunbari match only few of the total specimens described by Dunbar and Condra (1932) under N. triplicatus. However, they match
fairly with the descriptions of this species by Lane (1962), Spencer (1967), and Sturgeon & Hoare (1968).

This species when first described as *S. triplicata* (Hall) was considered identical to *S. cameratus* (Morton) which was very poorly defined. Girty (1920) showed that Hall's species was distinct and valid, and he took it out of the synonymy of *S. cameratus* and reestablished the species under Hall's name. King (1933) proposed the name *N. dunbari* for the species originally named *S. triplicatus* by Hall and this is presently the accepted name for this species.

**Occurrence.** - Upper Morrowan to Desmoinesian age rocks. Common.

**Locality.** - 3, 4, 5.

**NEOSPIRIFER SP. INDET.**

**Description.** - Shell moderately large, transverse, biconvex, cardinal extremities subrounded, greatest width at hinge, interarea linear, and prominent, partially covered by incurved, arched pedicle and brachial beaks; pedicle valve characterized by a narrow sulcus in the posterior region, bounded by 2 prominent plicae and eventually becoming broader in the anterior region by bifurcation of plicae; brachial valve characterized by a narrow fold in the extreme posterior
region, bifurcating into 4-5 plicae in the anterior region; lateral plicae between 15-20 in number on each valve.

**Discussion.** - Several specimens described here as *N. sp. indet.* somewhat resemble *N. pattersoni* (Sutherland & Harlow, 1967, p. 1082-1086, pl. 137, figs. 1-12). However, the pattern of multiplication of plicae and their numbers are different, hence a species identification could not be ascertained accurately. These specimens might represent a new species altogether; however, quality of preservation is rather poor and species identification could not be achieved with confidence.

**Occurrence.** - Rocks of Desmoinesian to Virgilian age.
Rare to common.

**Locality.** - 1a, 2, 7.

**Family SPIRIFERINIDAE** Davidson, 1884

**Genus PUNCTOSPIRIFER** North, 1920

**PUNCTOSPIRIFER KENTUCKYENSIS** (Shumard), 1855

*Spirifer kentuckyensis* Shumard, 1855, p. 203

*Spiriferina kentuckyensis* (Shumard), Girty, 1915, p. 85-87, pl. 11, figs. 8, 8a.

*Punctospirifer kentuckyensis* (Shumard), Dunbar & Condra, 1932, p. 351-355, pl. 38, figs. 1-5; Elias, 1957, p. 518, pl. 57, fig. 1; Langenheim, 1964, p. 94-95, pl. 6, fig. 5; Spencer, 1967, p. 14-15, figs. 7, 1; 8; Sturgeon &

**Description.** - Shell small, greatest width near the hinge, shell material punctate; beak of either valve not so prominent, lateral slopes bear rounded plications and are separated by rounded troughs, number of plicae not known in the specimen.

**Discussion.** - The specimens described here are poorly preserved and incomplete, hence identification is not very definitive. Since the plication in the fold and the brachial valve resemble the described and figured specimen of *P. kentuckyensis*, the specimens described here are assigned to *P. kentuckyensis*.

**Occurrence.** - The specimens were collected from only Atokan-Des Moines Stages of the Pennsylvanian System. It is very rare in vertical as well as in lateral distribution. In the mid-continent region this species has been reported from rocks of both Pennsylvanian and Permian Systems.

**Locality.** - 5, 7.

Superfamily RETZIACEA Waagen, 1883

Family RETZIIDAE Waagen, 1883
Genus HUSTEDIA Hall & Clark, 1893

HUSTEDIA MORMONI Marcou, 1858

Pl. III, fig. 9

_Hustedia mormoni_ Marcou, Girty, 1915, p. 196-197, pl. 12, figs. 5-6a; Dunbar & Condra, 1932, p. 356-358, pl. 42, figs. 9-11; Hoare, 1961, p. 86-87, pl. 11, figs. 12-14; Sturgeon & Hoare, 1968, p. 54, pl. 10, figs. 10-12.

**Description.** - Shell small, subrounded to subelongate, greatest width near mid-length, greatest thickness posterior to mid-length; posterolateral margins converging at approximately right angles, anterolateral margins subrounded; pedicle valve with relatively pronounced beak, perforated by a moderate-sized foramen; brachial valve with a small beak, incurved and hanging over the hinge; umbonal region slightly inflated in both valves, shell material punctate and marked by subangular to subrounded costae, about 10-12 on each valve, internal structures not observed.

**Dimensions.** -

<table>
<thead>
<tr>
<th></th>
<th>Length</th>
<th>Width</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Largest</td>
<td>1.6 cm.</td>
<td>1.4 cm.</td>
<td>1.0 cm.</td>
</tr>
<tr>
<td>Median</td>
<td>1.5 cm.</td>
<td>1.4 cm.</td>
<td>1.0 cm.</td>
</tr>
<tr>
<td>Average</td>
<td>1.4 cm.</td>
<td>1.2 cm.</td>
<td>0.9 cm.</td>
</tr>
</tbody>
</table>
Discussion. - *H. mormoni* is the most common species of *Hustedia* in the Pennsylvanian of North America. The specimens described here match fairly closely in shape to those described by Dunbar & Condra (1932) and Sturgeon & Hoare (1968). However, they are slightly larger in size and apparently have slightly fewer costae. Costae in the described specimens is on the average about 15 in number. It differs from *H. miseri* Mather by being more elongate and having fewer and more prominent costae. *H. brentwoodensis* Mather has a number of costae almost identical to that of *H. mormoni*, except it is more elongate in shape.


Locality. - 4.

**HUSTEDIA MISERI** Mather, 1915

Pl. III, figs. 10-12

*Hustedia miseri* Mather, 1915, p. 196, pl. 13, figs. 4-6c; Murphy, 1954, p. 26, 27, pl. 2, figs. 1a-c; Sturgeon & Hoare, 1968, p. 54, 55, pl. 10, fig. 13.

Description. - Shell small, subtriangular, subequally biconvex, greatest width anterior to mid-length, greatest thickness just anterior to umbo; pedicle valve with a moderately pronounced incurved beak arching over the hinge;
brachial valve with an unpronounced beak, arching over the hinge; surface of both valves marked by several rounded to subrounded costae numbering between 20-24, costae start at the umbonal region and radiate to anterior margins; occasionally a modest sulcus can be observed in the anterior region.

**Dimension.** -

<table>
<thead>
<tr>
<th>Length</th>
<th>Width</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 cm</td>
<td>0.9 cm</td>
<td>0.6 cm</td>
</tr>
</tbody>
</table>

**Discussion.** - The specimens described here as *H. miser* have similar shape and ornamentation to those described by Murphy (1954). Although their size is slightly bigger than those described by Murphy (1954) and Sturgeon and Hoare (1968), ratio of length, width, and thickness match fairly closely and the identification is definitive. Differences between this species and others related *Hustedia* are discussed under *H. mormoni*.

**Occurrence.** - This species was collected from rocks of Morrowan to Atokan age. Rare.

**Locality.** - 4

**HUSTEDIA MISERI subsp. GIBBOSA** Lane, 1962

Pl. III, figs. 13, 14

*Hustedia miser* subsp. *gibbosa* Lane, 1962, p. 906, pl. 127,
figs. 38-41.

Description. - Shell subelongate to suboval, biconvex, posterolateral margins converging at acute angle, anterolateral margins subrounded, greatest width near mid-length, greatest thickness just posterior to mid-length; pedicle valve with a pronounced incurved beak arching over the cardinal area, convexity of the valve increasing toward posterior region, sulcus very weak; brachial valve equally convex, with a very short and inconspicuous beak arching over a not so well defined cardinal area; costae on both valves subrounded, pronounced, numbering approximately 20-24 on each valve.

Dimension. - Length - 1.25 cm., Width - 0.85 cm., Thickness - 0.65 cm.

Discussion. - The specimens described here resemble the description of type species of *H. miser* subsp. *gibbosa* by Lane (1962). These specimens are quite different from the other described species and this writer agrees with Lane's designation of a new subspecies. It can be distinguished from *H. miser* in having more costae and more elongate outline.

Occurrence. - Rare in distribution in Des Moines Stage.

Locality. - 4
HUSTEDIA ROTUNDA Lane, 1962
Pl. III, fig. 15

Hustedia rotunda Lane, 1962, p. 905, 906, pl. 127, figs. 42-45; Langenheim, 1964, p. 96, 97, pl. 6, figs. 6-8.

Description. - Shell small, suboval, biconvex, greatest width anterior to mid-length, greatest thickness just posterior to mid-length, posterolateral margins converging at an acute angle, anterolateral margins subrounded; pedicle valve with slightly greater convexity than the brachial valve, beak moderately prominent, slightly incurved over a relatively undefined cardinal area, costae relatively fine, numbering approximately between 20-25 on both valves, sulcus very weak; brachial valve with identical costae and a not so prominent beak, slightly incurved over the cardinal area.

Dimension. - Length - 1.45 cm., Width - 1.25 cm., Thickness - 0.97 cm.

Discussion. - The specimens described here as H. rotunda are fairly close in size, shape, and ornamentation to those described by Lane (1962). H. rotunda can be distinguished from H. miseri subsp. gibbosa in having more rounded costellae and subrounded outline and from H. mormoni in having a greater number of costellae.
Occurrence. - Common in Desmoinesian Stage of the Pennsylvanian System.

Locality. - 4, 5, 7.

Superfamily CYRTIACEA Fredericks, 1919 (1924)
Family AMBOCOELIIDAE George, 1931
Genus CRURITHYRIS George, 1931
CRURITHYRIS PLANOCONVEXA (Shumard), 1855

Ambocoelia planoconvexa (Shumard), Girty, 1915, p. 94-96, pl. 11, figs. 6-7b.
Ambocoelia planoconvexa (Shumard), Dunbar and Condra, 1932, p. 344-348, pl. 42, figs. 12-14.
Crurithyris planoconvexa (Shumard), Hoare, 1961, p. 81-82, pl. 11, figs. 1-3; Stevens, 1962, p. 621, pl. 92, fig. 1; Lane, 1962, p. 905, pl. 127, figs. 34-35; Sutherland & Harlow, 1967, p. 1080-1081, pl. 136, figs. 7-8; Sturgeon & Hoare, 1968, p. 60-61, pl. 19, figs. 21-25; text. fig. 8.

Description. - Shell small, planoconvex, greatest width at mid-length, greatest thickness just posterior to mid-length; pedicle valve convex with a moderately pronounced beak overhanging the interarea, surface of the valve smooth, interarea broadly triangular and elongate; brachial valve plane with a very weak beak.
Measurements. -

<table>
<thead>
<tr>
<th></th>
<th>Length</th>
<th>Width</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>1.1 cm.</td>
<td>1.1 cm.</td>
<td>0.75 cm.</td>
</tr>
<tr>
<td>Average</td>
<td>1.0 cm.</td>
<td>1.1 cm.</td>
<td>0.7 cm.</td>
</tr>
</tbody>
</table>

Discussion. - *Crurithyris planoconvexa* differs from *C. expansa* by being smaller, less transverse, and by having a less pronounced incurved pedicle beak and umbo. *C. lobata* (Girty) has a more pronounced incurved pedicle valve.

Occurrence. - Missourian-Virgilian rocks of the Pennsylvanian System. It is a common species in the upper Pennsylvanian rocks but the range is far from restricted as it has been reported from both middle Pennsylvanian and lower Permian rocks. Common.

Locality. - 8.

**CRURITHYRIS EXPANSA** (Dunbar & Condra), 1932

*Ambocoelia expansa* Dunbar & Condra, 1932, p. 348-349, pl. 42, figs. 15-17.

Description. - Shell transverse, plano-convex, maximum width at or near the hinge, greatest thickness at the hinge, pedicle valve convex, beak strongly pronounced, overhanging on a subtriangular, elongate interarea, surface marked by faint growth lines; brachial valve plane but slightly convex in the posterior region and with a very weak beak. The specimens are incomplete to give an accurate measurement.
Discussion. - *C. expansa* differs from *C. planoconvexa* by being larger, more transverse and by having a more pronounced incurved beak.

Occurrence. - Missourian-Virgilian rocks of the Pennsylvanian System. Very rare.

Locality. - 8

Superfamily RETICULARIACEA Waagen, 1883

Family ELYTHIDAE Fredericks, 1919 (1924)

Genus PHRICODOTHYRIS George, 1932

PHRICODOTHYRIS PERPLEXA (McChesney), 1860

*Squamularia perplexa* (McChesney), Girty, 1915, p. 92-94, pl. 11, figs. 1-3a; Dunbar & Condra, 1932, p. 313-317, pl. 42, figs. 5-8.

Phricodothyris perplexa (McChesney), Sturgeon & Hoare, 1968, p. 67, 68, pl. 22, figs. 10-14.

Description. - Shell small, biconvex, subequal, greatest width 1/3 the distance from the hinge, maximum thickness near mid-length, beak of the pedicle valve small and incurved, sulcus faint and absent in younger specimens; brachial valve convex, beak small and incurved; surface of both valves marked by faint concentric growth lines.
Dimensions.

<table>
<thead>
<tr>
<th></th>
<th>Length</th>
<th>Width</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>1.4 cm.</td>
<td>1.6 cm.</td>
<td>1.0 cm.</td>
</tr>
<tr>
<td>Median</td>
<td>1.3 cm.</td>
<td>1.6 cm.</td>
<td>1.0 cm.</td>
</tr>
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</table>

Discussion. - The specimens described here as *P. perplexa* match closely with the description of this species by Girty (1915), Dunbar & Condra (1932), and Sturgeon & Hoare (1968); but, the growth lamellae are not as pronounced as they are in the specimens figured and described by Sturgeon & Hoare (1968). This could be, however, attributed to the mode of preservation. *P. perplexa* can be differentiated from *P. transversa* in being slightly smaller in size and less transverse.

Occurrence. - Morrowan-Atokan rocks. Rare to common.

Locality. - 3, 5.

Family MARTINIIDAE Waagen, 1883

Genus MARTINIA M'Coy, 1884

MARTINIA SP.

Description. - Shell subrounded to subtriangular, biconvex, greatest width near mid-length, pedicle valve convex, beak prominent, pointed and incurved over the hinge, shell surface generally smooth and devoid of any apparent
ornamentation, a shallow sulcus appears in the anterior region and continues beyond the mid-length; brachial valve convex, smooth, beak weakly developed and incurved, anterior region in most specimens highly deformed.

Discussion. - The specimens described here match very closely the description and characters of the genus Martinia. However, the specimens are too poorly preserved to determine if they belong to one or more species. Rich (1961) described the presence of Martinia sp. from nearly the same horizon in the Lee Canyon Section where the present specimens were collected.


Locality. - 6.

Order STROPHOMENIDA Opik, 1934
Superfamily PRODUCTACEA Gray, 1940
Family DICTYOCLOSTIDAE Stehli, 1954
Genus ANTIQUATONIA Miloradovich, 1945
ANTIQUATONIA HERMOSANA (Girty), 1903
Pl. IV, fig. 1

Productus semireticulatus var. hermosanus, Girty, 1903,
p. 358, 359, pl. 2, figs. 1-4b.

Dictyoclostus hermosanus (Girty), Hoare & Burgess, 1960,
Antiquatonia hermosana (Girty), Stevens, 1962, p. 628-629, pl. 95, fig. 6; pl. 96, fig. 4; Lane, 1962, p. 901, pl. 126, figs. 5-8; Langenheim, 1964, p. 80-81, pl. 5, figs. 1-4.

**Description.** - Shell subquadrate to subrectangular, size variable depending on maturity, concavo-convex, greatest width at or very near hinge, ears rarely preserved, but when preserved are relatively large; pedicle valve highly convex, greatest convexity in the posterior region, costae small, subrounded, becoming crowded in the posterior region, uniformly crossed by concentric growth lines producing reticulation, growth lines relatively not as prominent as costae with about twice the interspaces, beak moderately prominent, incurved and arched over cardinal area, sulcus appearing about 6 mm. anterior to the beak and continuing in the anterior region with a modest increase in depth and area, spines rarely preserved, when present are clustered in the posterior region and coarser and wider in the anterior region; brachial valve rarely preserved, when present reveals a strong reticulation.
Dimensions.

<table>
<thead>
<tr>
<th></th>
<th>Length</th>
<th>Width</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Largest</td>
<td>3.6 cm.</td>
<td>4.3 cm.</td>
<td>2.8 cm.</td>
</tr>
<tr>
<td>Large</td>
<td>3.4 cm.</td>
<td>4.1 cm.</td>
<td>2.7 cm.</td>
</tr>
<tr>
<td>Median</td>
<td>2.8 cm.</td>
<td>3.1 cm.</td>
<td>1.6 cm.</td>
</tr>
<tr>
<td>Average</td>
<td>2.9 cm.</td>
<td>3.1 cm.</td>
<td>1.7 cm.</td>
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</table>

Discussion. - The specimens described here, although varying in size, are quite distinctive and match very closely with the description of type species by Girty (1903). It is the most common species of Antiquatonia in the Cordilleran region. Its semireticulate ornamentation, relatively small in size, pronounced sulcus, and spinal distribution can easily distinguish this species from A. coloradoensis, A. elyensis, and A. morrowensis.

Genus Antiquatonia is now commonly used to describe these semireticulate brachiopods with uneven spinal distribution which have been differentiated from Dictyoclostus, Productus and other related genera on the basis of the above mentioned characters.

Occurrence. - One of the very abundant species in the Pennsylvanian rocks of the Cordillera. Although it appears to be more common in rocks of Morrowan Stage, the distribution is far from restricted as it was also collected from Atokan and higher stages.
Antiquatonia elyensis Lane, 1962, p. 901, pl. 126, figs. 12-14; pl. 127, figs. 8-11.

Description. - Shell relatively small, subquadrate, greatest width at the hinge, slightly wider than long; pedicle valve convex and geniculate, sulcus very faint in the posterior region, becoming pronounced and wider in the anterior region, costae low, subrounded, moderately pronounced, increasing in the anterior region by intercalation, concentric growth lines common in the posterior region, giving reticulate ornamentation, spines rarely preserved, when present regularly distributed over the surface of the valve; brachial valve not seen.

Discussion. - Lane (1962), cited the following characters which distinguish A. elyensis from A. hermosana and A. morrowensis. A. elyensis is smaller and more costate than A. hermosana and A. morrowensis. In my opinion, these characters are quite distinctive and they set this species apart from other Pennsylvanian Antiquatonia species.

Occurrence. - Rare to common in distribution in Morrowan and Atokan Stages of the Pennsylvanian System.
Description. - Shell subelongate, moderate sized, maximum width near the hinge, concavo-convex; pedicle valve strongly convex and geniculate, ear of moderate size and subrounded, extremely incurved beak arched over the cardinal area, sulcus extremely pronounced, beginning immediately anterior to the beak, and continuing in the anterior region with little increase in area but with pronounced deepening, concentric growth lines moderately prominent in the posterior region, giving reticulate pattern, costae rounded and prominent, coalesced in the posterior region, and increasing by intercalation in the anterior region, spines rarely preserved, when present are apparently regularly distributed; brachial valve rarely seen, when preserved show a typical reticulate pattern near the posterior region.

Dimensions. -

<table>
<thead>
<tr>
<th></th>
<th>Length</th>
<th>Width</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>3.2 cm.</td>
<td>2.9 cm.</td>
<td>2.2 cm.</td>
</tr>
<tr>
<td>Average</td>
<td>3.6 cm.</td>
<td>3.1 cm.</td>
<td>2.1 cm.</td>
</tr>
</tbody>
</table>

*This species is named in honor of Dr. Joseph Lintz, Jr., Professor of Geology at the University of Nevada.*
Discussion. - The specimens described here strongly resemble the characters of the genus Antiquatonia. However, they do not resemble any described Pennsylvanian Antiquatonia species. They differ from A. hermosana in being slightly longer than wide, in having a very deep and narrow sulcus, fainter reticulation and coarser and rounder costae. These characters also distinguish this species from A. coloradoensis, and A. elvensis. They can be distinguished from A. portlockianus and A. morrowensis by having a more pronounced and a deeper sulcus, which starts immediately anterior to the beak, finer costae, less pronounced reticulation and being slightly longer than wide. These characters set these specimen apart from previously described species of Antiquatonia. Hence, they have been described as a new species of Antiquatonia.

Occurrence. - This species is common in rocks of Morrowan-Atokan Stages.

Locality. - 4, 5.

ANTIQUATONIA LINTZI n. sp., var. COSTATUS n. var.

Pl. IV, fig. 5

Description. - Shell subelongate, concavo-convex, widest near the hinge; pedicle valve strongly convex and geniculate,
beak pointed, incurved and arched over the cardinal area, sulcus very deep, appearing immediately anterior to the beak and continuing with little increase in area, costae rounded and finer in the posterior region and coarse and very widely spaced in the anterior region, concentric growth lines are commonly visible in the posterior region, giving a faint reticulation, spines finer in the posterior region and regularly distributed over the surface of the valve; brachial valve not preserved.

**Dimension.** -

<table>
<thead>
<tr>
<th></th>
<th>Length</th>
<th>Width</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>3.7 cm.</td>
<td>3.0 cm.</td>
<td>2.8 cm.</td>
</tr>
</tbody>
</table>

**Discussion.** - The specimen described here resemble *A. lintzi* n. sp. in size, shape, and sulcus. However, ornamentation of this new variety is quite distinctive as the costae are much coarser and less numerous in the anterior region. Reticulation in the posterior region is also slightly pronounced than those in *A. lintzi* n. sp. These characters are quite distinctive and justify naming these specimen as a new variety of *A. lintzi* n. sp.

**Occurrence.** - *A. lintzi* var. *costatus* n. var. is rare in distribution in the Morrowan-Atokan Stages.

**Locality.** - 4, 5.
ANTQUATONIA SP. INDET.

Description. - Shell subquadrate, medium sized, greatest width at or near the hinge, ears pronounced; pedicle valve highly convex, with a pronounced beak, surface of the valve highly ornamented with pronounced growth lines and costae, a prominent sulcus appears slightly posterior to mid-length and continues with a slight enlargement and deepening toward the anterior margin, spines regularly scattered over the valve; brachial valve not preserved.

Dimension. - Length - 3.9 cm., Width - 4.2 cm., Thickness - 3.4 cm.

Discussion. - The quality of preservation and the scarcity of specimens (only 2) prevent establishing species rank. However, the shape, reticulation and spinal distribution point to its strong affinity to genus Antiquatonia. It differs from A. hermosana in size and stronger reticulation and finer costae. It resembles A. zamezensis Sutherland & Harlow (1967) in shape but differs in having finer costae in the anterior region.

Occurrence. - Rare in distribution in Late Morrowan-Atokan Stages of the Pennsylvanian System.

Localy. - 5.
**ANTQUATONIA PORTLOCKIANA var. CRASSICOSTATA**

(Dunbar & Condra), 1933

*Dictyoclostus portlockianus var. crassicostata* Dunbar & Condra, 1932, p. 217, 218, pl. 33, figs. 4-8; pl. 34, figs. 1, 2.

*Antiquatonia portlockiana var. crassicostata* (Dunbar & Condra), Sturgeon & Hoare, 1968, p. 46, 47, pl. 11, figs. 14-21.

**Description.** - Shell subquadrate, medium sized, greatest width at or very near the hinge; pedicle valve convex, with a small beak, and large ears, sulcus pronounced and narrow, surface ornamentation moderately pronounced, costellate, growth lines pronounced in the posterior region giving a reticulate ornamentation, spines scattered regularly in the anterior region; brachial valve not preserved.

**Discussion.** - This species can be easily distinguished from other species of *Antiquatonia* on the basis of its rather small beak and a fairly pronounced sulcus. It can be distinguished from *A. lintzi* n. sp. on its being slightly wider than long, in having a more pronounced reticulation, a coarser costae and a more sharply defined sulcus.

**Occurrence.** - Rare to common in distribution in Morrowan-Atokan Stages of the Pennsylvanian System.
Locality. - 3, 4.

RETTICULATIA Muir-Wood & Cooper, 1960

RETTICULATIA AMERICANUS Dunbar & Condra, 1932

Dictyoclostus americanus Dunbar & Condra, 1932, (in part)
  p. 218, pl. 34, figs. 3-6; Lane, 1962, p. 900, pl. 127, fig. 15.

Reticulatia americana (Dunbar & Condra), Branson, 1964,
  p. 272-274, pl. 1, figs. 1-4.

Description. - Shell subquadrate, concavo-convex,
greatest width near the hinge, length about equal to width;
pedicile valve convex, surface of the valve covered by almost
equally prominent rugae and costae, spinal bases distributed
over the surface of the valve; brachial valve and ears are
not seen.

Discussion. - The specimens described here as
Reticulatia americanus match closely with the description
and figure of this species by Lane (1962), but match only
figure 6 of Dunbar and Condra (1932).

Occurrence. - Atokan rocks. Rare.

Locality. - 2, 3.

Family PRODUCTIDAE Gray, 1840

Genus DIAPHRAGMUS Girty, 1910

DIAPHRAGMUS cf. D. FASCICULATUS (McChesney), 1860
  Pl. IV, fig. 6
Productus fasciculatus McChesney, 1860

Diaphragmus cf. D. fasciculatus (McChesney), Lane, 1962, p. 900, pl. 127, figs. 9-11.

**Description.** - Shell medium, concavo-convex, subquadrate, greatest width at the hinge; pedicle valve highly convex and geniculate, costellate with moderately pronounced costae, growth lines prominent in the posterior region giving a reticulate appearance, ears moderately large and subtriangular, spines not prominent and scattered, sulcus vague; brachial valve not preserved.

**Discussion.** - Only two specimens resembling D. fasciculatus were collected from Lower Pennsylvanian rocks. The specimens resemble Diaphragmus cf. D. fasciculatus described by Lane (1962). D. fasciculatus is primarily a Mississippian species but has been reported from Lower Pennsylvanian rocks of the Cordilleran region.

**Occurrence.** - Lower Morrowan rocks of the Pennsylvanian System. Rare.

**Locality.** - 3, 5.

Family BUXTONIIDAE Muir-Wood & Cooper, 1960

Genus JURESANIA Fredericks, 1928

JURESANIA aff. J. NEBRASCENSIS (Owen), 1852
**Juresania nebrascensis** (Owen), Dunbar and Condra, 1932, p. 195-198, pl. 22, figs. 1-9, 13; Hoare, 1961, p. 69, 70, pl. 8, figs. 1-6; Sturgeon and Hoare, 1968, p. 44-45, pl. 16, figs. 15-21.

**Description.** - Shell medium-sized, subquadrate, greatest width near mid-length, pedicle valve convex, beak small and slightly overhanging, ears small, surface of the valve marked by concentric bands and rugae; spines prominent and borne by rugae on the valve surface, and on the ears; brachial valve not seen.

**Discussion.** - The specimens described here resemble the description of *J. nebrascensis*. However, as only two incomplete specimens are in the present collection, identification is not definitive.

**Occurrence.** - Missourian rocks. Very rare.

**Locality.** - 8.

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**Juresania SP. INDET.**

**Description.** - Shell medium-sized, subquadrate, concavo-convex, subquadrate, greatest width on or near the hinge; pedicle valve convex, with a small overhanging
beak, lateral slopes steep and geniculate, ears small subtriangular, a vague sulcus appears about 6 mm. from the posterior margin and continues with little increase in area toward the anterior margin, ornamentation in the form of rugae are prominent on the shell surface, spines prominent occasionally clustered in the posterior region, but otherwise scattered over the surface of the valve; brachial valve not preserved.

**Discussion.** - Only two incomplete specimens are assigned to genus *Juresania*. Specimens described here resemble *J. nebrascensis* (Owen) in ornamentation, shape, and size, but the quality of preservation is too poor to make a definite species identification.

**Occurrence.** - Morrowan Stage of the Pennsylvanian System. Rare.

**Locality.** - 5.

Family MARGINIFERIDAE Stehli, 1954

Genus EOMARGINIFERA Muir-Wood, 1930

EOMARGINIFERA (LISSOMARGINIFERA) NUDA Lane, 1962

Pl. IV, figs. 7-9

Eomarginifera (Lissomarginifera) 1965, Treatise on Invertebrate Paleontology, Brachipoda, p. H904.

Description. - Shell relatively small, subquadrate, plano or concavo-convex, greatest width at the hinge, ears mucronate and distinct from the umbonal slopes; pedicle valve strongly convex, surface marked by very faint striae and rugae, spines prominent in the umbonal region and at the ears; brachial valve rarely preserved, when observed it is generally concave and apparently either devoid of any ornamentation or very faint striae and rugae.

Dimensions.-

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<tr>
<th></th>
<th>Length</th>
<th>Width</th>
<th>Thickness</th>
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<tbody>
<tr>
<td>Large</td>
<td>2.8 cm.</td>
<td>1.7 cm.</td>
<td>1.4 cm.</td>
</tr>
<tr>
<td>Average</td>
<td>2.4 cm.</td>
<td>1.4 cm.</td>
<td>1.1 cm.</td>
</tr>
<tr>
<td>Small</td>
<td>1.8 cm.</td>
<td>1.2 cm.</td>
<td>0.9 cm.</td>
</tr>
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</table>

Discussion. - The specimen described here match closely with the description of type species by Lane (1962). Lane (1962) differentiated Lissomarginifera nuda from Kozlowskia splendens (Norwood & Pratten) on the basis of its lack of a sulcus, and essentially its lack of surface ornamentation. However, the Treatise on Invertebrate Paleontology designates genus Lissomarginifera as a synonym of Eomarginifera which has precedent and hence Eomarginifera is being used here.
Occurrence. - Morrowan-Atokan Stages of the Pennsylvanian System.

Locality. - 3, 5.

Genus HYSTRICULINA Muir-Wood & Cooper, 1960

HYSTRICULINA WABASHENSIS (Norwood & Pratten), 1855

Pl. IV, fig. 10

Productus wabashensis Norwood and Pratten, 1855, p. 13, pl. 1, figs. 6a-d.

Marginifera wabashensis (Norwood & Pratten), Dunbar & Condra, 1932, p. 234-236, pl. 35, fig. 23, pl. 36, figs. 18-23, 25-26.

Hystriculina wabashensis (Norwood & Pratten), Sturgeon & Hoare, 1968, p. 39, pl. 12, figs. 11-14.

Description. - Shell small, subquadrate, concavo-convex, greatest width at the hinge; pedicle valve convex, with a median sulcus, beak and ears rather small, costae moderately pronounced, costellate, rugae faint and visible only in the posterior region, spines clustered on the ears and regularly distributed on the surface of the valve, sulcus appearing about 4 mm. anterior to the hinge and continuing as a narrow subcircular depression throughout the length of the valve; brachial valve highly concave but ornamentation not preserved.
Dimensions.-

<table>
<thead>
<tr>
<th></th>
<th>Length</th>
<th>Width</th>
<th>Thickness</th>
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<tbody>
<tr>
<td>Average</td>
<td>1.7 cm.</td>
<td>2.0 cm.</td>
<td>1.1 cm.</td>
</tr>
<tr>
<td>Average</td>
<td>1.6 cm.</td>
<td>1.9 cm.</td>
<td>1.0 cm.</td>
</tr>
</tbody>
</table>

Discussion. - The specimens described here match quite closely with those figured and described by Dunbar & Condra (1932) and Sturgeon & Hoare (1968). Shape and ornamentation are identical, but the specimens described here are slightly larger. H. wabashensis differs from H. fraglis and H. hystricula by being less spinose and being weakly costellate. Sulcus is less distinct in the present specimens than that of H. fraglis.


Locality. - 3, 4, 7.

Genus KOZLOWSKIA Fredericks, 1933

KOZLOWSKIA HAYDENENSIS (Girty), 1903
Pl. IV, fig. 11

Marginifera haydenensis Girty, 1903, p. 380, pl. 5, figs. 9-11a; Dunbar & Condra, 1932, p. 232-234, pl. 36, figs. 12-17.

Kozlowskia haydenensis (Girty), Muir-Wood & Cooper, 1960, p. 213, pl. 63, fig. 12; Sturgeon & Hoare, 1968,
Description. - Shell small, subquadrate, concavo-convex, greatest width at the hinge; pedicle valve moderately convex, geniculate, with a broad shallow sulcus, lateral flanks steep with subtriangular ears, beak small and incurved, spines not preserved except bases of spines, clustered around ears and irregularly distributed over the surface of the valve, ornamentation consisting of fine costae and faint rugae; brachial valve concave and marked by fine costae and rugae, giving a reticulate appearance.

Dimension. - Length - 1.5 cm., Width - 1.8 cm., Thickness - 1.0 cm.

Discussion. - The specimens described here as K. haydenensis match closely with those described by Dunbar & Condra (1932), and Sturgeon & Hoare (1968). They differ from K. splendens in being smaller in size and more quad-rangular in shape and in having a less distinct median sulcus.

Occurrence. - Des Moines Stage. Rare.

Locality. - 4.

Genus DESMOINESIA Hoare, 1960

DESMOINESIA MURICATINA (Dunbar & Condra), 1932
Pl. IV, fig. 12

Productus muricatus Norwood & Pratten, 1855, p. 14, pl. 1,
figs. 8a-e.

*Marginifera muricatina* Dunbar & Condra, 1932, p. 222-224, pl. 35, figs. 1-10.

*Desmoinesia muricatina* (Dunbar & Condra), Stevens, 1962, p. 625, pl. 94, figs. 3-4; Sturgeon & Hoare, 1968, p. 40-41, pl. 12, figs. 20-23.

**Description.** - Shell small, subquadrate, concavo-convex, greatest width at the hinge; pedicle valve convex, geniculate, with a small beak, and a very vague sulcus, ears small, mucronate, surface ornamentation costellate, with moderately prominent rugae in the median and posterior region, spines scattered over the surface of the valve but not well preserved; brachial valve not seen.

**Dimension.** - Length - 1.8 cm., Width - 1.9 cm., Thickness - 1.0 cm.

**Discussion.** - The specimens described here match closely with those figured and described by Sturgeon & Hoare (1968). They can be easily distinguished from species of *Kozlowskia* and *Hystriculina* on the basis of their unpronounced sulcus, their more pronounced rugae and by the presence of more spines on valves (Sturgeon & Hoare, 1968).

**Occurrence.** - Des Moines Stage. Rare to common.

**Locality.** - 4.
DESMOINESIA MURICATINA var. NEVADENSIS n. var.
Pl. IV, fig. 13

Description. - Shell small, subquadrate, concavo-convex, geniculate, greatest width at or near the hinge; pedicle valve convex with a small beak and a very vague sulcus, ears small and mucronate, ornamentation costellate, faint and unpronounced, rugae moderately pronounced in the posterior and median regions, spines clustered on the ears and posterior region and randomly distributed on the surface of the valve; brachial valve poorly preserved, ornamentation not observed.

Measurements.-

<table>
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<tr>
<th></th>
<th>Length</th>
<th>Width</th>
<th>Thickness</th>
</tr>
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<tbody>
<tr>
<td>Average</td>
<td>1.3 cm.</td>
<td>1.6 cm.</td>
<td>0.8 cm.</td>
</tr>
<tr>
<td>Average</td>
<td>1.4 cm.</td>
<td>1.8 cm.</td>
<td>1.0 cm.</td>
</tr>
</tbody>
</table>

Discussion. - The specimens described here resemble \textit{D. muricatina} in size and in shape. However, they differ from \textit{D. muricatina} by having fainter costae and less pronounced spines, and from species of \textit{Kozlowskia} and \textit{Hystriculina} by having stronger spinal and costation development. The present specimens are hence, designated as a new variety of \textit{D. muricatina}.

Occurrence. - Des Moines Stage. Rare.

Locality. - 4.
Family LINOPRODUCTIDAE Stehli, 1954

Genus LINOPRODUCTUS Chao, 1927

LINOPRODUCTUS PRATTENIANUS (Norwood & Pratten), 1855
Pl. V, figs. 1-2

Productus prattenianus Norwood & Pratten, 1855, p. 17,
pl. 1, figs. 10a-d.

Linoprocessus prattenianus (Norwood & Pratten), Dunbar &
Condra, 1932, p. 241-244, pl. 26, figs. 4-5b; pl. 27,
figs. 1-5, 9; Hoare & Burgess, 1960, p. 712, pl. 91,
figs. 14-15; Muir-Wood & Cooper, 1960, p. 417, pl. 111,
figs. 8-9; Stevens, 1962, p. 625, 628, pl. 94, fig. 14;
pl. 95, figs. 4, 7; Lane, 1962, p. 904, pl. 126, figs.
1, 3-4; Langenheim, 1964, p. 82-84, pl. 5, fig. 5;
Sutherland & Harlow, 1967, p. 1077, 1078, pl. 135, figs.
13-14; pl. 136, figs. 1-2; Sturgeon & Hoare, 1968,
p. 51-52, pl. 17, figs. 1-3.

Description. - Shell subquadrate to subelongate,
greatest width near the hinge; pedicle valve moderately to
strongly convex, ears large but seldom preserved, surface
marked by numerous fine, rounded costae, and sharp narrow
striae, costae increasing in number by intercalation and are
slightly coarser at the anterior margins than those at the
umbro, surface of the valve covered with spines, distinctive
but rarely preserved; brachial valve rarely preserved.
Measurements.

<table>
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<th>Length</th>
<th>Width</th>
<th>Thickness</th>
</tr>
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<tbody>
<tr>
<td>Largest</td>
<td>4.6 cm.</td>
<td>4.5 cm.</td>
<td>3.8 cm.</td>
</tr>
<tr>
<td>Median</td>
<td>3.4 cm.</td>
<td>3.6 cm.</td>
<td>?</td>
</tr>
</tbody>
</table>

Discussion. - The specimens described here match quite well with described and figured specimens of L. prattenianus in size, in shape, and in ornamentation. However, a closer examination of various paratypes described in the literature reveals extreme variability in the morphological characters of specimens described under L. prattenianus. In my opinion, detail work on the specimens listed under this species will reveal that they belong to more than one species.

Occurrence. - Morrowan to Des Moines Stages. Abundant. Apparently this species is widely distributed in eastern Nevada, and was collected from nearly all the localities.

Locality. 2, 3, 4, 5, 6, 7.

Linoproductus magnispinus Dunbar & Condra, 1932
Pl. V, fig. 3

Linoproductus magnispinus Dunbar & Condra, 1932, p. 244, pl. 27, figs. 6-8; Lane, 1962, p. 904, pl. 126, fig. 2; Sturgeon & Hoare, 1968, p. 51, pl. 17, figs. 11, 12, 14.

Discussion. - Shell subelongate, medium to large, greatest width on or near the hinge; pedicle valve convex,
with incurving beak, ears very rarely preserved, surface of the valve covered by radial costae, which increase by intercalation, generally 3-4 costae combining at the base of a spine, and then resplitting beyond the spine, occasionally, a vague sulcus seen in a few specimens, spines very prominent, randomly distributed over the surface of the valve; brachial valve not observed.

**Dimension.** - The specimens are highly fragmented, hence dimensions could not be accurately recorded.

**Discussion.** - The specimens described here can be differentiated from *L. prattenianus*, *L. platyumbonus*, *L. oklahomae*, and *L. echinatus* on the basis of their elongate outline and the size and number of spinal bases. Spinal bases are consistently larger than the other species of Pennsylvanian *Linoproductus*. The present specimens are consistently larger than the type species described by Dunbar & Condra (1932), but are consistent with those described by Lane (1962) and Sturgeon & Hoare (1968).


**Locality.** - 3, 4, 6, 7.
LINOPRODUCTUS FIRBYI* sp. nov.  
Pl. V, figs. 4-5

Description. - Shell relatively large, thin, elongate  
plano or concavo-convex, greatest width at or very near the  
hinge, ears rarely preserved, moderately large, pedicle  
valve strongly convex, geniculate, beak moderately pronounced,  
subrounded, incurved, and strongly arched over the hinge,  
surface of the valve covered with fine subrounded costae,  
about 15-18 per 10 mm., increasing in number in the anterior  
region through intercalation, spines weakly developed and  
randomly distributed over the surface of the valve; brachial  
valve not observed.

Dimensions.-

<table>
<thead>
<tr>
<th></th>
<th>Length</th>
<th>Width</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>4.8 cm.</td>
<td>4.4 cm.</td>
<td>3.1 cm.</td>
</tr>
<tr>
<td>Largest</td>
<td>5.3 cm.</td>
<td>4.9 cm.</td>
<td>3.4 cm.</td>
</tr>
</tbody>
</table>

Discussion. - The specimens described here as L. firbyi  
n. sp. can be distinguished from L. prattenionus, L. magni-  
spines, L. missouriensis on the basis of their large size,  
less conspicuous spines and moderately strong convexity in  
the umbonal region. L. platyumbonus, although essentially  
having the same size, has far less convexity in the umbonal  

*This species is named in honor of Dr. James R. Firby,  
Geology Department, University of Nevada, Reno, Nevada.
region, and less arched beak than that of this new species. These characteristics are unique and are not observed in any described Pennsylvanian species of Linopoductus. Hence, the present specimens are designated as a new species of Linopoductus.

**Occurrence.** - Morrowan-Atokan Stages. Abundant. This new species is apparently limited in lateral distribution as it was only collected from Pennsylvanian rocks in southern Nevada.

**Locality.** - 6, 7.

**LINOPRODUCTUS SP. INDET.**

**Description.** - Shell moderately large, subquadrate to transverse, greatest width at the hinge; pedicle valve moderately convex, with a weak beak, costae fine, subrounded, numbering approximately 15 per mm., spines not prominent and rarely preserved; brachial valve not observed.

**Dimension.** - The specimens are too poorly preserved to determine their various measurements.

**Discussion.** - The specimens described here are poorly preserved to make a definite species identification. They can be readily differentiated from other Pennsylvanian species of Linopoductus on the basis of their relatively large size,
and a narrow and weakly developed beak. These specimens resemble _L. meniscus_ Dunbar & Condra in size, in costation and in having a relatively narrow beak and quite possible belong to this species.

**Occurrence.** - Morrowan-Atokan Stage. Rare.

**Locality.** - 7.

Genus _OVATIA_ Muir-Wood & Cooper, 1960

_OVATIA_ aff. _O. ELONGATA_ Muir-Wood & Cooper, 1960

Pl. V, figs. 6, 7


**Description.** - Shell elongate, concavo-convex, greatest width near the hinge, greatest thickness near mid-length; pedicle valve highly convex, geniculate, umbo highly convex and strongly incurved, surface of the valve ornamented by fine costellae, approximately 20-25 in 10 mm., and increasing in number in the anterior region through intercalation, ears not preserved, few spinal bases seen, but spinal bases not well preserved near the hinge; brachial valve not seen but strong curvature indicates that it will be concave, if preserved. Most of the specimens are fragmental but probably had length in excess of 4.5-5 cm, and width and thickness approximately 3.5 cm.

**Discussion.** - Muir-Wood and Cooper (1960) explained that
the genus *Ovatia* differs from *Linoproductus* in its narrow, elongate shell, more concave brachial valve and strongly convex umbonal region. The specimens described here resemble *O. elongata* in size, shape and ornamentation, but other *Ovatia* sp. are not well described as yet. Hence, the present specimens are described as *Ovatia aff. O. elongata*.

**Occurrence.** - Morrowan rocks. Common.

**Locality.** - 5, 7.

Superfamily DAVIDSONIACEA King, 1850

Family ORTHOTETIDAE Waagen, 1884

Genus *DERBYIA* Waagen, 1884 (emend. Girty, 1908)

*DERBYIA aff. D. HAESITANS* Dunbar & Condra, 1932

**Description.** - Shell large, greatest width at or near the hinge, hinge line straight; pedicle valve almost flat, beak weakly developed, surface of the valve marked by inconspicuous growth lines, fine, and fairly wide spaced, by subangular costae increasing in number in the anterior region by intercalation to approximately 15-20 costellae per cm.; brachial valve not preserved.

**Discussion.** - The specimens described here match closely in size, in shape, and in ornamentation with those described by Dunbar & Condra (1932) and Lane (1962). However, only two poorly preserved specimen are in the collection; species identification is not certain.

Locality. - 3.

Superfamily CHONETACEA Bron, 1862

Family CHONETIDAE Bron, 1862

Genus NEOCHONETES Muir-Wood, 1962

NEOCHONETES GRANULIFER (Owen), 1852

Pl. V, fig. 8

Chonetes granulifer Owen, 1852, p. 583, pl. 5, figs. 12a-d;

Girty, 1915, p. 59-62, pl. 7, figs. 12-13b; Dunbar &

Condra, 1932, p. 138-142, pl. 18, figs. 1-10.

Neochonetes granulifer (Owen), Muir-Wood, 1962, p. 87, 89,

pl. 10, figs. 8, 15; Sturgeon & Hoare, 1968, p. 37,

pl. 9, figs. 1-19.

Description. - Shell small, subquadrate, greatest width

at the hinge; pedicle valve slightly convex, beak moderately

pronounced, sulcus rarely observed, and vague, surface

multicostellate with subrounded costae, faint growth lines

occasionally visible, spines observed but rarely preserved;

brachial valve concave, with almost identical ornamentation

of the pedicle valve.

Dimension. - Length - 0.8 cm., Width - 1.1 cm.,

Thickness - ?
Discussion. - The specimens described here match closely with the described and figured specimens of Neochonetes granulifer. It differs from N. semiacanthus (Lintz) in being consistently larger, in having costae and costellae of a more rounded shape, and in having a relatively pronounced beak.

Occurrence. - Des Moines Stage. Rare to common (4-5 specimens). The present specimens were collected from localities in east-central Nevada. Apparently, N. granulifer is not as widely distributed in the Cordilleran region as it is in the midcontinent region.

Locality. - 4, 5.

Genus RETICHONETES Muir-Wood, 1962

RETICHONETES LARSONI* n. sp.
Pl. V, figs. 9, 10

Description. - Shell small, subquadrate, greatest width at the hinge; pedicle valve strongly convex, beak low and inconspicuous, ears rather small, surface of the valve marked by subrounded costae which are capillate, and several faint growth lines; many spinal bases seen on the surface of the valve, but the spines are not preserved.

*This species is named in honor of Dr. E. R. Larson, Professor of Geology at the University of Nevada.
Dimension. - Length - 0.7 cm., Width - 1.1 cm.,
Convexity - 0.3 cm.

Discussion. - The specimens described here as R. Larsoni differ from other Pennsylvanian chonetids in having a very strong convexity. The shell shape, size and ornamentation correspond with the specimens of genus Retichonetes which have a geologic range of Devonian to Mississippian. These specimens are included in the genus Retichonetes and the geologic age of this genus is being extended to incorporate early Pennsylvanian.

Occurrence. - Morrowan Stage. Rare. Only two specimens are in the collection. Quality of preservation is very good.

Locality. - 5.

RUGOSOCHONETES SP. INDET.

Description. - Shell small, subquadrate, plano or concavo-convex, greatest width at or very near the hinge; pedicle valve moderately convex, beak weakly developed, ears not preserved, surface of the valve marked by subrounded capillate costae, few spinal bases observed but the spines are not preserved; brachial valve not preserved.

Dimension. - Length - 0.7 cm., Width - 0.9 cm.
Discussion. - Only two poorly preserved specimens are in the collection. The specimens resemble characters of the species of the genus *Rugosochonetes*, but species identification could not be established because of poor preservation of specimens.

Occurrence. - Morrowan Stage. Rare.

Locality. - 5.
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<table>
<thead>
<tr>
<th>FIGURES</th>
<th>DESCRIPTION</th>
<th>PAGE</th>
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<tbody>
<tr>
<td>1</td>
<td>Lingula lemniscata ? Price Pedicle valve.</td>
<td>36</td>
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<tr>
<td>2, 3</td>
<td>Rhipidomella carbonaria (Swallow)</td>
<td>37</td>
</tr>
<tr>
<td>2</td>
<td>Pedicle valve X1.80</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Posterior view X2.40</td>
<td></td>
</tr>
<tr>
<td>4, 5</td>
<td>Rhipidomella nevadensis (Meek)</td>
<td>40</td>
</tr>
<tr>
<td>4</td>
<td>Pedicle valve X1.25</td>
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<td>5</td>
<td>Lateral view X1.25</td>
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<td>Beecheria bovidens (Morton) Brachial valve X1.</td>
<td>42</td>
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<tr>
<td>7, 8</td>
<td>Wellerella dekalbensis var. elkcoensis n. var.</td>
<td>46</td>
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<td>7</td>
<td>Pedicle valve X2.9</td>
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<td>Brachial valve X2.1</td>
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<td>9, 10</td>
<td>Composita argentea (Shepard)</td>
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<td>9</td>
<td>Pedicle valve X1.60</td>
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<td>Brachial valve X2.00</td>
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<td>11-13</td>
<td>Composita ovata Mather</td>
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<td>11</td>
<td>Brachial valve X1.25</td>
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<td>12</td>
<td>Pedicle valve.</td>
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<td>Pedicle valve X1.25</td>
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<td>Composita subtilita (Hall). Brachial valve X1.25.</td>
<td>52</td>
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<td>15-17</td>
<td>Composita trilobata Dunbar &amp; Condra</td>
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<td>15</td>
<td>Anterior view X1.25</td>
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PLATE II

FIGURES

1-3  Composita elongata var. elvensia n. var.  54
1. Pedicle valve X1.25.
2. Brachial valve
3. Lateral view.

4-7  Composita nevadensis n. sp.  55
4. Pedicle valve X1.60.
5. Brachial valve X2.00.
7. Posterior view X1.25.

8  Cleiothyridina orbicularis (McChesney).  59
    Brachial valve X1.50.

9-10 Cleiothyridina orbicularis var. brogani n. var.  61

11-14 Anthracospirifer occiduus (Sadlick)  63
11. Posterior view X0.9.
12. Anterior view X0.9.
PLATE III
(All figures X0.9 except where noted)

<table>
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<th>FIGURES</th>
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<td>1</td>
<td><em>Spirifer opimus</em> (Hall). Brachial valve X1.25.</td>
<td>66</td>
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</table>
| 2-4     | *Spirifer rockymontanus* (Marcou).  
2. Brachial valve X1.1.  
3,4. Pedicle valve of two immature specimens X1.1. | 68   |
| 5-7     | *Neospirifer cameratus* (Morton).  
5. Broken brachial valve.  
6,7. Incomplete pedicle valve. | 69   |
| 8       | *Neospirifer dunbari* King. Incomplete pedicle valve. | 71   |
| 9       | *Hustedia mormoni* (Marcou). Brachial valve X1.25. | 76   |
| 10-12   | *Hustedia miser* Mather.  
11. Lateral view X2.50.  
12. Pedicle valve X2.30. | 77   |
| 13,14   | *Hustedia miser* subsp. *gibbosa* Lane.  
13. Pedicle valve X2.50.  
14. Lateral view X1.25. | 78   |
| 15      | *Hustedia rotunda* Lane. Pedicle valve X1.25. | 80   |
PLATE IV
(All figures X0.9 except where noted)

FIGURES

1  Antiquatonia hermosana (Girty).  Pedicle valve.  85

2-4  Antiquatonia lintzi n. sp.
     2.  Pedicle valve.
     3.  Posterior portion of the pedicle valve.
     4.  Incomplete brachial valve.  89

5  Antiquatonia lintzi var. costatus n. var.  Pedicle valve.  90

6  Diaphragmus cf. D. fasciculatus  94
    (McChesney)  Pedicle valve X1.25.

7-9  Eomarginifera (Lissomarginifera) nuda Lane
     7-9.  Pedicle valve X1.15.  97

10  Hystriculina wabashensis (Norwood & Pratten)  99
     Pedicle valve X1.1.

11  Kozlowskia haydenensis (Girty)  100
     Pedicle valve X1.25.

12  Desmoinesia muricatina (Dunbar & Condra)  101
     Pedicle valve X1.

13  Desmoinesia muricatina var. nevadensis n. var.  103
     Pedicle valve X1.50.
PLATE IV
PLATE V
(All figures X0.9 except where noted)

FIGURES

1,2 Linoproductus prattenianus (Norwood & Pratten).
   1. Pedicle valve X1.25.
   2. Pedicle valve of a well preserved specimen.

3 Linoproductus magnispinus Dunbar & Condra.
   Pedicle valve.

4,5 Linoproductus firbyi n. sp.
   4. Pedicle valve.
   5. Lateral view X1.25.

6,7 Ovatia aff. O. elongata Muir-Wood & Cooper.
   6. Posterior view.
   7. Lateral view X1.00.

8 Neochonetes granulifer (Owen).
   Pedicle valve X1.25.

9,10 Retichonetes larsoni n. sp.
   9,10. Pedicle valve X2.40