MICROFAUNAL ASSEMBLAGES OF THE PLACID SHALE (MISSOURIAN, UPPER PENNSYLVANIAN), BRAZOS RIVER VALLEY, NORTH-CENTRAL TEXAS

by

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DEDICATION

I would like to dedicate this thesis to my granddad Pope Meagher who as a geologist instilled in me, at a young age, my love for rocks. I don’t believe I would have gotten as far without this early love he planted and nurtured to grow within me.

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ABSTRACT

MICROFAUNAL ASSEMBLAGES OF THE PLACID SHALE (MISSOURIAN, UPPER PENNSYLVANIAN), BRAZOS RIVER VALLEY, NORTH-CENTRAL TEXAS

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The Pennsylvanian and lowermost part of the Permian strata in North-Central Texas is assigned to the Strawn, Canyon, and Cisco Groups. The Canyon Group is approximately equivalent to the middle-upper part of the Missourian (Upper Pennsylvanian) and crops out in the Brazos River valley in a generally northeast-southwest strip across Palo Pinto and Jack counties. The Canyon Group is subdivided into seven formations that contain several cycles of well-known clastic and carbonate units. The Placid Shale, one of the clastic units within the Canyon Group, consists of two cycles of gray, brown, olive sandstone/siltstone/mudstone with few thin limestone beds. It is bounded below by the Winchell Limestone and above by the Ranger Limestone. In the Possum Kingdom Lake area in Palo Pinto County, three localities of the Placid Shale were chosen for study of their microfossil content. Closely spaced samples were taken

from the two dominantly marine sequences of the two cycles, one in the lower part and one in the upper part of the formation. The dominant microfaunal elements present are holothurian sclerites, ostracodes, conodonts (*Streptognathodus firmus* and *S. pawhuskaensis*), fusulinids (which fall within the *Triticites newelli* zone) and a number of distinctive species of small foraminifers. The foraminifers are the main focus of the present study because of their diversity and biostratigraphic significance. The primary goal of this project is to describe and update the taxonomic assignments of the various microfaunal elements from two cycles of the Placid Shale.

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CHAPTER 1

INTRODUCTION

Geologic Setting

The Pennsylvanian and lower part of the Permian strata in North-Central Texas consists of three main groups: Strawn, Canyon, and Cisco. The microfaunal assemblages of the Placid Shale, a formation of the Canyon Group, Missourian Stage, Upper Pennsylvanian, is the focus of this study. Rocks of the Canyon Group were deposited under a series of cyclical conditions reflecting alternating shallow marine to non-marine conditions, representing a continuous deposition with only minor disconformities. Laury (1962, p. 108) did a serious reevaluation of the Canyon sequence in the type area in North-Central Texas and stated: “The Canyon strata are conformable with those of the Strawn and Cisco Groups”, and that they consist of a mix of carbonate and clastic rocks that dip slightly to the west. The general sequence of deposits of the Canyon Group consists of four thick limestone units with interbedded siltstone, mudstone and sandstone. Laury (1962) considered that the stratigraphic units (formations) of the Canyon Group, in ascending order, to be the Palo Pinto, Posideon, Wolf Mountain Shale, Winchell Limestone, Placid Shale, Ranger Limestone, Colony Creek Shale, and the Home Creek Limestone (table 1.1) and this nomenclature will be followed in this work.

Table 1.1: Correlation chart of all the name changes of strata of the Canyon Group from 1919-1962 (modified for the Brazos River Valley from Laury 1962)

Plummer 1919, Brazos River Valley

Division	Formation	Member
Canyon	Eastland	Eastland Ls
Canyon	Eastland	
Canyon	Ranger	Ranger Ls
Canyon	Ranger	
Canyon	Graford	Graford Ls
Canyon	Graford	
Canyon	Palo Pinto	

Plummer and Moore 1921, North-Central Texas — Colorado River Valley

Group	Formation	Member
Canyon	Caddo Creek	Home Creek Ls
Canyon	Caddo Creek	Hog Creek Sh
Canyon	Brad	Ranger Ls
Canyon	Brad	Placid Sh
Canyon	Brad	Clear Creek Ls
Canyon	Brad	Cedarton Sh
Canyon	Graford	Adams Branch Ls
Canyon	Graford	Brownwood Sh
Canyon	Graford	Rochelle Cgl

Plummer and Moore 1921, North-Central Texas — Brazos River Valey

Group	Formation	Member
Canyon	Caddo Creek	Home Creek Ls
Canyon	Caddo Creek	Hog Creek Sh
Canyon	Brad	Ranger Ls
Canyon	Brad	Seaman Ranch Beds
Canyon	Graford	Adams Branch Ls
Canyon	Graford	Brownwood Sh
Canyon	Palo Pinto	

Plummer and Hornberger 1935, PaloPinto County

Group	Formation	Member
Canyon	Caddo Creek	Home Creek Ls
Canyon	Caddo Creek	Hog Creek Sh
Canyon	Brad	Ranger Ls
Canyon	Brad	Seaman Ranch Beds
Canyon	Graford	Merriman Ls
Canyon	Graford	Wolf Mountian Sh
Canyon	Graford	Wiles Ls
Canyon	Graford	Posideon Sh
Canyon	Palo Pinto	

Bradish 1937, Stephens County

Group	Formation	Member
Canyon	Caddo Creek	Home Creek Ls
Canyon	Caddo Creek	Hog Creek Sh
Canyon	Brad	Ranger Ls
Canyon	Brad	Placid Sh
Canyon	Brad	Merriman Ls
Canyon	Brad	Cedarton Sh
Canyon	Brad	- - - - - - - - - - Ls
Canyon	Graford	Adams Branch Ls
Canyon	Graford	Brownwood Sh
Canyon	Graford	Wiles Ls Lentil
Canyon	Graford	Brownwood Sh
Canyon	Graford	Palo Pinto Ls

Cheny 1940, North-Central Texas

Series	Group	Formation	Member
		?	?
Canyon	Caddo Creek	Home Creek Ls	- - - - - Sh
Canyon	Caddo Creek	Hog Creek Sh (Colony CK SH, 1948)	
Canyon	Brad	Ranger Ls	
Canyon	Brad	Placid Sh	
Canyon	Graford	Winchell	
Canyon	Graford	Wolf Mountain	
Canyon	Whitt	Palo Pinto	Wiles Ls
Canyon	Whitt	Palo Pinto	Posideon Sh
Canyon	Whitt	Palo Pinto	Wynn Ls
Canyon	Whitt	Palo Pinto	- - - - - Ss
Canyon	Whitt	Keechi Creek	- - - - - Ls
Canyon	Whitt	Keechi Creek	- - - - - Ls
Canyon	Whitt	Keechi Creek	Turkey Creek Ss
Canyon	Whitt	Salesville	- - - - - - - Ss
Canyon	Whitt	Salesville	- - - - - - - Ls
Canyon	Whitt	Salesville	- - - - - - - Ss
Canyon	Whitt	Salesville	Dog Bend Ls
Canyon	Whitt	Salesville	
Canyon	Whitt	Salesville	Lake Pinto Ss

Laury 1962, Canyon Group Type Area

Group	Formation	Member
Canyon	Home Creek Ls	Pnc_3
Canyon	Home Creek Ls	Pnc_2 (marl)
Canyon	Home Creek Ls	Pnc_1
Canyon	Colony Creek Sh	
Canyon	Ranger Ls	Pr: Pr_3, Pr_2 (sh), Pr_1
Canyon	Placid Sh	Ppl: Ppl_3, (ls) Ppl_2, Ppl_1
Canyon	Winchell Ls	Pw: Pw_3, Pw_2 (sh), Pw_1
Canyon	Wolf Mountain Sh	Pwm: Pwm_3, Pwm_2, Staff Ls, Pwm_1
Canyon	Posideon	Wiles Ls, Pp_5 (sh), Pp_4 (ls), Pp_3 (sh)
Canyon	Posideon	Pp_2 (ls)
Canyon	Posideon	Pp_1 (sh), Fambro Ss, Pp_1 (sh)
Canyon	Palo Pinto Ls	

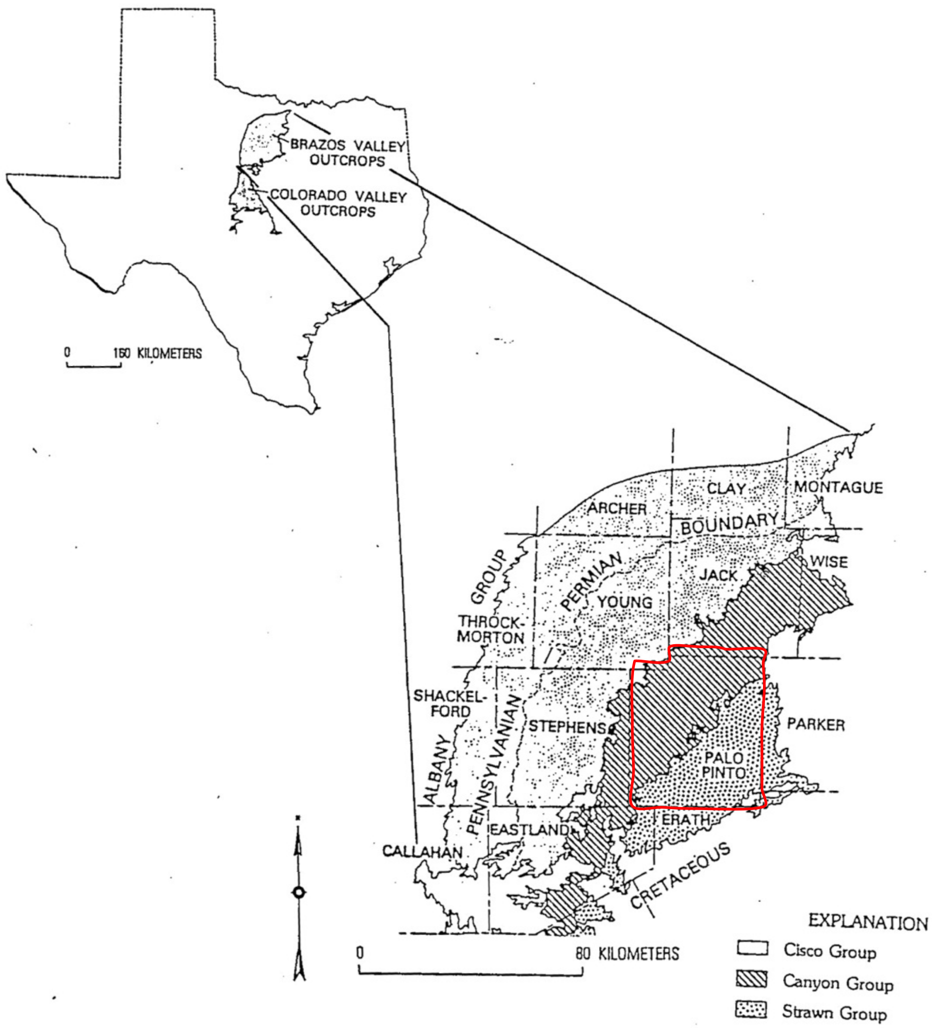


Figure 1.1: Map of Texas showing the exposed Upper Pennsylvanian strata in the Brazos River Valley, North-Central Texas. Study area is in the northwestern part of Palo Pinto County which is boxed in red (after Nail 1991).

Location

The two major surface outcrop areas in North-Central Texas of strata of the Canyon Group are located in the Colorado and Brazos River Valleys and are divided by Lower Cretaceous rocks along the Callahan Divide. Strata of the Placid Shale Formation can be seen in both the Colorado and Brazos River valleys. In the Brazos River Valley, it outcrops in a surface trend from northeast to southwest in Wise, Jack and Palo Pinto County, Texas. In the northwestern part of Palo Pinto County, the primary two cycles of the Placid Shale Formation outcrop in the area of Possum Kingdom Lake, located approximately 25 miles northwest of Mineral Wells, Texas (figure 1.1).

History of Previous Research

Pennsylvanian age strata of North-Central Texas have been studied by geologists and paleontologists since the late 1800's. However, because of frequency of lateral and vertical lithofacies changes and researchers attempting to correlate widely separated and poorly exposed outcrops, many units have been miscorrelated. This miscorrelation is clearly evident when comparing the formations of the Canyon Group of the Brazos River Valley to that of the Colorado River Valley.

Cummins (1891) was the first person to describe the Canyon Group strata in the northern part of Palo Pinto and southern parts of Young and Jack counties. Cummins named these rocks the Canyon "division" after the former town of Canyon that was located about four miles west of Strawn on the right-of-way of the Texas and Pacific Railroad. Plummer and Moore (1921) used Cummins's Canyon "division" to introduce the Canyon Group which they described as the strata deposited within the time after the deposition of strata of the Strawn Group and including all strata from the base of the Palo Pinto Limestone to the top of the Home Creek Limestone.

The name "Placid Shale Member" of the Brad Formation was first applied by Plummer and Moore (1921) to describe the stratigraphic interval in the Colorado River Valley below the Ranger Limestone and above the Clear Creek Limestone, which Cheney (1940) later renamed the Winchell Limestone. When Plummer and Moore named this unit in 1921 as the Placid Shale Member, they also proposed the name "Seaman Ranch Beds" for the interval that was below the Ranger Limestone and above the "Adams Branch Limestone" within the Brazos River Valley (Laury 1962). The term Seaman Ranch Beds included the units that were "…equivalent to the Placid Shale, the Clear Creek Limestone, and the Cedarton Beds of the Colorado River Valley…" (Plummer and Moore 1921, p. 111). Because the deposition of these units spans approximately the same time interval as the Placid Shale, the terms Placid Shale and Seaman Ranch Beds have been used interchangeably in both the Colorado and Brazos River valleys (table 1.1).

Yet, upon further study it was found that the Adams Branch Limestone that Drake named in the Brazos River Valley is stratigraphically lower than the Adams Branch Limestone of Plummer and Moore in the Colorado River Valley (Laury 1962). Cheney (1929) correlated the Adams Branch Limestone of the Brazos River Valley to the Clear Creek/Merriman Limestone of the Colorado River Valley (Laury 1962). Because of this confusion about the Adams Branch Limestone, the usage of this term was abandoned in the Brazos River Valley. The abandonment and confusion with the name "Adams Branch" also made the exact time of deposition of the Seaman Ranch Beds questionable. Plummer and Hornberger (1935) redefined the Seaman Ranch Beds as the unit overlying the Merriam Limestone. This reinterpretation made the Seaman Ranch Beds equivalent to the Placid Shale as used in the Colorado River Valley. Because of all of this confusion of names, most of the work on the aforementioned units has been done in the Colorado River Valley. For this reason, the name Placid Shale is preferred and more frequently used than the name Seaman Ranch Beds. Laury (1962) formally designated the Placid Shale Formation as the stratigraphic sequence that lies in the interval above the Winchell Limestone Formation and below the Ranger Limestone Formation.

Methods

Several trips were made to the study localities, samples were collected and stratigraphic sections were measured. Once the samples were collected, they were brought back to the laboratory to start the process of microfaunal extraction. Each of the samples was placed in a Varsol bath overnight after which the solution was poured off and the sample bucket was filled with water. The samples were then allowed to sit for a few days, stirring occasionally to help break down the mudrock. Once the samples were broken down they were rinsed clean with the help of sieves. This residue was then allowed to air dry before being picked for microfossil content. Each sample was picked onto a numbered slide for holothurian sclerites, ostracodes, conodonts, and foraminifers. After picking the samples, pictures were taken of the microfauna to help determine which samples to choose for Scanning Electron Microscope (SEM) pictures. Once the specimens were chosen they were placed on a stub and SEM pictures were taken. These SEM images permitted identification of the microfaunal content down to the species level and for systematics descriptions to be made. These identifications were then used to discuss the faunal relationships of the three localities.

Purpose of Study

The primary goal of this study is to analyze the microfaunal assemblages present in the two principle marine cycles in the Placid Shale. Closely spaced samples were collected at four different localities (table 1.2; figures 1.2, 1.3), a road cut on Highway 337, a stream drainage next to the Hills Estates Community Center, and at two road cuts, Hills Estates A, and B located on a private road in the Hills Estates Development project. These samples were processed and the microfossils picked to identify the assemblage of each section. The microfossils from the Hills Estates A section are not discussed in this thesis.

Table 1.2: Names and locations of sample outcrops.

Outcrop Name	**Outcrop Location**	**GPS Location**
Hwy 337	Highway 337, Mile 496	32°58.616' N 98°20.375' W
Hills Estates Community Center	Highway 16, west side of the road	32°58.409' N 98°23.247' W
Hills Estates A	Highway 16, east side of the road	32°58.460' N 98°23.060' W
Hills Estates B	Highway 16, east side of the road	32°58.592' N 98°23.095' W

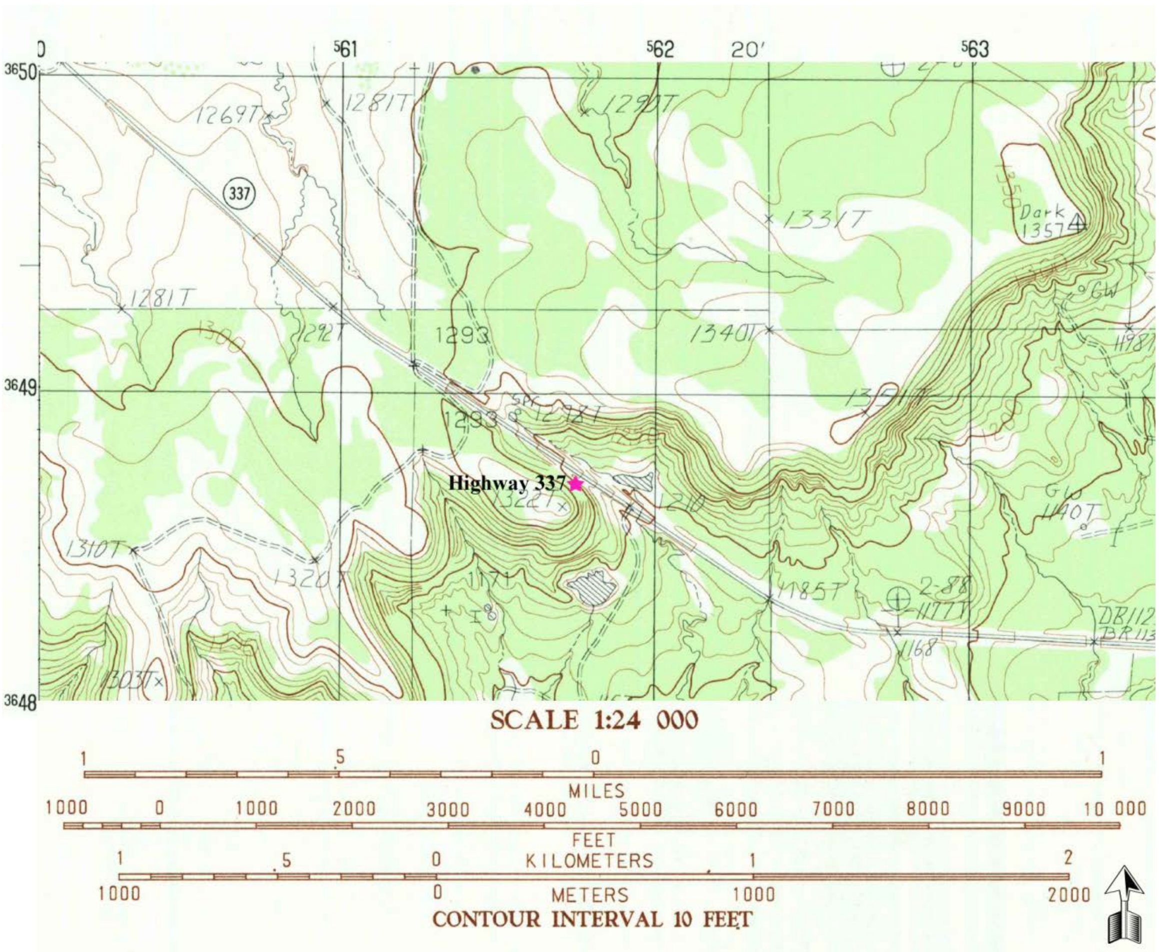


Figure 1.2: Topographic map showing the Highway 337 locality (USGS 1984).

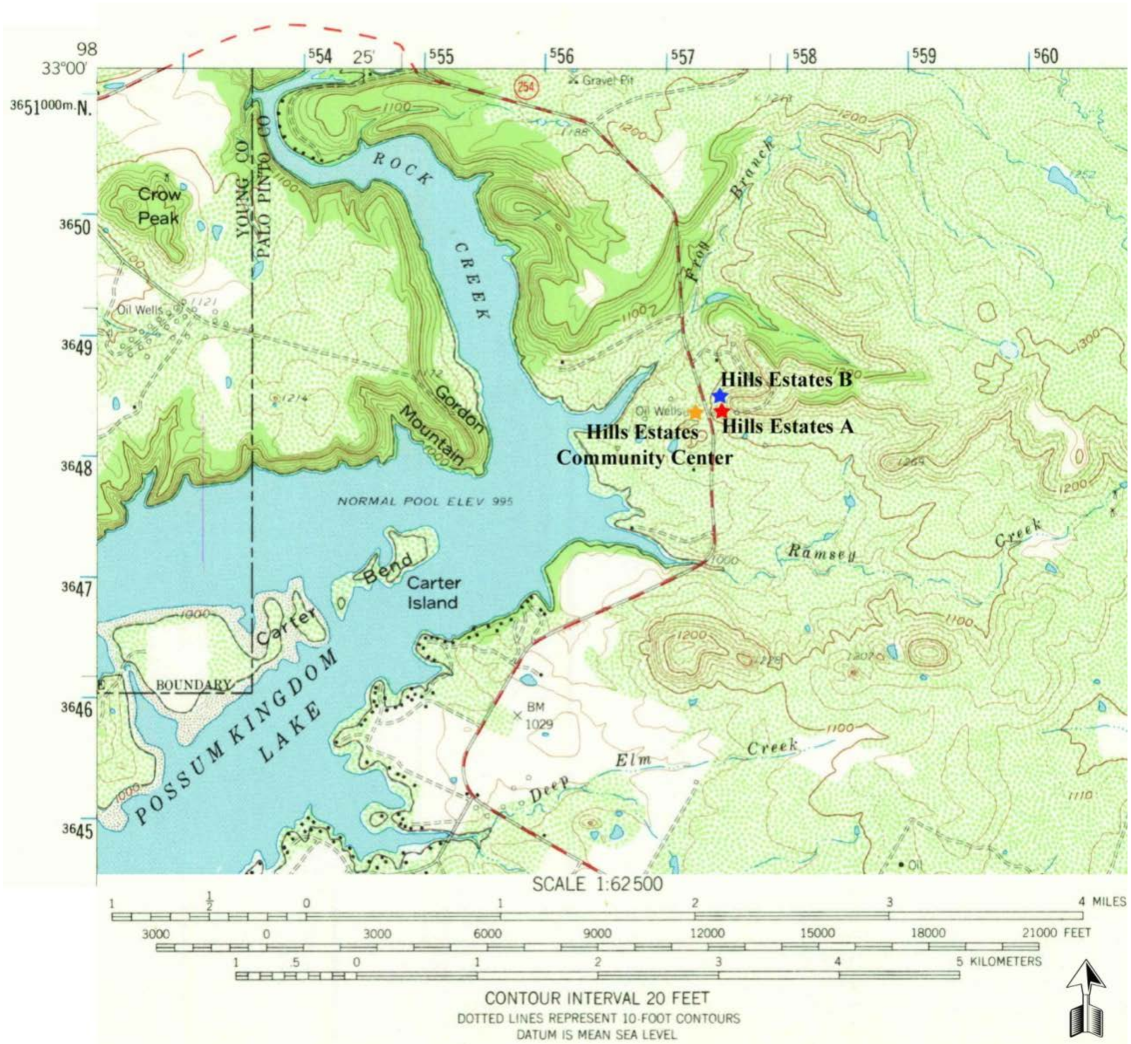


Figure 1.3: Topographic map showing the Hills Estates Community Center, Hills Estates A, and Hills Estates B localities (USGS 1958).

CHAPTER 2

PENNSYLVANIAN CYCLOTHEMS

The midcontinent of North America has undergone numerous cycles of transgression and regression during the Pennsylvanian and lower part of the Permian. These repetitive sea-level changes caused alternating marine and non-marine facies to be deposited over the midcontinent. This alternating deposition of strata is named a cyclothem, a term first introduced by Weller (1930) and Moore (1931), and expanded by Wanless and Weller (1932). In the midcontinent – Kansas type cyclothems tend to follow a specific five part ascending order: 1 – thick "outside" shale, deposited in sandy near shore to non-marine deposits; 2 – thin "middle" limestone, showing transgression; 3 – thin black "core" shale, a non-sandy offshore shale, usually fissile, that marks the maximum extent of the transgression; 4 – thick "upper" limestone, showing regression; 5 – thick shale, sandy near shore to non-marine shale (Heckel 1983).

The midcontinent cyclothems are so well documented that the Pennsylvanian series and stage names for North America were established from them. The regional stages, in ascending order are Morrowan, Atokan, Desmoinesian, Missourian, and Virgilian. Morrowan is used in reference to the Lower Pennsylvanian, Atokan and Desmoinesian to the Middle Pennsylvanian, and Missourian and Virgilian to the Upper Pennsylvanian. This paper is only concerned with the Missourian, and as such, will only detail the top and bottom boundaries of this stage and not go into detail on the other stages.

At the Desmoinesian-Missourian boundary, Boardman et al. (1990) records there being a distinct regional extinction event across North America where there is a loss of distinct Desmoinesian taxa and the appearance of the conodont *Streptognathodus s. s.* lineage. Heckel et al. (2002) designated the Missourian boundary stratotype at the base of a black shale equivalent to the Exline Limestone in the midcontinent, based on the first appearance of the conodont *Idiognathodus eccentricus*. It is also known that the Missourian is biostratigraphically placed in the lower part of the fusulinid zone of *Triticites*.

The Missourian-Virgilian boundary is not as well defined as the Desmoinesian-Missourian boundary. The boundary is currently suggested as the lower part of the Cass-Haskell cyclothem at the first appearance of the *Streptognathodus zethus* Chernykh 1987, above units that contain morphotypes of *S. pawhuskaensis* (Harris and Hollingsworth 1933) (Keairnes 2002). The boundary was proposed at the base of this cyclothem by Boardman and Heckel (1989) due to the ammonoid and conodont faunas, and their potential for regional correlation.

Cyclothems were not only deposited in the midcontinent during the Pennsylvanian, but were also deposited in Texas. The reason the midcontinent cyclothems are so well known and accepted is that more work has been done on them proving that they are indeed a response to sea level change and ruling out delta shift and tectonism as their origin (Heckel 1984). In Texas however, focus on the Pennsylvanian deltaic systems led to the idea that the alternation of terrestrial and marine deposits was primarily due to delta shifting (Boardman and Heckel 1989).

Boardman and Heckel (1989) studied the eustatic cycles that are recognized in the midcontinent and took a step to correlate these with those of Texas. In order to accomplish this they had to derive a eustatic sea-level curve by using lithic and microfaunal data from the Brazos-Trinity valley outcrop area. Using biostratigraphic criteria of ammonoids, conodonts, and fusulinids, Boardman and Heckel were able to correlate 17 cycles in Texas to those of the midcontinent. This successful correlation showed (figure 2.1) that eustatic sea-level changes were the main control factor over the Pennsylvanian cycles in Texas just like those of the midcontinent.

In the same 1989 study, Boardman and Heckel determined the two cycles within the Placid Shale to be the Lower Placid minor cycle and the Upper Placid intermediate cycle. The Lower Placid, a thin fossiliferous shale, was found to possibly correlate with a horizon of increased conodont abundance in the regressive part of the Stanton cycle of the midcontinent. They also noted that there was the possibility that this lower cycle might not have been caused by eustacy. The Upper Placid cycle, a limestone and fossiliferous shale, was found to contain *Triticites newelli* Burma 1942 along with conodonts that correlated to the South Bend major cycle of the midcontinent (Boardman and Heckel 1989). Boardman and Heckle do not disclose exactly what genus and species of conodonts they found. However, it has been documented by Ritter 1995 that *Streptognathodus firmus* Kozitskaya 1978 and *S. pawhuskaensis* (Harris and

Hollingsworth 1933) are two species of conodonts found abundantly in the South Bend Limestone.

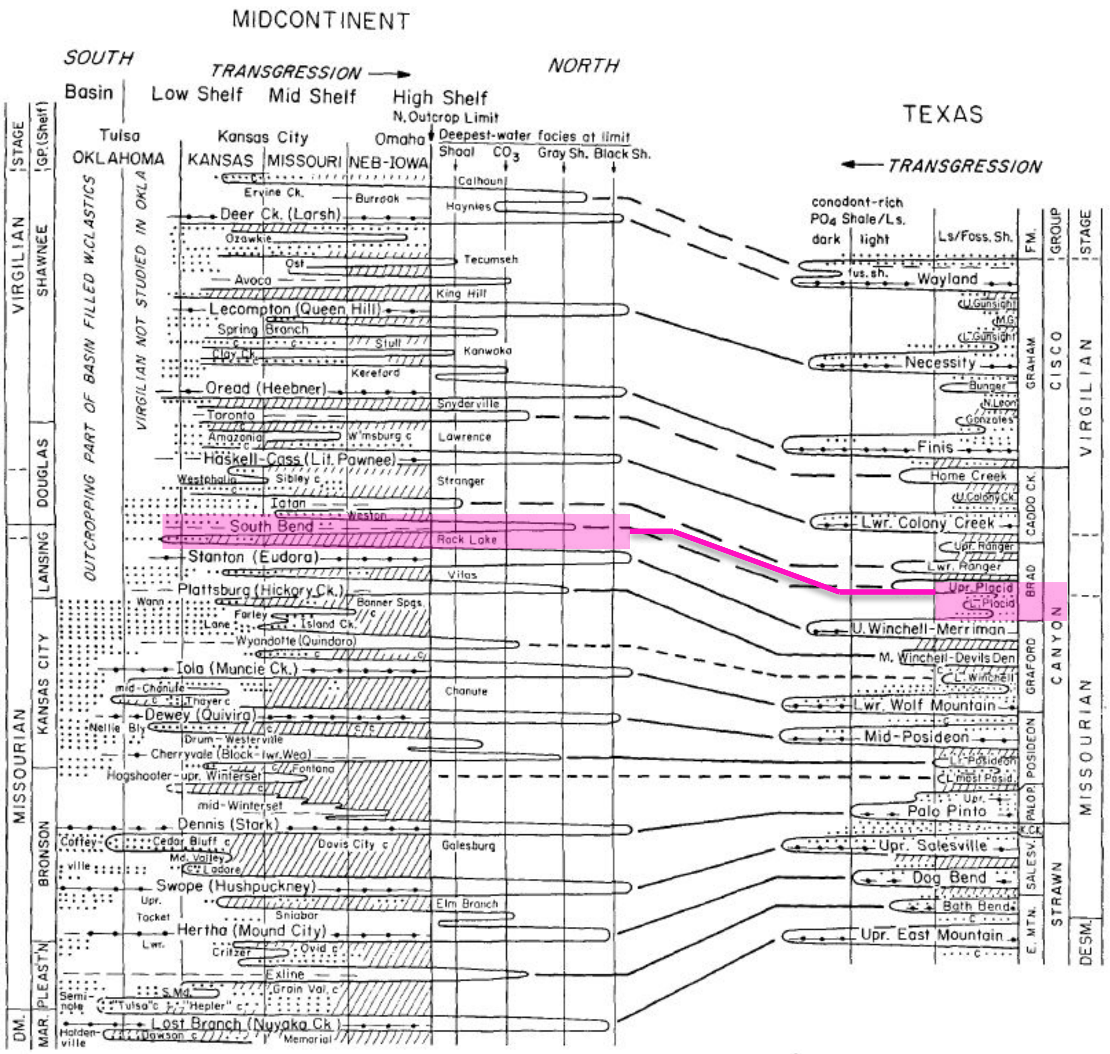


Figure 2.1: Diagram showing the correlation of the Texas lithological cycles to those of the midcontinent (after Boardman and Heckel 1989). The correlation of the Placid cycles are highlighted.

CHAPTER 3

FORAMINIFERA

Introduction

Foraminifers are single-celled protists that produce a shell which is commonly called a test. Foraminifers are marine organisms and can be either planktonic or benthonic. Planktonic foraminifers only appeared in the Jurassic, so those described in this study are benthonic. The test of foraminifers can be either single chambered or multi-chambered, agglutinated (composed of foreign particles cemented together by an organic layer) or calcareous (composed of secreted calcium carbonate). Foraminifers tend to be relatively small or sometimes very large and are measured in micrometers to centimeters. The small size of many foraminifers makes them difficult to identify without the use of a Scanning Electron Microscope (SEM) to take high magnification images, along with making thin sections to determine their internal structure.

Once SEM pictures and thin sections have been made, identification is possible and there are several characteristics that are used as a basis for classification: 1 – test morphology including type of coiling, chamber arrangement, and number of chambers, 2 – composition of the test, 3 – external and internal structures, 4 – structure and position of the aperture(s).

The family and generic level systematics followed for the Foraminifera are those of Loeblich and Tappan (1987). Only a few thin sections were made of free specimens. Also, foreign literature was only briefly researched.

Descriptions of Foraminifers

Kingdom PROTOZOA Goldfuss 1817; emend. Owen 1858

Subkingdom GYMNOMYXA Lankester 1878 stat. nov. emend. Cavalier-Smith 2002

Infrakingdom RHIZARIA Cavalier-Smith 2002

Phylum RETARIA Cavalier-Smith 1999 stat. nov. Cavalier-Smith 2002

Subphylum FORAMINIFERA (d'Orbigny 1826); Eichwald 1830 stat. nov. Margulis 1974; stat. emend. Cavalier-Smith 2002 [pro phylum Foraminifera by Cavalier-Smith 2002]

Order FORAMINIFERIDA Eichwald 1830

Agglutinated Species

Suborder TEXTULARIINA Delage and Hérouard 1896

Superfamily HIPPOCREPINACEA Rhumbler 1895

Family HIPPOCREPINIDAE Rhumbler 1895

Subfamily HYPERAMMININAE Eimer and Fickert 1899

Genus ***Hyperammina*** Brady 1878 [= *Bactrammina* Eimer and Fickert 1899; = *Arhyperammina* Rhumbler 1913]

Type species: *Hyperammina elongata* Brady 1878.

Diagnosis (after Loeblich and Tappan 1987): Test is free, elongate, reaching a maximum length of about 16mm, large proloculus followed by an undivided tubular chamber of the constant diameter but tapering slightly at the end to the rounded aperture; wall is agglutinated with medium-sized quartz particles that may be firmly to loosely cemented, interior cavity with smoothly finished surface.

Range: Lower Ordovician – Holocene (after Kaminski et al. 2008).

Hyperammina bulbosa Cushman and Waters 1927a

Plate 1, figures 1 – 3

Hyperammina bulbosa CUSHMAN AND WATERS 1927a, p. 109, pl. 22, fig. 7a, b. - CUSHMAN AND WATERS 1930, p. 34, pl. 2, figs. 4-5. - CUSHMAN 1933b, pl. 3, fig. 1. – PLUMMER 1945, p. 220, pl. 15, fig. 36.

Description: Test is bichambered, straight, with a large bulbous proloculus that is wider than the tubular second chamber, rectangular oval in transverse section. The test can be flattened on one side and convex on the other. Wall is agglutinated, of whitish color, rough in the appearance, composed of irregular sized grains, probably of quartz. The aperture is large, rectangular oval in shape, at the end of the second chamber.

Measurements (µm): Length is 374 - 814, diameter of the tubular chamber 77 – 176, diameter of the proloculus 121 - 220.

Material: 24 specimens.

Discussion: Based on the large, bulbous proloculus and wide second chamber, the described specimens are assigned to the type species of *H. bulbosa*.

Occurrence: Pennsylvanian; Michigan and Texas.

Described specimens were found at the Highway 337 locality, samples A0, C1, C2, C3, C5, and C9; and at the Highway 16 Hills Estates Community Center locality, samples 3, 19, 26, 27, 28, and 29.

Hyperammina clavata Waters 1928

Plate 1, figures 7, 11a – 12b

Hyperammina clavata WATERS 1928, p. 272, p. 42, fig. 9.

Description: Test is long, slender, slightly club shaped, tapering to the apertural end. It has a small bulbous proloculus following by a larger second chamber. The second chamber is narrowest right above the proloculus and then widens towards the terminal end. Growth lines can be seen on the surface of the test. The aperture is filled with sediments, but in some tests one can see a small fusiform to slit like aperture.

Measurements (μm): Length 495 – 1265, width 187 – 308, diameter of the proloculus 66 – 121.

Material: 26 specimens.

Discussion: Described specimens are similar in the shape of the test to the type species of *Hyperammina clavata*, but are slightly smaller in both length and diameter of the proloculus. Many of the larger specimens tended to be broken on the initial end with the result that the initial part of the test is missing. Also, a few but not all of the specimens designated as *H. clavata* herein show growth lines, of which Waters (1928) made no description.

Occurrence: Pennsylvanian; Texas.

Described specimens were found at the Highway 337 locality, samples 2, 4, 6, 7, 8, 9, 10, 11, 12, 15, and 16; at the Highway 16 Hills Estates Community Center locality, samples 28 and 29; at the Highway 16 Hills Estates B locality, sample 2.

Hyperammina glabra Cushman and Waters 1927b

Plate 1, figures 4a – 6b; Plate 6, fig. 1

Hyperammina glabra CUSHMAN AND WATERS 1927b, p. 146, pl. 26, fig. 1. - CUSHMAN AND WATERS 1930, p. 33, pl. 2, figs. 1-3. - LIEBUS 1932, p. 152, pl. 9, fig. 1.

Description: Test is long, straight to slightly curved with a small oval proloculus and an elongate tubular second chamber, round in transverse section. The second chamber expands very slowly to the apertural end. The wall is agglutinated, formed of fine rounded quartz grains of equal size and white to yellowish white in color. In thin section the wall is translucent, glassy in appearance with a thin black lining, probably of organic origin. The aperture is rounded, formed by the open end of the tube.

Measurements (μm): Length 396 – 1166, greatest diameter 132, diameter of the proloculus 41 - 132.

Material: 14 specimens.

Discussion: Described specimens are slightly shorter and wider than the holotype of *Hyperammina glabra* Cushman and Waters (1927b). The species differs from *H. bulbosa* by a very thin and tapering test

Occurrence: Pennsylvanian; Texas.

Described specimens were found at the Highway 337 locality, samples B1, C15 and C19; at the Highway 16 Hills Estates Community Center locality, samples 5, 19, 23, and 27; at the Highway 16 Hills Estates B locality, samples 1 and 2.

Hyperammina sp. 1

Plate 1, figure 13

Description: Test is long, with a small oval proloculus following the larger elongate second chamber. The second chamber slightly narrows right above the proloculus and then widens towards the terminal end. The wall is agglutinated, white in color, smooth in some areas, and made up of fine quartz grains. The apertural end of the second chamber has a very large, oval to rounded aperture that takes up almost the entire end.

Measurements (µm): Length 638 – 1265, width 154 – 220, diameter of the proloculus 44 – 110, diameter of the aperture 99 – 220.

Material: 12 specimens.

Discussion: This form is very similar to *Hyperammina clavata* Waters 1928, except the aperture is different. In *H. clavata* the aperture is a small slit like opening at the end of the test whereas in the described specimens the aperture takes up almost the entire terminal end.

Occurrence: Described specimens were found at the Highway 337 locality, samples C5, C6, C9 and C16; at the Highway 16 Hills Estates Community Center locality, sample 3; at the Highway 16 Hills Estates B locality, samples 1, 2, and 3.

Family HYPERAMMINOIDIDAE Loeblich and Tappan 1984

Genus ***Hyperamminoides*** Cushman and Waters 1928b [= *Hyperamminella* Cushman and Waters 1928d]

Type species: *Hyperamminella elegans* Cushman and Waters 1928b.

Diagnosis (after Loeblich and Tappan 1987): Test free, elongate, rounded proloculus followed by undivided second chamber that increases rapidly in width in the early stage, then may have nearly parallel sides, but with numerous deeply constricted transverse growth lines; wall very finely agglutinated, milky white to yellowish in color, surface smoothly finished; aperture a small rounded terminal opening.

Range: Upper Pennsylvanian – Paleocene (after Kaminski et al. 2008).

Hyperamminoides elegans (Cushman and Waters 1928b)

Plate 1, figures 8 – 10, 14a – 15b

Hyperamminella elegans CUSHMAN and WATERS 1928b, pl. 2, figs. 6-9.

Hyperamminoides elegans (Cushman and Waters) - CUSHMAN and WATERS 1930, p. 36, pl. 2, figs. 6-9.

Description: Elongated test with a bulbous proloculus and a second chamber that enlarges both in length and width as it grows with the aperture being at the top. Shape is round in transverse section. The second chamber has uneven constrictions. The wall is fairly evenly fine grained and white in color. The aperture is round with a lip and located at the end of the second chamber.

Measurements (µm): Length 605 – 1001, width 198 – 330, diameter of the proloculus 88 – 100, diameter of the aperture 99 – 220.

Material: 19 specimens.

Discussion: The specimens described above are not large as those described in the original description of *H. elegans* by Cushman and Waters (1928b). The holotype of *H. elegans* has length of 5mm. This discrepancy could be because many of the specimens in the collection were broken at the proloculus. Based on the shape similarity of the test with that of the holotype, these specimens have been classified as *H. elegans*.

Occurrence: Pennsylvanian; Texas.

Described specimens were found at the Highway 337 locality, samples C2, C6, and C12; at the Highway 16 Hills Estates Community Center locality, samples 25; at the Highway 16 Hills Estates B locality, sample 2.

Superfamily HORMOSINACEA Haeckel 1894

Family HORMOSINIDAE Haeckel 1894

Subfamily REOPHACINAE Cushman 1910

Genus ***Reophax*** de Montfort 1808 [= *Reophagus* Agassiz 1884; = *Proteonina* Williamson 1858; = *Lituolina* Goes 1881; = *Arproteonum* Rhumbler 1913; = *Arreophaxum* Rhumbler 1913]

Type species: *Reophax scorpiurus* de Montfort 1808; neotype was designated by Brönnimann and Whittaker 1980.

Diagnosis (after Loeblich and Tappan 1987): Test free, elongate, with few rounded to pyriform chambers in slightly irregular or arcuate series, each succeeding chamber attached near the base of the apertural neck of the preceding chamber; wall thin, of a single layer of agglutinated grains of quartz, mica, sponge spicules, or foraminiferal tests held in a minimum of organic cement but without a true organic inner layer; aperture terminal, rounded, produced on a slight neck.

Range: Middle Ordovician – Holocene (after Loeblich and Tappan 1987).

Reophax arenatus (Cushman and Waters 1927b)

Plate 2, figures 6 – 9b

Nodosinella arenata CUSHMAN and WATERS 1927b, p.147, pl. 26, figs. 2-3.

Nodosinella? arenata WARTHIN 1930, p.28, pl. 2, fig. 8.

Reophax arenatus PLUMMER 1945, pl. 17, figs. 1-3.

Description: Test is short, weakly elongate, uniserial, with two to three chambers. The proloculus is large, prominent and oval in shape; is connected to the second triangular chamber (in bichambered specimens), and rounded second and also triangular third chamber (in three chambered specimens) by a constricted neck. Test appears oval in transverse section. There are distinct deep sutures between the cambers. The wall is coarsely agglutinated, composed of different sized grains. The aperture is rounded, located on a wide neck at the end of the last chamber.

Measurements (µm): Total height 440 – 1342, total width 242 – 550, diameter of the proloculus 121 – 330, width of the second chamber 242 – 440, height 209 – 550, width of the third chamber 440 – 550, height 165 – 616.

Material: 9 specimens.

Discussion: Specimens of *Reophax arenatus* illustrated herein are morphologically very close to the type species as described by Cushman and Waters (1927). The only real difference is that the stated width of the holotype is 0.8mm whereas the described specimens are slightly narrower. *R. arenatus* differs from *R. fittsi* (Warthin 1930) by having two to three triangular to bulbous chambers and also tends to be slightly larger.

Occurrence: Pennsylvanian; Oklahoma, Texas.

Described specimens were found at the Highway 337 locality, samples C2, C6, C9, C11, and C12.

Reophax fittsi (Warthin 1930)

Plate 2, figures 1 – 5

Nodosinella? fittsi WARTHIN 1930, p.27, pl. 2, fig. 7.

Reophax fittsi PLUMMER 1945, pl. 17, figs. 10-17.

Description: Test is elongate, starts narrow with a small ovular proloculus and then widens in a second chamber. The second chamber widens and then starts to taper down to an apertural neck. Test appears circular to fusiform in transverse section. The wall is coarsely agglutinated, composed of different sized grains. The aperture is rounded at the end of an apertural neck.

Measurements (µm): Height 306 – 1144, width 165 – 407, diameter of the proloculus 44 – 121.

Material: 46 specimens.

Discussion: Some of the specimens identified herein as *Reophax fittsi* are flattened fusiform in cross section instead of circular as in the type specimen. Also, the aperture in these same specimens tends to be more slit like rather than rounded. The reason for this discrepancy could be due to the specimens being slightly crushed. In comparison with the holotype a few specimens herein are longer than the original height of 0.9mm as given by Warthin (1930).

Occurrence: Pennsylvanian; Oklahoma, Texas.

Described specimens were found at the Highway 337 locality, in samples A0, B1, C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C11, C12, and C15; and at the Highway 16 Hills Estates Community Center locality, samples 13, 25, 26, 27, 28, and 29.

Superfamily LITUOLACEA de Blainville 1827

Family LITUOLIDAE de Blainville 1827

Subfamily AMMOMARGINULININAE Podobina 1978

Genus ***Ammobaculites*** Cushman 1910; emend. Höglund 1947

Type species: *Spirolina agglutinans* d'Orbigny 1846.

Diagnosis (after Loeblich and Tappan 1987): Test free, elongate, early portion close coiled, later uncoiling and rectilinear, rounded in section; wall coarsely agglutinated, interior simple; aperture terminal, rounded.

Range: Lower Devonian (Pragian) – Holocene (after Kaminski et al. 2008).

Ammobaculites magnigranulus Ireland 1956

Plate 2, figures 11 – 16

Ammobaculites magnigranulus Ireland 1956, p. 856, tf. 6, figs. 26-27.

Description: Test is small, with two stages of growth. Initial part is planispiral, evolute, and consists of one volution with 5 chambers. The terminal part is uncoiled, uniserial, straight or slightly curved, of almost the same width and consists usually of 5-6 chambers. The test is round to oval in transverse section. The sutures between the chambers are depressed. The wall is agglutinated, rough, composed of large angular quartz grains. The aperture is small and circular, in the center of the last chamber.

Measurements (µm): Length 330 – 418, width 88 – 121, diameter of the coiled part 99 – 132.

Material: 10 specimens.

Discussion: The specimens described above agree closely with the description of the type species given by Ireland (1956) based on the size of the test and especially in the wall texture.

Occurrence: Pennsylvanian; Kansas.

Described specimens were found at the Highway 337 locality, samples C1, C3, C18; at the Highway 16 Hills Estates Community Center locality, samples 27, 28, 29.

Ammobaculites parallelus Ireland 1956

Plate 2, figure 18

Ammobaculites parallelus IRELAND 1956, p. 856, text-fig. 6, figs. 21-23.

Description: Test is slender, elongate. Initial part is planispirally coiled consisting of 5-6 chambers. The terminal part is uncoiled, uniserial, usually 7-8 chambers that tend to be even in size with parallel sides. The test is round to oval in transverse section. The sutures between the chambers are depressed and distinct. The wall is agglutinated, composed of quartz grains and has a rough appearance. The aperture is circular in the center of the last chamber.

Measurements (µm): Length 462 – 616, width 99 – 132, diameter of coiled part 121 - 143.

Material: 2 specimens.

Discussion: *Ammobaculites parallelus* differs from *A. gracilis* Waters 1928 by slightly larger diameter of the initial coiled part and its longer length.

Occurrence: Pennsylvanian; Kansas.

Described specimens were found at the Highway 337 locality, sample C3 and C6.

Ammobaculites spirans Cushman and Waters 1927b

Plate 2, figure 17

Ammobaculites spirans CUSHMAN and WATERS, 1927b, pl. 26, fig. 10.

Description: Test is slender, elongate. Initial part is planispirally coiled. The terminal portion is uniserial, but does become twisted causing some parts to be biserial. The test is round to oval in transverse section. The sutures between the chambers are depressed. The wall is agglutinated and rough. The aperture is circular in the center of the last chamber.

Measurements (μm): Length 473, width 143, diameter of the coiled part 110.

Material: 1 specimen.

Discussion: This specimen is different from *Ammobaculites gracilis* Waters 1928 and *A. parallelus* Ireland 1956 by the fact that it has twisted chambers in the uniserial part. None of the other *Ammobaculites* species discussed here have such a twisted shape of the uniserial part.

Occurrence: Pennsylvanian; Texas.

Described specimen was found at the Highway 16 Hills Estates Community Center locality, sample 25.

Ammobaculites (?) sp. 1

Plate 2, figure 10a, b

Description: Test is slender, elongate and curved. Initial part is planispirally coiled. Terminal part is uniserial with 11 chambers. The test is round to oval in transverse section. The sutures between the chambers are distinct and depressed. The wall is agglutinated and slightly rough. The aperture is circular in the center of the last chamber.

Measurements (µm): Length 396, width 55, diameter of the coiled part 88.

Material: 1 specimen.

Discussion: The described specimen is questionably assigned to *Ammobaculites* based on the general morphology of the test with the initial coiled and terminal uniserial parts. The described specimen varies from *A. parallelus* Ireland 1956, by the fact the terminal portion is curved and has more chambers and *A.* (?) sp. 1 is smaller in size than *A. parallelus*.

Occurrence: The specimen was found at the Highway 16 Hills Estates Community Center locality, sample 16.

Superfamily TEXTULARIACEA Ehrenberg 1838

Family TEXTULARIIDAE Ehrenberg 1838

Subfamily TEXTULARIINAE Ehrenberg 1838

Genus ***Textularia*** Defrance 1824 [= *Textilaria* Ehrenberg 1839; = *Textilina* Nørvang 1966; =*Vulvulinella* Saidova 1975; = *Dorothia (Textilina)* Hofker 1976; = *Textella* Mikhalevich 1979; = *Norvanganina* Mikhalevich 1981; = *Textilinita* Botvinnik 1983]

Type species: *Textularia sagittula* Defrance in de Blainville 1824.

Diagnosis (after Loeblich and Tappan 1987): Test biserial throughout or may have an adventitious third chamber against the first pair of chambers in the microspheric generation; wall agglutinated, traversed by canaliculi that may open as perforations or be closed externally by a thin agglutinated layer and typically are closed internally by the organic lining of the test; aperture a low arch or slit at the base of the apertural face.

Range: Pennsylvanian; Kansas, Texas: Cenomanian (Upper Cretaceous) – Holocene (after Kaminski et al. 2008).

The specimens described below disagree with the time period given by Kaminski et al. (2008). The discrepancy could be because not all literature was looked at for all occurrences of this genus. The generic assignment of Ireland (1956) could be incorrect. To determine if it is truly *Textularia*, thin sections need to be made to determine the presence of canaliculi. Thin sections were not made in this study, so this genus is being used conditionally based on test shape and past identification by Ireland.

Textularia* (?) *bucheri Ireland 1956

Plate 3, figures 1 – 2

Textularia bucheri IRELAND 1956, p. 860, text-fig. 7: 1, 2.

Description: Test biserial, wedge shaped, gradually expanding to the apertural end. Number of chambers on each row is 5-6. Oval to rectangular oval shaped in transverse section. Sutures of the chambers are indistinct, slightly depressed. Surface is very rough; the wall is agglutinated and consists of irregularly arranged and variably sized grains. Aperture is arched slit located at the base of the last chamber.

Measurements (µm): Height 297 – 550, width 132 – 220.

Material: 21 specimens.

Discussion: Based on the morphology of the test, the specimens described herein are similar to the type species of *Textularia bucheri* as described by Ireland (1956). The only difference is that some specimens are more elongate than those illustrated by Ireland. *T.* (?) *bucheri* differs from *T. eximia* Eichwald 1860 by not having distinct depressed sutures.

Occurrence: Pennsylvanian; Kansas.

Described specimens were found at the Highway 16 Hills Estates Community Center locality, sample 2, 3, 4, 5, 29; and at the Highway 337 locality, samples C1, C6, C8, C13, C14, C15, C16, and C17.

Calcareous Species

Suborder FUSULININA Wedekind 1937

Superfamily PARATHURAMMINACEA E.V. Bykova 1955

Family TUBERITINIDAE Miklukho-Maklay 1958

Genus ***Tuberitina*** Galloway and Harlton 1928a [= *Capidulina* Maslov 1935; = *Paratuberitina* Miklukho-Maklay 1957]

Type species: *Tuberitina bulbacea* Galloway and Harlton 1928a.

Diagnosis (after Loeblich and Tappan 1987): Test consisting of one or more rounded to ovate bulbous chambers in a straight to arcuate series and attached to a basal disc; wall calcareous, microgranular, thick and finely perforate, may have a punctate surface; no other aperture.

Range: Upper Carboniferous – Upper Permian (after Loeblich and Tappan 1987).

Tuberitina bulbacea Galloway and Harlton 1928a

Plate 3, figures 3 – 5c; Plate 6, fig. 2 – 3b

Tuberitina bulbacea GALLOWAY AND HARLTON 1928a, p. 346, pl. 45, fig. 8a- d. - CUSHMAN 1930, p. 93, pl. 12, figs. 13-14. - CUSHMAN AND WATERS 1930, p. 79, pl. 9, figs. 10-14. - GALLOWAY AND RYNIKER 1930, p. 20, pl. 4, figs. 10-12. - WARTHIN 1930, p. 29, pl. 1, fig. 22. - GALLOWAY 1933, p. 169, pl. 15, fig. 11. - RICH 1970, p. 1060, pl. 143, figs. 1-15. – TOOMEY 1972, p. 287, pl. 1, figs 1-3.

Description: Test is attached by a circular base, unilocular, pseudochambered with one to four elongate bulbous chambers growing in a somewhat uniserial form. The chambers are connected by an elongate neck and increase in size as they are added. The chambers have regularly arranged rounded pores (pl. 6, figs. 5b, 5c), but the necks appear to be smoother and lacking in pores. In thin section the wall is hyaline and the divisions between the chambers are evident, also the slits in the wall where the pores are can be seen (pl. 9, fig. 3b).

Measurements (µm): Length of test 451 – 1100, length of the last chamber 198 – 528, and width 165 – 374.

Material: 5 specimens.

Discussion: The specimens described herein are assigned to the species *Tuberitina bulbacea* based on the original description of the test morphology given by Galloway and Harlton (1928).

Occurrence: Pennsylvanian; Nevada, Oklahoma, Kansas, Texas, Utah. Described specimens were found at the Highway 16 Hills Estates B locality, samples 1 and 2.

Superfamily EARLANDIACEA Cummings 1955

Family EARLANDIIDAE Cummings 1955

Genus ***Earlandia*** Plummer 1930 [= *Oldella* Pronina 1968; = *Earlanida (Quasiearlandia)* Brazhnikova in Brazhnikova and Vdovenko 1973; = *Earlandia (Oldella)* Pronina 1978]

Type species: *Earlandia perparva* Plummer 1930.

Diagnosis (after Loeblich and Tappan 1987): Test free, elongate, globular proloculus followed by long, straight, undivided tubular chamber, very slight tapering; wall calcareous, microgranular; aperture at the open end of the tube.

Range: Silurian (Ludlovian) - Permian (after Loeblich and Tappan 1987).

Earlandia perparva Plummer 1930

Plate 3, figures 6 – 8b

Earlandia perparva PLUMMER 1930, pl. 1, fig. 2. - CUSHMAN 1930, p. 75. - CUSHMAN 1933a, p. 81, pl.3, fig. 6. - GALLOWAY 1933, p. 168, p. 15, fig. 7.

Description: Test is slender, elongate, bichambered, with a small globular proloculus and a slowly widening second chamber. The second chamber shows faintly constricted growth lines at irregular intervals. Test is often compressed probably by compaction; normal tests are rounded in cross section. The wall is formed by fine crystalline calcareous particles and is yellowish in color. Aperture is rounded at the end of the second chamber.

Measurements (µm): Length 330 – 605, width 55 – 99, diameter of the proloculus 11 – 44.

Material: 30 specimens.

Discussion: The described specimens are close in size to the holotype of *E. perparva* as given by Plummer (1930). The length is slightly shorter, perhaps as a result of the specimens being broken off at the terminal end. The diameter of the proloculus for the described specimens falls within the 0.2 - 0.3mm range that Plummer gave in the original description.

Occurrence: Pennsylvanian; Texas.

Described specimens were found at the Highway 337 locality, sample A0, A1, C1, C4, C6, C11, C15, C16, and C18; at the Highway 16 Hills Estates Community Center locality, samples 4, 5, 19, 23, 25, 26, 28, and 29.

Family PSEUDOAMMODISCIDAE Conil and Lys 1970

Genus ***Pseudoammodiscus*** Conil and Lys 1970

Type species: *Ammodiscus priscus* Rauzer-Chernousova 1948.

Diagnosis (after Loeblich and Tappan 1987): Test free, discoidal, up to 0.25mm in diameter, with globular proloculus followed by planispirally enrolled tubular second chamber; wall calcareous, microgranular; aperture at the open end of the tube.

Range: Devonian (rare), Lower Carboniferous (Tournaisian) – Triassic (after Vdovenko et al. 1993).

Pseudoammodiscus sp. 1

Plate 3, figures 9a, b, 10a, b

Description: Test is free, discoidal, evolute, coils planispirally throughout with roughly 5 - 7 volutions. The test is ribbon shape in axial section. Sutures between the coils can be very depressed to only slightly depressed. The wall is calcareous, fairly smooth and white to yellowish white in color. The aperture is formed by the open end of the tube.

Measurements (µm): Diameter 160 – 430.

Material: 100 specimens.

Discussion: The described specimens are assigned to *Pseudoammodiscus* based on the general morphology of the test.

Occurrence: Described specimens were found at the Highway 16 Hills Estates B locality, sample 1 and 4; at the Highway 16 Hills Estates Community Center locality, sample 3, 4, 5, 7, 10, 13, 14, 16, 19, 23, 25, 26, 27, 28, and 29; at the Highway 337 locality, samples A0, A1, B1, C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C11, C12, C13, C14, C15, C16, C17, and C18.

Superfamily PALAEOTEXTULARIACEA Galloway 1933

Family PALEOTEXTULARIIDAE Galloway 1933

Genus ***Deckerella*** Cushman and Waters 1928a; emend. Roth and Skinner 1930

Type species: *Deckerella clavata* Cushman and Waters 1928a.

Diagnosis (after Loeblich and Tappan 1987): Test free, elongate, globular proloculus followed by a tapering early stage, with slightly inflated, biserially arranged chambers, later uniserial and rectilinear, circular in section; wall thick, microgranular, dark in transmitted light, with incomplete inner fibrous layer lining the later wall and may have an irregular agglutinated external coating; aperture a low interior marginal lunate slit in the early stage, later areal, terminal, and symmetrical, with two parallel oval to slit like openings separated by a narrow partition.

Range: Lower Carboniferous (Visean) – Permian (after Rauzer-Chernousova et al. 1996).

Deckerella laheei Cushman and Waters 1928a

Plate 4, figures 1 – 2; Plate 6, figure 4

Deckerella laheei CUSHMAN and WATERS 1928a, p. 130, pl. 18, figs 1-14, pl. 19, figs 3, 4, 6. – CUSHMAN and WATERS 1930 p. 57, pl. 11, figs. 1-14. – WARTHIN 1930, p. 31, pl. 2, figs. 3a, b.

Description: Test is free, elongate, biserial in the initial stage, later with up to five uniform sized chambers becoming uniserial. Test is oval to round in transverse section. The sutures between the chambers are distinct depressions. The wall is yellowish in color and is rough in texture. The aperture in the biserial chambers are simple textularian, in the uniserial part the aperture is two elongate elliptical openings that have a narrow partition between them. In thin section the wall structure is calcareous, two layered, made up of a clear radial inner and an exterior agglutinated opaque layer. The double aperture can be seen in the last chamber, but not in the initial biserial part (pl. 9, fig. 4).

Measurements (µm): Length 1.155 – 1.517, width 462 – 605.

Material: 3 specimens.

Discussion: The size of the described specimens falls within the measurements for the holotype presented by Cushman and Waters (1928a). The length is slightly smaller, however, Cushman and Waters states only a maximum length.

Occurrence: Pennsylvanian; Texas.

Described specimens were found at the Highway 16 Hills Estates Community Center locality, samples 10, 11.

Genus ***Paleotextularia*** Schubert 1921

Type *species*: *Paleotextularia schellwieni* Galloway and Ryniker 1930.

Diagnosis (after Loeblich and Tappan 1987): Test biserial, elongate, rounded to ovate in section, chambers gradually enlarging as added; wall calcareous, with thick dark granular layer, and clear to yellowish fibrous inner layer, rarely may have a thin impersistent agglutinated outer coating; aperture a single low slit like opening at the base of the final chamber.

Range: Lower Carboniferous (Tournaisian) – Permian (after Loeblich and Tappan 1987, and Rauzer-Chernousova et al. 1996).

Paleotextularia grahamensis (Cushman and Waters 1927b)

Plate 4, figure 3

Textularia grahamensis CUSHMAN and WATERS 1927b, p. 151, pl. 27, figs. 3a, b.

Paleotextularia grahamensis GALLOWAY and RYNIKER 1930, p. 21, pl.4, figs. 13a-c, 14.

Description: Test is free, elongate, tapering, and triangular in side view with five chambers on a side. In transverse section the test is triangular to rectangular. The sutures are zig-zag down the center, slightly depressed and are nearly straight to the edges of the test. The wall is calcareous and surface is somewhat rough. The aperture is an arched slit like opening at the base of the last chamber.

Measurements (µm): Length 484, width 352.

Material: 1 specimen.

Discussion: The specimen described agrees with the original description that Galloway and Ryniker (1930) presented for *Paleotextularia grahamensis*. The only difference is the described specimen is shorter than the maximum length of 1.25mm given for the holotype. The specimen could be a juvenile, which would be supported by the fact that it only exhibits five chambers on each side instead up to eight as described by Galloway and Ryniker.

Occurrence: Pennsylvanian; Texas.

The described specimen was found at the Highway 16 Hills Estates B locality, sample 4.

Superfamily ENDOTHYRACEA Brady 1884

Family ENDOTHYRIDAE Brady 1884

Subfamily ENDOTHYRINAE Brady 1884

Genus ***Endothyra*** Phillips 1846 [= *Plectogyra* Zeller 1950; = *Plectogyrina* Retlinger 1958]; emend. Brady 1876; emend. China 1965

Type species: *Endothyra bowmani* Phillips 1846.

Diagnosis (after Loeblich and Tappan 1987): Test enrolled throughout, partially involute, periphery broadly rounded, early stage streptospirally enrolled or with a few whorls; wall calcareous, microgranular, with two or three layers, a thin dark outer layer or tectum and a thicker, fibrous to alveolar inner layer or diaphanotheca, commonly in a part recrystallized and may have an inner tectorium, secondary deposits consist of nodes, ridges, or hooks on the chamber floor; aperture a low basal slit, those of earlier chambers enlarged by resorption.

Range: Mississippian - Permian (after Hoare and Sturgeon 1998).

Endothyra ovata Waters 1928

Plate 4, figures 7 – 9

Endothyra ovata WATERS 1928, p. 274, pl. 42, fig. 6.

Description: Test is involute with a lobate final volution containing 10 chambers. The chambers have sutures that are only slightly depressed, more so on the outer edge than near the center. The umbilicus is narrow, forming a tight circle, and is depressed.

The wall is calcareous and slightly rough. The aperture is a high arch in the inner margin of the last chamber.

Measurements (µm): Diameter of the test 275 – 500, width 111 – 143.

Material: 20 specimens.

Discussion: The described specimens mainly conform closely to the original description of *Endothyra ovata* Waters 1928. However, some of the specimens studied are smaller in size than given by Waters (1928) for the holotype (0.63-0.84mm).

Occurrence: Pennsylvanian; Texas.

Described specimens were found at the Highway 16 Hills Estates Community Center locality, sample 19, 23, 24, 25, 26, 27, 28, and 29; at the Highway 337 locality, samples A0, A1, B1, C1, and C6.

Endothyra rothrocki Harlton 1928a

Plate 4, figures 4 – 6

Endothyra rothrocki HARLTON 1928a, p.306, pl.52, fig. 3.

Description: Test with involute enrolled portion and large lobate final volution containing 6 chambers. The chambers have distinct sutures. The center umbilicus is large and depressed. The wall is fairly smooth and off-white in color. The aperture is a curved slit at the base of the apertural face.

Measurements (µm): Diameter of the test 242 – 528, width 121 – 242.

Material: 16 specimens.

Discussion: The described specimens compare well to the original description of *E. rothrocki* given by Harlton (1928). However, some of the specimens are larger and some smaller, and the aperture of the specimens is larger than the slit like aperture described for the holotype. *Endothyra rothrocki* Harlton 1928a differs from *E. ovata* Waters 1928 by the sutures being more distinct.

Occurrence: Pennsylvanian; Texas.

Described specimens were found at the Highway 16 Hills Estates B locality, samples 2, 3, and 4; at the Highway 16 Hills Estates Community Center locality, samples 7, 10, 13, 14, 16, 19, and 23; at the Highway 337 locality, sample C17.

Subfamily ENDOTHYRANOPSINAE Reytlinger 1958

Genus ***Endothyranella*** Galloway and Harlton in Galloway and Ryniker 1930

Type species: *Ammobaculites powersi* Harlton 1927.

Diagnosis (after Loeblich and Tappan 1987): Test enrolled in the early stage, later uncoiling, early whorls slightly streptospiral, later planispiral and evolute, chambers slightly inflated and wedge like, sutures depressed, septa thickened, especially in the apertural region of the rectilinear chambers, where they may be up to four times the thickness of the outer wall; wall calcareous, thin, and undifferentiated, granular, fibrous, and perforate; aperture simple and basal in the enrolled stage, later areal and rounded, terminal in the rectilinear stage.

Range: Pennsylvanian (Morrowan) (after Hoare and Sturgeon 1998) – Lower Permian (Artinskian to Kungurian) (after Igonin 1998).

Endothyranella stormi (Cushman and Waters 1928b)

Plate 4, figures 10 – 11; Plate 6, figures 5 – 6

Ammobaculites stormi CUSHMAN and WATERS 1928b, p. 41, pl. 5, figs. 3.4.

Endothyranella stormi ST. JEAN 1957, p. 33, pl. 2, figs. 6a-c, 7. - HOARE 1996, p. 19, fig. 2.1-2.5.

[non] Endothyranella sp. cf. E. stormi TOOMEY 1972, p. 289, pl. 2, figs. 13-15.

Endothyranella cf. E. stormi HOARE and STURGEON 1998, p. 407, figs. 2.36-2.38, p. 415, figs. 7.7-7.12.

Description: Test with small, circular, involute enrolled portion with 6-7 chambers planispirally coiled in the final volution. This enrolled portion has 1-2 volutions that are coiled which can be seen in thin section (pl. 9, figs. 5 – 6). The uncoiled portion is composed of 4 chambers in a linear series. Wall is calcareous, microgranular. The aperture is round and located at the top of the uniserial portion.

Measurements (µm): Height 308 – 726, width 80 – 84, diameter of the enrolled portion 198 – 264.

Material: 36 specimens.

Discussion: The size of the described specimens agrees with the measurements originally given by Cushman and Waters (1928b) for the holotype of *E. stormi*, and those of Hoare and Sturgeon (1998) for *E.* cf. *E. stormi*.

Occurrence: Pennsylvanian; Appalachian basin, Indiana, Iowa, Texas. Described specimens were found in the Highway 337 locality, sample A0, B1, C1, C10, C11, C12, C13, C14, C15, C16, C17, and C18; at the Highway 16 Hills Estates

Community Center locality, sample 14, 19, and 23; at the Highway 16 Hills Estates B locality, sample 3.

Endothyranella sp. 1

Plate 4, figure 12

Description: Test with the early chambers forming a large initial part that is tightly coiled, circular in shape, and involute. Later chambers form a straight uncoiled linear series. The sutures are not distinctive on the enrolled chambers and are deeper and more defined on the uncoiled chambers. The aperture is round and located at the top of the straight end.

Measurements (μm): Height 715, width 84, diameter of the enrolled portion 275.

Material: 1 specimen.

Discussion: *Endotyhranella* sp. 1 differs from *Endothyranella stormi* (Cushman and Waters 1928b) by larger coiled initial part.

Occurrence: The specimen was found at the Highway 16 Hills Estates B locality, sample 3.

Family BRADYINIDAE Reytlinger 1950

Genus ***Pseudobradyina*** Reytlinger1950

Type species: *Pseudobradyina pulchra* Reytlinger 1950.

Diagnosis (after Loeblich and Tappan 1987): Test free, enrolled, planispiral, involute, chambers inflated, rapidly increasing in size as added, three per whorl, sutures incised, septa short, oblique, with a rudimentary postseptal lamina present only in the final chamber if at all; wall calcareous, granular, finely perforate, that of the final whorl much thicker than in earlier chambers; aperture simple and basal in the early stage, multiple with a few straight to arcuate slits perpendicular to the suture in the final chamber but poorly developed or no sutural silts present between earlier chambers.

Range: Upper Carboniferous (Moscovian) – Lower Permian (Sakmarian) (after Loeblich and Tappan 1987).

Pseudobradyina pulchra Reytlinger 1950

Plate 5, figures 1 – 3c; Plate 6, figure 7

Pseudobradyina pulchra REYTLINGER 1950, p. 46, pl. 7, figs. 9-10. – TOOMEY 1972, p. 292, pl. 2, figs. 9-10.

Description: Test is free with three visible sub-globular chambers that increase in size and are planispirally coiled. There are distinct sutures between the chambers that are slightly depressed. The wall is calcareous, microgranular, smooth and very fine grained. The aperture consists of three slit like openings at right angle to the suture line in the last chamber. In thin section there are two volutions not visible from the outside.

Measurements (µm): Diameter 242 – 660, diameter of the proloculus in thin section 100.

Material: 20 specimens.

Discussion: The measurements of the described specimens agree with the original measurements given by Reytlinger (1950) for the holotype of *P*. *pulchra*.

The genus *Pseudobradyina* was described, and species were assigned to this genus based on thin sections and scarce free specimens. The microgranular wall structure of the specimen (pl. 9, fig. 7) clearly indicates the correct generic assignment to *Pseudobradyina*. Without a thin section and based only on the shape of the test of a free specimen, these forms could be mistakenly assigned to the genus *Glyphostomella* (Cushman and Waters 1928b).

Occurrence: Middle - Upper Carboniferous; Kansas, Russia.

Described specimens were found at the Highway 16 Hills Estates B locality, samples 3 and 4; at the Highway 16 Hills Estates Community Center locality, samples 3, 7, 11, 13, and 14; at the Highway 337 locality, samples C2, C3, C4, C5, C6, C7, C8, C9, C10, C11, C12, C13, C15, C16, and C18.

Superfamily TETRATAXACEA Galloway 1933

Family TETRATAXIDAE Galloway 1933

Genus ***Tetrataxis*** Ehrenberg 1854 [= *Artetraxoum* Rhumbler 1913; = *?Ruditaxis* Schubert 1921; = *Pseudotetrataxis* Marie in Deleau and Marie 1961]

Type species: *Tetrataxis conica* Ehernberg 1854.

Diagnosis (after Loeblich and Tappan 1987): Test conical, of varied height, circular in plan, numerous whorls formed by a few, commonly four chambers per whorl, early chambers appearing rounded from the spiral side, those of later whorls becoming low, broad, and crescentiform but are strongly overlapping on the umbilical side where a median flap from the chambers partially overlaps the quadrilateral to cruciform umbilical cavity; wall calcareous, outer dark microgranular layer, and hyaline, white to amber-colored fibrous or radiate inner layer that is best developed on the test base around the umbilical opening; aperture a narrow slit beneath the valvular projection that opens into the umbilical cavity.

Range: Carboniferous (upper Tournaisian) – Permian (after Rauzer-Chernousova et al. 1996).

Tetrataxis corona Cushman and Waters 1928c

Plate 5, figures 4 – 5

Tetrataxis corona CUSHMAN and WATERS 1928c, pl. 8, figs. 10a, b. – CUSHMAN and WATERS 1930, p. 75, pl. 7, figs. 3, 8. – GALLOWAY and RYNIKER 1930, p. 17-18, pl. 3, fig. 5a-c.

Description: Test is free, low conical, raised to a point in the center and then sloping out towards the sides in all directions. The apertural side is flat to slightly convex. Chambers are arranged in spiral from the proloculus outward. The initial chambers which tend to develop in a series of four tend to be less distinct then the later chambers that expand. The sutures are more distinct in the later portion of the test. Wall is calcareous, smooth to slightly rough.

Measurements (µm): Diameter 275 – 550, height 110 – 220.

Material: 24 specimens.

Discussion: The described specimens compare well with the holotype of *T. corona* in both size and shape. When compared to other species of *Tetrataxis,* such as *T.*

scutella Cushman and Waters 1928c, the described specimens tend to be higher and the diameter smaller than the measurements given for *T. scutella*.

Occurrence: Pennsylvanian; Texas.

Described specimens were found at the Highway 16 Hills Estates B locality, sample 1, 3, and 4; at the Highway 16 Hills Estates Community Center locality, samples 10, 13, 14, 19, and 23; at the Highway 337 locality, samples C14 and C18.

Suborder MILIOLINA Delage and Hérouard 1896

Superfamily CORNUSPIRACEA Schultze 1854

Family CORNUSPIRIDAE Schultze 1854

Subfamily CALCIVERTELLINAE Loeblich and Tappan 1964

Genus ***Planiinvoluta*** Leischner 1961

Type species: *Planiinvoluta carinata* Leischner 1961.

Diagnosis (after Loeblich and Tappan 1987): Test flattened, probably originally attached, discoidal to centrally inflated on the unattached side, globular proloculus followed by nonseptate planispirally enrolled second chamber, coiling evolute against the attachment, involute above; wall calcareous, probably imperforate; aperture at the open end of the tube.

Range: Pennsylvanian - Upper Triassic (Rhaetian) (after Pronina 1994). Pronina (1994) stated conditionally that the first appearance of this genus is in the Middle Permian. The specimens found in the Placid Shale seem to be assignable to this genus and suggest that its first appearance is much earlier (Pennsylvanian, Missourian).

Planiinvoluta thompsoni (Cushman and Waters 1928b)

Plate 5, figures 6 – 9

Cornuspira thompsoni CUSHMAN and WATERS 1928b, p. 370, pl. 49, fig 3. – CUSHMAN and WATERS 1930, p. 61, pl. 5, figs. 4-5. – CUSHMAN 1933b, pl. 16, fig. 3.

Description: Test is attached in life but occurs as free specimens in the samples. The test has a rounded proloculus and a planispirally coiled second chamber. The second chamber consists of 5 – 6 volutions. The last one or two coils can curve up over the top of the test overlapping previous volutions. The wall is calcareous, white in color and slightly rough. The aperture is at the end of the last volution.

Measurements (µm): Diameter ranges from 330 – 605.

Material: 13 specimens.

Discussion: The described specimens compare agreeably with the holotype of *P. thompsoni*. The diameter of the holotype (0.35mm) is at the lower range of the diameters of the specimens from the Hills Estates B locality.

Occurrence: Pennsylvanian; Texas.

Described specimens were found at the Highway 16 Hills Estates B locality, samples 1, 2, and 4.

Foraminiferal Plates

Plate 1

Foraminifera from the Placid Shale Formation, Missourian, Upper Pennsylvanian.

Figure 1a, 9 – scale bar = 180 µm; Figure 1b – scale bar = 60 µm; Figure 2, 6a, 8, 15a – scale bar = 220 µm; Figure 3 – scale bar = 120 µm; Figure 4a, 14a – scale bar = 300 µm; Figure 4b – scale bar = 30 µm; Figure 5, 11a – scale bar = 280 µm; Figure 6b, 11b, 12b, 14b – scale bar = 20 µm; Figure 7– scale bar = 250 µm; Figure 10 – scale bar = 210 µm; Figure 12a – scale bar = 270 µm; Figure 13 – scale bar = 240 µm; Figure 15b – scale bar = 50 µm.

1 – 3: *Hyperammina bulbosa* Cushman and Waters 1927. 1a – side view, 1b – close up of wall structure, sample C9, 2 – side view, sample C3; section Highway 337; 3 – side view, sample 23; section Highway 16 Hills Estates Community Center.

4a – 6b: *Hyperammina glabra* Cushman and Waters 1927. 4a – side view, 4b – close up of proloculus, sample 19, 5 – side view, sample 27; section Highway 16 Hills Estates Community Center; 6a – side view, 6b – close up of wall structure, sample 1; section Highway 16 Hills Estates B.

7, 11a – 12b: *Hypperammina clavata* Waters 1928. 7 – side view, sample C2, 12a – side view, b – close up of wall structure, sample C8; section Highway 337; 11a – side view, b – close up of wall structure, sample 29; section Highway 16 Hills Estates Community Center.

8 – 10, 14a – 15b: *Hyperamminoides elegans* Cushman and Waters 1928b. 8 – side view, sample C12, 10 – side view, sample C2, 15a – side view, b – close up of wall structure, sample C6; section Highway 337; 14a – side view, b – close up of wall structure, sample 25; section Highway 16 Hills Estates Community Center.

13: *Hypperammina* sp. 1. Side view, sample 2; section Highway 16 Hills Estates B.

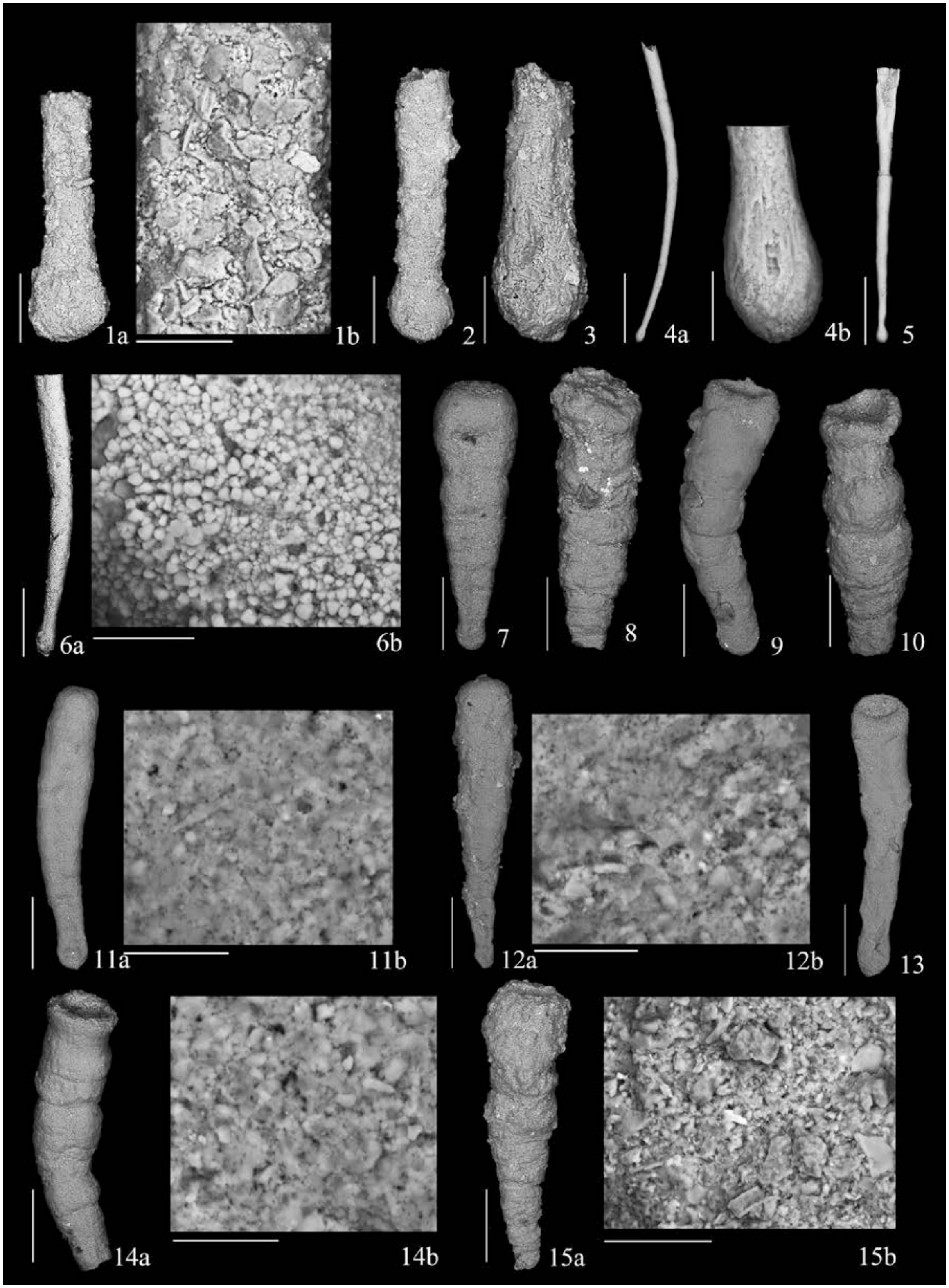


Plate 1

<u>Plate 2</u>

Foraminifera from the Placid Shale Formation, Missourian, Upper Pennsylvanian.

Figure 1, 3a – scale bar = 220 µm; Figure 2 – scale bar = 250 µm; Figure 3b – scale bar = 40 µm; Figure 4 – scale bar = 180 µm; Figure 5, 8, 9a – scale bar = 400 µm; Figure 6, 7 – scale bar = 240 µm; Figure 9b – scale bar = 70 µm; Figure 10a, 11, 12, 13, 15, 16 – scale bar = 100 µm; Figure 10b – scale bar = 20 µm; Figure 14 – scale bar = 120 µm; Figure 17 – scale bar = 150 µm; Figure 18 – scale bar = 500 µm.

1 – 5: *Reophax fittsi* (Warthin 1930). 1 – side view, sample C8, 2 – side view, sample C10, 5 – side view, sample C1; section Highway 337; 3a – side view, 3b – close up of wall structure, 4 – side view, sample 27; section Highway 16 Hills Estates Community Center.

6 – 9b: *Reophax arenatus* (Cushman and Waters 1927b). 6 – side view, sample C9, 7 – side view, sample C12, 8 – side view, sample C6, 9a – side view, 9b – close up of wall structure, sample C2; section Highway 337.

10a, b: *Ammobaculites* (?) sp. 1. 10a – side view, 10b – close up of wall structure, sample 28; section Highway 16 Hills Estates Community Center.

11 – 16: *Ammobaculites magnigranulus* Ireland 1956. 11 – side view, 15 – side view, sample 28, 12 – side view, 13 – side view, 16 – side view, sample 27; section Highway 16 Hills Estates Community Center; 14 – side view, sample C3; section Highway 337.

17: *Ammobaculites spirans* Cushman and Waters 1927b. Side view, sample 25; section Highway 16 Hills Estates Community Center.

18: *Ammobaculites parallelus* Ireland 1956. Side view, sample C3; section Highway 337.

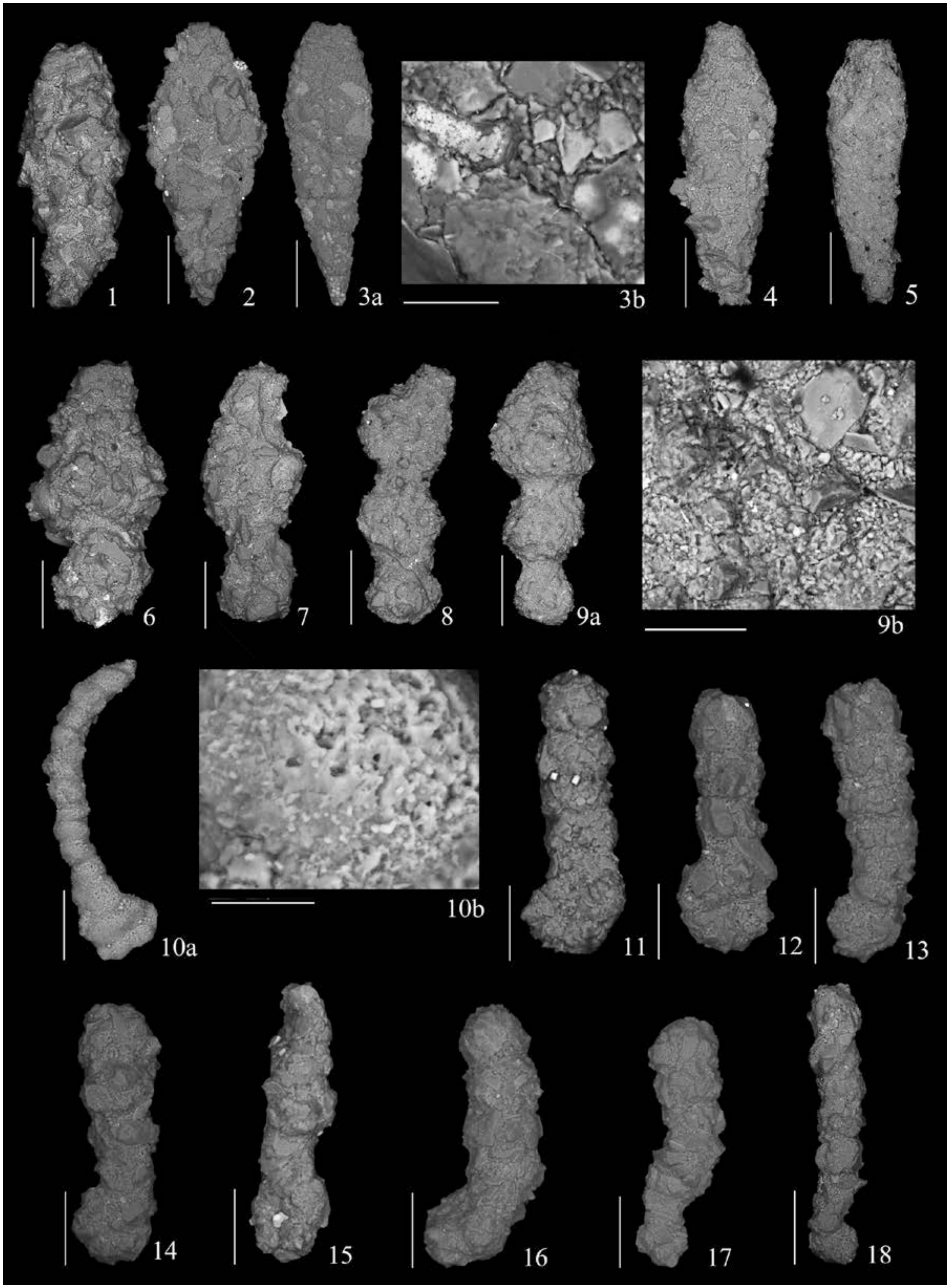


Plate 2

Plate 3

Foraminifera from the Placid Shale Formation, Missourian, Upper Pennsylvanian.

Figure 1, 10a – scale bar = 100 µm; Figure 2 – scale bar = 120 µm; Figure 3 – scale bar = 500 µm; Figure 4 – scale = 180 µm; Figure 5a – scale bar = 280 µm; Figure 5b – scale bar = 60 µm; Figure 5c, 8b – scale bar = 20 µm; Figure 6, 7 – scale bar = 150 µm; Figure 8a – scale bar = 160 µm; Figure 9a – scale bar = 110 µm; Figure 9b – scale bar = 25 µm; Figure 10b – scale bar = 30 µm.

1, 2: *Textularia* (?) *bucheri* Ireland 1956. 1 – side view, 2 – side view, sample 29; section Highway 16 Hills Estates Community Center.

3 – 5c: *Tuberitina bulbacea* Galloway and Harlton 1928. 3 – side view, 4 – side view, 5a side view, 5b – close up of wall pores, 5c – closer view of pores, sample 1; section Highway 16 Hills Estates B.

6 – 8b: *Earlandia perparva* Plummer 1930. 6 – side view, sample 5, 7 – side view, sample 28; section Highway 16 Hills Estates Community Center; 8a – side view, 8b – close up of wall structure, sample A0; section Highway 337.

9a, b, 10a, b: *Pseudoammodiscus* sp. 1. 9a – side view, b – close up of wall structure, sample 1; section Highway 16 Hills Estates B; 10a – side view, b – close up of wall structure, sample 25; section Highway 16 Hills Estates Community Center.

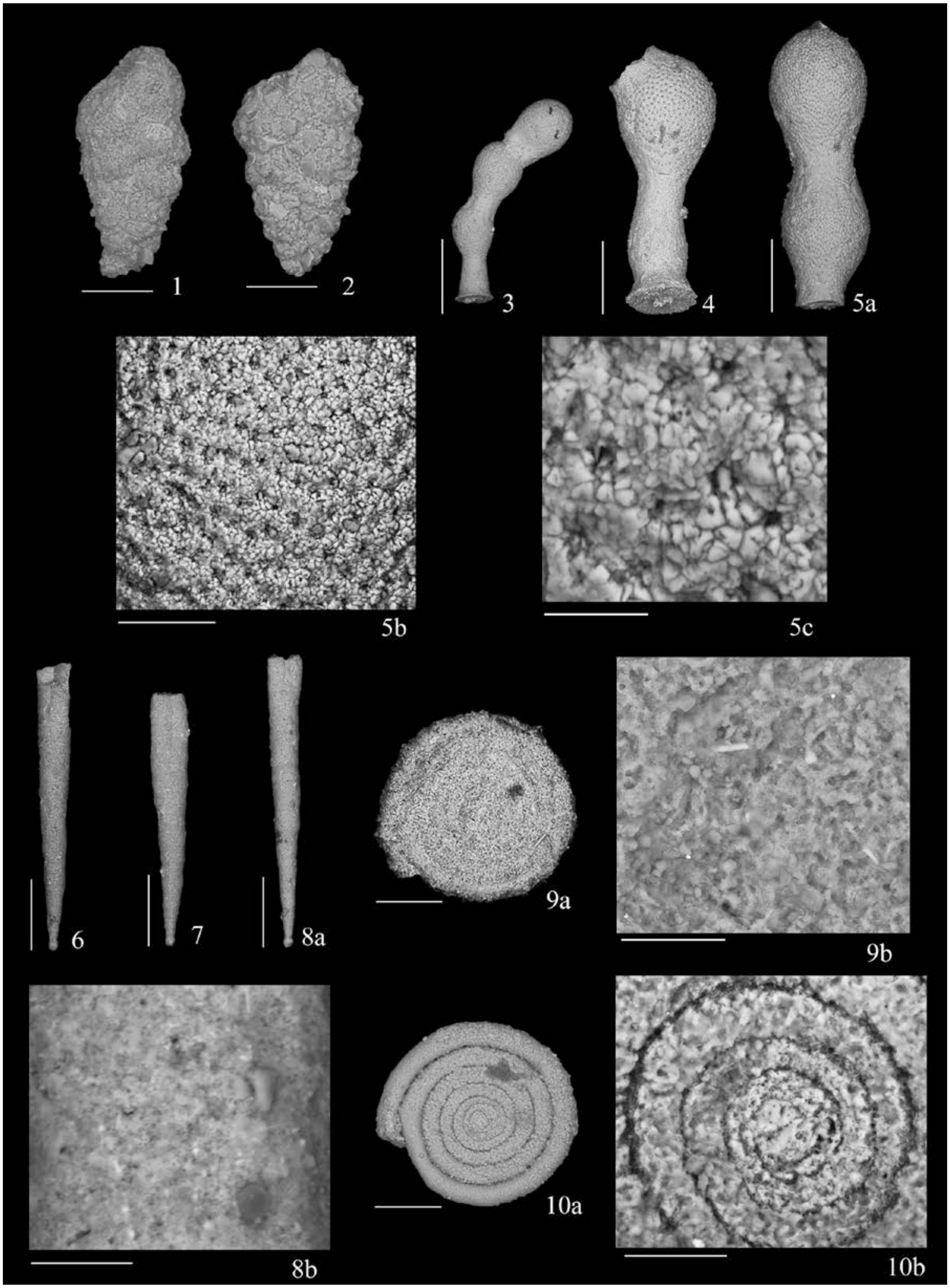


Plate 3

Plate 4

Foraminifera from the Placid Shale Formation, Missourian, Upper Pennsylvanian.

Figure 1 – scale bar = 300 µm; Figure 2 – scale bar = 400 µm; Figure 4, 5 – scale bar = 150 µm; Figure 3, 6, 8, 11 – scale bar = 160 µm; Figure 7 – scale bar = 170 µm; Figure 12, 10 – scale bar = 200 µm; Figure 9 – scale bar = 180 µm.

1 – 2: *Deckerella laheei* Cushman and Waters 1928a. 1 – side view, sample 10, 2 – side view, sample 11; section Highway 16 Hills Estates Community Center.

3: *Paleotextularia grahamensis* (Cushman and Waters 1927b). Side view, sample 4; section Highway 16 Hills Estates B.

4 – 6: *Endothyra rothrocki* Harlton 1928. 4 – side view, 5 – side view, sample 19; section Highway 16 Hills Estates Community Center; 6 – apertural view, sample C7; section Highway 337.

7 – 9: *Endothyra ovata* Waters 1928. 7 – side view, sample A0; section Highway 337: 8 – side view, sample 23, 9 – apertural view, sample 25; section Highway 16 Hills Estates Community Center.

10 – 11: *Endothyranella* cf. *E. stormi* (Cushman and Waters 1928b). 10 – side view, sample C18; section Highway 337; 11 – side view, sample 19; section Highway 16 Hills Estates Community Center.

12: *Endothyranella* sp. 1. Side view – sample 3; section Highway 16 Hills Estates B.

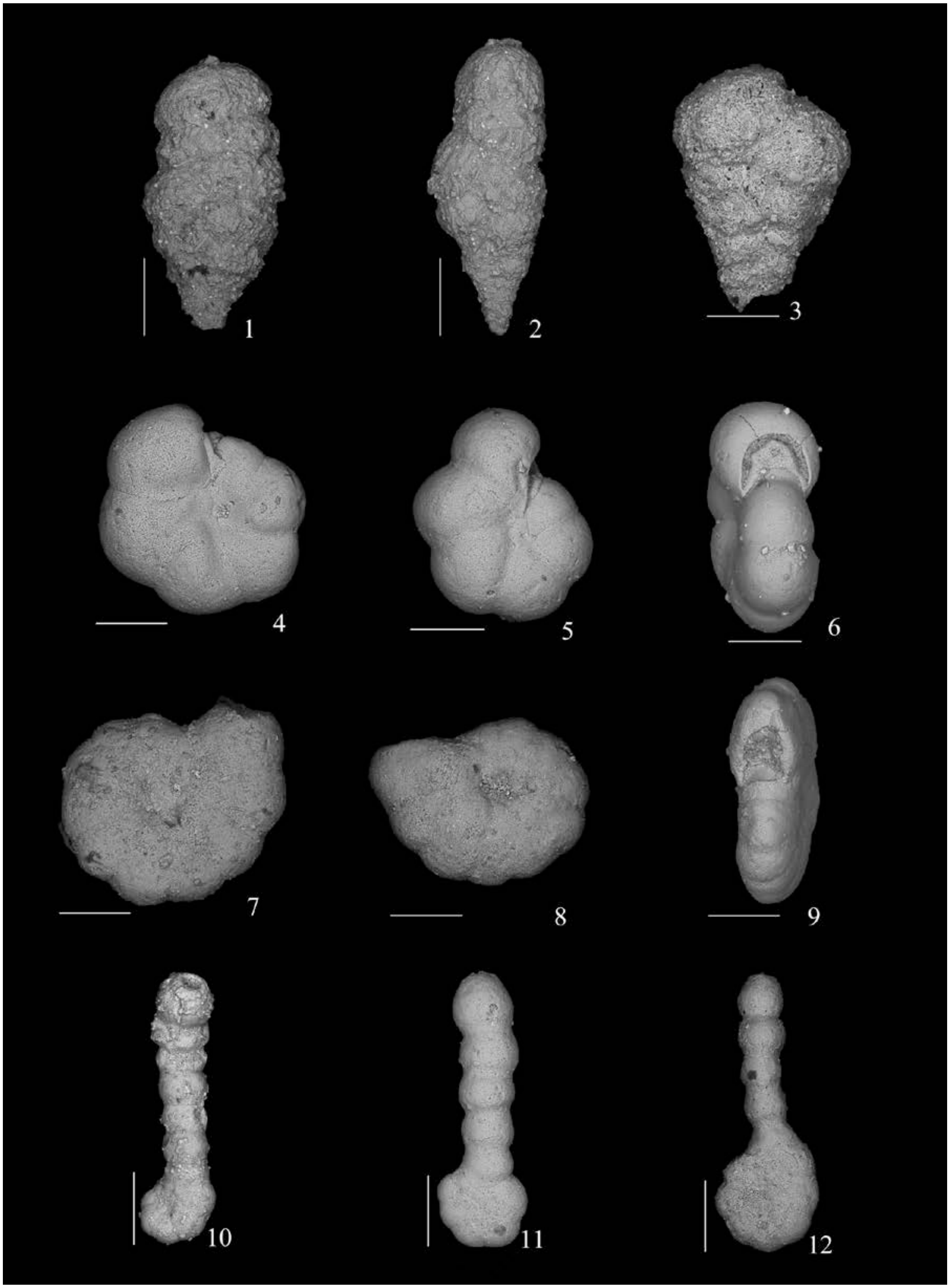


Plate 4

Plate 5

Foraminifera from the Placid Shale Formation, Missourian, Upper Pennsylvanian.

Figure 1 – scale bar = 120 µm; Figure 2, 7 – scale bar = 220 µm; Figure 3a – scale bar = 300 µm; Figure 3b – scale bar = 70 µm; Figure 3c – scale bar = 25 µm; Figure 4, 5 – scale bar = 150 µm; Figure 9 – scale bar = 160 µm; Figure 6 – scale bar = 180 µm; Figure 8 – scale bar = 200 µm.

1 – 3c: *Pseudobradyina pulchra* Reytlinger 1950. 1 – side view, sample 4; section Highway 16 Hills Estates B; 2 – side view, sample 14, 3a – side view, 3b – close up of aperture, c – close up of aperture, sample 11; section Highway 16 Hills Estates Community Center.

4 – 5: *Tetrataxis corona* Cushman and Waters 1928c. 17 – top view, 18 – bottom view, sample 13; section Highway 16 Hills Estates Community Center.

6 – 9: *Planiinvoluta thompsoni* (Cushman and Waters 1928b). 6 – top view, 7 – bottom view, 8 – top view, 9 – bottom view, sample 1; section Highway 16 Hills Estates B.

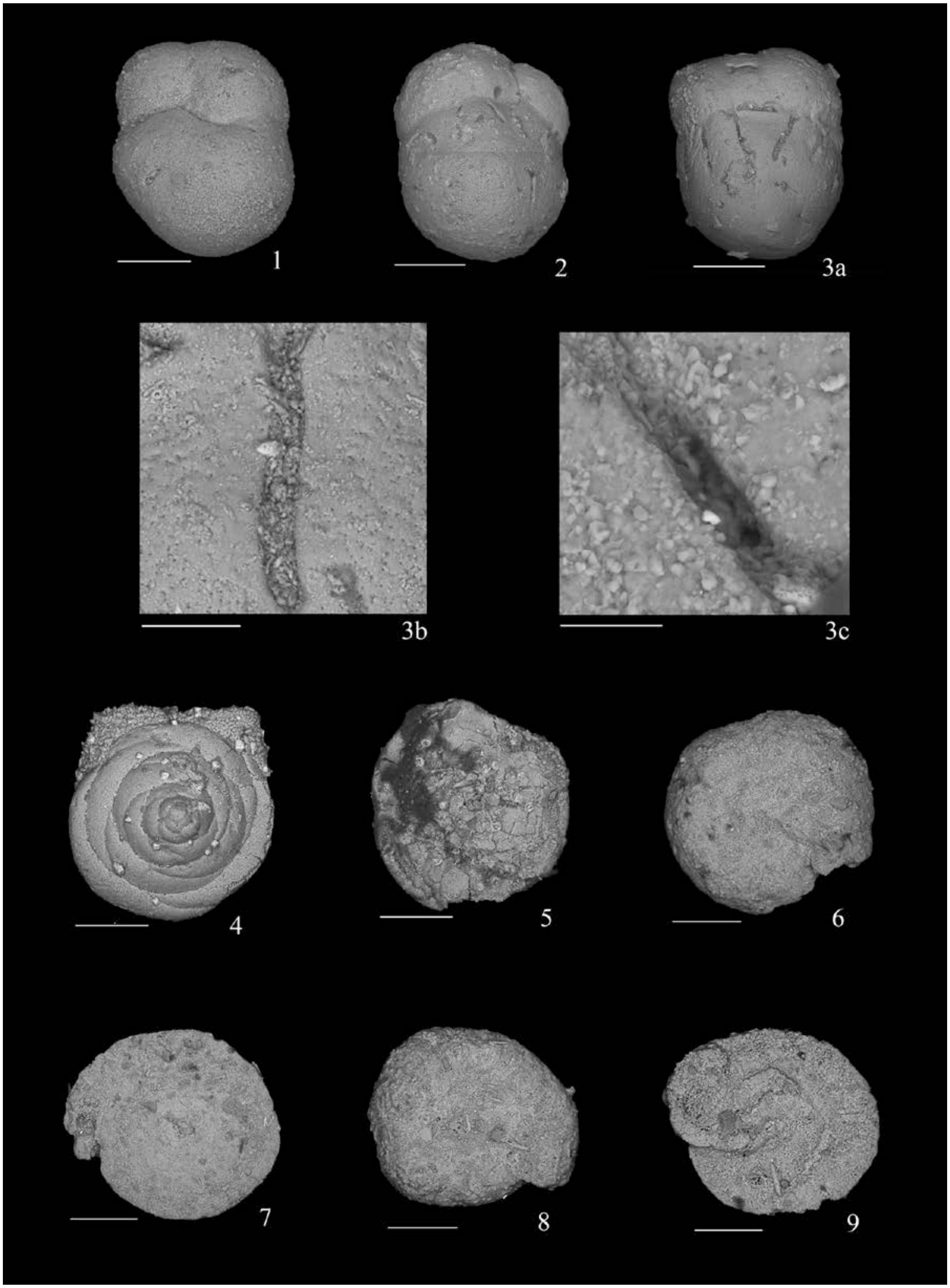


Plate 5

Plate 6

Foraminifera from the Placid Shale Formation, Missourian, Upper Pennsylvanian.

Scale bar = 100 µm.

1: *Hyperammina glabra* Cushman and Waters 1927b. 1 – axial section, sample 1; section Highway 16 Hills Estates B.

2 – 3b: *Tuberitina bulbacea* Galloway and Harlton 1928. 2 – axial section, sample 2, 3a – axial section, b – axial section, close up of wall structure, sample 1; section Highway 16 Hills Estates B.

4: *Deckerella laheei* Cushman and Waters 1928a. close to axial section, sample 11; section Highway 16 Hills Estates Community Center.

5 – 6: *Endothyranella* cf. *E. stormi* (Cushman and Waters 1928b). 5 – longitudinal section, sample 14, 6 – longitudinal section, sample 19; section Highway 16 Hills Estates Community Center.

7: *Pseudobradyina pulchra* Reytlinger 1950. Transverse section, sample 13; section Highway 16 Hills Estates Community Center.

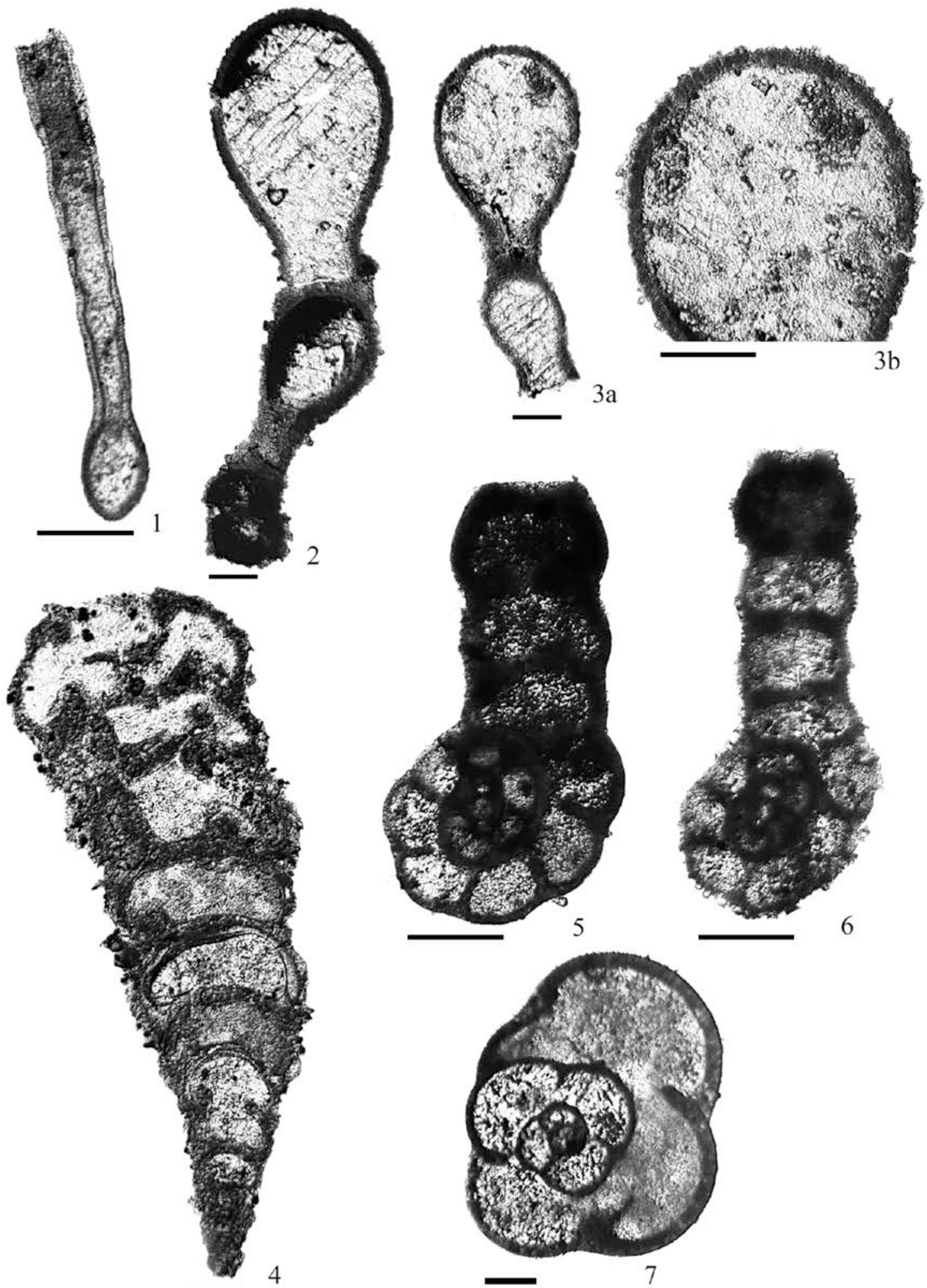


Plate 6

CHAPTER 4

FUSULINACEANS

Introduction

The fusulinaceans (commonly called fusulinids) were a type of single-celled marine organism that resembled the size and shape of a small grain of wheat. In 1823, Thomas Say described *Milolites secalicus* Say, from the Pennsylvanian of Nebraska which was in fact the first described fusulinid even though it was misidentified. Girty (1904) corrected this misidentification and made it the type species of the fusulinid genus *Triticites*. Fusulinids thrived during the Pennsylvanian and became extinct at the end of the Permian. Their shells, called tests, consist of calcium carbonate and tend to be somewhat complex. As the fusulinids developed, their test walls evolved from a four layered profusulinellid wall structure to a three layered fusulinellid wall structure, and then finally to keriothecal schwagerinid wall structure. Fusulinids tests tend to look very similar on the outside, but are complexly developed internally, requiring the preparation of specimens in thin section to correctly identify the genus and species. Fusulinids tend to make good biostratigraphic markers because of their geologically short time span, highly variable interior structure and evolution of their wall structure.

The family and generic level systematics followed for the Foraminifera are those of Loeblich and Tappan (1987).

Descriptions of Fusulinaceans

Suborder FUSULININA Wedekind 1937

Superfamily FUSULINACEA von Möller 1878

Family SCHWAGERINIDAE Dunbar and Henbest 1930

Subfamily SCHWAGERININAE Dunbar and Henbest 1930

Genus ***Kansanella*** Thompson 1957

Type species: *Kansanella joensis* Thompson 1957.

Diagnosis (after Loeblich and Tappan 1987): Test large, up to 10 or more mm in length, elongate, subcylindrical to fusiform, poles rounded to bluntly pointed, small spherical proloculus followed by about nine slowly and uniformly expanding whorls, septa irregularly fluted throughout the test length; wall thin, of tectum and thin keriotheca, tunnel narrow at first, later moderately wide, bordered in the earlier whorls by broad and asymmetrical chomata that extend a considerable distance towards the poles, chomata are more symmetrical in outer whorls, thin and discontinuous axial fillings present in the polar regions.

Range: Upper Carboniferous (Stephanian, Upper Missourian); Iowa, Kansas, Missouri, Oklahoma, Utah (after Loeblich and Tappan 1987).

Kansanella sp. 1

Plate 7, figures 1 – 4

Description: Large elongate test, fusiform, with the poles being slightly bowed down and bluntly rounded. Small spherical proloculus with seven to ten uniform whorls coiled tightly in the first four or five whorls and becoming more loosely coiled. The septa are closely spaced but the spacing is not uniform; they are irregularly fluted throughout the test, becoming much more irregular towards the axial poles. The wall is thin, composed of a tectum and thick keriotheca, with a narrow tunnel bordered by irregularly shaped broad chomata and that widens in the later volutions. The tunnel is partially obscured by dense axial filling in the first several volutions.

Measurements (mm): Length 11.75 – 17, width 2.8 – 4, diameter of the proloculus 0.11 – 0.25.

Material: 4 specimens.

Discussion: This *Kansanella* species is very large and the described specimens appear to fall on the Missourian fusulinid distribution time scale presented by Thompson (1957) between *Kansanella (Kansanella) joensis* Thompson 1957 and *Kansanella (Kansanella) neglecta* (Newell 1934) based on the size and shape of the test. However, *Kansanella* sp. 1 as herein described is much larger in length and width than either of the aforementioned species. Additional specimens must be studied before a species designation can be determined for this form.

Occurrence: Pennsylvanian; Texas.

Described specimens are very rare and occur as loose specimens in the upper part of the section at the Highway 16 Hills Estates Community Center locality.

Genus ***Triticites*** Girty 1904 [= *Girtyina* Staff 1909; = *Schwagerina (Triticites)* Deprat 1913; = *Grabauina* Lee 1924; = *Triticites (Rauserites)* Rozovskaya 1948; = *Triticites*

(Rauserites) Rozovskaya 1950; = *Ferganites* Miklukho-Maklay 1959; = *Paratriticites* Kochansky-Devidé 1969]

Type species: *Miliolites secalicus* Say in James 1823.

Diagnosis (after Loeblich and Tappan 1987): Small to medium in size, inflated fusiform to subcylindrical, poles acuminate to bluntly pointed, whorls expanding slowly and evenly, septa of advanced species regularly fluted throughout; wall of tectum and well-defined alveolar keriotheca, single straight tunnel bordered by chomata that range from thin to massive.

Range: Upper Carboniferous (Lower Stephanian, Missourian) - Lower Permian (Sakmarian, Wolfcampian); USA: Arizona, California, Idaho, Iowa, Illinois, Ohio, Kansas, Missouri, Texas, New Mexico, Nevada, Utah, Wyoming; South America; Yugoslavia; Russia; Japan; China; Southeast Asia (after Loeblich and Tappan 1987).

Triticites newelli Burma 1942

Plate 7, figures 5 – 7b

Triticites cf. *moorei* NEWELL 1936, p. 29-31

Triticites newelli BURMA 1942, p.749-751, pl. 118, figs. 7, 10; THOMPSON 1957, p 323-325, pl. 29, figs. 13-20.

Triticites cf. *T. newelli* MEYERS 1960, pl. 17, fig. 12.

Description: A medium sized test that is fusiform to irregularly subcylindrical with blunted pointed ends. The central region is inflated with the axis of coiling being fairly straight and loose. Whorls expand slowly and evenly to seven volutions. The septa are generally gently to moderately fluted across the middle, becoming strongly fluted at the poles. There are small and conspicuous septal pores in the outer volutions that are circular to slightly irregular in shape (pl. 10, fig. 7b).

Measurements (mm): Length 6.6 – 7, width 2.5 – 2.6, diameter of the proloculus 0.06 – 0.09.

Material: 2 specimens

Discussion: The described specimens fit very well with the original description of *T. newelli* of Burma 1942. The species was described and well-illustrated by Nail (1991) from the same locality as studied in this work.

Occurrence: Pennsylvanian; Kansas, Missouri, Texas.

Described specimens were found as loose specimens at the Highway 337 locality in the middle of the C sample interval.

Fusulinacean Plate

Plate 7

Fusulinids from the Placid Shale Formation, Missourian, Upper Pennsylvanian.

Figures 1 – 7a scale bar = 1 mm, figure 7b scale bar = .2 mm.

1 – 4: *Kansanella* sp. 1. 1 – axial section, 2 – axial section, 3 – axial section, 4 – equatorial section, free specimens; section Highway 16 Hills Estates Community Center.

5 – 7b: *Triticites newelli* Burma 1942. 5 – axial section, 6 – axial section, 7a – axial section, 7b - mural pores and keriothecal wall, free specimens from the middle of C level; section Highway 337.

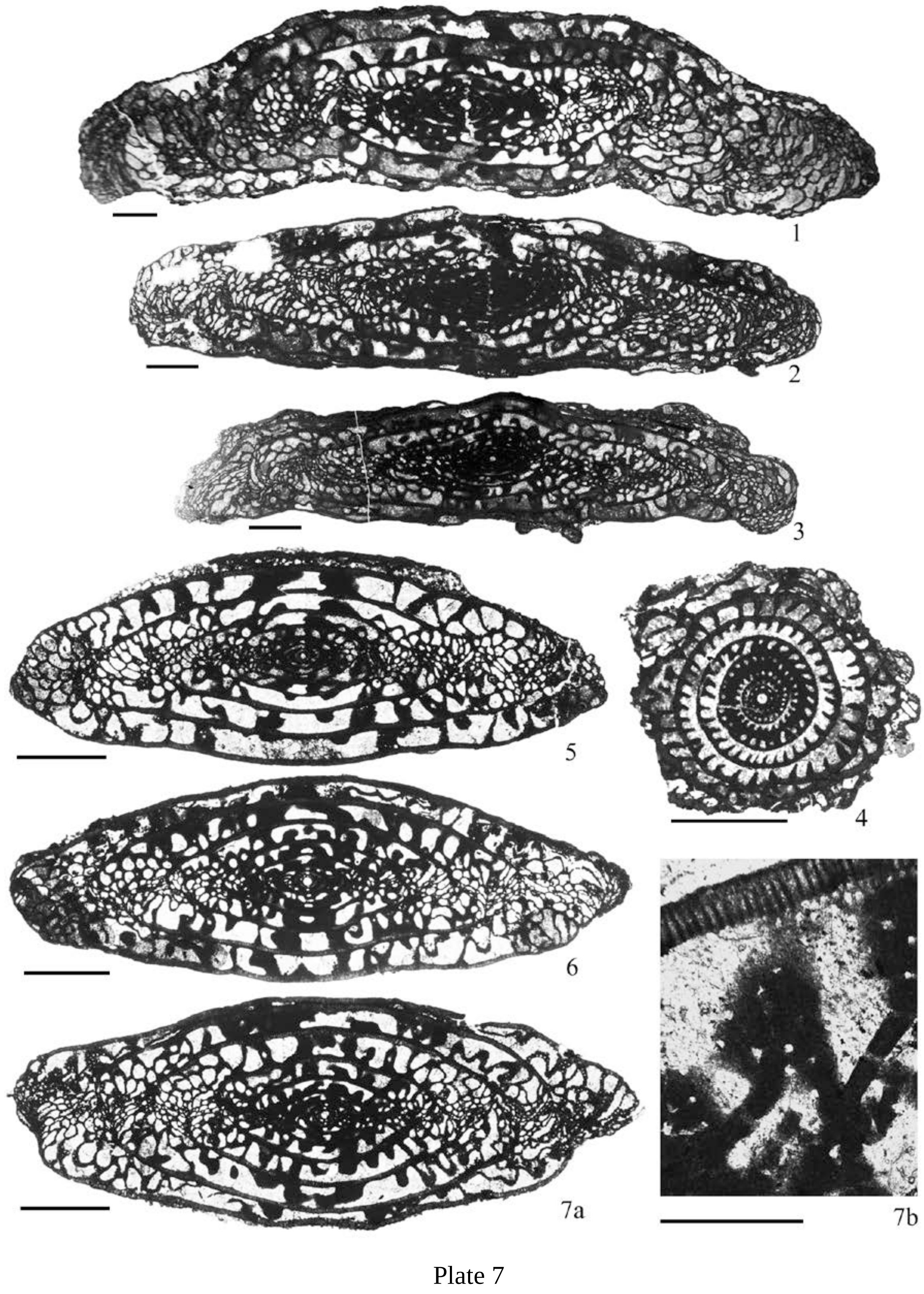


Plate 7

CHAPTER 5

OSTRACODES

Introduction

What we see as ostracode remains in the rock record are in fact only the bivalved shells (moult stages) of small arthropods. Ostracodes have a very well-known fossil history and are normally identified based on the physical characteristics of their shells. According to Melnyk and Maddocks (1988), the abundance, diversity, and rapidly evolving nature of Carboniferous-Permian ostracodes make them a great biostratigraphic marker. Traits that are studied to help identify ostracodes include size, shape, breadth, and physical ornamentation. The main interest in the ostracodes lies in their ecological and evolutionary record. Because there are so many species preserved with fine detail, they are extremely useful in biostratigraphy by looking at patterns of their distribution through time and space. Taxonomically, they are very difficult to describe because there are often up to a dozen moult stages in their life cycle. Ostracodes commonly occur in calcareous shale, and so it is no surprise that they are found within the Placid Shale.

The time ranges used for the genera in their descriptions are from the Paleobiology Database. This database is still a work in progress and is not complete.

<u>Descriptions of Ostracodes</u>

Phylum ARTHROPODA Latreille 1829

Subphylum CRUSTACEA Brünnich 1772

Subclass OSTRACODA Latreille 1802

Family AMPHISSITIDAE Knight 1928

Genus ***Kegelites*** Coryell and Booth 1933

Type species: *Girtyites spinosus* Coryell and Booth 1933; = *Kegelites dattonensis* (Harlton) 1927.

Diagnosis: Short carapace with two equal valves. Ends are rounded with one, usually the posterior, being somewhat higher than the other. There is a small median node and a well-developed posterior node or shoulder, and there is no anterior node. There are two marginal rims and an incomplete marginal ridge on some specimens.

Range: Upper Mississippian of the United States; Permian of China, and the United States.

Kegelites dattonensis (Harlton 1927)

Plate 8, figures 1 – 4

Amphissites dattonensis HARLTON 1927, p. 206, pl. 32, figs. 9a-c. - SOHN 1961, p. 128-129, pl. 9, figs. 1-7, 16-18, 26, with all synonymy.

Description: Small carapace with a dorsal margin that is straight to slightly concave in the center and a ventral margin that is slightly concave to straight. Both the anterior and posterior margins are rounded with the anterior margin being slightly narrower. The posterior node presents as a well-defined vertical ridge that extends downward about two-thirds of the height of the carapace. A prominent central node is present and it can be slightly off center and has a strong posterior slope. The central node can be seen in both the later and dorsal views.

Measurements (µm): Length 332 – 486, height 232 – 250, width 166 – 259.

Material: 4 specimens.

Discussion: These specimens were initially classified as belonging to *Amphissites*, however, the specimens described above do not have a dorsal shield. According to Sohn (1961), this lack of a dorsal shield classifies them as belong to *Kegelites* and not *Amphissites.* The specimens described above are classified as *K. dattonensis* have well-defined posterior and central nodes and no anterior node which also separates these specimens from belonging to the genus *Amphissites*.

It could be that the above described specimens, classified as *K. dattonensis,* are small instars which might account for the dorsal margin being concave and not straight to slightly concave as can be seen in larger specimens. The sieve pores which can be seen at high magnification in the fossae of the specimens have never been described. Also, the arrangement and intercalation of fossae during growth have never been described, nor have the pore cones that are very numerous over the surface of these well preserved specimens. When these smaller details of this species are studied more in depth, it might be found out that *K. dattonensis* is in fact a lineage of several species which would account for the range of stratigraphic intervals found in Sohn's synonymy.

Occurrence: Pennsylvanian; Oklahoma.

Described specimens were found at the Highway 16 Hills Estates Community Center locality, sample 24.

Family HEALDIIDAE Harlton 1933

Genus ***Healdia*** Roundy 1926; emend. Harlton 1929

Type species: *Healdia simplex* Roundy 1926.

Diagnosis: Short ovate carapace that has the appearance of being swollen with the greatest thickness being in the posterior. The dorsal margin is strongly convex and the ventral margin is nearly straight. The ends of the carapace are about equally rounded. There is slight overlap of the valves. Surface ornamentation shows widely spaced small spines.

Range: Silurian of United States; Devonian of Poland, Russia, Ukraine, United States; Carboniferous of China, the United Kingdom, United States; Permian of Australia, Azerbaijan, Canada, China, Italy, Lithuania, Russia, United States, Venezuela; Triassic of China, Iran, Romania; Jurassic of Switzerland.

Healdia spinosa Cooper 1946

Plate 8, figures 5 – 9

Healdia spinosa COOPER 1946, p. 86, pl. 12, fig. 11-13.

Description: Small semiovate carapace with an arched dorsal margin and a slightly curved ventral margin. The valves are nearly uniform in size with only a slight overlap. The ends of the carapace are rounded with four short spines (two on each valve) projecting out of the posterior end. The spines are cylindrical, elongated, taper to a point and are the only ornamentation on the carapace.

Measurements (µm): Length 470 – 486, height 200 – 302, width 210 – 230.

Material: 5 specimens.

Discussion: *H. spinosa* is easily distinguished from some of the other species of *Healdia* by the long cylindrical spines. *H. elegans* Warthin 1930 also has long cylindrical spines, but is about twice the size of *H. spinosa*.

Occurrence: Pennsylvanian; Illinois.

Described specimens were found at the Highway 337 locality, sample C1.

Family CAVELLINIDAE Egorov 1950

Genus ***Cavellina*** Coryell 1928; emend. Kellett 1935

Type species: *Cavellina pulchella* Coryell 1928.

Diagnosis: Smooth ovate to elongate inequivalved carapace with the dorsal margin arched and the ventral margin slightly convex to concave. Right valve larger than the left and grooved. The ends of the carapace are rounded and the posterior end is thicker than the anterior end.

Range: Silurian of Germany, Russia, and the United Kingdom; Devonian of China, Czech Republic, France, Poland, Russia, and the United States; Carboniferous of Canada, China, United Kingdom, and the United States; Permian of Azerbaijan, China, Greece, Israel, Italy, Japan, Lithuania, Oman, Russia, Saudi Arabia, Serbia and Montenegro, United States, and Venezuela; Triassic of Italy and Turkey.

Cavellina nebrascensis (Geinitz 1867); emend. Lalicker 1935

Plate 8, figures 10 – 14

Cythere nebrascensis GEINITZ 1867, p. 2, pl. 1, fig. 2.

Cavellina nebrascensis KELLETT 1935, p. 146, pl. 18, figs. 1a-h. – LALICKER 1935, p. 744, figs. 1-3c. – not SCOTT and BORGER 1941, p. 357, pl. 50, figs. 3, 9, 10. – COOPER 1946, p. 73, pl. 10, figs. 1-4.

Description: Large smooth elongate carapace with convex dorsal and ventral margins. The ends are rounded and the widest point is around the center to closer to the posterior. The right valve is larger than the left valve and the overlap is most prominent along the center of the dorsal and ventral margins.

Measurements (µm): Length 1016 – 1089, height 647 – 726, width 375 – 599.

Material: 4 specimens.

Occurrence: Pennsylvanian; Illinois, Kansas, Nebraska.

Described specimens were found at the Highway 16 Hills Estates Community Center locality, sample 25.

Family BAIRDIIDAE Sars 1888

Genus ***Bairdia*** M'Coy 1844

Type species: *Bairdia curta* M'Coy 1844; designated by Miller 1892.

Diagnosis: Elongate carapace that tapers at both ends. The valves are not of equal size and a portion of one overlaps the abdominal margin.

Range: Devonian of Afghanistan, Belgium, Brazil, China, the Czech Republic, France, Poland, Russia, Spain, and the United States; Mississippian of the United States; Carboniferous of Canada and the United States; Permian of Australia, Azerbaijan, Canada, China, Greece, Israel, Italy, Japan, Lithuania, Oman, Russia, Saudi Arabia, Serbia and Montenegro, Thailand, Turkey, United States; Triassic of Australia, China, Germany, Hungary, Iran, Israel, Italy, Pakistan, Romania, Turkey; Jurassic of France, Germany, Madagascar, Portugal, Saudi Arabia, Spain, Switzerland, and the United Kingdom; Cretaceous of Antarctica, France, Mexico, Portugal, South Africa, Tunisia; Paleocene of Pakistan, Togo, Trinidad and Tobago, and the United States; Eocene of India, Libya, Pakistan, Trinidad and Tobago, the United Kingdom, and the United States; Oligocene of Antigua and Barbuda, Germany, Italy, and Puerto Rico; Miocene of Algeria, Colombia, Cuba, India, Italy, Panama, Poland, Puerto Rico, Trinidad and Tobago, and Venezuela; Pliocene of New Zealand.

Bairdia blakei Harlton 1931

Plate 8, figures 15 – 19

Bairdia blakei HARLTON 1931, p. 163; new name for *B. nitida* HARLTON 1928. – UPSON 1933, p. 21, pl. 2, figs. 1a, b. – not BRADFIELD 1935, p. 84, pl. 6, figs. 1a, b, 2. – COOPER 1946, p. 42, pl. 1, figs. 16-19.

Bairdia bidorsalis BRADFIELD 1935, p. 81, pl. 5, figs 6a, b.

Bairdia crassa BRADFIELD 1935, p. 80, pl. 5, figs. 8a, b.

Bairdia nitida HARLTON 1928b, p. 139, pl. 21, figs. 12a-b. – HARLTON 1929, p. 155, pl. 3, figs. 3a, b. – not *Bairdia nitida* JONES and KIRKBY 1879.

Description: Large thick carapace with an arched dorsal margin and a flat to slightly convex ventral margin. There is a posteriodorsal slope that forms by the continuation of the arch of the dorsal margin. This arch continues down giving it a semicircular look where it terminates into a short beak on the posterior that forms a point that falls at or a slightly below midheight. The anterior end is rounded to slightly pointed and falls above the midheight.

Measurements (µm): Length 970 – 1040, height 645 – 647, width 462 – 588.

Material: 5 specimens.

Discussion: *B. blakei* is easily recognized from other species of *Bairdia* because of the semicircular dorsal outline and the swollen look of the carapace.

Occurrence: Pennsylvanian; Illinois, Nebraska, Oklahoma, Texas.

Described specimens were found at the Highway 337 locality, sample C12.

Family YOUNGIELLIDAE Kellett 1933

Genus ***Moorites*** Coryell and Billings 1932

Type species: *Moorites hewetti* Coryell and Billings 1932.

Diagnosis: Small elongate carapace with equal valves. The dorsal margin is straight and the ventral margin has a raised flange towards the ends. The surface has punctae that tend to be in elongate and curved depressions.

Range: Devonian of Russia; Carboniferous of the United States; Permian of Australia, Azerbaijan, Israel, and Oman.

Moorites minutus (Warthin 1930)

Plate 8, figures 20 – 22

Glyptopleurina ? minuta WARTHIN 1930, p. 67, pl. 5, figs. 6a, b.

Moorites minutus CORYELL and BILLINGS 1932, p. 183, pl. 18, fig. 6. – CORYELL and SAMPLE 1932, p. 256, pl. 24, fig. 18. – KELLETT 1933, p. 104, pl.14, figs. 37-39. – BRADFIELD 1935, p. 73, pl. 5, figs. 1a, b. – JOHNSON 1936, p. 37, pl. 3, figs. 20, 21. – COOPER 1946, p. 42, pl. 1, figs. 16-19.

Youngiella minutus WILSON 1933, p. 416, pl. 50, fig. 7.

Youngiella? convergens BRADFIELD 1935, p. 72, pl. 4, figs. 16a, b.

Description: Small elongate carapace with a long straight dorsal margin and a concave ventral margin. The posterior is rounded and the anterior is slightly rounded to almost straight. There seems to be no overlap of the valves. The surface is punctate except around the marginal border and there are low slightly raised ridges that separate rows/groups of punctae.

Measurements (µm): Length 349 – 430, height 225 – 230, width 101 – 133.

Material: 3 specimens.

Discussion: Kellet (1933) considered *M. hewetti* Coryell and Billings 1932 to be a synonym of *M. minutus*, because the two species have the same characteristics with the only difference being in the anterior convergence of the dorsal and ventral margins. She believed this to be a common variation within a species and thought that *M. hewetti* was just an immature moult of *M. minutus*. Cooper (1946) wrote that he thought they were probably the same species, just different moult stages because they have the same form ratio, however, *M. hewetti* is considerably smaller than *M. minutus*. *M. hewetti* was not used in the synonymy for *M. minutus* because a moult study was not completed and so a definite answer as to if they are the same species or not cannot be determined.

Occurrence: Pennsylvanian; Illinois, Kansas, Nebraska, Oklahoma, Texas. Described specimens were found at the Highway 16 Hills Estates Community Center locality, sample 24, and at the Highway 337 locality, sample C16.

<u>Ostracode Plate</u>

<u>Plate 8</u>

Ostracoda from the Placid Shale Formation, Missourian, Upper Pennsylvanian.

Figures 1, 3, 5, 6, 8, 9 – scale bar = 130 µm; figures 2, 4, 7, 20 – scale bar = 100 µm; figure 10 – scale bar = 290 µm; figure 11, 12, 15, 16, 17 – scale bar = 300 µm; figure 13 - scale bar = 190 µm; figure 14 – scale bar = 250 µm; figure 18 – scale bar = 150 µm; figures 19, 21 – scale bar 120 µm.

1 – 4: *Amphissites irregularis* Coryell and Sample 1932. 1 – right valve, 2 – left valve, 3 – dorsal view, 4 – ventral view; sample 24; section Highway 16 Hills Estates Community Center.

5 – 9: *Healdia spinosa* Cooper 1946. 5 – dorsal view, 6 – ventral view, 7 – posterior view, 8 – left valve, 9 – right valve; sample C1; section Highway 337.

10 – 13: *Cavellina nebrascensis* (Geinitz 1867). 10 – right valve, 11 – left valve, 12 – ventral view, 13 – anterior view; sample 25, section Highway 16 Hills Estates Community Center.

14 – 18: *Bairdia blakei* Harlton 1931. 14 – right valve, 15 – left valve, 16 – dorsal view, 17 – ventral view, 18 – posterior view; sample C12; section Highway 337.

19 – 21: *Moorites minutus* (Warthin 1930). 19 – right valve, sample 24; section Highway 16 Hills Estates Community Center; 20 – dorsal view, 21 – ventral view; sample C16; section Highway 337.

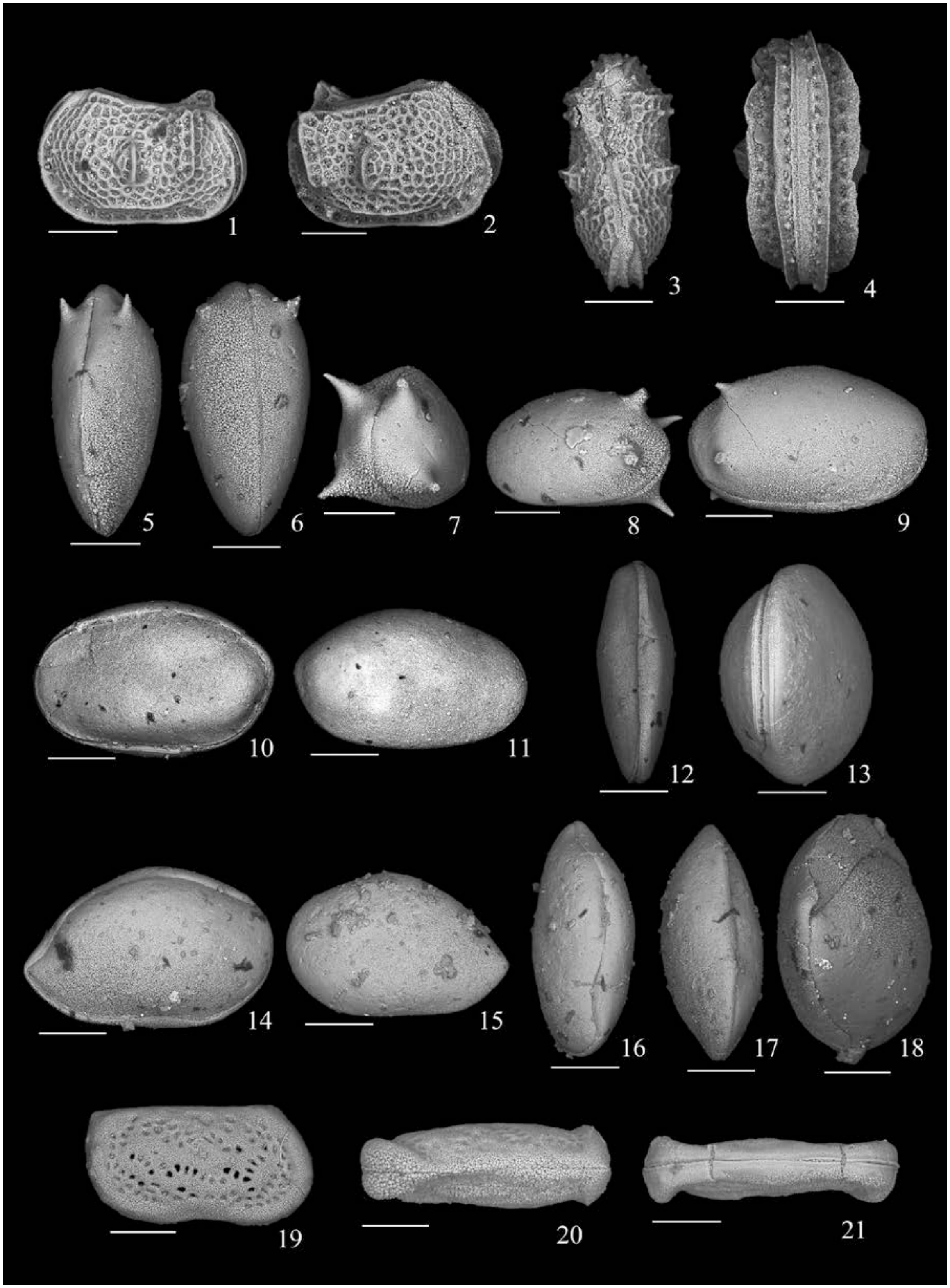


Plate 8

CHAPTER 6

HOLOTHURIAN SCLERITES AND SKELETAL ELEMENTS OF THE OPHIUROIDEA

Introduction

Holothurian sclerites are calcareous pieces, like bones, that sea cucumbers secrete as skeletal supports. These sclerites take distinctive geometric shapes and are extremely diverse in shape and size. Sclerites tend to be named after objects they resemble such as tables, wheels, anchors, hooks and rods. The first holothurian sclerite, *Synapta sieboldi*, an "anchor spicule consisting of a long shaft, non-serrated flukes, and a small transverse terminal piece" was described in a publication by Münster in 1843 (Croneis and McCormick 1932). According to Frizzell and Exline (1955), the Carboniferous and Jurassic periods were a time of rapid evolution of holothurians. During this time several new patterns of sclerites appeared and only a few of these forms were abandoned. Fossil holothurian sclerites are found in marine deposits from tropical to subarctic environments and sublittoral to moderate depths. They also tell us that the marine environment was of normal salinity (Frizzell and Exline 1955). Holothurian sclerites are usually found in siltstone and clay, so it is not unexpected that they are found within the Placid Shale.

The descriptions of holothurian sclerites presented by Gilliland (1993) is followed herein.

Descriptions of Holothurian Sclerites and Skeletal Elements of the Ophiuroidea

Phylum ECHINODERMATA Klein 1754

Class HOLOTHUROIDEA de Blainville 1834

Order APODIDA Brandt 1835

Family ACHISTRIDAE Frizzell and Exline 1955

Genus ***Achistrum*** Etheridge 1881; emend. Frizzell and Exline 1955

Type species: *Achistrum nicholsoni* Etheridge 1881.

Diagnosis: Sclerite formed of a simple hook that is composed of an eye, shaft, and spear.

Range: Devonian?; Mississippian – Jurassic.

Achistrum monochordata Hodson, Harris, and Lawson 1956

Plate 9, figures 13-14

Achistrum monochordata HODSON et al. 1956, p. 340-341, figs. 10-11. - GILLILAND 1992, pl. 4, figs. 1-8 with all synonymy. - WERNLUND 1996, figs. 6.1, pl. 1: 11 to 20; figs. 6.2, pl. 2: 1 to 20 with all synonymy.

Description: Sclerite in the form of a hook with a long, straight, narrow shaft that curves slightly at the base where it joins the spear. Of all the hook sclerites found, most of the specimens were broken showing only the eye and shaft. Only two specimens included the spear, which occurs at roughly a right angle to the direction of the eye. All of the specimens appear to have a straight shaft that is uniform in diameter and does not show signs of tapering towards either the spear or eye. The eye on all of these specimens is rather small and roughly uniform in thickness with the perforation being small and ovoid shaped with one side being larger than the other. The eye shows a crossbar that is on the larger side of the eye away from the shaft.

Measurements (µm): Shaft width 28.5-64, length of unbroken shaft 393–400 and broken 356–850, width of eye 115-156, width of perforation 29-66.

Material: 10 specimens.

Discussion: These hooks were assigned to *A. monochordata* instead of *A. brownwoodensis* (Croneis in Cronis and McCormick 1932) because there is a crossbar across the eye in the specimens. The presence of the crossbar on the eye can be seenclearly in SEM pictures.

Occurrence: Carboniferous of United States (Kentucky, Missouri, Montana, Texas); Permian of United States (Texas); Triassic of Hungary and Poland; Cretaceous of Poland; Jurassic of Egypt, France, Germany, Poland, and the United Kingdom.

Described specimens were found at the Highway 16 Hills Estates Community Center, samples 4, 23, 25, 26, and 27 as well as at the Highway 337 locality, sample C1.

Family PALEOCHIRIDOTIDAE Frizzell and Exline 1966; emend. Gutschick et al. 1967

Genus ***Paleochiridota*** Croneis in Cronis and McCormick 1932; emend. Frizzell and Exline 1955

Type species: *Paleochiridota plummerae* Croneis in Cronis and McCormick 1932.

Diagnosis: Sclerite in the form of a wheel with a solid central portion that radiates into short spokes. The central hub is raised on the lower side and may exhibit depressions forming a flower shaped pattern.

Range: Carboniferous of United States.

Paleochiridota plummerae Croneis in Cronis and McCormick 1932; emend. Frizzell and Exline 1955

Plate 9, figures 5 - 6

Paleochiridota plummerae Croneis in CRONEIS and MCCORMACK, p.140, pl. 20, figs, 18-19. - SCHINDEWOLF 1950, text fig. 85.– FRIZZELL and EXLINE 1955, p. 140, pl. 9, fig. 1, with all synonymy.

Description: Wheel sclerite with six spokes that taper towards the outside rim. The interspace holes between the spokes are dentate with four – six teeth in each space. These teeth are better defined in some specimens than in others. The lower side of the central portion shows six depressions that form a flower shape along the same lines as the spokes. The upper side of the central hub has no perforations or depressions. It is thicker in the center and then thins towards the middle of the six spokes.

Measurements (µm): Diameter 210 – 275.

Material: 6 specimens.

Discussion: When Croneis originally described *P. plummerae* in 1932, he described the depressions on the underside as piercing all the way through the entire hub. However, in 1955 when Frizzell and Exline looked at topotypes of *P. plummerae* and *P.*

“*radiata*” they noticed that the depressions did not in fact pierce through the central hub. They also noticed that *P*. “*radiata*”, *P*. “*terquemi*”, and *P*. “*waylandensis*” should all be classified as *P. plummerae*, but they were not originally because they were broken in different ways that made them seem to be separate species. On plate 1, fig. 6, it is easy to see how the central hub being eroded can cause identification problems. In the specimen on fig. 6 the links to the center depression have been eroded making the six depressions look like they are one big depression instead of 6 individual depressions connected to a center depression. Although the central depressions on the hub have been eroded, specimen on fig. 6 still has been identified as *Paleochiridota plummerae*.

Occurrence: Carboniferous of United States (Texas).

Described specimens were found at the Highway 337 locality, samples A0, B1, C1, C13, and C16.

Order ELASIPODA Theel 1882

Parafamily PROTOCAUDINIDAE Deflandre-Rigaud 1961

Genus ***Microantyx*** Kornicker and Imbrie 1958

Type species: *Microantyx permiana* Kornicker and Imbrie 1958.

Diagnosis: Sclerites in the form of wheels with commonly eight – ten short spokes, however, there are specimens that show four spokes that split toward the rim. They have a raised center on the upper side, and four depressions on the lower side that do not penetrate all the way through.

Range: Devonian of Poland; Mississippian of Afghanistan; Carboniferous of United States (Indiana, Missouri, Montana); Permian of Iran, Italy, and United States (Kansas, Texas).

Discussion: Gilliland (1993) discusses the possibility that *Microantyx* is possibly a synonym for *Protocaudina*, but that more work needs to be done to determine if this is the case. He also points out that the two genera could be confused if the holes become infilled. Gilliland left the genus *Microantyx* as being classified under *Protocaudinidae* .His decision is followed herein.

Microantyx botoni Gutschick 1959

Plate 9, figures 7 - 8

Microantyx botoni GUTSCHICK 1959, p. 134-135, text-fig. 3 A-C, pl. 26, figs. 22-23, 28-29; - WERNLUND 1996, p. 157, figs. 6.4, pl. 4:10-13 with all synonymy.

Protocaudina botoni (Gutschick 1959) – BOCZAROWSKI 1997, p. 334, not illustrated.

Description: Sclerite of wheel form with eight short narrow spokes. The space between the spokes is rather wide with a high arc on the inner margin and the outer margin appears to be straight. The lower side has a wide broad center that elevates in the center. The upper side has four circular depressions in the center that do not penetrate through to the other side.

Measurements (µm): Diameter 220.

Material: 2 specimens.

Discussion: *M. botoni* can be distinguished from the type species of *M. permiana* Kornicker and Imbrie 1958 by the fact that it has 8 spokes instead of 10.

Boczarowski (1997) assigned this species to the genus *Protocaudina*, however, he failed to illustrate the specimen so it cannot be concluded for certain if it is the same as *M. botoni*. This change could be due to the discussion of Gilliland (1993). It is the opinion herein that this change in the generic assignment is inaccurate because specimens studied appear to be clearly the same as in the original description from Gutschick (1959).

Occurrence: Mississippian of Afghanistan; Carboniferous of United States (Texas, Indiana, Missouri, Montana); Permian of Iran, United States (Texas).

Described specimen was found at the Highway 16 Hills Estates Community Center, sample 14.

Genus ***Protocaudina*** Croneis 1932

Type species: *Cheirodota (?) traquairii* Etheridge 1881.

Diagnosis: A wheel sclerite with the central hub having a cross shape that includes 4 holes.

Discussion: It must be noted that there are a few problems with this genus and Gilliland (1993) discusses several of these problems. He examined the type specimen and found that it should not be assigned to *Protocaudina* because it has the characteristics of *Microantyx*, which is part of the same parafamily Protocaudinidae. This conclusion leads to the question of if *Microantyx* and *Paleocaudina* could be synonyms, but Gilliland does not suggest doing anything about this problem. Gilliland also notes that *Microantyx* might not be a holothurian sclerite, but might belong to the Ophiuroidea. Boczarowski (1997) changed the generic affinity of some species of *Protocaudina* to *Paleocaudina* because "as it has been demonstrated by Gilliland (1993) only the type species of *Protocaudina* is based on ophiocistioid sclerites." However, Gilliland never stated that this type species was an ophiocistioid sclerite. This renaming by Boczarowski based on his interpretation of Gilliland has led to confusion in the morphological differences among the three genera *Protocaudina*, *Paleocaudina*, and *Microantyx*. However, herein the opinion of Gilliland (1993) regarding *Protocaudina* is followed.

Range: Devonian of Poland; Carboniferous of the United States (Kansas, Kentucky, Texas); Permian of Iran and the United States (Kansas).

Protocaudina kansasensis (Hanna 1930)

Plate 9, figures 9 - 10

Laetmophasma kansasensis n. sp. HANNA 1930, p. 413-414, pl. 40, figs. 1-2, 4-7.

Caudina traquairii (Etheridge) - CRONEIS 1931, p. 47-48 (name combination suggested but not used; - not "*Cheirodota(?)" traquairii* (Etheridge).

Protocaudina kansasensis CRONEIS and MCCORMACK 1932, p. 138-139, pl. 20, figs. 2, 6. – FRIZZELL and EXLINE 1955, p. 137, pl. 8, fig. 16, with all synonymy.

Palaeocaudina kansasensis - BOCZAROWSKI 1997, p. 334, not illustrated.

Description: Sclerite in form of a wheel typically with ten short and wide spokes. Interspoke spaces are wide with the inner margin being much arched and the outer margin being almost straight. The center portion is large with four rounded to ovoid perforations in the middle. One pair of the central holes is close together while the other pair is further apart. This arrangement makes the four perforations seem to make an oval shape of their own.

Measurements (µm): Diameter 200 – 294.

Material: 5 specimens.

Discussion: *P. kansasensis* is very similar to *P. traquairii* (Etheridge), however, *P. kansasensis* has more spokes and the center perforations are unequally spaced creating an oval shape.

Occurrence: Carboniferous of United States (Kansas, Kentucky, Texas); Pennsylvanian of United States (Kansas, Missouri); Permian of Iran, United States (Kansas).

Described specimens were found at the Highway 16 Hills Estates Community Center, samples 4, 5, and 13 as well as at the Highway 337 locality, sample A0.

Order DENDROCHIROTACEA Gilliland 1992

Parafamily PRISCOPEDATIDAE Frizzell and Exline 1955; emend. Gilliland 1992

Genus ***Clavallus*** Gilliland 1992

Type species: *Priscopedatus spicaudina* Gutschick, Canis, and Brill 1967.

Diagnosis: Sclerite in the form of a single layered basal plate that has a tall smooth spire projecting from it.

Range: Carboniferous of the United States; Permian of Iran and the United States.

Clavallus spicaudina (Gutschick, Canis, and Brill 1967)

Plate 9, figures 11 - 12

Priscopedatus spicaudina GUTSCHICK et al. 1967, p. 1471, text-fig. 2 A-C, pl. 186, figs. 38-40, pl. 187, figs. 19, 24.

Priscopedatus cf spicaudina MOSTLER 1968, p. 17, pl. 6, fig. 14. - MOSTLER and RAHIMI-YAZD 1976, p. 14, pl. 4, fig. 14 (misprinted as 15), p1. 5, figs. 8-9.

Description: Sclerite in the form of a single layered basal plate that is circular to sub-circular with perforations of all sizes on it arranged in what appears to be no particular order. The plate curves upward to where a tall smooth spire projects out of it that narrows after the connection with the plate and then widens again into a bulb shape at the end.

Measurements (µm): Diameter of plate 205 – 263, length of spire 179 – 458.

Material: 6 specimens.

Discussion: Of six specimens studied only four of them had the plate with the spire still attached. The other two had only the plate, which at first suggested that they should be classified with the other plates in *Eocaudina*. However, upon examining these two plates under the microscope, it was obvious where the spire should have been. The area that was broken still showed the upward curving to where the spire should have been attached.

Occurrence: Carboniferous of the United States; Permian of Iran and the United States.

Described specimens were found at the Highway 337 location, sample C1.

Order DENDROCHIROTIDA Grube 1840

Parafamily CALCLAMNIDAE Frizzell and Exline 1955

Genus ***Eocaudina*** Martin 1952; emend. Gutschick and Canis 1971

Type species: *Eocaudina septaforaminalis* Martin 1952; emend. Gutschick and Canis 1971.

Diagnosis: Sclerites in the form of flat plates with circular holes in them. The holes in the plates are usually circular and tend to form rows. These plates are termed sieve plates.

Range: Devonian of Germany, Poland, and the United States; Mississippian of Afghanistan; Carboniferous of United States; Permian of Germany, Iran, Italy, and United States; Triassic of Australia, Austria, Bosnia and Herzegovina, China, Germany, Hungary, Iran, Italy, Poland, Slovakia, Slovenia, and Turkey; Jurassic of Austria and Egypt; Cretaceous of France and Germany.

Eocaudina gutschicki Frizzell and Exline 1955

Plate 9, figures 1 -2

Eocaudina gutschicki FRIZZELL and EXLINE 1955, p. 87, pl. 3, figs. 7-8, with all synonymy.

Eocaudina septaforminalis Martin 1952 - WERNLUND 1997, fig. 6.12, pl. 12: 1-14, fig. 6.13, pl. 13 :1-14, fig. 6.14, pl. 14:1-4.

Description: Sclerite sieve plate that is thin with circular to sub-circular perforations that are arranged in four-eight parallel rows. These rows contain anywhere from three up to eight perforations. The plates tend to be irregularly hexagonal with some of the outer rim being broken.

Measurements (µm): Width 389-617, there were a few specimens that measured in the high 200's, but these specimens appeared to be severely broken.

Material: 29 specimens.

Discussion: *E. gutschicki* is rather similar to *E. mccormacki* Frizzell and Exline (1955) but it has fewer perforations and fewer rows. *E. gutschicki* is also very similar to *E. croneisi* (Gutschick) emended by Frizzell and Exline (1955) in its perforations, however, *E. gutschicki* does not tend to elongate like *E. croneisi*. The difference between *E. gutschicki* and the genus type species of *E. septaforaminalis* Gutschick and Canis (1971) is that the later starts with a single perforation that is surrounded by an inner ring of six more perforations and an outer ring of roughly eleven perforations. *E. gutschicki*, on the other hand, has its perforations lined up in rows and not in this hexagonal flower type structure.

Occurrence: Lower Carboniferous of Scotland; Mississippian of Afghanistan; Pennsylvanian of Texas.

Described specimens were found at the Highway 16 Hills Estates Community Center location, samples 4, 7, 13, and 16; at the Highway 337 location, samples A0, A1, B1, C1, C2, C4, C6, C7, C8, C10, C11, C13, C14, C15, C16, C17, and C18.

Eocaudina (?) sp.

Plate 9, figures 3 - 4

Discussion: Five specimens were found that had varying perforation sizes, but the perforations are too infilled to determine exact species. These specimens have been assigned to *Eocaudina* conditionally.

Measurements (µm): Diameter 500 – 617.

Material: 5 specimens.

Occurrence: These two specimens were found in sample B1 and C15 at the Highway 337 locality.

Subphylum ASTEROZOA Zittel 1895

Class OPHIUROIDEA Gray 1840

Skeletal elements

Plate 9, figures 18 - 19

Description: Webbed spines.

Measurements (µm): Height 341 – 660, diameter of base of spine 41 – 60.

Material: 2 specimens.

Discussion: Flattened spines that have a small pocket on one side. The base is ball shape connecting to a thinner neck which connects to the webbed paddle of the spine. Connected to the webbed paddle are 3 spines with the center one being the longest.

Occurrence: These two specimens were found in sample C1 at the Highway 337 locality.

Order STENURIDA Spencer 1951

Suborder SCALARINA Hotchkiss 1976

Family KLASMURIDAE Spencer 1925; emend. Hotchkiss 1976

Genus ***Pectenura*** Haude 1982

Type species: *Pectenura horni* Haude 1982.

Diagnosis: Ophiuroids hooks.

Pectenura sp.

Plate 9, figures 16 – 17

Description: Ophiuroids hooks.

Discussion: The studied specimens belong to the genus *Pectenura*, but the exact species name was not able to be determined. The hooks shown on pl. 1, figs. 16 – 17 appear to be very similar to *P. formosa* Boczarowski 2001. However, the specimens have more than six accessory teeth, and the second to last tooth from the distal end is not the largest. In these specimens the second to last tooth is just smaller or close to the same size as the most distal tooth.

Measurements (µm): Height 667 – 1083.

Material: 8 specimens.

Occurrence: Described specimens were found in samples C1 and C16 at the Highway 337 locality.

Pectenura (?) sp.

Plate 9, figure 15

Discussion: The exact genus and species of this ophiuroid hook could not be determined, but based on its appearance as resembling other *Pectenura* hooks, it has been assigned conditionally herein to *Pectenura*.

Measurements (µm): Height 273.

Material: 1 specimen.

Occurrence: The specimen was found in sample C1 at the Highway 337 locality.

Holothurian Sclerites and Skeletal Elements of the Ophiuroidea Plate

Plate 9

Holothurian sclerites (Figs 1-14) and skeletal elements of the Ophiuroidea (Figs 15-19) from the Placid Shale Formation, Missourian, Upper Pennsylvanian.

Figure 1 – scale bar = 150 µm; figure 2 – scale bar = 200 µm; figures 3, 18 – scale bar = 160 µm; figure 4, 16 – scale bar = 180 µm; figures 5, 6, 12, 13, 14, 19 - scale bar = 100 µm; figure 7 – scale bar = 70 µm; figures 8, 11, 15 – scale bar = 80 µm; figures 9, 10 – scale bar 60 µm; figure 17 – scale bar = 250 µm.

1 – 2: *Eocaudina gutschicki* Frizzell and Exline 1955. 1 – sample C1, 2 – sample A0; section Highway 337.

3 – 4: *Eocaudina* (?) sp. 3 – sample C15, 4 – sample B1; section Highway 337.

5 – 6: *Paleochiridota plummerae* Croneis in Croneis and McCormack 1932. 5 – upper view, sample A0, 6 – lower view, sample C16; section Highway 337.

7 – 8: *Microantyx botoni* Gutschick 1959. 7 – upper view, 8 – lower view; sample 14; section Highway 16 Hills Estates Community Center.

9 – 10: *Protocaudina kansasensis* (Hanna 1930). 9 – upper view, sample 13, 10 – lower view, sample 4; section Highway 16 Hills Estates Community Center.

11 – 12: *Clavallus spicaudina* (Gutschick et al. 1967). 11 – upper view, 12 – side view; sample C1; section Highway 337.

13 – 14: *Achistrum monochordata* Hodson, Harris and Lawson 1956. 13 – side view 14 – side view sample 27; section Highway 16 Hills Estates Community Center.

15: *Pectenura* (?) sp. sample C1, section Highway 337.

16 – 17: *Pectenura* sp. 16 – sample C1, 17 – sample C16; section Highway 337.

18 – 19: “Webbed” spines, sample C1; section Highway 337.

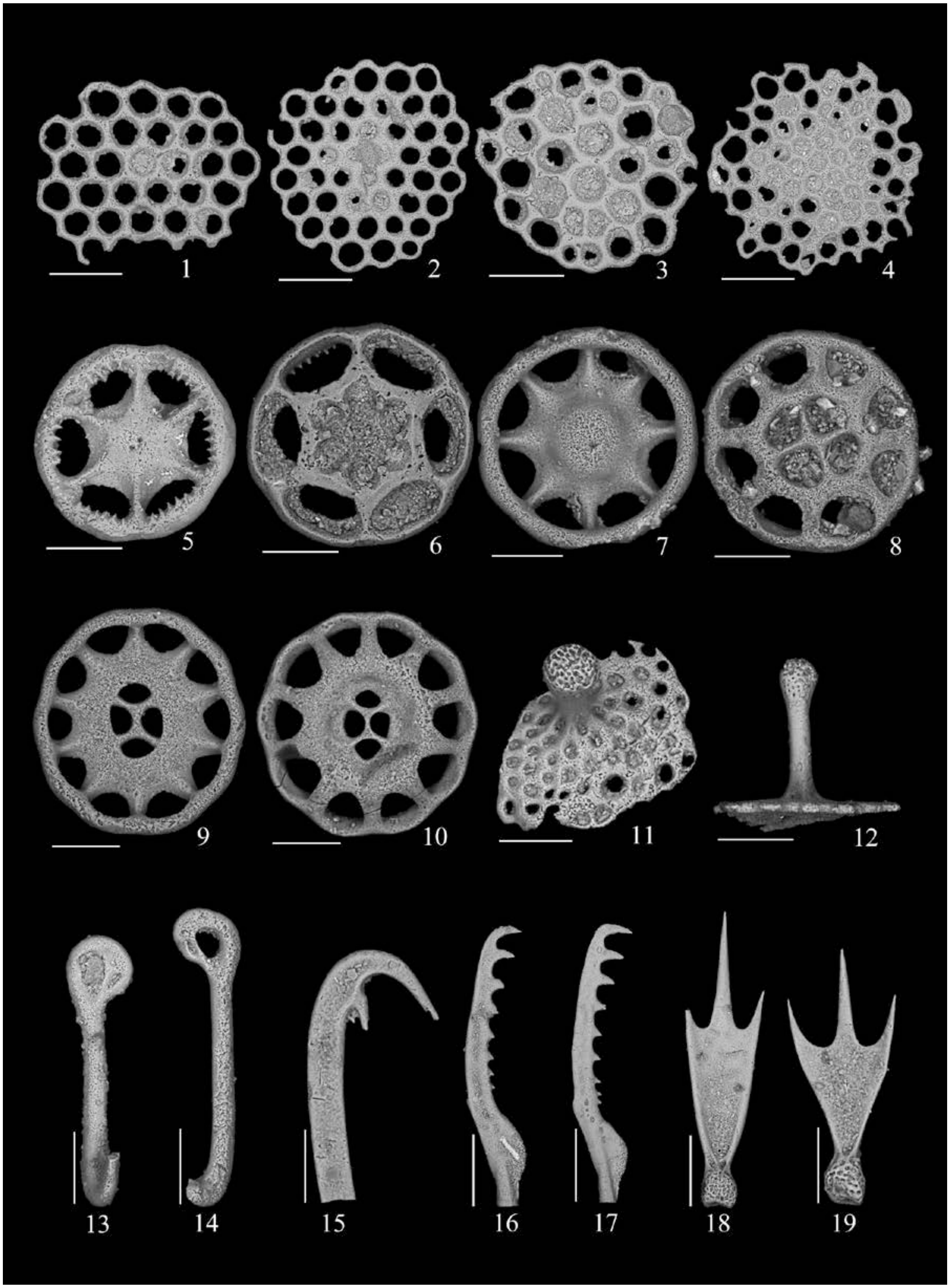


Plate 9

CHAPTER 7

CONODONTS

Introduction

Conodonts are teeth like remains of mouth part apparatuses that are the only parts preserved of a soft-bodied eel-like vertebrate. There have been some fossils of impressions of the conodont animal such as the Namurian (Carboniferous) specimens described by Briggs et al. (1983) from Scotland that show the preservation of the original soft parts in the head region of the organism. From these specimens, along with others, ideas of what the living conodont animal might have looked like have been presented (Keairnes 2002). Conodonts are tiny, usually only several hundred micrometers in length. They are found only in marine rocks, and have a stratigraphic range from the Cambrian – Triassic. Conodonts have very diverse morphologies, global distribution and rapid evolution which make them excellent index fossils for biostratigraphy.

The time ranges for the conodonts was gathered from the Paleobiology Database and, because the Paleobiology Database is a work in progress, the time ranges for many species may not be complete.

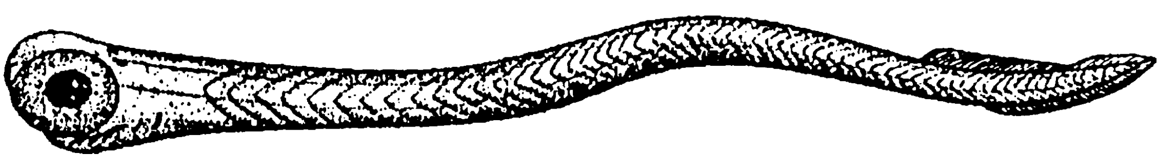


Figure 7.1: Reconstructred conodont illustrating what they may have looked like during life (after Aldridge et al. 1994).

Descriptions of Conodonts

Kingdom ANIMALIA

Phylum CHORDATA Bateson 1885; em. Bateson 1886

Class CONODONTA Eichenberg 1930

Order CONODONTOPHORIDA Eichenberg 1930

Genus ***Streptognathodus*** Stauffer and Plummer 1932

Type species: *Streptognathodus excelsus* Stauffer and Plummer 1932.

Diagnosis: A broad platform that has a deep median furrow on the upper surface that contains eight to twelve lateral ridges. Ridges fuse into lines or nodes that bend downwards at each side of the base of the platform. The blade shows sixteen or more denticles on its upper edge. Denticles are fused along their edges to about three-quarters of their length.

Range: Carboniferous: Brazil, Mexico, United States; Permian: Mexico, Russia, Turkey and the United States.

Streptognathodus firmus Kozitskaya 1978

Plate 10, figure 13

Streptognathodus firmus KOZITSKAYA et al. 1978, p. 340-341, figs. 10-11. - KEAIRNES 2002, figs. 6.1, 6.3, 6.4, 6.5.

Description: A Pa element that has a centered carina that is long, extending over 95% of the length of the platform. The carina is continuous, without developing carinal nodes, and has a slight downward slope from anterior to posterior. Grooves on both sides of the platform run along the carina and transverse ridges are visible.

Material: 1 specimen.

Discussion: *Streptognathodus firmus* can be distinguished from *S.* sp. *C* by the fact that *S. firmus* has a carina that is greater than 95% the length of the platform whereas the carina in *S.* sp. C is only greater than 75% of the platform length and tends to become nodes towards its termination point.

Occurrence: The specimen was found at the Highway 337 locality, sample PlCon1.

Streptognathodus pawhuskaensis (Harris and Hollingsworth 1933)

Plate 10, figures 10, 12

Polygnathus pawhuskaensis HARRIS and HOLLINGSWORTH 1933, p. 199-200, pl. 1, figs. 12a, b.

Streptognathodus pawhuskaensis KEAIRNES 2002, figs. 6.1, 6.3, 6.4, 6.5.

Description: A Pa element that has a centered carina that extends one-third of the length of the platform and then ends abruptly without any tapering down or carinal nodes. A deep central trough extends along the platform and transverse ridges can be seen along both sides of the platform.

Material: 2 specimens.

Discussion: *Streptognathodus pawhuskaensis* can be distinguished from *S. sp. D* by the abrupt termination of its carina without any carinal nodes after the termination. *S. pawhuskaensis* can mainly be distinguished from *S. sp. C* and *S. firmus* Kozitskaya (1978) by the length of the carina.

Occurrence: Described specimens were found at the Highway 337 locality, sample PlCon2.

Streptognathodus **sp. C**

Plate 10, figures 8, 14

Streptognathodus sp. C KEAIRNES 2002, figs. 6.1, 6.3, 6.4, 6.5.

Description: A Pa element that has a centered carina that extends at least 75% of the length of the platform. The carina has a downward slope to the posterior and can either end by sloping down into the platform or by terminating beyond the midway point and becoming carinal nodes.

Material: 2 specimens.

Discussion: *Streptognathodus* sp. C can be destinguished from *S. firmus* Kozitskaya (1978) by the overall length of the carina. *S. firmus* has a carina that runs 95% of the length of the platform whereas the caarina in *S. sp. C* only extends to 75% of the length of the platform. *S. sp. C* can also show carinal noding whereas *S. firmus* does not.

Occurrence: Described specimens were found at the Highway 337 locality, samples PlCon1 and PlCon2.

Streptognathodus sp. D

Plate 10, figures 7, 9, 11, 15, 16

Streptognathodus sp. D KEAIRNES 2002, figs. 6.2, 6.3, 6.4, 6.5.

Description: A Pa element that has a centered carina that runs over 50% and up to 75% of the length of the platform. The carina has a high anterior portion that slopes down to the posterior and has a sudden drop off or nick point at the posterior portion. After the nick point the carina does not end, but instead becomes a series of carinal nodes or a smaller carina that trails off to the posterior, but terminate before reaching the posterior end.

Material: 5 specimens.

Discussion: *Streptognathodus* sp. D can be distinguished from *S. firmus* Kozitskaya (1978) by the carina length and by the appearance of a definite "nick point" in the carina (Keairns, p. 139, 2002). *S.* sp. D can be distinguished from *S.* sp. C by the fact that *S.* sp. C has a gradual slope of the carina whereas *S.* sp. D does not.

Occurrence: Describedspecimens were found at the Highway 337 locality, samples PlCon1 and PlCon2.

Streptognathodus sp**.**

Plate 10, figures 4 – 6

Description: Narrow Pa element with a deep median furrow with a carina that extends over 75% of the length of the platform. The carina develops into nodes at the posterior end. The bar shows roughly 12 denticles on its upper edge.

Material: 3 specimens.

Discussion: The specimens of *Streptognathodus* appear to be possibly juvenile forms of either *S*. sp. C or *S*. sp. D. of Keairns (2002). They are smaller in size and platform width than the other specimens found at the same locations.

Occurrence: Described specimens were found at the Highway 337 locality, sample PlCon2; at the Hills Estates B locality, sample 3; and at the Hills Estates Community Center locality, sample 23.

Genus ***Adetognathus*** Lane 1967

Type species: *Cavusgnathus lautus [sic]* Gunnell 1933.

Diagnosis: A platform that has a blade that is attached to either the right or left margin and in the center is a deep trough.

Range: Carboniferous of Brazil, Mexico, and the United States; Permian of Russia.

Adetognathus sp**.**

Plate 10, figures 1 – 3, 18

Description: A Pa element that has a center trough that is flanked on either side by a margin that shows transverse ridges. The blade is attached to either margin and a carina is not present.

Material: 4 specimens

Discussion: Out of the four specimens photographed, three of them had a blade that attached to the left margin with only one showing attachment at the right margin.

Occurrence: Described specimens were found at the Highway 337 locality in samples PlCon1, C3, and C16.

Genus ***Hindeodus*** Rexroad and Furnish 1964

Type species: *Trichonodella imperfecta* Rexroad 1957.

Diagnosis: *Hindeodus* was original described as a genus based on phylogeny and not morphology. This being stated, the diagnosis is based on evolutionary relationships and not just descriptions. *Hindeodus* includes specimens that are derived directly from *Hindeodella*.

<u>Range</u>: Carboniferous of Egypt, Mexico, Russia, the United Kingdom, and the United States; Permian of Armenia, China, Hungary, Italy, India, Oman, Serbia and Montenegro, Turkey, and the United States;Triassic of Armenia, Austria, China, Greenland, Hungary, India, Italy, and Oman.

Hindeodus (?) sp**.**

Plate 10, figure 17

Description: P1 element that has 14 denticles. There are 2 smaller denticles followed by a very large horn like denticle, followed by 11 denticles that are fairly equal in size and shape. These trailing denticles are attached at the base, but have space between them. The sides of the element inflate into a convex shape that tapers down to the posterior and anterior.

Material: 1 specimen.

Occurrence: The specimen was found at the Highway 337 locality, sample PlCon2.

Conodont Plate

Plate 10

Conodonts from the Placid Shale Formation, Missourian, Upper Pennsylvanian.

Figure 1, 2 – scale bar = 150 µm; figure 17– scale bar = 200 µm; figure 3, 5 – scale bar = 250 µm; figure 12, 18 – scale bar = 290 µm; figure 4, 6, 8, 9, 10, 11, 14, 15, 16 – scale bar = 300 µm; figure 7 – scale bar = 310 µm; figure 13 – scale bar = 400 µm.

1 – 3, 18: *Adetognathus* sp. 1, 2 – sample C3, 3 – sample C16, 18 – sample PlCon1; section Highway 337.

4 – 6: *Streptognathodus* sp., possible juveniles of sp. C or sp. D, 4 – sample 23; section Highway 16 Hills Estates Community Center; 5 – sample 3; section Highway 16 Hills Estates B; 6 – sample PlCon2, section Highway 337.

8, 14: *Streptognathodus* sp. C. 8 – sample PlCon2, 14 – sample PlCon1; section Highway 337.

13: *Streptognathodus firmus* Kozitskaya 1978. Sample PlCon1; section Highway 337.
7, 9, 11, 15, 16: *Streptognathodus* sp. D. 7, 9, 11 – sample PlCon2, 15, 16 – sample PlCon1; section Highway 337.

10, 12: *Streptognathodus pawhuskaensis* (Harris and Hollingsworth 1933). 10, 12 – sample PlCon2; section Highway 337.

17: *Hindeodus* (?) sp.Sample PlCon2; section Highway 337.

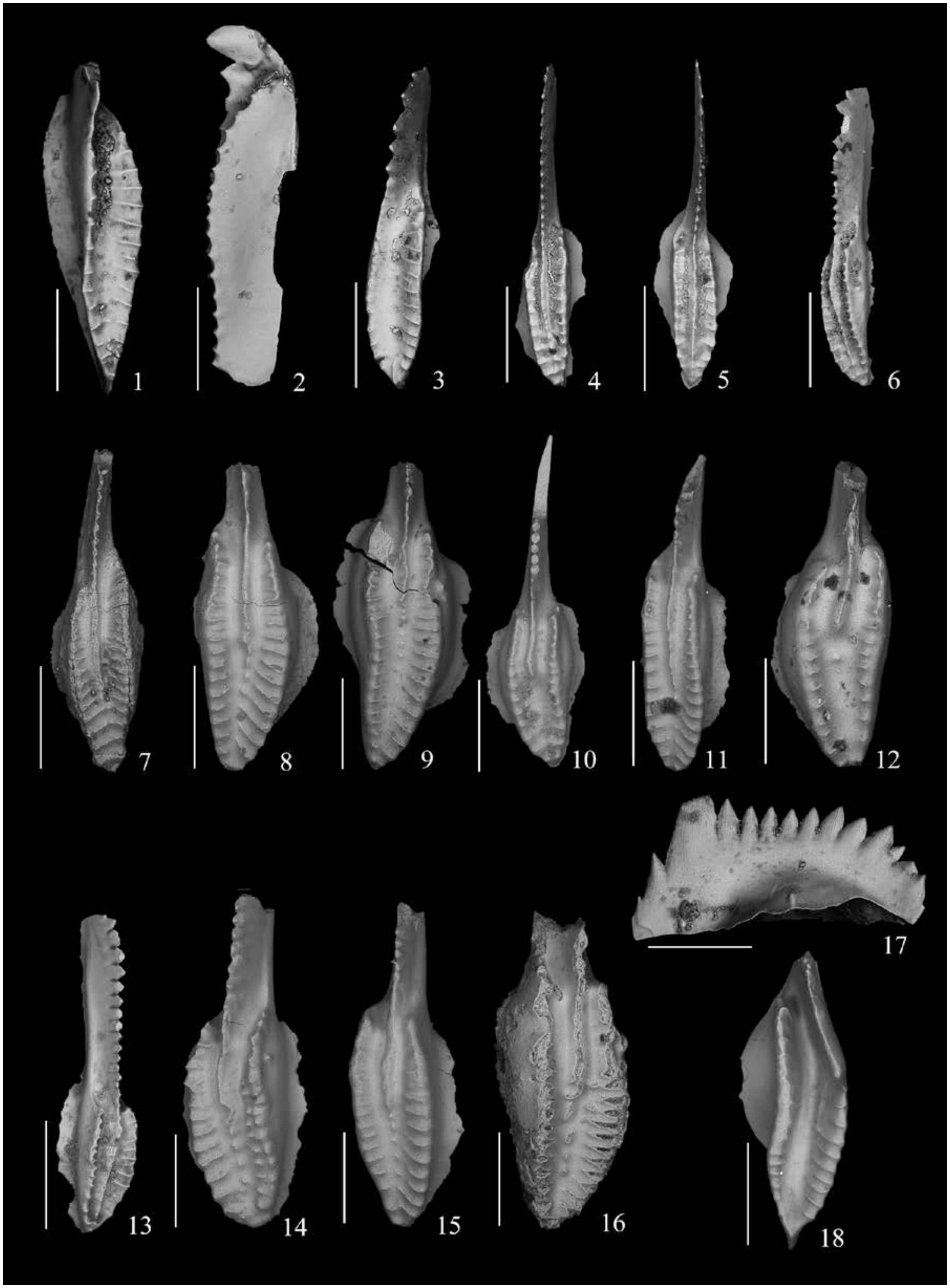


Plate 10

CHAPTER 8

CONCLUSIONS

Documenting and identifying the microfauna at three localities of the Placid Shale Highway 337, Highway 16 Hills Estates Community Center, and Highway 16 Hills Estates B (figs. 1.2, 1.3) are the focus of this study. The microfaunal elements included are holothurian sclerites, ophiuroids, ostracodes, conodonts, fusulinids, and small foraminifers. These specific taxa were examined because little work has been done on the microfaunas from Late Pennsylvanian age strata in the Brazos River Valley in the last fifty years. The systematics of the microfaunal elements taxa needed to be updated by using Scanning Electron Microscope (SEM) pictures and thin sections. This new study resulted in the identification of forty seven species including twenty four species of small foraminifers, two species of fusulinids, five species of ostracodes, nine species of holothurian sclerites, one skeletal element and two species of ophiuroids, and seven species of conodonts. During the identification of the microfaunal elements in this study, it was found that their taxonomic assignments needed revision. For example, the generic assignment of the foraminifer *Textularia* (?) *bucheri* Ireland 1956 needed to be changed.

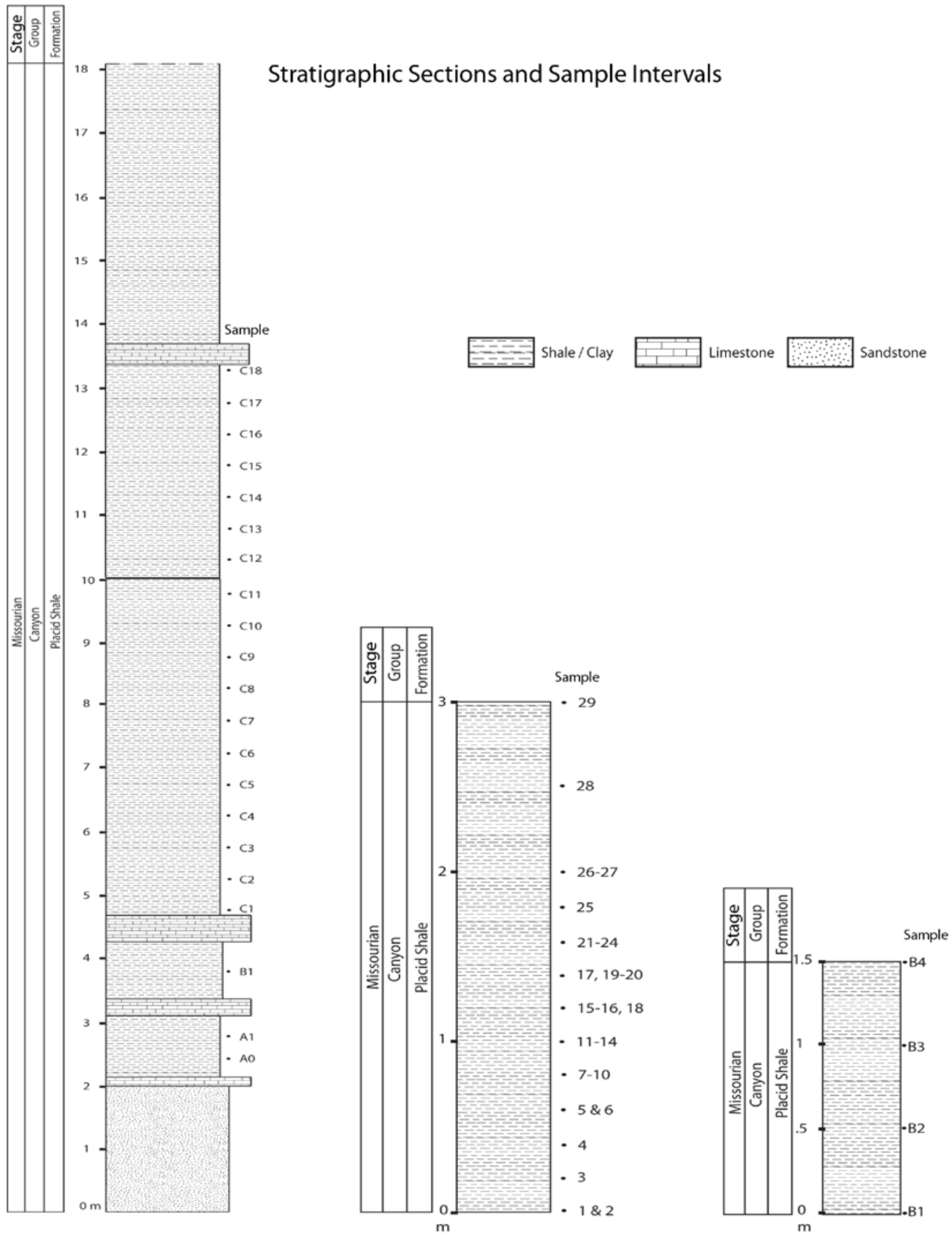
The microfaunal assemblage of this study is also used to assign the strata of the three sample localities to the upper and lower transgressive cycles within the Placid Shale. Boardman and Heckel (1989) identified a number of cycles in the Late Pennsylvanian age strata of North-Central Texas and correlated them with the well-known Pennsylvanian cyclothems of the midcontinent. They correlated the cycle of the Lower Placid to one of the regressive parts of the Stanton cycle and the cycle of the Upper Placid to the South Bend Limestone of the midcontinent. This assignment is based on the species of conodonts and fusulinids found in both areas.

To correlate the Upper Placid cycle to the South Bend Limestone of the midcontinent, Boardman and Heckel (1989) used the fusulinid *Triticites newelli* and undisclosed conodont species. In later studies of the conodonts of the South Bend Limestone, Ritter (1995) established the presence of the diagnostic conodont *Streptognathodus firmus* near the base of the South Bend Limestone. The occurrence of *T. newelli* along with *S. firmus* at the Highway 337 locality shows that these strata of the Upper Placid cycle can be definitely correlated with the South Bend Limestone of the midcontinent as Boardman and Heckle indicated. Additional evidence supporting this conclusion is the presence of the Ranger Limestone which stratigraphically overlies the Placid Shale section at the Highway 337 locality.

Regarding the Highway 16 Hills Estates localities, there was one locality, Highway 16 Hills Estates A, which was sampled but not studied. The Ranger Limestone also stratigraphically overlies the Placid Shale at the Hills Estates A locality. This evidence supports that the Hills Estates A locality is stratigraphically the same interval as the Highway 337 locality and represents the same upper cycle. The other two localities, the Highway 16 Hills Estates Community Center and Highway 16 Hills Estates B, are stratigraphically more than 15 meters below the Hills Estates A locality and therefore appear to be located in the Lower Placid cycle. Boardman and Heckel (1989) did not give any specific microfauna taxa as their reason for correlating the Lower Placid cycle to a regressive unit within the Stanton Limestone. Not having specific designated taxa on which to base a comparative correlation, the fusulinid genera *Kansanella* was used to attempt a correlation between the Lower Placid cycle and the Stanton Limestone. Fusulinids have been well documented and have become an acceptable, if not preferred microfossil for correlations of Pennsylvanian age strata. Thompson (1957) did a study on midcontinent Missourian fusulinids where he described many species of *Kansanella*. However, during this study it appears that the species of *Kansanella* found at the Highway 16 Hills Estates Community Center is probably new. Comparing *Kansanella* sp. 1 to the work of Thompson (1957) it looks as if this possibly new species lies morphologically between *Kansanella (Kansanella) neglecta* (Newell 1934) found in the Captain Creek Limestone member of the Stanton Limestone and *Kansanella (Kansanella) joensis* Thompson 1957 of the Iatan Limestone of the midcontinent. Once further work is done, and a new species is established for *Kansanella* sp. 1, another effort to correlate the Lower Placid cycle to the midcontinent can be attempted.

APPENDIX A

STRATIGRAPHIC SECTIONS AND SAMPLE INTERVALS



Highway 337
18 meter section

Highway 16
Hills Estates Community Center
3 meter section

Highway 16
Hills Estates B
1.5 meter section

APPENDIX B

PICTURES OF SAMPLE LOCALITIES

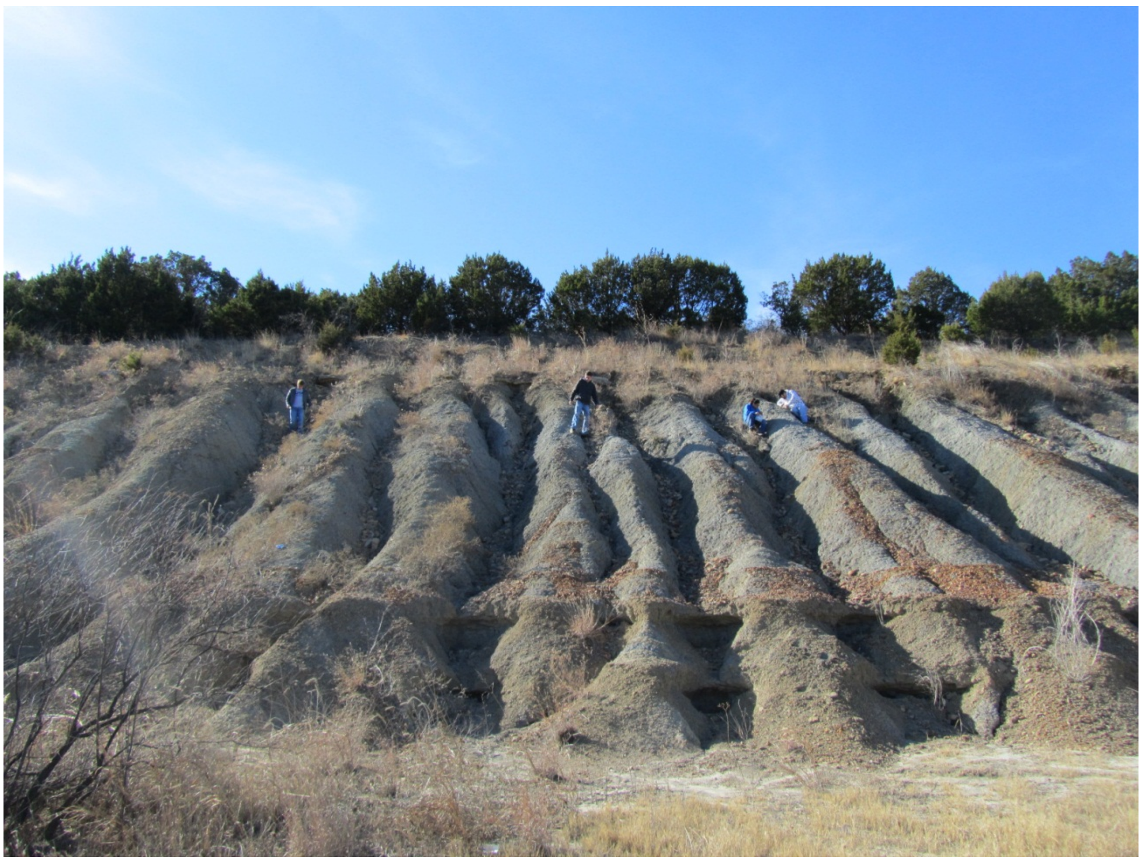


Photo 1: Highway 337 locality

Photo 2: Trench sampled at the Highway 337 locality

Photo 3: Highway 16 Hills Estates Community Center locality.

Photo 4: Fossiliferous ground at the Highway 16 Hills Estates Community Center

Photo 5: Highway 16 Hills Estates A locality

Photo 6: Highway 16 Hills Estates B locality

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BIOGRAPHICAL INFORMATION

Brittany Meagher began studying at the University of California Riverside. During her time there she realized that she could major in geology, a topic she has always been passionate about. She transferred to the University of Kansas and earned her Bachelors of Science in Geology in 2007. After finishing her undergraduate degree, she went to work in the oil industry, and gained experience as a mudlogger and later a geology technician. In 2009 Brittany decided it was time to return to school. She decided to attend the University of Texas Arlington to complete her Masters of Science Degree focusing on micropaleontology. After graduation Brittany will resume working in the oil and gas industry as a Geologist.