This dissertation has been 64-5172
microfilmed exactly as received

WADDELL, Dwight Ernest, 1927-
STATISTICAL ANALYSIS OF THE FUSULINID GENERA FUSULINELLA, FUSULINA, WEDEKINDELLINA?, AND TRITICITES IN THE ARDMORE BASIN, OKLAHOMA.

The University of Oklahoma, Ph.D., 1964
Geology

University Microfilms, Inc., Ann Arbor, Michigan

THE UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

STATISTICAL ANALYSIS OF THE FUSULINID GENERA FUSULINELLA FUSULINA, WEDEKINDELLINA?, AND TRITICITES IN THE ARDMORE BASIN, OKLAHOMA

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the

degree of

DOCTOR OF PHILOSOPHY

BY

Ernest

DWIGHT E. WADDELL

Norman, Oklahoma

1964

STATISTICAL ANALYSIS OF THE FUSULINID GENERA FUSULINELLA,

FUSULINA, WEDEKINDELLINA?, AND TRITICITES

IN THE ARDMORE BASIN, OKLAHOMA

APPROVED BY

E.A. Frederickson

E.L. Lucas

R.H. Harris

C.A. Merritt

Teague Self

David B. Kitts

DISSERTATION COMMITTEE

DISSERTATION

Abstract

STATISTICAL ANALYSIS OF THE FUSULINID GENERA FUSULINELLA, FUSULINA, WEDEKINDELLINA?, AND TRITICITES IN THE ARDMORE BASIN, OKLAHOMA

A total of 17 fusulinid species from the Pennsylvanian System in the Ardmore Basin, Oklahoma, are described, of these four are new. In connection with the investigation a multivariate method is presented for treatment of the principal morphological features of fusulinids. The statistical presentation is based upon the dimensions of half lengths, radius vector, protheca thickness, septal count, tunnel width, and proloculus. The taxonomic, and evolutionary investigations are supported by both univariate and multivariate statistical methods. Hotelling's T^2 and the linear discriminant function are presented in detail to facilitate biometric analysis. Confidence intervals are given which provide a means of precisely stating what is meant by the range of some measurement when the range is based upon sample data. It is postulated that in comparing the many variables it is possible to test the statistical significance of the observational data.

Most of the existing confusion in the Ardmore Basin stratigraphy is the result of confusing lithostratigraphic units and biostratgraphic zones. Those formations which are not lithologic entities but are bio-zones are rejected. Formations thus rejected include the Golf Course, Lake Murray, and Big Branch.

The lithology and stratigraphy of the Pennsylvanian Dornick Hills, Deese, and Hoxbar Groups is presented. The Dornick Hills Group includes rocks of Morrowan, "Atokan", and Desmoinesian Age and is characterized by the fusulinid genera *Fusulinella*, *Fusulina*, and *Wedekindellina*. The Deese Group is Desmoinesian in age and contains the genera *Fusulina*, and *Wedekindellina*. The Hoxbar Group is considered Missourian in age and possesses the fusulinid genera *Wedekindellina* ?, and *Triticites*. Fusulinid evidence indicates that conglomerates on the so-called west limb of the Overbrook anticline are Desmoinesian in age and not "Atokan" as generally considered.

The identification and correlation of the fusulinids of the Ardmore Basin with those of adjacent areas will increase the usefulness of existing valid stratigraphic names in this structurally isolated provence.

ACKNOWLEDGMENTS

This study is submitted as partial fulfillment for the degree of Doctor of Philosophy. Portions of the study were supported by The Southern Fellowship Fund, Oklahoma Geological Survey, and the Oklahoma Chapter of The Society of The Sigma Xi. To these organizations the writer is grateful.

The problem was directed by Dr. E. A. Frederickson whose council and supervision are gratefully acknowledged.

Members of the writer's doctorial committee who read the manuscript and made available their advice and guidance are: Dr. D. B. Kitts, Dr. C. A. Merritt, and Dr. C. C. Branson. To these men the writer is grateful.

To Mr. Charles Maudlin for advice in programming methodology and to Dr. Raymond L. Roth, St. Bonaventure College, for critical review of the statistical portion of the dissertation the writer offers grateful acknowledgment.

Particularly the writer is grateful to Mr. William Bellis, graduate student, for photographic assistance and Mr. Tom Rowland, Oklahoma Geological Survey, for drafting the columnar sections.

This study could not have been completed without the encouragement and moral support provided by my wife "Jerry" S. Waddell.

Lastly to the Fellows of F. E. S. A., I gratefully acknowledge intangible benefits from constant encouragement to maintain rationality.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

STATISTICAL ANALYSIS OF THE FUSULINID GENERA FUSILINELLA,

FUSULINA, WEDEKINDELLINA?, AND TRITICITES

IN THE ARDMORE BASIN, OKLAHOMA

INTRODUCTION

Burma (1948) indicated that of the invertebrate fossils, fusulinids have been studied under a quantitative guise more consistently than other groups. The word quantitative should read quasi-quantitative, because the practice of tabulation of raw data and computing the average of the $\underline{k}$ th variable of a sample do not constitute a quantitative method.

Such workers as Thompson, Dunbar, Condra, Henbest, and many others have made significant contributions to fusulinid morphology, phylogeny, and stratigraphy. However, methods of comparison of samples which have been largely ignored in the past are available and should be utilized.

Purpose of Investigation

The purpose of this investigation was two-fold: (1) to consider the application of the statistical method and the computer to the morphology and distribution of characters of fusulinids both geographically and in time, and (2) to characterize and describe the genera

Fusulina, *Fusulinella*, *Wedekindellina*? and *Triticites* in the Ardmore Basin of Oklahoma.

Previous Investigations

A brief chronologic history and development of the terminology applied in the Ardmore Basin above the Jolliff Limestone Member is presented below.

1903: J. A. Taff (p. 5) first mapped and described the rocks cropping out south of the Arbuckle Mountains. He assigned the name Glenn Formation to the sedimentary section overlying the Caney Shale and below the "Franks" Conglomerate and recognized an early Pennsylvanian age for the fossils present.

1922: W. L. Goldston (p. 7-13) recognized the conformable nature of the Caney-Glenn contact and subdivided the Glenn formation into five members (ascending): Springer, Otterville, Cup Coral, Deese, and Hoxbar.

1923: G. H. Girty, and P. V. Roundy (p. 331-341) disagreed with Goldston on the selection of the lower and upper limits of the Glenn Formation and suggested that his Hoxbar member was stratigraphically above the Glenn as recognized by Taff, and the Springer and Otterville Members were below. The mapping of the Springer Formation about the Criner Hills by Goldston (p. 7) was shown to be wrong and they suggested that these rocks are as young as Hoxbar.

1926: H. D. Miser mapped the Glenn Formation as defined by

Goldston in the Ardmore Basin with the exception of excluding the Springer Member.

1929: C. W. Tomlinson (p. 11) raised the Springer and Hoxbar Members of Goldston to formation rank and subdivided the remaining sedimentary units into a lower Dornick Hills Formation and an upper Deese Formation.

1933: W. M. Guthrey, and C. A. Milner mapped the area south and southeast of Ardmore, Oklahoma. Three new member names were suggested on this map, the Rockpoint Conglomerate, Williams Member, and the "Hollis" Sandstone-Limestone, all in the upper Deese Formation. The map also showed that Tomlinson's Confederate Member and Westheimer Member were the same unit. The map is unpublished, but Tomlinson (1937) who first published the names Williams and "Hollis" gave Guthrey and Milner credit as the authors of the names. The name Rocky Point (replaces Rockpoint on map) was apparently first published by Dott (1941) although Tomlinson (1937) showed the unit in his outcrop map of the Ardmore Basin.

1934: C. W. Tomlinson (p. 1085) acknowledged the corrections resulting from Guthrey and Milner's mapping, and made a further correction by indicating that the Union Dairy and Crinerville Members were one and the same and he suppressed the name Union Dairy.

1934: F. W. Floyd and D. C. Nufer (p. 10-11) proposed the name Big Branch for rocks of the interval from the top of the

Lester Member to the top of the Pumpkin Creek Member.

1936: J. Westheimer (p. 5) removed the "basal, nodular, white, dense limestone" of Tomlinson (1929, p. 34) from the Pumpkin Creek and applied the name Frensley Member.

1937: C. W. Tomlinson (p. 1) proposed the name Natsy for rocks with the preoccupied name "Hollis."

1941: R. H. Dott (p. 1664-1668) presented a general discussion on the Ardmore Basin stratigraphic elements.

1945: M. G. Cheney et al. (p. 143) employed the name Goddard for the first time in the literature although the name was first used by J. Westheimer.

1954: A. P. Bennison (p. 913) proposed the name Target Limestone Member for a limestone which he mapped in secs. 2, 3, T. 3 S., R. 2 E., 60 feet below the Lake Ardmore Sandstone of the Springer Formation.

1954: H. D. Miser, on the latest edition of the Geologic Map of Oklahoma, mapped the Goddard Shale as the basal member of the Springer Formation. The Dornick Hills, Deese, and Hoxbar were mapped as formations.

1956: B. H. Harlton (p. 139-142) proposed the name Lake Murray Formation to include the rock strata from the top of the Otterville Member to the top of the Frensley Member. The new name Golf Course Formation was proposed for strata from the base of the Primrose Member through the Otterville Member. He also modified the Big Branch Formation by raising the base from the top of the Lester Member to the top of the Frensley Member, and subordinated the name Lester to the rank of bed in the Frensley Member.

1956: I. C. Hicks et al. (p. 4 footnote 1, forward) elevated the Springer, Dornick Hills, Deese, and Hoxbar Formations to Group rank.

1956: J. M. Westheimer, and F. P. Schweers (p. 146-147) proposed the name Dolman Formation for beds in the subsurface which occur between the Anadarche Limestone and the Crinerville Limestone. (This name is preempted by the Dolman Gneiss, Devonian, Newfoundland, 1954).

1957: C. L. Ramay (p. 45) formalized the name Camp Ground Member by publication although it was proposed informally by I. C. Hicks in 1953 after consultation with the Board of Geologic Names.

1959: C. W. Tomlinson, and W. McBee, Jr. (p. 461-499) have a revision of their 1959 article in The Pennsylvanian System in the United States with editorial corrections by C. C. Branson (p. 479-480). These corrections were based upon an unpublished Master of Science thesis (1959) concerning the "Atokan"-Desmoinesian boundary in the Ardmore Basin.

1962: E. A. Frederickson (p. 295-296) described the surface extent of the type section of the "Dolman" Formation. (Name preempted).

Location of Area

The area studied includes the outcropping Pennsylvanian strata above the Golf Course Formation in Carter and Love Counties, Oklahoma. Most of the field work was confined to the area south of the city of Ardmore because of the structurally uncomplicated nature of the southeast limb of the Overbrook anticline. In addition, formations of the Brock anticline and Pleasant Hill syncline were sampled for correlation purposes with the standard of the Overbrook anticline.

Method of Investigation

Approximately 2,000 thin-sections of fusulinids from various strata were prepared and examined. Measurements, explained later in the text, were taken from both the sagittal and axial sections.

In keeping with the practice of other fusulinid workers, the mean of each volution was computed. Also the standard deviation, and a 99 percent confidence limit about the mean was computed for all the volutions. These are presented in the tables in Appendix II.

It was considered that genera are purely subjective entities, therefore generic differentiation was based upon the broad aspects of general morphology utilized by most workers in the field. Because it is believed that species differentiation in the fusulinids is primarily based upon degree of character difference, a statistical test which would consider many characters simultaneously was utilized. Hotelling's T^2, a multivariate generalization of Studert's-t, was programmed for the IBM 1620 computer. This test was applied when there was doubt as to the affinities of samples from different stratigraphic or geographic locations.

A linear discriminant function was utilized to place a small sample of individuals into their most probable population on the basis of a standard discriminating formula.

Although discrimination among fusulinids within the Ardmore Basin is handled in a general statistical manner, the final disposition to species is subjectively handled for obvious reasons. It is felt that future species assignment based upon actual measurements from populations is not impossible or improbable for a statistical-computer program.

Eighteen measured sections are described in the appendix. Columnar sections of these described sections are also presented.

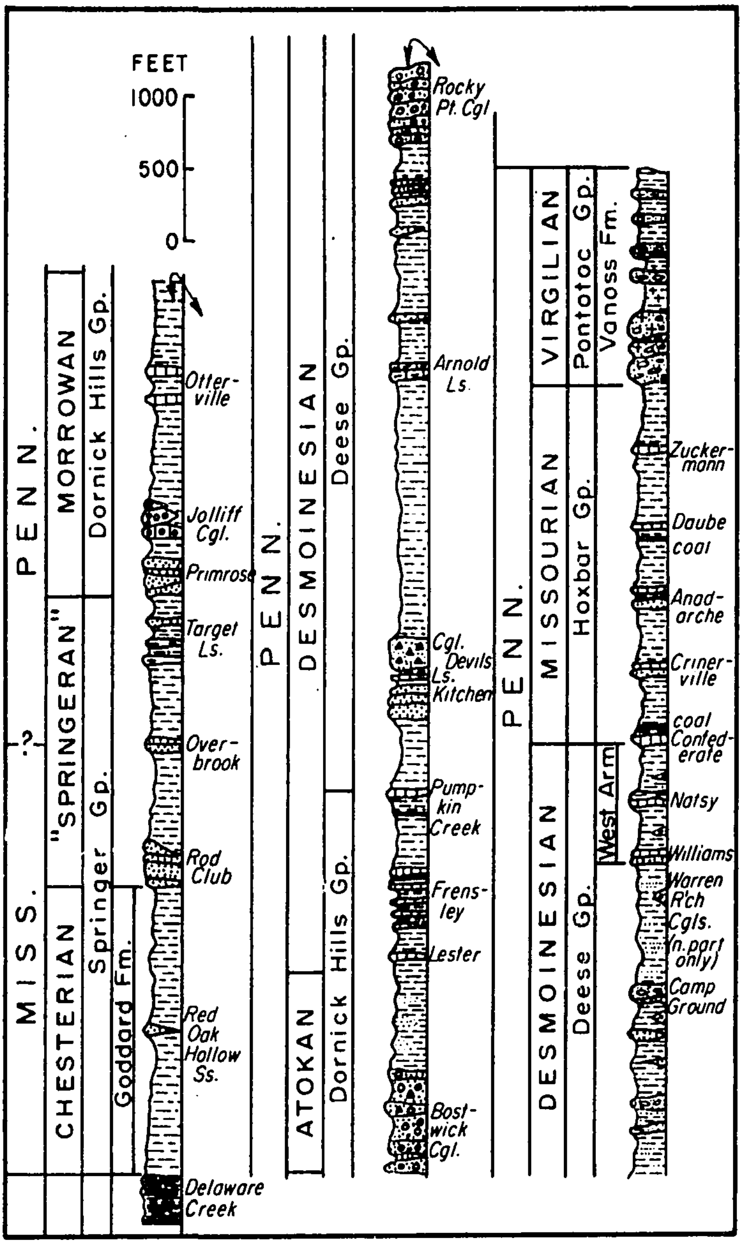
LITHOSTRATIGRAPHY

Stratigraphic Philosophy

The nomenclature of rock-stratigraphic units in the Ardmore Basin is in a confused state, primarily because of the conflict between two opposing philosophies. Arbitrary manipulation of member and formation boundaries to "better" fit an imposed time designation has added nothing but confusion to this structurally and sedimentary complex area. Series and systemic boundaries are not mappable units and do not necessarily conform to mappable lithologic units. Therefore, when a time-stratigraphic boundary is raised or lowered (such as the lowering of the Desmoinesian boundary from above the Frensley Limestone to below the Lester Limestone in Tomlinson and McBee, 1962, footnote 10, p. 479) based upon new paleontologic evidence, the lithostratigraphic units involved should remain unhindered by redefinition.

The first thorough treatment of the Ardmore Basin rocks was presented by C. W. Tomlinson (1929). Formations and members assigned by Tomlinson were based upon the underlying principle that rock-stratigraphic units are lithologic entities and are divorced from any formal time connotation. Later formations proposed by Floyd and Nufer (1934, p. 10), Westheimer (1936, p. 5), Harlton (1956, p. 138-140), and others

FIGURE I



COMPOSITE COLUMNAR SECTION
modified from
Tomlinson & McBee, 1959

have been based upon an entirely different philosophy. This philosophy allows definition of rock-stratigraphic units based upon rather ill-defined biostratigraphic criteria. It is acceptable to use fossils as physical criteria in definition of a formation, but units defined solely on the basis of fossils become biostratigraphic zones and not formations.

In 1956 (in Petroleum Geology of Southern Oklahoma, vol. II) existing formations of the Ardmore Basin were elevated to group rank without first proposing new formation names. Hicks (1956, footnote 1 to table II, p. 4) indicated that a study on recommending new formation names was in progress. Nothing has been recommended to date and it is extremely unlikely that anything will soon develop. The formations proposed by Harlton (1956, p. 138-140) and the older Big Branch Formation are not distinguishable lithologically but are poorly defined biostratigraphic zones and are for that reason unacceptable as formations under the code of stratigraphic nomenclature (1961, p. 650). This presents the dilemna of groups not composed of formations and members not assigned to formations.

The preceding discussion is one view on a significant stratigraphic problem, and it is hoped it will serve as food for thought against continued aimless nomenclatorial designation. It is not intended as justification to the presentation of new formation names because an useful formational classification should be a joint effort of the geologists regionally involved with the problem.

General Description

The Ardmore Basin is located adjacent to two major Oklahoma uplifts; the Arbuckle Mountains to the north and the Criner Hills to the southwest. It is an area of apparently uninterrupted depositional history throughout late Mississippian and part of Pennsylvanian time. The above depositional history began with the deposition of the late Mississippian--early Pennsylvanian Springer Group, which is characterized by dark gray limonitic shales, and rather extensive sandstones. The Dornick Hills Group contains largely shale, thin but important limestones, and minor but important conglomerates. The Deese Group is represented by a great development of sandstones and shale, and some conglomerate. The Hoxbar Group is essentially a shale and thin limestone sequence, although sandstone and conglomerate become increasingly important in late Hoxbar time. The proportion of each lithology within a particular group varies depending upon position within the basin; however, the groups are readily identifiable.

Pennsylvanian rocks in the Ardmore Basin are predominantly clastic with a few associated limestones. Coal has been reported from above the Frensley Limestone (Tomlinson and McBee, 1959, p. 30) in sec. 17, T. 4 S., R. 4 E., the Daube Coal in sec. 8, T. 5 S., R. 2 E. is well known, and another lignite-coal, with peculiar book-leaf structure, was found by the writer in NE$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 17, T. 5 S., R. 2 E. above the Confederate Limestone. In spite of the coal, it is considered that the Pennsylvanian rocks are largely marine in origin, with coals representing restricted areas of local importance. A maximum thickness of 17,000 to

18,000 feet of Pennsylvanian rocks occurs in the basin. Such thicknesses and the clastic nature of the section indicate accelerated subsidence. Jacobsen (1959, p. 108) considers the rate of sedimentation for Pennsylvanian rocks to range from 333 to 750 feet per million years, with a mean value of 500 feet per million years, which is rapid accumulation.

Dornick Hills Group

The Dornick Hills Group (Harlton, 1956, p. 138) consists mainly of shales, thin limestones, lenticular conglomerates and some sandstone. Limestones are largely medium- to coarse-crystalline with fragmental fossil debris and at some places some fine sand (sandy biosparrudites of Folk). The only noteworthy exceptions are the fine-crystalline limestones (micrites) in the upper part of the Bostwick Member and the reef limestones in the Pumpkin Creek Member. Conglomerates contain limestone pebbles as old as upper Arbuckle (Ordovician). Cementing material in the conglomerates is most commonly sandstone and carbonate. Conglomerates are lenticular fanglomerate-like deposits, thickest near the Criner Hills. Jacobsen (1959, p. 58-65) indicated that the sandstones are quartzose greywackes, composed of angular to subangular quartz grains with up to 32 percent rock fragments.

The Golf Course Formation was proposed by Harlton (1956, p. 138). In discussing his basis for proposing this new formation Harlton stated:

> The Golf Course. . . is segregated upon the basis of its stratigraphic position, its diastrophic record, its fauna, and its areal distribution. . . . The entire sequence carries a large and varied Morrow fauna. It

> includes all the rocks generally recognized as of Morrow age in the Ardmore basin. . . .

Not a single criterion quoted as basis of delimiting this formation is acceptable, and it becomes apparent after reading the article that the only criterion used was paleontologic. Not once is the fundamental standard of formational characterization, lithology, mentioned. The Golf Course Formation is considered unacceptable and the term is therefore not used in this paper.

A much more logical and useful grouping would be to consider the Jolliff, Otterville, and Bostwick Members as a unit. Each is characterized on the surface by limestone conglomerates and limestones. Shales and sandstones necessarily comprise a majority of the rock type of this grouping. However, it is the limestones and limestone conglomerates that afford character. This grouping is also in part genetic as the source for the conglomerates in each member is the Criner Hill complex.

Primrose Member. The Primrose Sandstone was described and proposed by Tomlinson (1929, p. 19). It is a thin-bedded sandstone with thin lenticular intraclasts of dark shale. This unit can be confidently mapped only about the Caddo anticline. Tomlinson and McBee (1959, p. 18) indicated that the absence of the Primrose south of Ardmore is due to pre-Jolliff erosion.

Unnamed Unit. Approximately 1,200 feet of black to dark gray shales overlie the Primrose, and have been assigned to the Morrowan series.

Jolliff Member. The Jolliff limestones and conglomerates (Tomlinson, 1929, p. 29) crop out southwest of Ardmore where the most persistent element is the conglomerate. Conglomerates are lenticular and disappear but many grade into thin limestones. Colonial rugose corals have been taken from the Jolliff, and are considered Morrowan in age.

Unnamed Units. From 500 to 800 feet of shales overlie the Jolliff. These shales are dark with ferruginous layers common.

Otterville Member. The Otterville Limestone (Tomlinson and McBee, 1959, footnote 7, p. 20) is commonly about 10-20 feet in thickness and is composed of fragmental fossil debris set in a clear sparry calcite matrix. Ooliths are common in the upper 2 to 3 feet. In the area south of Ardmore along the Carter County-Love County line, conglomeratic beds are developed. The Otterville is correlated with the Wapanucka.

The Lake Murray Formation was proposed by Harlton (1956, p. 139) to include rocks from the top of the Otterville Member to the top of the Frensley Member. In proposing the new name, Lake Murray Formations, Harlton stated:

> It has long been recognized that this section between the top of the Otterville and the top of the Lester [Frensley?] contains derivatives of Morrow brachiopods, gastropods, and bryozoa. But it is the advent of a host of Fusilinella, entirely unknown in true Morrow rocks, that stamp the Lake Murray as a separate unit in geologic history.

Here, as with the Golf Course Formation, no criterion has been presented which would warrant formational standing. As proposed by Harlton, the

Lake Murray Formation is a nebulous, ill-defined, biostratigraphic zone, defined solely on fossil content, with an incorrect time connotation. The Lake Murray Formation is not employed in this paper.

A logical lithologic entity would be to group the Lester, including the shales which underlie it, Frensley, and Pumpkin Creek Members into a lithic unit. This grouping is mainly a shale sequence with important thin limestones and minor sandstones. Such a union is suggested for consideration, but is not proposed for reasons earlier indicated.

Unnamed Unit. South of Ardmore approximately 475 feet of light yellow-tan shales overlie the Otterville.

Bostwick Member. The Bostwick Member (Tomlinson, 1929, p. 30) is the most conspicuous natural topographic feature of any extent south of Ardmore and can be traced continuously along the northeast flank of the Overbrook anticline for approximately fifteen miles. A lithologic description of a measured section can be found in section 5, appendix I. The most conspicuous lithologic element comprising the approximately 380 feet of Bostwick south of Ardmore is the abundant limestone conglomerate in the lower 175 feet. The conglomerate contains pebbles of limestone as old as upper Arbuckle (Ordovician) in a matrix of sandstone and calcite. Fine-crystalline, dark gray to black limestone constitutes the top of the Bostwick as measured. Such fine-crystalline (micritic) limestones are not common in the Dornick Hills Group. The conglomerate lenses are thickest in the vicinity of the Criner Hills and decrease in thickness and size in three directions away from their source, indicating fan-like deposits.

Adjacent to the Criner Hills in sec. 36, T. 5 S., R. 1 E., a thick limestone conglomerate section (appendix I, section 11) occurs with a brown fine-grained (micrite) limestone at the base. This limestone grades upward into a brown limestone conglomerate. Rocks of this interval have been considered as the west limb of the Overbrook anticline and indicated as of probable Bostwick equivalence by Tomlinson and McBee (1959, p. 26, and 1962, p. 480), Jacobsen (1959, p. 33), Ardmore Geological Society (Guidebook, 1948, p. III), and Tomlinson (1929, p. 32): however, Frederickson (1957) indicated this conglomerate to be in the Deese Group. I have obtained fusulinids from the lower fine-crystalline brown limestone, of the genus Fusulina, which are at least as young as Pumpkin Creek fusulinids and probably as young or younger than Devils Kitchen forms. I was unable to obtain fusulinids in sec. 7, T. 6 S., R. 2 E.; however, I am inclined to believe that much of the so-called Bostwick on the southwest flank of the Overbrook anticline is in reality much younger.

The Bostwick Member contains fusulinids of the genus Fusulinella, which are of "Atokan" equivalence. These fusulinids occur in shales and limestone zones which are associated in the upper 100 feet of the member.

Unnamed Unit. A maximum of 750 feet of beds was measured between the Bostwick and the overlying Lester Member in sec. 22, T. 6 S., R. 2 E. Tomlinson (1929, p. 33) indicated this unit to be approximately 400 feet thick north of Ardmore. Within the unit south of

Ardmore occur several tens of feet of variegated shales, thin sandstone beds, and concretionary limonitic zones. Three distinct sandy limestones, or calcareous sandstones, occur in the upper 200 feet and are mappable for approximately two miles along strike in secs. 22 and 23, T. 6 S., R. 2 E.

Lester Member. The Lester Limestone (Tomlinson, 1929, p. 32) at its type locality in sec. 13, T. 4 S., R. 1 E. is an oolitic, sparry calcite-cemented limestone containing large quantities of fossil debris, especially bryozoan. Approximately 90 feet below the Lester Member, as defined by Tomlinson, is a deeply weathered sandy limestone containing an abundant primitive species of Fusulina. South of Ardmore in NE$\frac{1}{4}$ sec. 22, and NW$\frac{1}{4}$ sec. 23, T. 6 S., R. 2 E., the Lester Member is represented by a coarse-crystalline, brown, sparry calcite-cemented limestone with only a few ooliths. Approximately 150 feet below the Lester, south of Ardmore, occurs a sandy, non-oolitic, sparry calcite-cemented limestone which contains primitive Fusulina specimens identifiable with those below the type Lester north of Ardmore. The "oolitic" Lester south of Ardmore contains fusulinids; the type Lester does not contain fusulinids. However, on the basis of the primitive fusulinids found within the "oolitic" Lester south of Ardmore, it was suggested (Waddell, 1959, p. 72) that the rocks of the Dornick Hills Group stratigraphically as low as Lester are of Desmoinesian age. In view of the discovery of the genus Fusulina below the Lester Member, both north and south of Ardmore, the formal lowering of the Desmoinesian lower time-stratigraphic boundary to include the Lester Member does not seem radical.

This proposal was formalized in the revision of Tomlinson and McBee's manuscript when presented for publication in The Pennsylvanian System of the United States, by C. C. Branson.

In the restriction of the Lake Murray Formation (Tomlinson and McBee revised, 1962, footnote 10, p. 479) it is stated that:

> The downward shift of the Atokan-Desmoinesian boundary also shifts the corresponding boundary between the Lake Murray and Big Branch formations, and constitutes a re-definition of those formations.

As thus restricted, the Lake Murray Formation contains the Bostwick Member and approximately 300 to 400 feet of shales which overlie it. This redefinition is as objectional as Harlton's original proposal because it is an attempt to force-fit lithostratigraphic and time-stratigraphic boundaries.

The Big Branch Formation was proposed by Floyd and Nufer in a paper given before the Tulsa Geological Society in November, 1934. The succeeding description is quoted from a letter to Harlton from Nufer:

> The type locality was given as exposures along the Big Branch of the Washita River in NW$\frac{1}{4}$ Sec. 11, T. 3 S., R. 2 E. Here complete exposures were found of the upper part of the formation and included the limestones characterized by the Marginifera sp. and the Campophyllum sp. The lithology of the Big Branch was described as 800 feet of section, lower part gray shale with one thin sand bed near the middle, the upper 400 feet mainly shale with sandstones, a chert conglomerate, and several limestones near the top of the section. The Big Branch formation was placed in the geologic column as that unit from the top of the Pumpkin Creek Limestone down to the top of the Lester Limestone. The fauna of this unit is Des Moines in age and has no Morrow characteristics, and should be removed from the Dornick Hills as described by Dr. Tomlinson.

Although Floyd and Nufer were correct in recognizing a Desmoinesian age for these rocks, such paleontological evidence is no criterion for proposing formations. Harlton modified the original description by raising the base of the Big Branch to the top of the Frensley because of a belief of the latter's "Atokan" age. Tomlinson and McBee (1962, footnote 10, p. 479) shifted the boundary down to include about 200 feet of shales below the Lester Member.

The Big Branch Formation has created confusion from the time of its proposal because it is not a lithologically distinguishable unit, but a biostratigraphic zone. It is not used in this paper.

Unnamed Unit. Between the redesignated Frensley Member (Tomlinson, 1959, p. 317) and the Lester Member in secs. 22, 23, T. 6 S., R. 2 E., occurs approximately 225 feet of sandy shale with two well-developed sandstones. The upper of these sandstones is the more persistent and is the sandstone commonly between the Lester and Frensley toward the northwest along strike.

Frensley Member. The Frensley Member was proposed by J. M. Westheimer (1936, p. 5). In proposing this new member, Westheimer stated:

> The Pumpkin Creek, as described by C. W. Tomlinson, contains south of Ardmore some 1,000 feet of sediments. At the base is a nodular, white, dense, limestone varying in thickness from one to ten feet or more. This limestone contains an undescribed species of Fusulina which also occurs 50 feet below the top of the Atoka in T. 1 N., R. 8 E., in the so-called Red Oak member. Because of the marked difference in the Fusulinid and other fauna in this bed and the limestone at the top of the Pumpkin Creek, which has more of a Deese fauna, the name Frensley limestone is here proposed for this

> limestone and the shale overlying it and beneath the overlying prominent sandstone. This section is well exposed on the Frensley farm in the SE$\frac{1}{4}$ Sec. 30, T. 3 S., R. 2 E.

It is apparent from the above statement that Westheimer's evidence for removing the Frensley Limestone from the Pumpkin Creek came from the chalky limestone described by Tomlinson as occurring four or five hundred feet below the main Pumpkin Creek ledge south of Ardmore in the Overbrook anticline. Unfortunately, Westheimer chose as his type section an outcrop of rocks that are better exposed north of Ardmore in the Caddo anticline. The type section of the Frensley Member proposed by Westheimer was found to be Pumpkin Creek (Waddell, 1959, p. 20-22) and a new type section was proposed (Waddell, p. 21) and formerly presented by C. W. Tomlinson (1959, p. 317).

At the redesignated Frensley locality in NE$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 22, and SE$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 15, T. 6 S., R. 2 E., six limestones occur in approximately 165 feet of section (1-8 through 1-11, appendix I, measured section 1). These limestones are yellow-brown, fine- to coarse-crystalline and are fossiliferous. Fusulinids are common in units 1-8 and 1-11. Unit 1-8 of measured section 1 marks the lowest occurrence, of which I am aware, of the genus Wedekindellina in the Ardmore Basin.

Unnamed Unit. Approximately 630 feet of yellow-gray to tan shales with yellow-brown sandstone beds overlie the Frensley Member. Within the upper 200 feet of this shale unit occurs three sandy limestones which range in thickness from 2 to 6 feet in NE$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 15, T. 6 S., R. 2 E. These limestones thicken toward the southeast and in SW$\frac{1}{4}$ sec. 14, SE$\frac{1}{4}$ sec. 15, and NW$\frac{1}{4}$ sec. 23 range in thickness up to 16 feet.

The upper and thickest of these sandy limestones carries a fusulinid fauna identical to that of the overlying Pumpkin Creek.

Pumpkin Creek Member. The Pumpkin Creek Member (Tomlinson, 1929, p. 33) comprises from 40 to 60 feet of medium- to coarse-crystalline, locally sandy, sparry calcite-cemented, fossiliferous limestone. The lower part of the limestone contains blue and black chert pebbles and is at many places cross-bedded. Approximately 16 feet above the base in NE$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 15, T. 6 S., R. 2 E., occurs a poorly cemented zone composed of the broken fragments of a multitude of fossils. Along strike at this same horizon, reefing occurs (description Appendix I, measured section 2). The unconsolidated fragmental zone is found southeast along strike in secs. 14, 15, and 23; however, no reef development was observed. The reef structures, small domal bodies up to 2 feet high and 6 feet long, possess fenestrate bryozoans, large amplexizaphrentid horn corals, and the colonial coral Michelinia, in a very fine-crystalline (micrite) matrix.

The Pumpkin Creek on the southwest limb of the Caddo anticline is traced only in sec. 13, T. 4 S., R. 1 E., and then with extreme difficulty, and one cannot be certain that beds have not been crossed. However, on the northeast limb, Pumpkin Creek beds are traceable into sec. 9, T. 3 S., R. 2 E.

Deese Group

The Deese Group is identical with the Deese Formation originally proposed by Tomlinson (1929, p. 35) and is limited at its lower boundary by the top of the Pumpkin Creek Member of the Dornick

Hills Group and the base of the Confederate Member of the Hoxbar Group above. In the thickest section, south of Ardmore, the Deese reaches a maximum of nearly 8,000 feet. The rocks of this interval are mainly sandy shales, with considerable sandstone, some conglomerate, and minor amounts of limestone.

Unnamed Unit. Between the Pumpkin Creek and overlying Devils Kitchen is approximately 700 feet of shale and sandstone. Shales are very sandy and sandstones, all fine-grained, are thin- to thick-bedded.

Devils Kitchen Member. The Devils Kitchen Member (Tomlinson, 1929, p. 35) is divisible into a lower sandstone ranging up to 200 feet thick, a middle shale ranging up to 225 feet thick with approximately 15 to 20 feet of limestone at the upper limit, and an upper unit, of thin-bedded sandstone either overlain by very thick-bedded sandstone or conglomerate, which attains a thickness of approximately 200 feet.

The conglomeratic phase of the Devils Kitchen is limited to the Overbrook anticline. It begins in about the center of sec. 4, T. 6 S., R. 2 E., and becomes thicker southeastward to the last surface exposure in sec. 29, T. 6 S., R. 3 E. The composition of the pebbles and cobbles is wholly chert. The matrix is sandstone and silica.

Most Devils Kitchen outcrops include the middle shale and overlying sandstones which commonly contain small weathered chert grains. The chert becomes less important as a constituent in the sandstone, or as a distinct phase, both toward the Criner Hills and the Arbuckle Mountains. Schacht (1947, p. 27-29) indicated a probable source somewhere in the Ouachitas for the Devils Kitchen conglomerate. Jacobsen

(1959, p. 115-16) stated that:

> . . .the apparent coarsening and thickening of the Devils Kitchen conglomerate toward the southeast is only a two dimensional component of the true relationship. . . . The direction of maximum increase in thickness and coarseness could well be to the east rather than to the southeast. . . . The absence of limestone pebbles may be due. . .to the absence of limestone in the source; but. . .it would be highly unexpected to find any limestone pebble capable of surviving the degree of weathering shown by the chert. . . . Without more detailed study, it is not possible to trace the Devils Kitchen chert pebbles to a definite source. However, none of the distinctive chert lithologies of the Ouachita Mountains were recognized in the Devils Kitchen pebbles.

Unnamed Unit. Above the Devils Kitchen and below the Arnold is approximately 1,750 feet of shales with interbedded sandstones. Although no limestones were found in this unit south of Ardmore, as Tomlinson (1959, p. 314) indicated, seven limestones occur within this unit on the northeast limb of the Caddo anticline. Fusulinids occur in the upper and middle limestones.

Arnold Member. The Arnold Member (Tomlinson, 1929, p. 38) was described at its type section north of Ardmore on the southwest flank of the Caddo anticline. On the northeast limb of the Overbrook anticline, the Arnold is approximately 75 feet thick in NW$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 4, T. 6 S., R. 2 E., and carries an abundant fauna including two genera of fusulinids.

Unnamed Unit. Above the Arnold Member is approximately 1,400 feet of red and gray shale with thick beds of sandstone. Two one-foot limestones occur north of Ardmore in secs. 4 and 9, T. 4 S., R. 2 E. (Tomlinson, 1959, p. 313). On the northeast limb of the

Overbrook anticline, Guthrey and Milner (1933, map) mapped two sandy limestones intermittently for a distance of approximately three miles. In both areas however, shales with sandstone beds are the dominant lithologies.

Rocky Point Member. The Rocky Point Member (Guthrey and Milner, 1933 map) is well exposed on the northeast limb of the Overbrook anticline. Chert pebble conglomerates are prominent at several horizons in a 200 to 300 feet thick sequence of very thick-bedded sandstone and red-brown shale.

Unnamed Unit. Approximately 2,000 feet of yellow-brown to red-brown shales and sandstones occur above the highest mappable conglomerate of the Rocky Point Member. In SW$\frac{1}{4}$ NE$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 20, T. 5 S., R. 2 E., are three limestones in approximately the middle of this unit. The upper of these, a red-brown, clay-intraclast, fine-crystalline limestone, contains abundant fusulinids.

Camp Ground Member. The name Camp Ground Member was first used formally in the literature by Ramay (1957, p. 45). A measured section of this unit in approximately the area indicated by Hicks (personal communication, Tomlinson, 1959) as his "type" locality is presented in appendix I, measured section 9. Ramay (1957, p. 15-17) indicated that the Camp Ground occurs in the Pleasant Hill syncline and is composed of approximately 65 feet of coarse-grained sandstones, unconsolidated coquinoid limestone, and shale. Within the sandstones and shales of the Camp Ground on the west edge of Lake Murray occur two thin-bedded, deeply weathered limestones containing fusulinids.

Unnamed Unit. South of Ardmore, the rocks that overlie the Camp Ground are reddish-brown to yellow-tan shales with thin-bedded to thick-bedded sandstones and are approximately 575 feet thick. North of Ardmore equivalent rocks are found in a part of the Warren Ranch Member (Tomlinson and McBee, 1959, p. 33-34) which is postulated to extend from the Camp Ground to the shales above the Natsy. Equivalent conglomerates are not found in the Overbrook anticline.

West Arm Formation

The West Arm Formation was proposed by Harlton (1960, p. 220-221). In describing the new formation Harlton stated:

> The West Arm Formation approximates 900 feet in thickness and underlies the Confederate limestone (Tomlinson, 1929) of basal Hoxbar age. It includes the Natsy Member (Tomlinson, 1937) which lies about 450 feet below the top of the Deese. The William Member (Guthrey and Milner, 1933) marks the base of the West Arm Formation.

The West Arm Formation as described is a lithologically discrete entity. Fossils are present within the formation which indicate its age. However, they correctly play no part in definition of the rock-stratigraphic unit. The West Arm Formation is considered valid and is employed in this paper.

Williams Member. The Williams Member (Guthrey and Milner, 1933) in NW$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 17, T. 5 S., R. 2 E., is composed of 2 feet of medium-bedded sandy, *Myalina*-rich limestone overlain by 25 feet of limonitic, thin- to medium-bedded, fine-grained sandstone (appendix I, measured section 10). In the Pleasant Hill syncline in sec. 23, T. 5 S., R. 1 E., Ramay (1957, p. 18) mapped 20 feet of thin-bedded coarsely crystalline limestone as the Williams. In sec. 14, T. 5 S., R. 1 E., a local limestone conglomerate occurs below the Williams. Myalina is also common in the Williams Member as traced in the Pleasant Hill syncline.

Unnamed Unit. Rocks of this interval have a maximum thickness of approximately 375 feet on the northeast limb of the Overbrook anticline. Here the rocks are composed of gray-tan to yellow-tan, sandy, clay shales with abundant limonite nodules and a few thin-bedded, fine-grained sandstones. Above the Williams, approximately 50 feet, are two or three thin brachiopod fragmental zones (only the genus Juresania was identifiable). In the Pleasant Hill syncline, rocks of this interval range in thickness from 100 to 175 feet.

Natsy Member. The Natsy Member (Tomlinson, 1937, p. 1) in sec. 17, T. 5 S., R. 2 E., was measured (appendix I, measured section 10, unit 2) to be 15 to 17 feet of thin- to medium-bedded, gray-tan to yellow-brown, fine-crystalline limestone overlying 32 feet of thick-bedded, fine-grained sandstone. Guthrey and Milner (1933) indicated that a conglomeratic phase develops to the southeast. Chert conglomerate occurs in the Natsy, as correlated by Tomlinson, north of Ardmore. In the Pleasant Hill syncline, Ramay (1957, p. 19) mapped 20 feet of pink crinoidal limestone as the Natsy in sec. 23, T. 5 S., R. 1 E.

Unnamed Unit. The unnamed rocks above the Natsy and below the Confederate are approximately 400 to 450 feet thick in the Overbrook anticline and the Pleasant Hill syncline, and consist of gray-tan shales with thin sandstone layers cemented with carbonate.

Hoxbar Group

Confederate Member. This lowest member of the Hoxbar Group (Tomlinson, 1929, p. 39-40) in NE$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 17, T. 5 S., R. 2 E., is composed of approximately 15 feet of thin-bedded to nodular, yellow-brown fine-crystalline limestone; 16 feet of mostly covered tan shales; and 2 feet of very coarse-crystalline fragmental limestone which becomes conglomeratic along strike. Within the next 10 feet above the fragmental limestone unit occurs approximately 4.5 feet of carbonaceous shale (lignite?) with veins of coal up to $\frac{1}{2}$ inch in thickness throughout. L. R. Wilson (1962, oral communication) has indicated that spores obtained from this carbonaceous unit show affinities to both Desmoinesian and Missourian spores. Associated with the book-like leaves are thin perfectly formed crystals of selenite gypsum.

In the Pleasant Hill syncline, the Confederate Member consists of approximately 10 feet of calcareous fine-grained sandstone; 6 to 8 feet of medium- to thick-bedded, coarse-crystalline limestone; and approximately 5 feet of conglomeratic limestone above a 5-foot covered interval. Fusulinids from shales below this locality are correlative with those from the locality in the Overbrook anticline. In the Brock anticline, the Confederate crops out in sec. 34, 35, T. 5 S., R. 1 E., and consists of 10 feet or more of brown, sandy limestone.

Unnamed Unit. Approximately 450 feet of gray-tan shales with associated thin sandstones occur above the Confederate Member.

Crinerville Member. In NW$\frac{1}{4}$ NE$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 6, T. 5 S., R. 2 E., the Crinerville Member (Tomlinson, 1929, p. 42-43) consists of approximately 20 feet of thin- to medium-bedded, fine-crystalline limestone. Southeast along strike in sec. 8, T. 5 S., R. 2 E., a lower sandstone approximately 30 feet thick occurs 20 to 30 feet below a limestone conglomerate phase. The limestone is absent at this locality but it is suggested that the limestone conglomerate may represent it.

In the Pleasant Hill syncline, the Crinerville is represented by approximately 20 feet of gray-white to tan, fine- to medium-crystalline limestone in SE¼ NW¼ SW¼ sec. 14, T. 5 S., R. 1 E. In the Brock anticline, the Crinerville consists of approximately 20 feet of sandstone, shale, and gray fine-crystalline limestone. The fusulinid *Triticites* is common in all three areas.

Unnamed Unit. Approximately 650 feet of shale and calcareous cemented thin sandstones overlie the Crinerville.

Anadarche Member. In SW¼ SE¼ sec. 8, T. 5 S., R. 2 E., the Anadarche Member (Tomlinson, 1929, p. 36) consists of a single gray-white, medium-bedded limestone approximately 12 feet in thickness. The fusulinid *Triticites*, the brachiopod *Echinoconchus* and the foraminifern *Climacammina* are commonly present. In the SW¼ SE¼ sec. 35, T. 5 S., R. 2 E., a sandy zone is developed approximately 20 feet below the limestone between T. 5 S., and T. 6 S., and all units of the Anadarche as described by Tomlinson are present. The Anadarche is indicated by Frederickson (1957, map) to be the highest Hoxbar Member recognized in the axis of the Pleasant Hill syncline. The Anadarche is well defined in the Brock anticline where a fusulinid fauna occurs in approximately 10 feet of brown, shaly, fine-crystalline limestone.

Unnamed Unit. Overlying the Anadarche are approximately 475 feet of shales with occasional zones of nodular limestones.

Daube Member. The Daube Member (Tomlinson, 1929, p. 44-45) was measured in SE$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 16, T. 5 S., R. 2 E. Here it is thin and consists of approximately 10 feet of highly calcareous shale with limestone nodules overlain by 2 feet of dull brown, sandy, fine-crystalline limestone. Although the typical limestone of sec. 8, T. 5 S., R. 2 E., is not developed at this locality, it is considered the best fossil collecting locality for Daube fauna on the Overbrook anticline.

On the Brock anticline, the Daube Member crops out on the west limb in a series of faulted outcrops in secs. 19, 20, 29, T. 5 S., R. 1 E. In W$\frac{1}{2}$ SE$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 19, the Daube consists of approximately 20 feet of thin- to medium-bedded, gray-brown limestone with abundant fusulinids. The Daube is the highest mapped unit in the Brock anticline of Hoxbar age.

Zuckermann Member. Approximately 430 feet above the Daube in SW$\frac{1}{4}$ sec. 15, T. 5 S., R. 2 E., is a ridge of calcareous sandstones and conglomerates called Zuckermann by Tomlinson (1929, p. 46).

STATISTICAL METHOD

Characters and Measurements

Burma (1948, p. 758) pointed out that the characters currently measured and the methods of measuring these characters are in general adequate for the fusulinids. The following characters were measured and their data recorded herein.

Half length - measured from the center of the proloculus to the tectum of the polar extremities of each volution, parallel to the axis of coiling.

Radius vector - measured from the center of the proloculus to the tectum at the equator of each volution perpendicular to the axis of coiling.

Protheca - consists of the thickness of the tectum and diaphanotheca/keriotheca per volution measured as near the center of tunnel as practicable.

Tunnel width - the linear width of the tunnel in millimeters measured from bisected angle of slope crest of adjacent chomata. It is recognized that this measurement is limited as is the more commonly used tunnel angle when singularly employed. However, interdependent expression in terms of a regression line or reduced major axis is possible with tunnel width and impossible with the tunnel angle. Average tunnel angles may be obtained from this data by plotting tunnel width against corresponding radius vector and measuring the angle.

Chomata height - as used, this measurement is the height of the chomata above the tectum. The chomata is a secondary deposit and may be controlled by environment as well as genetic factors. Therefore its significance is probably questionable in part, but it does yield data concerning the chomata which are useful. Because this measurement is questionable, it rightly played no part in the multivariate test or following discriminant test.

Septa count - is the number of septa counted per volution as illustrated by Dunbar and Henbest (1942, p. 63).

Proloculus - is the measure of the outside diameter of the initial chamber. In most cases the maximum and minimum outside diameter values are recorded.

A Zeiss petrographic microscope was employed for all measurement. Those measurable data are presented in Appendix II. Mean values (averages) are denoted in this paper in the form .123/40. The .123 represents the mean value of the character under consideration and the integer following the slash mark represents the number of specimens yielding the associated mean.

Sample statistics are presented in Appendix II and consist of the mean ($\bar{x}$), the variance (s^2) and the standard deviation (s). Confidence limits for the inferred population mean are also indicated for each character.

Certain morphologic characters of fusulinids have not been validly quantified and will probably never be expressed in numerical terms. These features include over-all shape, shape and size of chomata, axial filling, fluting of septa, and polar shapes. The terminology here used to describe such features is presented below.

Figure 2.

General Mature Shape of Fusulinids

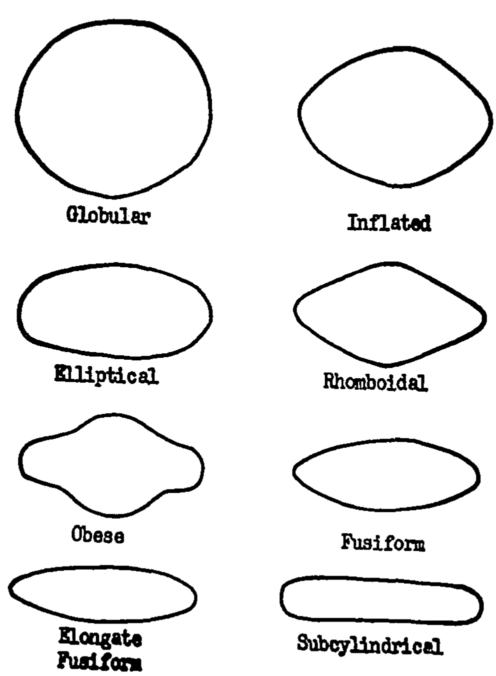


Figure 3.

Chomata Development

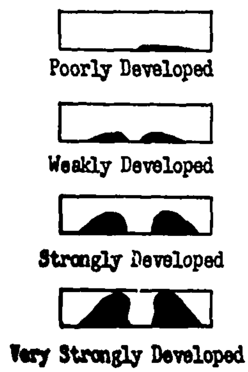


Figure 4.

Shape of Polar Extremities

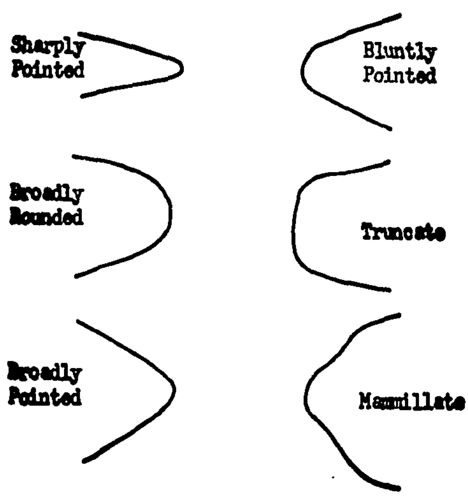
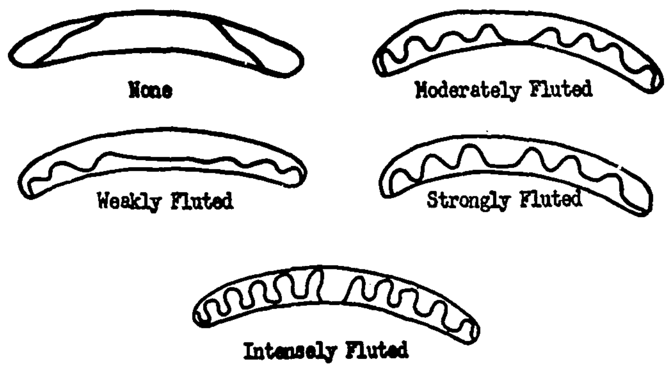


Figure 5.

Degree of Septal Fluting



The Population

Population as used in this paper carries two connotations as follows:

1. Paleontologic population is a natural group of individuals which possess identical morphological features (within a range of variation) that set them apart from other groups of individuals. Implicit in this definition is a correlation between reproductive isolation and morphologic deviation.

2. Statistical population, as used by Miller and Kahn (1962, p. 445), indicates a statistical population as an abstraction represented by the group of numbers which are tabulated from measuring the same morphological character from a number of individuals of the same species. In the multivariate case, an extension is made to include the set of numbers formed by measuring all characteristics from all individuals.

The Sample

The paleontologic sample would be ideally represented by a collection of randomly chosen specimens which would represent the range of variation of morphologic characters of a population unaffected by the selectivity applied by nature due to chemical and physical conditions associated with transfer (erosion, transportation and deposition) and diagenesis. Randomness in sampling theoretically implies that an element drawn from a population is selected in such a manner that each of the N elements of the population has the same probability, $p = \frac{1}{N}$, of being drawn. It is difficult to obtain a random sample and haphazard selection is not sufficient.

Paleontologic samples are generally small in number and, particularly in the megafossil groups, represent those specimens that are available for collection at a particular outcrop. Bias is fundamental to any sample, because of conditions which tend to preserve one individual rather than another, and because as indicated by Kermack (1956), all ages of the population are not subject to the same death rate. A discussion on this subject is presented by Miller and Kahn (1962, p. 447-450). Forced to accept these inadequacies in sampling, the paleontologist should select no element over another, study not one or two but many individual elements, and study both large and small forms in order to keep from adding personal bias to uncontrolled preservation bias. The paleontologist should also keep in mind that sample statistics are only estimators of population parameters and that no two samples, even if taken from the same locality and from the same lithic unit are identical. It is reasonable to assume however that the mean of any single character will not differ significantly among these samples.

When two paleontologic samples are considered during taxonomic study, the following questions must be answered. What is the probability that the two samples under consideration differ as much as they do by chance? Is the apparent difference due to sampling error or does it represent a morphologic difference and have genetic implications? Such questions may be intuitively answered with experience or may be answered statistically by tests which are based upon such features of samples as size, variance, and covariance.

Regardless of the approach to the final solution paleontologists are all faced with the problem of whether two samples belong to the same species (population). Methods of statistical analysis and rapid methods of computation although no panacea, are valuable objective tools to the solution of this problem and should be afforded greater use than at present.

Univariate Statistics

The initial step in the application of statistical methods to paleontologic data is the calculation of certain statistics which characterize the various morphologic features of a sample.

Such a statistic is the mean or average of a series of observations. If an indefinite number, n, of observations are made on a character, X, indicated by the values X_1, X_2, ... X_n; then the mean, $\bar{X}$, is defined as

$$\bar{X} = \frac{X_1 + X_2 + \ldots + X_n}{n} = \frac{1}{n} \sum_{i=1}^{n} (X_i).$$

The mean yields information only on the magnitude of observations. It is desirable to define the scattering about the mean to gather some concept as to how closely the individual values are grouped. From the n observations above, calculate the variance, s^2, by

$$s^2 = \frac{\sum_{i=1}^{n} (X_i - \bar{X})^2}{n - 1}$$

then the standard deviation, s, which is the positive value of the square root of the variance is calculated by

$$s = \sqrt{s^2} = \sqrt{\frac{\sum_{i=1}^{n} (X_i - \bar{X})^2}{n - 1}} .$$

Imbre (1956, p. 224) pointed out that the relationship between size and variance is direct and as the size of a character increases, the variance or dispersion about the mean becomes greater. This fact is readily observable, for example, in a graph of radius vector against volution number.

A convenient statistic that estimates the limits of population means and is readily displayed graphically or understood visually is the confidence limit. If the sample is from a normal population (sufficient data has been studied to indicate that this is a valid assumption in most cases concerning paleontological measurements) and if $\bar{X}$ and s are sample mean and sample standard deviation, then

$$t = \frac{(\bar{X}-u)\sqrt{n-1}}{s} \qquad \text{(where } \underline{u} \text{ is the population mean)}$$

has a Student's t-distribution with (n-1) degrees of freedom. Degrees of freedom may be defined as the number of quantities minus the number of linear relations between them.

It is desirable now to determine two numbers, $\underline{k}$ and $\underline{l}$, such that one can be 99% confident that the value of $\underline{t}$ lies between these two numbers. In probability notation this is expressed as

$$P\left\{ l \leq t \leq k \right\} = 0.99$$

In general $\underline{k}$ and $\underline{l}$ are chosen so that $l = -k$. Substituting for $\underline{t}$ and solving the inequality for $\underline{u}$.

$$P\left\{ -k \leq \frac{(\bar{X}-u)\sqrt{n-1}}{s} \leq k \right\} = 0.99$$

$$P\left\{ \bar{X} - \frac{sk}{\sqrt{n-1}} \leq u \leq \bar{X} + \frac{sk}{\sqrt{n-1}} \right\} = 0.99$$

$$\text{and } \hat{u} = \bar{X} \pm \frac{sk}{\sqrt{n-1}}$$

determines the confidence interval for the population mean of the character under consideration. The above univariate sample statistics are given in the tables of data on the various species.

Multivariate Statistics and Application

Suppose that instead of considering a sample from a univariate normal population, as is the case when the preceding statistics are appropriate, we sample from a multivariate normal population in which we desire to test all components involved and the hypotheses specifying their mean values. A statistic to test the above hypothesis was proposed by Hotelling (1931, p. 360-378) and termed T^2.

General assumptions basic to biometric methods of distinguishing between samples, and to some extent the qualitative method, are as follows: (1) paleontologic samples are made up of specimens possessing several identifying characteristics whose measurements are normally, or nearly normally, distributed; that is, the samples are taken from multivariate normal populations; (2) the most basic and yet most tenuous assumption is that the initial assignment of individual specimens into groups is correct; (3) correlation among pairs of measurements are stable within a population; (4) the variance and covariance of samples are equal; and (5) that samples from different geographic locations (if the time differential is small) should be similar.

Under the above assumptions, T^2 is here used to test the null hypothesis that two multivariate samples were taken from the same population, against the alternative hypothesis that the samples are from different populations.

Five characters (half length, radius vector, septal count, tunnel width, and protheca thickness) each of which is composed of from 5 to 12 variables are considered as multivariate systems. It is recognized that greater discrimination would be attained considering all characters simultaneously which would result in a 35 by 35 or greater matrix inversion problem. This problem is beyond the capacity of the available computer. Although greater discrimination is possible using all characters simultaneously, the exact position of the difference would remain unknown unless later tests were performed. The method used in this paper necessitates no later tests. In this method if the T^2 test indicates a significant difference, then the character under consideration differs between the two samples and cannot be attributed to sample error, within the probability determined.

The T^2 test presented next is largely taken from Hodges (1955, p. 27-34), but is modified slightly to allow working with arrays with missing data.

Consider the linear distance from the center of the proloculus to the tectum of volution 1 of a fusulinid sagittal section as a variable, also the linear distance from the center of the proloculus to the tectum of volution 2 as a variable, and ... through p volutions giving p variables for n samples. Let X_{rik} express the value of the i^{th} variable measured on the k^{th} specimen from the r^{th} sample, where r = a, b, $k = 1,2, \cdots n$, and $i = 1,2, \cdots p$. Then $\bar{X}_{ai}$ and $\bar{X}_{bi}$ are the arithmetic means for the i^{th} trait in samples a and b derived from

$$\bar{X}_{ai} = \frac{1}{n} \sum_{k=1}^{n} (X_{aik}) \text{ and } \bar{X}_{bi} = \frac{1}{n} \sum_{k=1}^{n} (X_{bik}).$$

The mean values of the columns in table 1 are calculated by the above formula.

Table 1

Measurements of Six Characters on 17 Specimens of

Fusulina cf. *F. novamexicana* and 16 Specimens of *Fusulina euryteines*

(a)						(b)					
X_{a1}	X_{a2}	X_{a3}	X_{a4}	X_{a5}	X_{a6}	X_{b1}	X_{b2}	X_{b3}	X_{b4}	X_{b5}	X_{b6}
.129	.203	.315	.473	.676	.000	.145	.242	.393	.602	.847	1.110
.196	.286	.393	.547	.750	.976	.155	.251	.393	.583	.805	1.000
.148	.209	.316	.448	.621	.844	.180	.299	.415	.576	.818	1.110
.161	.264	.422	.628	.000	.000	.171	.270	.444	.692	.950	.000
.200	.296	.425	.621	.824	.000	.203	.325	.473	.673	.873	1.120
.145	.235	.341	.506	.721	.966	.155	.264	.409	.605	.831	.000
.110	.180	.287	.425	.611	.000	.200	.335	.509	.683	.914	1.180
.123	.258	.386	.564	.000	.000	.219	.303	.457	.644	.847	.000
.180	.268	.393	.528	.725	.914	.174	.280	.467	.673	.940	1.190
.158	.254	.374	.570	.799	1.030	.171	.277	.454	.663	.000	.000
.200	.303	.457	.663	.000	.000	.158	.270	.451	.615	.902	.000
.142	.219	.345	.512	.744	.000	.177	.267	.405	.586	.805	.000
.138	.222	.345	.493	.699	.940	.171	.306	.480	.702	.966	1.230
.145	.219	.338	.493	.686	.966	.171	.254	.393	.560	.773	.000
.161	.242	.357	.483	.679	.000	.196	.325	.511	.728	.943	.000
.219	.306	.451	.618	.873	.000	.171	.325	.483	.689	.921	.000
.190	.296	.448	.644	.917	.000						
$\bar{X}_{a1}$	$\bar{X}_{a2}$	$\bar{X}_{a3}$	$\bar{X}_{a4}$	$\bar{X}_{a5}$	$\bar{X}_{a6}$	$\bar{X}_{b1}$	$\bar{X}_{b2}$	$\bar{X}_{b3}$	$\bar{X}_{b4}$	$\bar{X}_{b5}$	$\bar{X}_{b6}$
.161	.251	.376	.542	.738	.948	.176	.287	.446	.642	.876	1.134

Now compute the quantity $d_i = \dfrac{\bar{X}_{ai} - \bar{X}_{bi}}{\sqrt{\dfrac{1}{n_{ai}} + \dfrac{1}{n_{bi}}}}$ where $\underline{n_{ai}}$ equals the number of specimens from sample $\underline{a}$ possessing the $\underline{i}^{th}$ trait, and $\underline{n_{bi}}$ the number of specimens from sample $\underline{b}$ with the $\underline{i}^{th}$ trait. If no missing data are present $\underline{n_{ai}}$ will be identical for all values of $\underline{i}$ and $\underline{n_{bi}}$ will be identical for all values of $\underline{i}$. This does not necessarily mean $\underline{n_{ai}}$ equals $\underline{n_{bi}}$. The value of $\underline{d_i}$ is computed below for

$\underline{i} = 1$. Other values for $\underline{i} = 2, 3, \cdots 6$ are calculated similarly.

$$d_1 = \frac{.161 - .176}{\sqrt{\frac{1}{17} + \frac{1}{16}}} = \frac{-.015}{\sqrt{\frac{16+17}{272}}} = -.043$$

The values $\underline{d_i}$ in Table 2 are computer output information and have greater accuracy than the slide rule method above.

Table 2

Values of d_i $i = 1\text{-}6$

d_1	=	-.042
d_2	=	-.105
d_3	=	-.201
d_4	=	-.287
d_5	=	-.372
d_6	=	-.349

The next step is to define

$$N_{ij} S_{ij} = \sum_{k=1}^{n_{ai}} (X_{aik} - \bar{X}_{ai})(X_{ajk} - \bar{X}_{aj}) + \sum_{k=1}^{n_{bi}} (X_{bik} - \bar{X}_{bi})(X_{bjk} - \bar{X}_{bj})$$

If $\underline{SP_{aij}}$ is the sum of the pairs from sample $\underline{a}$ possessing characters $\underline{i}$ and $\underline{j}$ and $\underline{SP_{bij}}$ is the sum of the pairs from sample $\underline{b}$ possessing characters $\underline{i}$ and $\underline{j}$ then

$$N_{ij} = SP_{aij} + SP_{bij} - 2.$$

If all data are present within each array, it is unnecessary to compute each $\underline{N_{ij}}$ as all values are equal to the total number of specimens minus 2.

Compute the element $\underline{S_{11}}$ as follows:

(.129-.161)	(.129-.161)	.001024	(.145-.176)	(.145-.176)	.000961
(.196-.161)	(.196-.161)	.001225	(.155-.176)	(.155-.176)	.000441
(.148-.161)	(.148-.161)	.000169	(.180-.176)	(.180-.176)	.000016
(.161-.161)	(.161-.161)	.000000	(.171-.176)	(.171-.176)	.000025
(.200-.161)	(.200-.161)	.001521	(.203-.176)	(.203-.176)	.000729
(.145-.161)	(.145-.161)	.000256	(.155-.176)	(.155-.176)	.000441
(.110-.161)	(.110-.161)	.002601	(.200-.176)	(.200-.176)	.000576
(.123-.161)	(.123-.161)	.001444	(.219-.176)	(.219-.176)	.001849
(.180-.161)	(.180-.161)	.000361	(.174-.176)	(.174-.176)	.000004
(.158-.161)	(.158-.161)	.000009	(.171-.176)	(.171-.176)	.000025
(.200-.161)	(.200-.161)	.001521	(.158-.176)	(.158-.176)	.000324
(.142-.161)	(.142-.161)	.000361	(.177-.176)	(.177-.176)	.000001
(.138-.161)	(.138-.161)	.000529	(.171-.176)	(.171-.176)	.000025
(.145-.161)	(.145-.161)	.000256	(.171-.176)	(.171-.176)	.000025
(.161-.161)	(.161-.161)	.000000	(.196-.176)	(.196-.176)	.000400
(.219-.161)	(.219-.161)	.003364	(.171-.176)	(.171-.176)	.000025
(.190-.161)	(.190-.161)	.000841			
	Total	.015482		Total	.005867

$$N_{11}S_{11} = .015482 + .005867 = .021349$$

$$N_{11} = 17 + 16 - 2 = 31$$

$$S_{11} = \frac{.021349}{31} = .00069$$

Compute the element $\underline{S_{56}}$ as follows:

(.750-.738)	(.976-.948)	.000336	(.847-.876)	(1.11-1.13)	.000580
(.621-.738)	(.844-.948)	.012168	(.805-.876)	(1.00-1.13)	.009230
(.721-.738)	(.966-.948)	.000306	(.818-.876)	(1.11-1.13)	.001160
(.725-.738)	(.914-.948)	.000442	(.873-.876)	(1.12-1.13)	.000030
(.799-.738)	(1.03-.948)	.005002	(.914-.876)	(1.18-1.13)	.001900
(.699-.738)	(.940-.948)	.000312	(.940-.876)	(1.19-1.13)	.003840
(.686-.738)	(.966-.948)	-.000936	(.966-.876)	(1.23-1.13)	.009000
	Total	.017018		Total	.025740

$$N_{56}S_{56} = .017018 + .025740 = .042758$$

$$N_{56} = 7 + 7 - 2 = 12$$

$$S_{56} = \frac{.042758}{12} = .00356$$

Now form the matrix $\underline{A}$ of the quantities $\underline{S_{ij}}$.

$$
A = \left| \begin{array}{cccccc}
.0006^{*} & .0007 & .0009 & .0010 & .0011 & .0003 \\
8855 & 7172 & 3298 & 6822 & 5072 & 8710 \\[1ex]
.0007 & .0012 & .0015 & .0018 & .0020 & .0010 \\
7172 & 0371 & 0788 & 3538 & 0341 & 9164 \\[1ex]
.0009 & .0015 & .0021 & .0027 & .0030 & .0017 \\
3298 & 0788 & 7109 & 8502 & 8780 & 4864 \\[1ex]
.0010 & .0018 & .0027 & .0040 & .0043 & .0025 \\
6822 & 3538 & 8502 & 2773 & 9182 & 7905 \\[1ex]
.0011 & .0020 & .0030 & .0043 & .0058 & .0035 \\
5072 & 0341 & 8780 & 9182 & 3188 & 5210 \\[1ex]
.0003 & .0010 & .0017 & .0025 & .0035 & .0044 \\
8710 & 9164 & 4864 & 7905 & 5210 & 9695
\end{array} \right|
$$

Now the matrix $\underline{A}$ is inverted to form the matrix $\underline{A}^{-1}$ composed of elements $\underline{S}^{ij}$, where each element $\underline{S}^{ij}$ is the inverse of the element $\underline{S_{ij}}$. Any one of several methods may be used. The method of pivoting on the diagonal elements of the matrix was used in my program. For practical reasons, the variables probably should not exceed four or five if this type of test is to be used utilizing a desk calculator. The results of the inversion of matrix $\underline{A}$ are shown in matrix $\underline{A}^{-1}$.

$$ {}^{*}\begin{array}{l} .0006 \\ 8855 \end{array} = .00068855 $$

$$A^{-1} = \begin{vmatrix} 6173.8180 & -4269.4331 & -590.22362 & 662.90056 & -296.83937 & 588.77195 \\ -4269.4331 & 10490.190 & -6985.2691 & 848.17793 & 515.65168 & -356.52163 \\ -590.22362 & -6985.2691 & 11463.037 & -3979.2993 & -569.27790 & 20.916766 \\ 662.90056 & 848.17793 & -3979.2993 & 3363.8070 & -878.24746 & 48.935558 \\ -296.83937 & 515.65168 & -569.27790 & -878.24746 & 1223.3065 & -340.85256 \\ 588.77195 & -356.52163 & 20.916766 & 48.935558 & -340.85256 & 491.27519 \end{vmatrix}$$

Hotelling's statistic is then defined as

$$T^2 = \sum_{i=1}^{p} \sum_{j=1}^{p} S^{ij} d_i d_j$$

The hypothesis of equal means is rejected if T^2 is too large. Hotelling proved that $\left(\frac{N + 1 - p}{N \cdot p}\right) T^2$ has an F-distribution with p and $n + 1 - p$ degrees of freedom. The critical value of F may therefore be taken from the tables of the F-distribution.

In this example $T^2 = 35.126071$, $N = 24$, $p = 6$

then $\left(\frac{N + 1 - p}{N \cdot p}\right) T^2 = \left(\frac{24 + 1 - 6}{24 \cdot 6}\right) 35.126071 = 4.63469$

The final step is to look up in any book of statistical tables the critical value of F. This value is obtained by looking in column 6 ($p = 6$) and row 24 ($N = 24$). Here one finds the critical value of F at the 1% level to be 3.67. Thus the computed value of 4.63 is considerably larger than the critical value of 3.67, and the samples would be expected to differ as much as they do by chance alone less than once in a hundred times. One may conclude in this case that the samples are significantly different and, since the difference cannot be attributed to sample error, attribute the difference to a true morphologic difference.

The example presented is not peculiar in paleontology and significant application could be made to most of the coiled fossil invertebrates. It is true that most coiled invertebrates tend to have some form of logarithmic expansion of the shell. The question may well be asked why not then use logarithms of the measured values rather than the original measurements? The answer is that although logarithmic values were used for half length, radius vector (sagittal), and radius vector (axial) comparisons on the computer, the original values were used for simplicity during presentation of the computations. Both logs ($F = 8.101$) and original measurements ($F = 4.63$) yield significant values for F.

Now that samples _a_ and _b_ have been shown to differ significantly, is this all that can be done? This depends upon the individual and his particular problem. If his problem is satisfied by the knowledge of significant or insignificant difference, then Hotelling's T^2 is a logical terminus. However, if he desires the relation of other samples to the populations which he has just determined significantly different, then the linear discriminant functions should logically follow.

The Linear Discriminant Function

There are two samples, a and b, from paleontologic populations A and B. From each sample p characters are measured and recorded for each of n individuals. It is known, *a priori*, that populations A and B differ significantly. A third sample c is collected separated in time or space or both from samples a and b but study of the data indicates that sample c belongs to either population A or population B. The problem is to assign sample c to its most probable population based upon the information at hand.

If two populations are different then it is possible to choose coefficients for the several variables of

$$R = h_1X_1 + h_2X_2 + \cdots + h_pX_p$$

such that a maximum separation is attained between populations. If the two populations are not different it is apparent that it is impossible to choose values of the coefficients which will give any separation because none exist. Samples were first subjected to Hotelling's T^2 test in this paper to test for significant difference. If there was a significant difference, then the linear discriminant function was employed.

A detailed statement on the problem of discrimination and formal solution may be found in Hodges (1955, p. 35-45). The presentation here is only to indicate how the discriminating index values of R are obtained and what they are interpreted to mean in relation to fusulinid populations.

The general form of the solution for the values of $\underline{h_p}$ is a set of $\underline{p}$ simultaneous linear equations

$$S'_{11}h_1 + S'_{12}h_2 + \cdots + S'_{1p}h_p = d_1$$
$$S'_{21}h_1 + S'_{22}h_2 + \cdots + S'_{2p}h_p = d_2$$
$$S'_{p1}h_1 + S'_{p2}h_2 + \cdots + S'_{pp}h_p = d_p$$

where the elements $\underline{S'_{ij}}$ are computed from

$$S'_{ij} = \sum_{k=1}^{n_{ai}} (X_{aik} - \bar{X}_{ai})(X_{ajk} - \bar{X}_{aj}) + \sum_{k=1}^{n_{bi}} (X_{bik} - \bar{X}_{bi})(X_{bjk} - \bar{X}_{bj})$$

and elements $\underline{d_i}$ are computed from

$$d_i = \bar{X}_{ai} - \bar{X}_{bi}, \quad \text{for } i = 1, 2 \cdots p.$$

As an example the linear discriminant function will be applied to the same samples on which Hotelling's T^2 test was previously applied.

First compute the value of $\underline{d_i}$. The value of $\underline{d_i}$ is computed below for $\underline{i} = 1$. Other values for $\underline{i} = 2, 3 \cdots 6$ are calculated similarly and shown in Table 3.

$$d_i = .161 - .176 = -.015$$

Table 3

Values of d_i	$i = 1, 2, \cdots 6$
d_1	$= -.015$
d_2	$= -.036$
d_3	$= -.070$
d_4	$= -.100$
d_5	$= -.138$
d_6	$= -.186$

Elements $\underline{S'_{ij}}$ are identical to elements $\underline{N_{ij}S_{ij}}$ computed in the previous example. Thus the form of the final discriminant matrix is:

$$.0213h_1 + .0239h_2 + .0289h_3 + .0331h_4 + .0311h_5 + .0046h_6 = -.015$$

$$.0239h_1 + .0373h_2 + .0467h_3 + .0569h_4 + .0541h_5 + .0131h_6 = -.036$$

$$.0289h_1 + .0467h_2 + .0673h_3 + .0863h_4 + .0834h_5 + .0210h_6 = -.070$$

$$.0331h_1 + .0569h_2 + .0863h_3 + .1249h_4 + .1186h_5 + .0309h_6 = -.100$$

$$.0311h_1 + .0541h_2 + .0834h_3 + .1186h_4 + .1575h_5 + .0426h_6 = -.138$$

$$.0046h_1 + .0131h_2 + .0210h_3 + .0309h_4 + .0426h_5 + .0540h_6 = -.186$$

Solving the determinant matrix for values of $\underline{h_i}$,

$$h_1 = -0.7641 \qquad h_4 = +0.4922$$
$$h_2 = +2.4503 \qquad h_5 = +0.1408$$
$$h_3 = -2.1114 \qquad h_6 = -3.5536$$

Substituting for $\underline{h_i}$ in the linear discriminant function

$$R = -.7641X_1 + 2.4503X_2 - 2.1114X_3 + .4922X_4 + .1408X_5 - 3.5536X_6.$$

The values of $\underline{h_i}$ above are those values which maximize the separation between samples and minimize the dispersion within samples.

Applying the above equation to the data from each specimen an index value is obtained for that specimen. This process is repeated for each individual of sample a and b. In Table 4 index values are presented for the specimens of sample a and b which possess six volutions.

Table 4

Index Values R, of Specimens Possessing Six Volutions, of *F.* cf. *F. novamexicana* and *F. euryteines*

Fusulina cf. *F. novamexicana*	*Fusulina euryteines*
-3.555	-4.284
-3.381	-4.198
-3.372	-4.135
-3.337	-3.883
-3.289	-3.877
-3.197	-3.827
-2.959	-3.486

There is very little overlapping of index values between the two species. Therefore no great difficulty should arise in assigning specimens from sample c to either *Fusulina* cf. *F. novamexicana* or *Fusulina euryteines*. Specimens from sample c yield index values of -2.7762, -2.8423, and -3.2799. These values are all within the range of index values of *F.* cf. *F. novamexicana*. The probability is that these few specimens from sample c belong to the population called *F.* cf. *F. novamexicana* rather than to *F. euryteines*. Note that it is not stated that this assignment of sample c to *F.* cf. *F. novamexicana* is absolute or even correct. It is simply stated that according to the presently available information, the probability is greatest that sample c was taken from the same population as sample a (F. cf. F. novamexicana). This fits the geologic picture quite nicely because although sample c was collected from an outcrop which is offset from the main Pumpkin Creek ledge the faulted outcrop was considered as Pumpkin Creek on lithologic grounds.

The linear discriminant function is given in the discussion of individual species for significantly different characters of similar species. This discriminating index is considered valid only for the vicinity of the Ardmore Basin because as previously indicated, although differentiation in the Ardmore Basin is largely statistical, the designation of species names is subjective. If samples are measured as indicated previously, then index values should be attained which will allow assignment of a new sample to one of two populations (species). The worker must first be able to limit the new sample to one of two, either population A or B. This, in the majority of cases (in the Ardmore Basin), is not too difficult.

The paleontologist never knows the absolute limits of character variation within the population sampled. He knows only that certain limits are exhibited by his sample. How this sample information is interpreted and the final inferences concerning the population made is critical to both phylogeny and stratigraphy. To the writer, a method based upon probability is superior to one based upon the speculative nature of qualitative interpretation. An estimate of reliability is explicit in statistical inference; it is not in qualitative inference.

Although the methods applied in this paper may appear lengthy it is a rather simple problem to program for the computer. Once programmed, for the general case, time consumed in comparing and discriminating samples is less than that generally required for non-statistical comparison and discrimination.

SYSTEMATIC PALEONTOLOGY

Order FORAMINIFERA D'Orbigny, 1826

Family FUSULINIDAE Möller, 1878

Subfamily FUSULININAE Rhumbler, 1895

Genus FUSULINELLA Möller, 1877

FUSULINELLA DAKOTENSIS Thompson, 1936

Plate I, figs. 1-4

Fusulinella dakotensis Thompson, 1936, Jour. Paleontology, vol. 10, p. 99-100. pl. 13, fig. 8-10.

Diagnosis:

Shape. Fusiform with bluntly pointed polar extremities. Axis of coiling slightly curved.

Size. Specimens which are considered mature range in length from 4.2 to 5.7 mm and in width from 1.4 to 1.9 mm.

Number of volutions. Generally 7 with only 4 of 22 specimens possessing 8 volutions.

Protheca. Not of sufficient thickness to be measured reliably in first volution. Mean thicknesses of second through seventh volution are: 6.8/22, 9.1/37, 11.4/37, 13.7/37, 16.6/37, and 19.0/37 microns.

Half length. Mean lengths are: .150/22, .295/22, .484/22, .779/22, 1.21/22, 1.79/22, and 2.40/20 mm for the first through the seventh volutions.

Radius vector. Mean radius vector values of the first through the seventh volutions are: .106/37, .160/37, .232/37, .326/37, .449/37, .608/37, and .793/37 mm.

Wall. The protheca is thin with well-developed tectum* and diaphanotheca. Epitheca thick in inner volutions but becomes thin in outer volutions.

Chomata. Chomata are strongly developed in the first few volutions and appear continuous with the epitheca, but develop into distinct asymmetrical deposits in outer volutions. Chomata height yields mean values of 28/22, 36/22, 46/22, 59/22, 63/21, and 69/18 microns for the first through sixth volutions.

Tunnel width. Tunnel outline is concave toward the poles. Mean widths of the first through the sixth volutions are: 57/22, 87/22, 129/22, 207/22, 363/22, and 632/18 microns.

Septa. Fluting is confined to the poleward extremities and is well developed there. The mean septal counts of the first

---

*These terms are used as defined by Henbest (1937). The tectum is a thin, discontinuous discoloration and is probably not a separate layer. The diaphanotheca is a clear finely granular layer possessing keriothecal structure.

through the seventh volutions are: 10.7/15, 16.6/15, 18.6/15, 20.1/15, 22.7/15, 24.6/15, and 26.8/15.

Proloculus. Maximum and minimum mean values of the outside diameter of the proloculus are: 111/37, and 127/37 microns.

Discussion: *Fusulinella dakotensis* Thompson, differs considerably from other species of the genus described from Oklahoma. *Fusulinella prolifica* Thompson differs by possessing a smaller proloculus, less intensely fluted septa and in general being smaller. *Fusulinella juncea* Thompson is similar to *F. dakotensis* but differs principally in its tighter coiling and smaller radius vector values. *Fusulinella vacua*, new species, is closely similar to *F. dakotensis*. Discrimination of these two species is discussed under *F. vacua*.

Occurrence: *Fusulinella dakotensis* occurs abundantly in unit 6 (Appendix I, section 5, unit 6) of the Bostwick Member center north line NW$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 5, T. 6 S., R. 2 E., and SW$\frac{1}{4}$ SW$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 32, T. 5 S., R. 2 E., Carter and Love Counties, Oklahoma, respectively.

FUSULINELLA VACUA, new species

Plate I, figs. 5-8

Diagnosis:

Size. Specimens which are considered mature range in length from 4.7 to 6.2 mm and in width from 1.6 to 1.9 mm.

Number of volutions. The majority of specimens possessed 6 volutions with a few having 7.

Protheca. The mean thicknesses of the tectum and diaphanotheca of the second through the sixth volutions are: 6.7/39, 9.5/39, 12.3/39, 14.7/39, and 17.2/38 microns.

Wall. The wall is thick relative to that of Fusulinella dakotensis, with well-developed epitheca in the interior volutions. The epitheca thins outward from the proloculus but remains quite distinct.

Half length. The mean lengths for the first through the seventh volutions are: .194/24, .364/24, .604/24, .974/24, 1.45/24, 2.07/23, and 2.52/10 mm.

Radius vector. Mean widths of the first through the seventh volutions are: .121/39, .189/39, .275/39, .396/39, .549/39, .723/34, and .920/15 mm.

Chomata. Mean chomata heights of the first through the sixth volutions are: 35/24, 43/24, 57/24, 70/24, 80/24, and 80/15 microns. Chomata are coincident with the upper tectorium in inner volutions but discrete asymmetrical chomata develop in the outer volutions.

Tunnel width. The trace of the tunnel is slightly concave toward the poles. Mean tunnel widths of the first through sixth volutions are: 69/24, 101/24, 152/24, 259/24, 415/24, and 616/13 microns.

Septa. Septa are severely fluted in the polar regions in the same manner as Fusulinella dakotensis, however, some midplane fluting has been developed. The mean septal counts of the first through seventh volutions are: 10.6/15, 16.8/15, 20.2/15, 22.6/15, 26.0/14, 28.2/12, and 27.5/8.

Proloculus. The maximum and minimum mean outside diameters of the proloculus are: 146/15, and 123/15 microns for the sagittal sections and 156/24, and 138/24 microns for the axial sections.

Discussion: Fusulinella vacua, new species, descended directly from F. dakotensis in the Ardmore Basin. F. vacua has reached a more advanced stage of septal fluting than F. dakotensis and is larger in the interior volutions.

It was believed after studying the data from each sample that a real difference existed, in half length and radius vector in particular. The previously mentioned characters plus the septal count, tunnel width, and proloculus diameter were determined as significantly different. The results from application of the T^2 test were interpreted as differences of morphologic character of an organism due to evolution and not attributable to sampling error. For half length, radius vector, tunnel width, and septal count a value of R was computed from the linear discriminant function. Values of R were obtained by considering volutions 1 through 6. This was the maximum possible as forms from measured section 5, unit 7 are somewhat weathered. The entry of values for randomly selected individual specimens are given below.

Half Length

$$R = + .3278X_1 - .2018X_2 + .3945X_3 + .2942X_4 - .0331X_5 - .3215X_6$$

Fusulinella dakotensis	Fusulinella vacua
-.2476	-.3101
-.2388	-.2694
-.2351	-.2607
-.1828	-.2513
-.1798	-.2097
-.1770	-.2023
-.1742	-.2002
-.1641	-.1798

Radius Vector
(sagittal sections only)

$$R = + .5052X_1 - 1.1281X_2 + .5927X_3 + 1.1377X_4 - 1.6974X_5 - .3089X_6$$

Fusulinella dakotensis		Fusulinella vacua	
-.6441	-.5860	-.7605	-.6792
-.6333	-.5718	-.7480	-.6708
-.6256	-.5595	-.7442	-.6608
-.6122	-.5350	-.7368	-.6238
-.5896	-.5274	-.7345	-.5947

Tunnel Width

$$R = + 3.783X_1 + 1.314X_2 + .1714X_3 + .3183X_4 + .0237X_5 - .1500X_6$$

Fusulinella dakotensis		Fusulinella vacua	
.4886	.3776	.6499	.5240
.4651	.3664	.6132	.5157
.4441	.3657	.6081	.5049
.4325	.3637	.5468	.4945
.4274	.2842	.5455	.4920
.3824	.1778	.5298	.4017

Septal Count

$$R = -30.99X_1 - 39.47X_2 + 24.99X_3 + 5.246X_4 + 17.11X_5 + 16.60X_6$$

Fusulinella dakotensis		*Fusulinella vacua*	
.5103	.3824	.6499	.5240
.4885	.3776	.6132	.5157
.4651	.3657	.6081	.5047
.4441	.3653	.5467	.4945
.4325	.3636	.5455	.4920

Although *F. dakotensis* and *F. vacua* are closely related, it has been demonstrated above that an unbiased separation is possible. There is little overlap of *R* values for any morphologic character. Thus the process of classifying a new sample population in its most probable paleontological population is facilitated.

The species is named from Latin vacuus, -a, -um, meaning empty.

Occurrence. *Fusulinella vacua* occurs abundantly in the shales separating the nodular limestone beds of the upper Bostwick Member in SW$\frac{1}{4}$ SW$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 32, T. 5 S., R. 2 E., Carter County, Oklahoma. Sparingly fossiliferous upper limestones occur along strike for several miles. The fossiliferous horizon is unit 7 of measured section 5 (see Appendix I).

FUSULINA INSOLITA Thompson, 1948

Plate II, figs. 8-11

Fusulina ? *insolita* Thompson, 1948, Kansas Univ., Paleont. Contr., Protozoa, art. 1, p. 96-97, pl. 32, fig. 7, pl. 38, figs. 9-13.

Diagnosis:

Size. Mature specimens of 6 volutions range in length from 3 to 4 mm and in width from 1.6 to 1.8 mm.

Shape. The form is inflated fusiform with rather bluntly pointed or broadly rounded poles.

Number of volutions. Most specimens have 5 to 6 volutions; however these specimens have been weathered so it is possible that another volution may be present on non-eroded forms.

Protheca. The mean thicknesses of the second through the sixth volution are: 7.1/34, 9.3/35, 12.1/35, 14.6/34, and 16.8/10 microns.

Wall. Epithecal deposits about the primary layers makes the wall thick, and although the thickness of the secondary deposit decreases in the outer volutions, the wall is still quite thick. Mean values of wall thickness of the first through the sixth volutions are: 15.0/33, 22.2/35, 30.4/35, 37.4/35, 40.5/34, and 42.5/9 microns.

Half length. The mean values of the half length of the first through the sixth volutions are: .147/20, .311/20, .562/20, .882/20, 1.31/20, and 1.68/10 mm.

Radius vector. The mean values of the radius vector of the first through the sixth volutions are: .110/35, .187/35, .302/35, .458/35, .659/33, and .808/14 mm.

Chomata. Chomata are wider than high in the interior 2-3 volutions, but in outer volutions they become approximately equal in height to width. These deposits are very strongly developed throughout the test. Mean chomata heights of the first through the fifth volutions are: 37/20, 57/20, 76/20, 103/20, and 105/12 microns.

Tunnel width. Mean tunnel widths of the first through the fifth volutions are: 59/20, 99/20, 152/20, 246/20, and 348/13 microns.

Septa. Fluting in the polar regions is slightly more extreme than that developed across the midplane. Midplane fluting is low and rather broad giving indication of its overall weak development. The mean septal counts of the first through the sixth volutions are: 9.1/15, 13.2/15, 15.5/15, 18.4/15, 21.4/13, and 24.2/4.

Proloculus. The proloculus is a variable character in *Fusulina insolita*. The minimum and maximum mean outside diameters are: 112/35 and 124/35 microns. Values range from approximately 80 to 180 microns.

Discussion: *Fusulina insolita* in the Ardmore Basin is one of the early forms of the genus *Fusulina*. As indicated by Thompson, it possesses characters of both *Fusulina* and *Fusulinella*. Although my specimens appear to have better developed midplane fluting than those studied by Thompson, this one variable characteristic is not considered as grounds for a new species. *Fusulina insolita* is more primitive than *F. mutabilis* from the upper part of the same formation in that the septa of *F. inso-*

lita are not so highly fluted, the shell is inflated where F. mutabilis is elliptical to rhomboidal, and the spirotheca is much thicker. Values of R from the linear discriminant function that should allow placement of new samples to either F. insolita or F. mutabilis are given in discussion of F. mutabilis.

Occurrence: Fusulina insolita occurs sparingly in measured section 1, unit 4 (Appendix I, measured section 1). This sandy limestone is thin- to medium-bedded, and crops out in the northeast corner of NW$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 22, T. 6 S., R. 2 E., Love County, Oklahoma. The unit is approximately 150 feet below the "oolitic" Lester Member as mapped in the Overbrook anticline.

FUSULINA MUTABILIS, new species

Plate II, figs. 1-5

Diagnosis:

Size. Mature specimens of 6$\frac{1}{2}$ to 7 volutions range in length from 2.2 to 4.2 mm and in width from 1.2 to 1.5 mm.

Shape. The general shape is fusiform with some forms inflated and some approaching elongate fusiform.

Number of volutions. Most specimens posses 6 volutions; however 7 is not uncommon and if the preservation were better, as many as 8 might be present.

Protheca. The mean thicknesses of the second through the sixth volutions are: 6.9/40, 9.1/40, 11.7/40, 13.8/39 and 16.1/21 microns.

Wall. The wall is thick with well-developed epitheca. Mean thicknesses of the first through the sixth volutions are: 17.3/40, 23.3/40, 29.4/40, 35.1/40, and 38.3/40 microns.

Half length. Mean values of the half lengths of the first through the seventh volutions are: .137/36, .296/36, .514/36, .822/36, 1.28/36, 1.75/27, and 2.11/4 mm.

Radius vector. Mean values of the first through the sixth volutions are: .095/40, .155/40, .237/40, .360/40, .521/39, and .696/26 mm.

Chomata. Chomata are strongly developed and are continuous with the epitheca in the inner volutions as in Fusulinella. In the outer volutions, the chomata range from prominent asymmetrical to almost symmetrical ridges. Heights of chomata above underlying tectum of the first through the sixth volutions are: 32/36, 47/36, 68/36, 88/36, 92/32, and 92/10 microns.

Tunnel width. Mean values of the first through sixth volutions are: 54/36, 80/36, 130/36, 210/36, 323/33, and 457/11 microns.

Septa. The septa show considerable variation among specimens, ranging from forms which appear similar to Fusulinella to those that have well developed midplane septal fluting. This is a common feature associated with fusulinids of this stratigraphic position. The mean septal counts for volutions 1 through 6 are: 8.7/22, 12.7/22, 15.2/22, 17.6/22, 20.9/22, and 24.9/13.

Proloculus. The minimum and maximum mean value of the outside diameter of the proloculus is 95/40, and 105/40 microns.

Discussion: Fusulina mutabilis, new species, is one of the several primitive fusulinids of the Ardmore Basin assignable to the genus Fusulina. F. mutabilis differs from F. insolita in tunnel width, proloculus width, and possesses a higher degree of midplane septal fluting. Values of R for the tunnel to allow future samples from this general stratigraphic position to be assigned to F. insolita or F. mutabilis are given below.

Tunnel Width

$$R = + .7297X_1 - 2.8331X_2 - .4212X_3 + .1952X_4 + .0509X_5$$

Fusulina insolita		Fusulina mutabilis	
.3033	.2390	.2261	.1895
.2750	.2314	.2212	.1768
.2521	.2258	.2091	.1731
.2453	.2150	.2017	.1606
.2406	.1976	.1942	.1539
.2396	.1914	.1912	.1507

F. mutabilis is similar to F. kayi Thompson but differs markedly in septal count. Topotypes of F. leei Skinner from the Inola Limestone differ from F. mutabilis in possessing a larger septal count and being longer.

The species is named from the Latin mutabilis, e, meaning changeable and refers to the variable degree of fluting of these forms.

Occurrence: Fusulina mutabilis, new species, is common in the "oolitic" Lester Member in NW¼ NE¼ NE¼ sec. 22, T. 6 S., R. 2 E., Love County, Oklahoma. The Lester Member at this locality consists of approximately

8 to 9 feet of brown, thin- to medium-bedded, oolitic, sparry calcite-cemented limestone with numerous fusulinids and abundant other fossils. See measured section 1, unit 6 of Appendix I. Fusulina mutabilis also occurs approximately 90 feet below the type Lester Member in the NE$\frac{1}{4}$ NE$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 13, T. 4 S., R. 1 E., Carter County, Oklahoma, in a deeply-weathered yellow-tan, thin- to medium-bedded, sparry calcite-cemented, sandy limestone.

FUSULINA PUMILA Thompson, 1934

Plate III, figs. 10-13

Fusulina pumila Thompson, 1934, Iowa Univ. Studies Nat. History, vol. 16., no. 248, p. 313-314, pl. 22, figs. 6, 8, 10, 11.

[?] Fusulina pumila Thompson, Dunbar and Henbest, 1942, Illinois State Geol. Survey, Bull. 67, p. 107-109, figs. 9-21.

Diagnosis:

Size. Specimens which are considered mature range in length from 2.5 to 3.8 mm and in width from 1.2 to 1.5 mm in the seventh volution.

Shape. The general shape of this form is inflated with rather broadly pointed polar extremities.

Number of volutions. There are generally 6 to 7 volutions present on these forms, but a volution or two is missing due to abrasion or solution.

Protheca. The protheca is thin throughout the test.

Mean thicknesses of the first through the sixth volutions are: 4.3/41, 6.0/41, 7.7/41, 10.0/41, 12.1/41, and 13.9/40 microns.

Half length. The length of the specimens is quite short. Mean half length values of the first through the seventh volutions are: .075/28, .168/28, .302/28, .509/28, .807/28, 1.22/27, and 1.59/11 mm.

Radius vector. The mean values of the radius vector of the first through sixth volutions are: .069/41, .113/41, .175/41, .264/41, .390/41, and .548/40 mm.

Wall. The wall is thick in comparison to the size of the shell. The mean thicknesses of the first through sixth volutions are: 11/41, 15.4/41, 20.2/41, 26.5/41, 30.3/41, and 32.0/40 microns.

Chomata. The shape of the chomata is generally symmetrical in inner volutions. The chomata are very strongly developed and are comparatively high. The mean heights of the chomata of the first through sixth volutions are: 22/28, 34/28, 50/28, 71/28, 85/28, and 86/22 microns.

Tunnel width. The high massive chomata are closely set to form a narrow tunnel that is well defined. The mean width of the first through the sixth volutions are: 37/28, 59/28, 86/28, 131/28, 186/27, and 264/20 microns.

Septa. The septa are fluted from the poles across the mid-plane to the chomata. The degree of fluting is moderate to strong with some looping occurring near the chomata. The mean septal counts of the first through sixth volutions are: 9.0/13, 13.8/13, 16.3/13, 19.5/13, 22.4/13, and 26/13.

Proloculus. The proloculus is small possessing mean values of 63/41 and 71/41 microns for the minimum and maximum outside diameter.

Discussion: The forms which are assigned to *Fusulina pumila* Thompson from the Ardmore Basin agree in all characters save septal count. The septal count of the Ardmore Basin forms is less per volution than designated on the Iowa forms.

Associated with *Fusulina pumila* are small forms of the genus *Wedekindellina* of which several are illustrated.

Occurrence: *Fusulina pumila* occurs in abundance in the lower part of the Frensley Limestone Member (Appendix I, measured section 1, unit 8) center west line NE$\frac{1}{4}$ NE$\frac{1}{4}$ NE$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 22, T. 6 S., R. 2 E., Love County, Oklahoma.

FUSULINA PLATTENSIS Thompson, 1936

Plate III, figs. 5-9

Fusulina plattensis Thompson, 1936, Jour. Paleontology, vol. 10, p. 109-111, pl. 14, figs. 12-17.

Fusulina sp. Thompson, 1936, Ibid., p. 11, pl. 14, figs. 23, 24.

Fusulina plattensis Thompson, Thompson and Thomas, 1953, Wyoming Geol. Survey, Bull. 46, p. 24-26, pl. 1, figs. 12-14, 16-18.

Diagnosis:

<u>Size</u>. Mature specimens of 6 to 6½ volutions range in length from 2.6 to 4.0 mm and in width from 1.0 to 1.5 mm.

<u>Shape</u>. The shell is fusiform in general outline with some specimens appearing rather elongate.

<u>Number of volutions</u>. Mature specimens contain 6 to 7 volutions.

<u>Protheca</u>. The tectum and diaphanotheca are thin. Mean thicknesses of the second through the sixth volutions are: 6.3/30, 8.9/30, 10.8/29, 12.8/29, and 14.5/17 microns.

<u>Half length</u>. Mean values of the first through sixth volutions are: .093/20, .218/20, .414/20, .732/20, 1.15/20, and 1.56/17 mm.

<u>Radius vector</u>. Mean values of the first through sixth volutions are: .079/31, .128/31, .203/31, .307/31, 449/31, and .605/22 mm.

<u>Wall</u>. The mean thicknesses of the spirotheca of the first through the sixth volutions are: 12.7/30, 17.8/30, 22.3/30, 27.6/29, 30.2/29, and 30.517 microns.

<u>Chomata</u>. The chomata are asymmetrical throughout the shell. In the inner volutions, asymmetry is due to tapering-off of the chomata toward the poles. In the outer two volutions, this asymmetry is due to overhang of the tunnel side of the chomata. Mean chomata heights of the first through the sixth volutions are: 26/20, 40/20, 60/20, 73/20, 80/18, and 83/6 microns.

<u>Tunnel width</u>. The tunnel appears narrow in comparison to

length of shell. Mean widths of the first through sixth volutions are: 46/20, 72/20, 107/20, 178/20, 243/18, and 329/3 microns.

Septa. Septa are fluted throughout the shell. The flutes form closed chamberlets across the midplane that do not touch the upper part of the chamber. Fluting intensity is moderate. The mean values of the septal counts of the first through sixth volutions are: 8.6/11, 14.1/11, 16.8/11, 18.9/10, 22.6/11, and 24.5/4.

Proloculus. The diameter of the proloculus is small. The mean minimum and maximum outside diameters are 78/31 and 87/31 microns.

Discussion: *Fusulina plattensis* Thompson is one of several small primitive fusulines in the Ardmore Basin which belong to the genus *Fusulina*. Topotype material from the Inola Limestone indicates *Fusulina leei* is similar but differs from *F. plattensis* in more severely fluted septa, larger septal count per volution, and in being larger.

Occurring in association with *Fusulina plattensis* are occasional specimens of *Wedekindellina*. The wedekindellinas are so rare that only two were found in approximately ten pounds of sample.

Occurrence: *Fusulina plattensis* Thompson occurs in the upper thin-bedded limestone of the Frensley Member in SW¼ SE¼ SE¼ sec. 15, T. 6 S., R. 2 E., Love County, Oklahoma. See Appendix I, measured section 1, unit 11.

FUSULINA cf. F. NOVAMEXICANA Needham, 1937

Plate III, figs. 1-4

Fusulina murrayensis Devonshire [nomen nudem], 1954, Shale Shaker, vol. 5, no. 1, p. 10.

Diagnosis:

Size. The test is of medium size. Specimens which are considered mature range from 4.0 to 5.0 mm in length and from 1.7 to 2.2 mm in width.

Shape. The shell is inflated and has rounded polar extremities.

Number of volutions. Weathering has caused some loss of volutions so that only 6 volutions normally are found on the forms studied.

Protheca. The protheca is rather thin for a form as large as those studied. The mean thicknesses of the first through the sixth volutions are: 6.3/48, 8.6/48, 10.5/48, 12.3/48, 14.5/44, and 16.4/25 microns.

Half length. The inflated shape is reflected in the rather short half length values. The mean lengths of the first through the sixth volutions are: .198/31, .360/31, .585/31, .889/31, 1.27/30, and 1.73/20 mm.

Radius vector. The mean values of the radius vector measures of the first through sixth volutions are: .147/48, .234/48, .354/48, .519/48, .717/44, and .936/25 mm.

Wall. The wall is thick and varies little in thickness from mid-tunnel to polar extremes. The epitheca is the thickest deposit and is well-developed both above and below the protheca.

Chomata. The chomata are very strongly developed. They are asymmetrical in the inner volutions but are symmetrical in the outer 2 or 3 volutions. They are high and define a rather narrow tunnel. The mean heights of the chomata of the first through the sixth volutions are: 51/31, 75/31, 96/31, 111/31, 119/25, and 113/6 microns.

Tunnel width. The tunnel appears rather narrow. The mean values of the tunnel widths of the first through the sixth volutions are: 61/31, 89/31, 139/31, 208/31, 293/24, and 368/6 microns.

Septa. The septa are fluted throughout the shell and form closed chamberlets which generally are rather broad at their tops. The mean septal counts of the first through the sixth volutions are: 10.9/17, 17.2/17, 21.0/17, 24.2/17, 27.3/14, and 32.5/7. The values range from 9-14, 15-20, 17-25, 21-31, 21-34, and 30-39 for the same volutions.

Proloculus. The proloculus is variable in size ranging between 100 and 229 microns for maximum outside diameter. The mean values of the minimum and maximum outside diameters are 154/48 and 168/48 microns.

Discussion: Fusulina cf. F. novamexicana is somewhat similar to F. euryteines Thompson. Hotelling's T^2 indicates that significant differences occur in half length, radius vector, and tunnel width. Each character that was shown to differ significantly and the linear discriminant set up to distinguish these forms in the Ardmore Basin is fully discussed under F. euryteines. Numerous specimens of Wedekindellina sp. occur with F. cf. F. novamexicana at all localities sampled.

Preservation of the fusulines from the Pumpkin Creek Member tentatively identified as Fusulina cf. F. novamexicana is very poor. Many specimens possess only four volutions.

Occurrence: Fusulina cf. F. novamexicana Needham, is common in the Pumpkin Creek Limestone. The species was identified in SW¼ SW¼ SW¼ sec. 14, NW¼ NE¼ NW¼ sec. 23, NE¼ NW¼ sec. 15, and near center NW¼ NE¼ sec. 9, T. 6 S., R. 2 E., Love County, Oklahoma.

FUSULINA EURYTEINES Thompson, 1934

Plate IV, figs. 1-5

Fusulina meeki White, 1932, Texas Univ., Bull. 3211, p. 27-30, pl. 1, figs. 7-12.

Fusulina euryteines Thompson, 1954, Iowa Univ. Studies Nat. History, vol. 16, no. 248, p. 310-313, pl. 22, figs. 4, 13, 14, 18.

Fusulina euryteines Thompson, Needham, 1937, New Mexico School of Mines, Bull. 14, p. 22, 23, pl. 2, figs. 6-10.

Diagnosis:

Size. Mature specimens of 6 to 6½ volutions range in length from 4.0 to 5.6 mm and in width from 2.0 to 2.4 mm.

Shape. The outline of the mature shell is inflated fusiform with bluntly pointed poles.

Protheca. The primary layers are thin. Mean thicknesses of the first through the sixth volutions are: 6.4/36, 8.5/36, 10.5/36, 12.4/36, 14.3/36, and 16.4/24 microns.

Half length. The mean half lengths of the first through sixth volutions are: .257/20, .476/20, .763/20, 1.15/20, 1.68/20, and 2.25/14 mm.

Radius vector. The mean values of the radius vector of the first through the sixth volutions are: .168/36, .276/36, .427/36, .619/36, .846/35, and 1.08/21 mm.

Chomata. The chomata are very strongly developed. The heights of these deposits average 59/20, 81/20, 102/20, 111/20, 110/16, and 108/5 microns in volutions 1 through 6.

Tunnel width. Mean tunnel widths of the first through the sixth volutions are: .080/20, .122/20, .188/20, .289/20, .398/16, and .422/2 mm.

Septa. The septa are folded from midplane of the shell to the poles. The mean septal counts of the first through the sixth volutions are: 11.0/16, 17.8/16, 22.0/16, 26.1/16, 30.0/15, and 31.7/8.

Proloculus. The proloculus is rather large, yielding mean values of 168/36 and 186/36 microns for the minimum and maximum outside diameter.

Discussion. Fusulina euryteines Thompson, differs from F. cf. F. novamexicana Needham, in that F. euryteines is more highly fluted, longer, wider, and has a wider tunnel. Index values of R are given below for half length, radius vector, and tunnel width which should serve to help differentiate these forms in the Ardmore Basin.

Half length

$$R = +.0556X_1 - .1012X_2 - .6277X_3 + .5327X_4 + .0785X_5 - 1.2870X_6$$

Fusulina cf. F. novamexicana		Fusulina euryteines	
-2.373	-2.009	-2.998	-2.717
-2.274	-1.976	-2.844	-2.666
-2.272	-1.912	-2.843	-2.568
-2.231	-1.907	-2.819	-2.539
-2.123	-1.866	-2.799	-2.483
-2.089	-1.863	-2.761	-2.342
-2.026	-1.716	-2.745	-2.333

Radius vector
(sagittal sections only)

$$R = -.2606X_1 + 1.112X_2 - 2.464X_3 + 1.404X_4 + .5963X_5 - 7.043X_6$$

Fusulina cf. F. novamexicana	Fusulina euryteines
-6.658	-7.988
-6.360	-7.760
-6.329	-7.741
-6.280	-7.280
-6.151	-7.258
-5.981	-7.205
-5.530	-6.471

Tunnel Width

$$R = -3.9022X_1 - .5185X_2 + .1287X_3 - .0086X_4 - 1.0695X_5$$

Fusulina cf. *F. novamexicana*		*Fusulina euryteines*	
-.6913	-.5595	-.8779	-.7570
-.6087	-.5478	-.8498	-.7465
-.5943	-.5375	-.8419	-.7395
-.5901	-.5371	-.8266	-.7344
-.5828	-.5252	-.8036	-.7325
-.5805	-.4708	-.7897	-.6814
-.5668	-.4611	-.7581	-.6722

Fusulina euryteines differs from *Fusulina haworthi* by having longer half length and wider radius vector measurements at any given volution. *F. haworthi* also differs by having a significantly smaller proloculus and more narrow fluting. Index values of *R* are given below for half length, radius vector, and tunnel width of randomly chosen specimens.

Half Length

$$R = -.5142X_1 + .1020X_2 - .8945X_3 + .5306X_4 - .1385X_5 - .1561X_6$$

Fusulina euryteines		*Fusulina haworthi*	
-.8195	-.7132	-.6284	-.5075
-.7901	-.6886	-.6142	-.5038
-.7877	-.6877	-.6097	-.4909
-.7678	-.6817	-.5512	-.4852
-.7305	-.6592	-.5509	-.4831
-.7165	-.6313	-.5079	-.4831

Radius Vector

$$R = -.0033X_1 + .1088X_2 - .3734X_3 - .2091X_4 + .2230X_5 - .4566X_6$$

Fusulina eurytenes		*Fusulina haworthi*	
-.6320	-.5511	-.4831	-.4264
-.6189	-.5423	-.4817	-.4200
-.5993	-.5189	-.4716	-.4027
-.5954	-.5069	-.4630	-.3731
-.5679	-.4976	-.4490	-.3544
-.5598	-.4753	-.4443	-.3419

Tunnel Width

$$R = -3.5552X_1 - .9014X_2 - 2.7206X_3 + .5388X_4 - 1.4324X_5$$

Fusulina eurytenes		*Fusulina haworthi*	
-1.518	-1.281	-.9866	-.8495
-1.509	-1.280	-.9716	-.8439
-1.429	-1.272	-.9466	-.8234
-1.372	-1.248	-.9363	-.8052
-1.345	-1.229	-.8902	-.7930
-1.310	-1.204	-.8781	-.7882
-1.297	-1.199	-.8694	-.7793
-1.289	-1.143	-.8514	-.6640

Fusulina euryteines was associated with abundant forms of the genus *Wedekindellina* at all outcrops in which it was found.

Occurrence: *Fusulina euryteines* occurs commonly in the Devils Kitchen Member at section 3, unit 1 (c, e, and f) NE¼ NE¼ SW¼ sec. 4, T. 6 S., R. 2 E., Love County, Oklahoma; and section 4, unit 2 (b, d, and e) SE¼ SE¼ SE¼ sec. 32, T. 5 S., R. 2 E., Carter County, Oklahoma.

FUSULINA ERUGATA, new species

Plate VI, figs. 8-12

Diagnosis:

Shape. The mature shell is fusiform to elongate fusiform.

Size. Specimens range in length from near 2.4 to 4.2 mm, and in width from 0.9 to 1.4 mm in the sixth volution.

Number of volutions. Mature specimens possess 6 to 6½ volutions.

Protheca. The primary layers are thin. The mean thicknesses of the protheca of the second through the sixth volutions are: 8.0/46, 10.0/46, 11.7/46, 13.8/45, and 15.1/26 microns.

Half length. The mean values of the half lengths of the first through the sixth volutions are: .108/33, .225/33, .425/33, .753/33, 1.22/33, and 1.678/23 mm.

Radius vector. Mean radius vector values of the first through the sixth volutions are: .071/46, .120/46, .187/46, .289/46, .428/46, and .559/32 mm.

Wall. The wall is moderately thick and rather peculiarly formed. The protheca is the upper-most wall layer or if upper secondary deposits are present, they are extremely thin. The lower wall layer is a thick deposit of secondary material at midplane but thins poleward rapidly so that polar areas are generally composed of only protheca.

Chomata. The chomata are discrete secondary deposits of shell material that range from weakly developed to strongly developed. They are, in general, symmetrical with overhangs on both the tunnel and polar sides. Some, however, are slightly asymmetrical and taper toward the poles. Mean heights of the chomata of the first through the sixth volutions are: 22/33, 38/33, 60/33, 80/33, 87/27, and 80/5 microns.

Tunnel width. The tunnel is wide and well outlined by the chomata. Mean tunnel widths of the first through the sixth volutions are: 50/33, 86/33, 145/33, 243/33, 391/33, and 531/6 microns.

Septa. The septa are delicately fluted throughout the shell. Fluting decreases in intensity toward the midplane and in most specimens is not developed across the central one-half of the shell. Folds present are very tight and high. The mean septal counts of the first through the sixth volutions are: 9.0/13, 13.0/13, 15.4/13, 17.6/13, 20.4/13, and 22.7/4.

Proloculus. The minimum and maximum mean values of the outside diameter of the proloculus are 85/46 and 96/46 microns.

Discussion. *Fusulina erugata*, new species, is similar in all measurements with *F. plattensis* Thompson, from the Frensley Member with the exception of tunnel width. The tunnel of *F. erugata* is wider. However the main difference is that the septa of *F. erugata* are considerably less highly fluted than *F. plattensis*.

Tunnel Width

$$R = -\ .4073X_1 + 1.542X_2 + .0857X_3 - .1494X_4 + .3296X_5$$

Fusulina erugata		Fusulina plattensis	
.3377	.2155	.1950	.1521
.2731	.2025	.1832	.1483
.2675	.1963	.1656	.1477
.2275	.1881	.1545	.1438
.2188	.1724	.1543	.1352

Higher Desmoinesian _Fusulina_ with little fluting have been described as _F._ ? _arenaria_ Thompson, and _F. rickerensis_ Thompson. Although _F. erugata_ is not as devoid of fluting as _F. rickerensis_ it possesses weak fluting. _Fusulina erugata_ occurs approximately 60 feet below _F. haworthi_ in the Arnold Member.

The species is named from Latin _erugatus_, _a_, _um_, meaning clear of wrinkles and refers to the poor septal fluting.

Occurrence: _Fusulina erugata_, new species, occurs abundantly in the lower part of the Arnold Member (measured section 7, unit 2) NE¼ NW¼ NE¼ sec. 4, T. 6 S., R. 2 E., Love County, Oklahoma.

FUSULINA HAWORTHI (Beede), 1916, emend.

Dunbar and Henbest, 1942

Plate V, figs. 1-5

Girtyina haworthi Beede, 1916, Indiana Univ. Studies, vol. 3, no. 29, p. 14. (Not _Fusulinella haworthi_ of Dunbar and Condra, 1927, Nebraska Geol. Survey, ser. 2, Bull. 2, p. 62, pl. 2, figs. 6-11).

<u>Fusulina</u> <u>haworthi</u> (Beede), White, 1932, Texas Univ. Bull. 3211, p. 26-27, pl. 1, figs. 4-6.

<u>Fusulina</u> <u>stookeyi</u> Thompson, 1934, Univ. of Iowa Studies in Nat. History, vol. 16, no. 4 (new series no. 284) p. 316-318, pl. 22, figs. 3, 15, 16, and 21.

<u>Fusulina</u> <u>haworthi</u> (Beede), Dunbar and Henbest, 1942, Illinois State Geol. Survey, Bull. 67, p. 119-121, pl. 12, fig. 1, pl. 14, figs. 1-18.

<u>Fusulina</u> <u>haworthi</u> (Beede), Alexander, 1954, Oklahoma Geol. Survey, Circ. 31, p. 30-32, pl. 2, figs. 11-12.

<u>Diagnosis</u>:

<u>Size</u>. Mature specimens of 6 to 6½ volutions range in length from 4.2 to 5.6 mm and in width from 1.6 to 2.1 mm.

<u>Shape</u>. The shell is fusiform in shape with bluntly pointed polar extremes.

<u>Protheca</u>. The protheca is thin with mean thickness values of 6.4/38, 8.7/38, 10.8/38, 12.6/38, 14.4/38, and 16.9/36 microns for the first through sixth volutions.

<u>Half length</u>. The mean half lengths of the first through the seventh volutions are: .172/25, .317/25, .522/25, .818/25, 1.23/25, 1.76/25, and 2.36/18 mm.

<u>Radius vector</u>. The mean values of the radius vectors of the first through the sixth volutions are: .118/38, .184/38, .280/38, .411/38, .588/38, and .802/37 mm.

<u>Wall</u>. The wall is thin and is composed principally of tectum

and diaphanotheca. The lower tectorium is the thicker of the secondary layers and in the outer volution is the only secondary layer.

Chomata. The chomata appear to be thickenings of the septa adjacent to the tunnel rather than discrete deposits. The mean chomata heights of the first through the sixth volutions are: 35/25, 53/25, 77/25, 99/25, 110/25, and 112/24 microns.

Tunnel width. The tunnel is narrow and its path rather irregular. The mean widths of the tunnel of the first through the sixth volutions are: 54/25, 81/25, 118/25, 187/25, 279/24, and 402/24 microns.

Septa. The septa are tightly fluted from pole to midplane. The mean septal counts of the first through the sixth volutions are: 11.0/13, 17.1/13, 20.3/13, 24.0/13, 27.3/13 and 30.0/13.

Proloculus. The minimum and maximum mean values of the outside diameter of the proloculus are: 130/35 and 143/35 microns.

Discussion. Fusulina haworthi (Beede) emend. Dunbar and Henbest, is similar in some respects to F. expedita Alexander, but may be distinguished from the latter by its larger proloculus, longer text, and more intense septal fluting.

Fusulina haworthi is readily distinguished from F. euryteines as indicated in the discussion of the latter species. Fusulina haworthi may be distinguished from F. aff. F. whitakeri in the Ardmore Basin by the longer half length, thicker protheca, and degree of fluting of the latter. Index values from the linear discriminant are given below for those characters determined significantly different by Hotelling's test.

Half Length

$$R = .2317X_1 - .3257X_2 - .0584X_3 + .1472X_4 - .2542X_5 - .1494X_6$$

Fusulina haworthi		Fusulina aff. F. whitakeri	
-.6250	-.5039	-.8140	-.7078
-.6145	-.5024	-.8054	-.6851
-.5946	-.4956	-.7931	-.6837
-.5715	-.4837	-.7759	-.6246
-.5169	-.4771	-.7299	-.5783
-.5094	-.4591	-.7289	-.5780

Protheca Thickness

$$R = 18.198X_1 + 3.059X_2 + 8.819X_3 + 1.112X_4 + 12.121X_5 + 15.332X_6$$

Fusulina haworthi		Fusulina aff. F. whitakeri	
.7794	.7145	.8887	.8061
.7605	.6885	.8874	.7936
.7443	.6793	.8511	.7737
.7302	.6662	.8509	.7638
.7281	.6655	.8124	.7579
.7171	.6368	.8113	.7455

Fusulina haworthi is associated with abundant fusulinids of the genus Wedekindellina. The occurrence in the upper part of the Arnold Member of Wedekindellina marks the last occurrence of the genus in the Ardmore Basin to the writer's knowledge.

Occurrence: Fusulina haworthi occurs abundantly in the upper part of the Arnold Member (Appendix I, measured section 6, 12 feet below unit 4) in NE¼ SE¼ SW¼ sec. 33, T. 5 S., R. 2 E., Carter County, and (measured section 7, unit 5a) NE¼ NW¼ NE¼ sec. 4, T. 6 S., R. 2 E., Love County, Oklahoma.

FUSULINA aff. F. WHITAKERI Stewart, 1958

Plate VII, figs. 1-3, 5

Discussion: Several rather badly weathered forms were found in measured section 8, unit 3 which are similar to Fusulina acme from the overlying Camp Ground except in tunnel width and proloculus diameter. These specimens are without doubt of Marmaton age. Values of the index R from the linear discriminant function are given below for the tunnel width.

Tunnel Width

$$R = 2.641X_1 + 1.2444X_2 - .5588X_3 + .0043X_4 - .1544X_5 + .3422X_6$$

Fusulina aff. F. whitakeri		Fusulina acme	
.3500	.2768	.4542	.3493
.3206	.2755	.4288	.3404
.3153	.2734	.4070	.3353
.3149	.2647	.3863	.3325
.2997	.2613	.3769	.2934
.2967	.2589	.3624	.2767

Occurrence: Fusulina aff. F. whitakeri occurs in an unnamed limestone (Appendix I, measured section 8, unit 3) which is very deeply weathered that is stratigraphically between the Rocky Point Conglomerate and the Camp Ground Member. The locality is SW¼ NE¼ SE¼ sec. 20, T. 5 S., R. 2 E., Carter County, Oklahoma.

FUSULINA ACME Dunbar and Henbest, 1942

Plate VII, figs. 4, 6-7; Plate VIII, figs. 1-2

Fusulinella haworthi Dunbar and Condra [not Fusulina haworthi (Beede)], 1927, Nebraska Geol. Survey, Bull. 2, 2nd series, p. 82-84, pl. 2, figs. 6-11.

Fusulina acme Dunbar and Henbest, 1942, Illinois State Geol. Survey, Bull. 67, p. 122-123, p. 15, figs. 1-18, pl. 16, fig. 14.

Fusulina acme Dunbar and Henbest, Stewart, 1958, Jour. Paleontology, vol. 32, p. 1058-1059, pl. 134, figs. 1-4.

Diagnosis:

Size. Specimens from the Ardmore Basin are rather badly weathered and all volutions are not present. Specimens of $6\frac{1}{2}$ to 7 volutions are 6 to 6.8 mm long and 1.5 to 2.1 mm wide.

Shape. Most specimens are fusiform in shape with a few becoming slightly extended.

Half length. Mean half length values are: .221/30, .416/30, .732/30, 1.16/30, 1.77/30, 2.44/30, and 3.13/16 mm for volutions one through seven.

Radius vector. The means of the radius vectors of the first through sixth volutions are: .143/36, .218/36, 323/36, .469/36, .656/36, and .865/34 mm.

Protheca. The primary wall layers are thin averaging 8.6/36, 11.1/36, 13.6/36, 16.3/36, 19.7/36, and 23.7/34 microns for volutions one through six.

Chomata. Chomata are thickenings of the septa adjacent to the tunnel or actual deposits in the inner volutions, but become rather obscure in outer volutions. Mean chomata heights of the first through the sixth volutions are: 38/30, 57/30, 84/30, 100/30, 109/27, and 113/20 microns.

Tunnel width. The tunnel is narrow and its path straight to slightly irregular. Mean tunnel widths of the first through the sixth volutions are: 65/30, 98/30, 157/30, 307/30, 400/30 and 614/21 microns.

Septa. Septa are intensely fluted throughout the shell. The mean septal counts of the first through the sixth volutions are: 10.7/16, 18.2/16, 21.0/16, 24.3/16, 28.8/15 and 31.5/11.

Proloculus. The proloculus is of moderate size, possessing a minimum and maximum outside diameter of 164/36 and 178/36 microns.

Discussion. *Fusulina acme* Dunbar and Henbest, is similar to *F.* aff. *F. whitakeri* in the Ardmore Basin. Hotelling's T^2 indicates that they differ significantly only in tunnel width with *F.* aff. *F. whitakeri* having the wider tunnel. A simple t-test on the proloculus sizes indicates a significant deviation in this character with *F. acme* possessing the larger. See discussion of *F.* aff. *F. whitakeri*.

Index values below from the linear discriminant differentiate *Fusulina acme* from *F. haworthi* for half length, radius vector, tunnel, and protheca thickness.

Half Length

$$R = -.1350X_1 + .1298X_2 + .0277X_3 + .0208X_4 + .4387X_5 + .0423X_6$$

Fusulina acme		Fusulina haworthi	
.7999	.6893	1.1640	.8343
.7686	.6765	1.0152	.8327
.7400	.6196	.9734	.8202
.7218	.6141	.9499	.7813
.7030	.6116	.8693	.7618

Radius Vector

$$R = -.0570X_1 + .0162X_2 + .0075X_3 - .0673X_4 + .0087X_5 - .0130X_6$$

Fusulina acme		Fusulina haworthi	
.0454	.0389	.0406	.0311
.0454	.0374	.0390	.0367
.0426	.0367	.0365	.0299
.0417	.0361	.0360	.0293
.0404	.0349	.0336	.0283
.0390	.0333	.0314	.0280

Tunnel Width

$$R = 2.9074X_1 + .2634X_2 + .8838X_3 + .0336X_4 - .1585X_5 + .2903X_6$$

Fusulina acme		Fusulina haworthi	
.5309	.4815	.3963	.3590
.4948	.4419	.3824	.3354
.4924	.4351	.3813	.3322
.4897	.4093	.3728	.3281
.4844	.3983	.3650	.2983

Protheca

$$R = -57.20X_1 - 40.86X_2 - 8.39X_3 - 9.035X_4 - 1.600X_5 - 18.37X_6$$

Fusulina acme		*Fusulina haworthi*	
-1.361	-1.302	-1.760	-1.672
-1.351	-1.246	-1.734	-1.652
-1.350	-1.246	-1.721	-1.610
-1.310	-1.232	-1.682	-1.603
-1.303	-1.172	-1.682	-1.497

Occurrence. *Fusulina acme* Dunbar and Henbest, occurs sparingly in the sandy, sparry calcite-cemented limestone in the Camp Ground Member in center west line NW¼ SW¼ sec. 21, T. 5 S., R. 2 E., Carter County, Oklahoma. See measured section 9, unit 1d.

WEDEKINDELLINA ? ARDMORENSIS Thompson, Verville, and Lokke, 1956

Plate VI, figs. 1-7

Wedekindellina ardmorensis Thompson, Verville and Lokke, 1956, Jour. Paleontology, vol. 30, p. 803-807, pl. 92, figs. 1-12.

Diagnosis:

Shape. The shell is fusiform to only slightly elongate fusiform with rather bluntly pointed polar extremes. The axis of coiling is nearly straight.

Size. Mature specimens range in length from 3.6 to 4.6 mm and in width from 1.3 to 1.6 mm in the seventh volution.

Number of volutions. Mature specimens possess from 6½ to 7½ volutions.

Protheca. Structures are present within the primary layer which cause reservation as to the assignment of this form to <u>Wedekindellina</u>. The primary layer is a primitive keriotheca. Secondary deposits in the form of tectoria do not exist in many forms and as only a trace in others.

<u>Half length</u>. Mean half lengths of the first through the seventh volutions are: .133/30, .273/30, .468/30, .759/30, 1.17/30, 1.69/30, and 2.17/22 mm.

<u>Radius vector</u>. Mean values of the radius vectors of the first through the seventh volutions are: .079/46, .126/46, .189/46, .278/46, .399/46, .556/46, and .725/37 mm.

<u>Wall</u>. The wall is thin and is composed of the protheca in almost all cases. Nothing which could be interpreted as axial filling was observed in any of the 60 specimens studied. Occasionally a section was cut parallel to a septum which falsely appeared as filling.

<u>Chomata</u>. Chomata are weakly developed in most specimens. Mean chomata heights of the first through the sixth volutions are: 21/30, 28/30, 45/30, 62/30, 74/29, and 66/15 microns.

<u>Tunnel width</u>. The tunnel path is straight in most specimens. The mean tunnel widths of the first through the sixth volutions are: 47/30, 68/30, 118/30, 187/30, 312/30, and 420/19 microns.

<u>Septa</u>. Septa are unfolded throughout the test. Only in the extreme polar ends does any bending occur and this is due to twisting during the coiling process and is not true fluting.

The mean septal count of the first through the seventh volutions are: 8.3/16, 12.8/16, 15.2/16, 16.0/16, 18.3/16, 20.0/16, and 19.7/14.

Proloculus. The proloculus is small. The mean maximum outside diameter is 90/46 microns.

Discussion. Wedekindellina ? ardmorensis Thompson, Verville, and Lokke, occurs abundantly in the Confederate Limestone in the Ardmore Basin. The shape of the specimens from the Confederate Member is more similar to an elongate Fusulinella or early Triticites than to Wedekindellina. Axial filling, which is nonexistent in specimens from my collection, is one of the principal criteria for definition of Desmoinesian Wedekindellina. Specimens studied from the Confederate Member (60 specimens) are assigned with reservation to the genus Wedekindellina.

Occurrence. Wedekindellina ? ardmorensis occurs abundantly in the Confederate Member in a fine-crystalline, yellow-tan to brown limestone in NE$\frac{1}{4}$ NW$\frac{1}{4}$ NE$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 17, T. 5 S., R. 2 E., Carter County, Oklahoma. This is locality 0-68 of Thompson, Verville, and Lokke.

Subfamily SCHWAGERININAE Dunbar and Henbest, 1930

Genus TRITICITES Girty, 1904

TRITICITES TOMLINSONI, new species

Plate VIII, figs. 3-7; Plate IX, fig. 9; Plate X, fig. 4

Diagnosis:

Size. Those forms which are considered mature range in length from 5.2 to 7.0 mm and in width from 1.7 to 2.3 mm at 6 to 6½ volutions.

Shape. The shape of the test is fusiform, however, the central part of the shell is inflated on many specimens.

Protheca. The protheca consists of tectum and rather thick keriotheca. The outer volutions show well the keriothecal structure of the wall; however, the inner volutions do not show distinct keriothecal development. This form may represent the genus Protriticites in North America. The mean thicknesses of the protheca of the first through the sixth volutions are: 10.7/57, 17.3/57, 27.3/57, 41.5/57, 52.5/57, and 56.6/42 microns.

Half length. The mean half lengths of the first through the sixth volutions are: .179/38, .361/38, .669/38, 1.20/38, 2.02/38, and 2.81/29 mm.

Radius vector. The mean radius vector values of the first through the sixth volutions are: .121/57, .198/57, .318/57,

.502/57, .758/57, and 1.01/42 mm.

Chomata. Chomata are weakly developed in the interior volutions and usually not developed at all in the outer three volutions. When present, the chomata are small mound-like deposits of secondary material which are low and symmetrical. Mean chomata heights of the first through the fifth volutions are: 36/38, 55/38, 80/38, 85/33, and 61/14 microns.

Tunnel width. The tunnel is poorly developed except in the first three or four volutions and is narrow. The mean tunnel widths of the first through the fifth volutions are: 68/38, 121/38, 248/38, 523/35, and 781/15 microns.

Septa. The septa are only weakly fluted in the polar extremities and are not fluted at all across the midplane of the test. The septal fluting is similar to that expressed by T. hobblensis Thompson, Verville, and Bissell and T. moorei Dunbar and Condra. The mean septal counts of the first through the sixth volutions are: 9.6/19, 14.3/19, 16.4/19, 19.2/19, 21.4/19, and 22.2/17.

Proloculus. The maximum mean outside diameter of the proloculus is 133/57 microns.

Discussion. Triticites tomlinsoni is unlike any of the early Missourian forms of the genus thus far described. Its weak septal fluting, weakly developed chomata, short length and thick wall set it apart from other described lower Missourian Triticites. There is a possibility that the interior volutions possess a diaphanotheca with poorly developed pores.

In several specimens the lower tectorium, which was porous, was separated from the upper secondary layer by a less dense (apparently non-porous) layer in the interior volutions. No assignment of specimens to the genus Protriticites was attempted as the writer does not possess topotypes.

Occurrence. Triticites tomlinsoni, new species, occurs abundantly in the Crinerville Member both in the Overbrook anticline and the Pleasant Hill syncline. Within the Overbrook anticline, it occurs in a yellow-tan, thin- to medium-bedded, fine-crystalline limestone (micrite) in NW¼ NE¼ SW¼ sec. 6, T. 5 S., R. 2 E., Carter County, Oklahoma, in a railroad cut on the Gulf, Colorado and Santa Fe railroad right of way. In the Pleasant Hill syncline, the species occurs in SE¼ NW¼ SW¼ sec. 14, T. 5 S., R. 1 E., Carter County, Oklahoma, in the Crinerville Member. The Overbrook anticline locality is designated as type locality of the species.

TRITICITES IRREGULARIS (Staff), emend. Dunbar and Condra, 1927

Plate IX, figs. 1-7

Fusulina centralis var. irregularis Staff (part), 1912, Palaeontographica, vol. 59, p. 178-179, pl. 17, fig. 10.

Triticites irregularis (Staff) Dunbar and Condra, 1927, Nebraska Geol. Survey, Bull. 2, ser. 2, p. 108-11, pl. 8, figs. 7-10, pl. 9, figs. 1-3.

Triticites irregularis (Staff) Newell, 1934, Jour. Paleontology, vol. 8, pl. 52, fig. 1.

Triticites irregularis (Staff) Merchant and Keroher, 1939, Jour. Paleontology, vol. 13, p. 600-603, pl. 69, figs. 4-6.

Triticites irregularis (Staff) Burma, 1942, Jour. Paleontology, vol. 16, p. 743.

Triticites irregularis (Staff) Thompson, Verville, and Bissell, 1950, p. 446, pl. 58, figs. 14-15, 19-21.

Diagnosis.

Size. Specimens which possess 6 volutions range in length from 4.5 to 6.5 mm and in width from 1.2 to 1.7 mm.

Shape. The shape of the test is elongate fusiform to subcylindrical with rather bluntly rounded poles in the outer volutions.

Protheca. The wall is almost entirely composed of tectum and keriotheca with little secondary deposits. Mean thicknesses of the tectum and keriotheca of the first through the sixth volutions are: 8.1/47, 12.2/47, 20.1/47, 30.2/47, 41.5/47, and 49.9/36 microns.

Half length. Mean half length of the first through the sixth volutions are: .136/31, .273/31, .508/31, .959/31, 1.74/31 and 2.68/26 mm.

Radius vector. Mean radius vectors of the first through the sixth volutions are: .087/47, .143/47, .228/47, .346/47, .522/47, and .729/37 mm.

Chomata. The chomata are weakly developed and do not occur in the outer volutions of the shell. The shape of the chomata ranges from broad and asymmetrical to short and symmetrical. The mean thicknesses of the chomata of the first through the fifth volutions are: 22.3/31, 35/31, 56/31, 72/29, and 70/23 microns.

Tunnel width. The tunnel is rather broad and rather irregular in its development. The mean tunnel widths of the first through the fifth volutions are: 56/31, 93/31, 167/31, 338/31, and 594/24 microns.

Septa. The septa are fluted in the polar ends and to some extent up the slope, however this is weak fluting. The septal counts of the first through the sixth volutions are: 9.1/16, 13.3/16, 16.3/16, 19.0/16, 21.0/16, and 20.4/11.

Proloculus. The maximum mean outside diameter of the proloculus is 93/47 microns.

Discussion. *Triticites irregularis* (Staff) emend. as identified in the Ardmore Basin is the same type recognized by Dunbar as typical from the Winterset Limestone. Forms which were given me from the Winterset (NW¼ NE¼ sec. 12, T. 75 N., R. 28 W., Madison County, Iowa) agree with the forms within the Ardmore Basin. There is some lesser degree of septal fluting on the forms in the Anadarche Limestone of the Overbrook anticline compared to forms from the same formation in the Brock anticline. Those within the Overbrook anticline may well find affinity to forms from the Brownwood Shale of Texas (Myers, 1960, pl. 16, figs. 9-17). For all measurable characters, Hotelling's T^2 indicates that the forms from the two Ardmore Basin localities are drawn from the same population.

Occurrence. Triticites irregularis (Staff) emend. occurs sparingly in the Anadarche Member in north one-half of NW$\frac{1}{4}$ SW$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 8, T. 5 S., R. 2 E., Carter County, Oklahoma, in a gray-white, fossiliferous, thin- to medium-bedded, micritic limestone. In the Brock anticline, this species is found in the Anadarche Member in SE$\frac{1}{4}$ SW$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 17, T. 5 S., R. 1 E., Carter County, Oklahoma.

TRITICITES PRIMARIUS Merchant and Keroher, 1939

Plate IX, fig. 8; Plate XI, figs. 1-5

Triticites secalicus var. primarius Merchant and Keroher, 1939, Jour. Paleontology, vol. 13, p. 611-614, pl. 69, figs. 10-12.

Triticites primarius Merchant and Keroher, Burma, 1942, Jour. Paleontology, vol. 16, p. 748-749, text figs. 5-13, pl. 118, figs. 1, 8.

Diagnosis.

Shape. The shape of the adult form is fusiform with bluntly pointed to broadly rounded polar ends.

Size. Specimens which are considered mature average 6.6 mm in length and 1.9 mm in width in the sixth volution.

Protheca. The protheca is thick. Mean values of the thicknesses of the tectum and keriotheca of the first through the sixth volutions are: 10.4/35, 16.5/36, 27.2/36, 43.3/36, 55.9/36, and 61.1/11 microns.

Half length. Mean values of the half length of the first through the sixth volutions are: .176/19, .403/19, .781/19, 1.59/19, 2.66/19, and 3.37/5 mm.

Radius vector. Mean values of the radius vectors of the first through the sixth volutions are: .112/35, .199/35, .338/35, .543/35, .790/33, and .973/10 mm.

Chomata. Chomata are strongly developed and tend to be irregular in shape. Mean chomata heights of the first through the fifth volutions are: 38.5/20, 60.1/20, 94.6/19, 103.4/18, and 96.6/5 microns.

Tunnel width. The tunnel is wide and its path straight to slightly irregular. Mean tunnel widths of the first through the fifth volutions are: .084/20, .151/20, .309/19, .712/18, and 1.03/6 mm.

Septa. Septal fluting is well developed in the polar areas but is lacking or only weakly developed across midplane of the shell. Mean septal counts of the first through the sixth volutions are: 9.0/15, 14.8/15, 17.4/15, 20.1/15, 22.4/15, and 20.8/5.

Proloculus. The mean value of the proloculus maximum outside diameter is 127/35 microns.

Discussion. Triticites primarius Merchant and Keroher, differs from Triticites newelli Burma, in half length, protheca thickness, tunnel width, and septal count. Index values of R from the linear discriminant are given below for the above significantly different characters.

Half Length

$$R = -\ .2830X_1 + .2184X_2 - .2991X_3 + .2168X_4 + .2448X_5 + .6075X_6$$

<u>Triticites primarius</u>	<u>Triticites newelli</u>
.3079	.2551
.2616	.2466
.2609	.2285
.2545	.2269
.2400	.1921

Protheca

$$R = +\ 23.47X_1 - 6.557X_2 - 4.967X_3 + 6.789X_4 + 5.519X_5 - 4.811X_6$$

<u>Triticites primarius</u>		<u>Triticites newelli</u>	
.3850	.2960	.2731	.1789
.3232	.2923	.2509	.1749
.3194	.2887	.2397	.1664
.3176	.2806	.2318	.1656
.3074	.2787	.1809	.1510

Septa

$$R = +\ 2.152X_1 + 13.48X_2 - 39.43X_3 + 57.05X_4 - 9.90X_5 - 166.59X_6$$

<u>Triticites primarius</u>	<u>Triticites newelli</u>
-3.179	-4.118
-3.140	-4.104
-3.087	-3.917
-3.034	-3.820
-2.508	-3.245

Tunnel Width

$$R = -3.315X_1 - .9077X_2 - .1279X_3 + .6547X_4 + 1.332X_5$$

Triticites primarius	Triticites newelli
1.489	1.134
1.389	1.125
1.387	0.886
1.340	0.754
1.330	0.726
1.200	0.725

Occurrence. Triticites primarius occurs abundantly in the Daube Member in the Overbrook anticline in the SW$\frac{1}{4}$ SE$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 16, T. 5 S., R. 2 E., Carter County, Oklahoma.

TRITICITES NEWELLI Burma, 1942

Plate X, figs. 1-3

Triticites newelli Burma, 1942, Jour. Paleontology, vol. 16, p. 749-751, text figs. 5-13, pl. 118, figs. 7, 10.

Diagnosis.

Shape. The shell is fusiform to rhomboidal with bluntly pointed poles.

Size. Mature specimens of six volutions average 5.4 mm in length and 2.0 mm in width.

Protheca. The primary layers of the wall are thick. The mean thicknesses of the first through the sixth volutions are: 8.9/23, 15.8/23, 24.3/23, 36.5/23, 49.9/23, and 60.5/22 microns.

Half length. Mean half lengths of the first through the seventh volutions are: .161/15, .331/15, .577/15, 1.00/15, 1.75/15, 2.72/15, and 3.67/8 mm.

Radius vector. Mean radius vector values of the first through the sixth volutions are: .118/23, .199/23, .323/23, .496/23, .736/23, and 1.02/21 mm.

Chomata. Chomata range from weakly developed to strongly developed. Mean chomata heights of the first through the fifth volutions are: 37.8/15, 58.3/15, 77.9/15, 93.4/15, and 94.2/12 microns.

Tunnel width. The tunnel is narrow in comparison to the tunnel of *T. primarius*. The mean tunnel widths of the first through fifth volutions are: .067/15, .114/15, .196/15, .383/15, and .718/14 mm.

Septa. The septa are tightly folded in the polar extremes and extend up the sides toward the chomata in early volutions, decreasing in intensity. The mean septal counts of the first through the sixth volutions are: 9.1/8, 16.0/8, 18.7/8, 21.2/8, 24.5/8, and 26.1/7.

Proloculus. The mean maximum and minimum outside diameters of the proloculus are 135/23, and 121/23 microns.

Discussion. *Triticites newelli* Burma, is similar to *T. primarius* Merchant and Keroher, but may be distinguished in the Ardmore Basin as indicated in the discussion of *T. primarius*.

Occurrence. *Triticites newelli* occurs abundantly in the Daube Member as mapped in the Brock anticline in measured section 14 in the center of the NW¼ SE¼ NE¼ sec. 19, T. 5 S., R. 1 E., Carter County, Oklahoma.

STRATIGRAPHIC CONCLUSIONS

Fusulinids are among the more abundant, and show the greatest morphological diversity, of any common fossil group in rocks of Pennsylvanian age. Thus when present, they are a most useful biological tool in the detection or formulation of time-stratigraphic boundaries, and are exceedingly helpful in the solution of problems of correlation within this interval of geological time.

The lower Middle Pennsylvanian rocks ("Atokan" series) of the Ardmore Basin contain representatives of the genus Fusulinella. Both Fusulinella dakotensis Thompson and Fusulinella vacua, new species, occur in the Bostwick Member and their presence is interpreted to indicate an "Atokan" age for the Bostwick.

The time-stratigraphic boundary between the "Atokan" and the Desmoinesian Series' is considered to be contained within the approximately 600 feet of unnamed shale overlying the Bostwick Member. For convenience however this boundary is placed at the base of the Lester Limestone which has the first indisputable occurrence of the genus Fusulina in the Ardmore Basin (see Figure 1).

Within the Ardmore Basin the genus Fusulina occurs for the first time in the Lester Limestone. The genus persists through the Camp Ground Member and probably considerably higher. Fusulina insolita

Thompson, F. mutabilis, new species, F. pumila Thompson, and F. plattensis Thompson are all primitive forms of the genus and indicate an early Desmoinesian age for the Lester and Frensley Members in which they are found. The Lester and Frensley Members are considered the equivalents of the McAlester Formation in east-central Oklahoma and are of Krebs age. Wedekindellina sp., associated with F. pumila in the middle Frensley Member, is the first representative of the genus to occur in the Ardmore Basin.

The Pumpkin Creek Member contains Fusulina cf. F. novamexicana and Wedekindellina sp. The Pumpkin Creek is considered to be the probable equivalent of the Inola Limestone of northeastern Oklahoma, in which similar representatives of Fusulina occur in association with Wedekindellina henbesti (Skinner).

The Devils Kitchen Member contains Fusulina euryteines Thompson and Wedekindellina sp. The Devils Kitchen is considered to be of early Cabaniss age.

The Arnold Limestone contains the youngest Wedekindellina fauna in the Ardmore Basin that is known to the writer. Two species of Fusulina are also present. The Arnold is considered to be of late Cabaniss age.

Fusulina aff. F. whitakeri, which is found in an unnamed limestone between the Rocky Point Conglomerate and the Camp Ground Member, is the first species in the Ardmore Basin which is identifiable with those commonly found in the Marmaton Group of northeastern Oklahoma. Because of the similarity of fusulinids this unnamed limestone is considered to be of early Marmaton age.

<ins>Fusulina acme</ins> is found in the Camp Ground Member and is the youngest representative of the genus found in the Ardmore Basin by the writer. The Camp Ground is of Marmaton age.

The time-stratigraphic boundary between the Desmoinesian and Missourian Series is placed for the sake of convenience at the base of the Confederate Member. The Confederate Member contains <ins>Wedekindellina</ins> ? <ins>ardmorensis</ins>, which is similar to fusulinids from the Swope Formation of Kansas.

The Crinerville Member contains <ins>Triticites tomlinsoni</ins>, new species, and is probably equivalent to the lower part of the Kansas City Group of Kansas. The Anadarche Member contains fusulinids of the type commonly referred to as <ins>Triticites irregularis</ins>. These forms from the Anadarche are similar to those in the Brownwood Shale. For this reason the Anadarche Member is considered equivalent to the limestone lentils in the upper part of the Brownwood Shale of Texas. The Daube Member contains <ins>Triticites primarius</ins> and <ins>Triticites newelli</ins>, which are associated in the Stanton Formation in Kansas. The Daube Member is considered the approximate equivalent of the Captain Creek - Stoner Members of the Stanton Formation of Kansas and the Placid Shale - Ranger Limestone Members of the Brad Formation of Texas.

SELECTED REFERENCES

Alexander, R. D., 1954, Desmoinesian fusulinids of northeastern Oklahoma: Oklahoma Geol. Survey, Circ. 31, 67 p., 4 pls.

American Commission of Stratigraphic Nomenclature, 1956, Nature, usage, and nomenclature of Rock-Stratigraphic units: Amer. Assoc. Petroleum Geologists, Bull., vol. 40, p. 2003-2014.

________, 1961, Code of stratigraphic nomenclature: Amer. Assoc. Petroleum Geologists, Bull., vol. 45, p. 645-665.

Beede, J. W., 1916, New species of fossils from the Pennsylvanian and Permian rocks of Kansas and Oklahoma: Indiana Univ. Studies, vol. 11, p. 118-125, pl. 22.

Bennison, A. P., 1954, Target Limestone, new member of Springer Formation, Carter County, Oklahoma: Amer. Assoc. Petroleum Geologists, Bull., vol. 38, p. 913-914.

Burnk, H. D., 1960, An introduction to mathematical statistics: Ginn and Company, New York, 403 p.

Burma, B. H., 1948, Studies in quantitative paleontology, I: Jour. Paleontology, vol. 22, p. 725-760.

Cheney, M. G., et al., 1940, Geology of north-central Texas: Amer. Assoc. Petroleum Geologists, Bull., vol. 24, p. 81-90.

Colman, H. L., Smallwood, C., and Brown, G. W., 1962, Computer language: McGraw-Hill, New York, 196 p.

Devonshire, P. F. P. C., 1954, A faunal study of the Pumpkin Creek Limestone Member of the Big Branch Formation in the Ardmore area: Shale Shaker, vol. 5, no. 1, p. 10.

Dott, R. H., 1941, Regional stratigraphy of Mid-Continent: Amer. Assoc. Petroleum Geologists, Bull., vol. 25, p. 1664-1668.

Dunbar, C. O., and Condra, G. E., 1927, The Fusulinidae of the Pennsylvanian

System of Nebraska: Nebraska Geol. Survey, Bull. 2, 135 p. 15 pls.

________, and Skinner, J. W., 1937, Permian Fusulinidae of Texas: Texas Univ., Bull. 3701, p. 523-828, pls. 42-81.

________, and Henbest, L. G., 1942, Pennsylvanian Fusulinidae of Illinois: Illinois Geol. Survey, Bull. 67, 218 p., 23 pls.

Floyd, F. W., and Jufer, D. C., 1934, Stratigraphy in the Ardmore area: Tulsa Geol. Soc., Digest, vol. 3, p. 10-11.

Folk, R. L., 1959, Petrology of sedimentary rocks: Univ. of Texas Press.

Frederickson, E. A., 1957, Geologic map of the Criner Hills area: Oklahoma Geol. Survey, Map GM - 4.

________, 1962, Extent of the Dolman Member of the Hoxbar Formation: Oklahoma Geological Survey, Okla. Geology Notes, vol. 22, p. 295-296.

Galler, B. A., 1962, The language of computers: McGraw-Hill Book Company, Inc., New York, 244 p.

Girty, G. H., and Roundy, P. V., 1923, Notes on the Glenn Formation of Oklahoma with consideration of new paleontological evidences: Amer. Assoc. Petroleum Geologists, Bull., vol. 7, p. 331-349.

Goldston, W. L., Jr., 1922, Differentiation and structure of the Glenn Formation: Amer. Assoc. Petroleum Geologists, Bull., vol. 6, p. 5-23.

Guthrey, W. M., and Milner, C. A., 1933, Unpublished preliminary map of the Hoxbar, Deese and a portion of the upper Dornick Hills Formations, southeast of Ardmore, Oklahoma.

Hald, A., 1960, Statistical tables and formulas: John Wiley and Sons, Inc., New York, 79 p.

________, 1960, Statistical theory with engineering applications: John Wiley and Sons, Inc., New York, 783 p.

Harlton, B. H., 1956, The Harrisburg Trough Stephens and Carter Counties, Oklahoma: Amer. Assoc. Petroleum Geologists, Symposium. Petroleum Geology of Southern Oklahoma, vol. 1, p. 135-143.

________, 1960, Stratigraphy of Cement Pool and adjacent areas, Caddo and Grady Counties, Oklahoma: Amer. Assoc. Petroleum Geologists, Bull., vol. 44, p. 216-223.

Henbest, L. G., 1928, Fusulinids from the Stonefort Limestone Member of the Tradewater Formation: Jour. Paleontology, vol. 2, p. 70-85, pls. 8-10.

________, 1937, Keriothecal wall-structure in <u>Fusulina</u>: Jour. Paleontology, vol. 11, p. 212-229.

Hicks, I. C., et al., 1956, Editorial footnote: Amer. Assoc. Petroleum Geologists, Symposium. Petroleum Geology of Southern Oklahoma. vol. 1, p. 4.

Hodges, J. L., Jr., 1955, Survey of discriminatory analysis: U. S. Air Force School of Aviation Medicine, Project no. 21-49-004, Report no. 1.

Hoel, P. G., 1960, Introduction to mathematical statistics: John Wiley and Sons, Inc., New York, 331 p.

Hotelling, H., 1931, The generalization of Student's ratio: Annals of Math. Statistics, vol. 2, p. 360-378.

Imbre, J., 1956, Biometric methods in the study of invertebrate fossils: Amer. Mus. Natural History Bull., vol. 108, art. 2, p. 217-252.

Ingram, R. L., 1954, Terminology in sedimentary rocks: Geol. Soc. America, Bull., vol. 65, p. 938.

Jacobsen, L., 1959, Petrology of Pennsylvanian sandstones and conglomerates of the Ardmore Basin: Oklahoma Geol. Survey, Bull. 79. 144 p.

Kerns, R. L., 1963, Personal communication.

Merchant, F. E., and Keroher, R. P., 1939, Some fusulinids from the Missouri series of Kansas: Jour. Paleontology, vol. 13, p. 549-614, pl. 69.

Miller, R. L., and Kahn, J. S., 1962, Statistical analysis in the geological sciences: John Wiley and Sons, Inc., New York, 483 p.

Miser, H. D., 1926, Geological Map of Oklahoma: U. S. Geol. Survey.

________, 1954, Geological Map of Oklahoma: U. S. Geol. Survey and Oklahoma Geol. Survey.

McKee, E. D., and Weir, G. W., 1953, Terminology for stratification and cross-stratification in sedimentary rocks: Geol. Soc. America, Bull., vol. 64, p. 382-388.

Needham, C. E., 1937, Some New Mexico Fusulinidae: New Mexico School of Mines, Bull. 14, 88 p, 12 pls.

Newell, N. D., 1934, Some Mid-Pennsylvanian invertebrates from Kansas and Oklahoma: Jour. Paleontology, vol. 8, p. 422-432, pl. 52-55.

________, and Keroher, R. P., 1937, The fusulinid Wedekindellina, in Mid-Pennsylvanian formations: Amer. Assoc. Petroleum Geologists, Bull., vol. 14, p. 698-705, pl. 93.

Ramay, C. L., 1957a, Clarification of Desmoinesian stratigraphy in the Pleasant Hill syncline of the Criner Hills: Unpublished Master of Science thesis, University of Oklahoma.

________, 1957b, Clarification of Desmoinesian stratigraphy in the Pleasant Hill syncline: Ardmore Geol. Soc., Guidebook, Criner Hills Field Conference, p. 45.

Roth, R., and Skinner, J. W., 1930, The fauna of the McCoy Formation, Pennsylvanian, of Colorado: Jour. Paleontology, vol. 4, p. 332-352, pls. 28-31.

Schacht, D. W., 1947, Lithologic variations in the Devils Kitchen Member of the Deese Formation in the Ardmore Basin: Unpublished Master of Science thesis, University of Oklahoma.

Skinner, J. W., 1931, Primitive fusulinids of the Mid-Continent region: Jour. Paleontology, vol. 5, 253-259, pl. 30.

Stewart, W. J., 1958, Some fusulinids from the upper Strawn, Pennsylvanian, of Texas: Jour. Paleontology, vol. 32, p. 1051-1070, pls. 132-137.

Taff, J. A., 1903, Description of the Tishomingo quadrangle: U. S. Geol. Survey, Geol. Atlas, Folio 98.

Thompson, M. L., 1934, The fusulinids of the Des Moines series of Iowa: Iowa Univ. Studies in Nat. History, vol. 16, no. 284, p. 277-332, pls. 20-23.

________, 1935, Fusulinids from the Lower Pennsylvanian Atoka and Boggy Formations of Oklahoma: Jour. Paleontology, vol. 9, p. 298-303, pl. 26.

________, 1936a, Fusulinids from the Black Hills and adjacent areas in Wyoming: Jour. Paleontology, vol. 10, p. 95-113, pls. 13-16.

________, 1936b, Pennsylvanian fusulinids from Ohio: Jour. Paleontology, vol. 10, p. 673-683, pls. 90-91.

________, 1945, Pennsylvanian rocks and fusulinids of east Utah and northwest Colorado correlated with Kansas section: Kansas State Geol. Survey, Bull., 60, pt. 2, 84 p., 5 pls.

________, 1948, Studies of American fusulinids: Kansas Univ. Paleont. Contr., Protozoa, art. 1, 184 p., 38 pls.

________, Verville, G. J., and Bissell, H. J., 1950, Pennsylvanian fusulinids of the south-central Wasatch Mountains, Utah: Jour. Paleontology, vol. 24, p. 430-465, pls. 57-64.

________, and Thomas, H. D., 1953, Systematic paleontology of fusulinids from the Casper Formation: Wyoming Geol. Survey, Bull. 46, p. 15-56, pls. 108.

________, Verville, G. J., and Lokke, D. H., 1956, Fusulinids of the Desmoinesian - Missourian contact: Jour. Paleontology, vol. 30, p. 793-810, pls. 89-93.

Tomlinson, C. W., 1929, The Pennsylvanian System in the Ardmore Basin: Oklahoma Geol. Survey, Bull. 46, 79 p.

________, 1934, Correction to stratigraphy of Hoxbar Formation, Oklahoma: Amer. Assoc. Petroleum Geologists, Bull., vol. 28, p. 1083-1085.

________, 1937, Hoxbar and upper Deese Formations south of Ardmore: Ardmore Geol. Soc., Guidebook, March 3, 7 p.

________, 1959, Best exposures of various strata in Ardmore Basin, 1957: Amer. Assoc. Petroleum Geologists, Symposium. Petroleum Geology of Southern Oklahoma, vol. 2, p. 302-334.

________, and McBee, W., J., 1959, Pennsylvanian sediments and orogenies of Ardmore district, Oklahoma: Amer. Assoc. Petroleum Geologists, Symposium. Petroleum Geology of Southern Oklahoma, vol. 2, p. 3-51.

________, ________, 1962, Pennsylvanian sediments and orogenies of Ardmore district, Oklahoma: Amer. Assoc. Petroleum Geologists, Symposium. Pennsylvanian System in the United States, p. 479-483.

Waddell, D. E., 1959, The Atokan-Desmoinesian contact in the Ardmore Basin, as defined by fusulinids: Unpublished Master of Science thesis, University of Oklahoma, 94 p., 8 pls.

Westheimer, J., 1936, Correlation of Pennsylvanian sediments of the Ardmore Basin with the Franks Graben: Conference on Pennsylvanian of Oklahoma, Kansas, and north Texas, sponsored by Sigma Gamma Epsilon. Norman, Oklahoma.

________, and Schweers, F. P., 1956, Southwest Lone Grove Field, Carter County, Oklahoma: Amer. Assoc. Petroleum Geologists, Symposium. Petroleum Geology of Southern Oklahoma, vol. 1, p. 144-153.

White, M. P., 1932, Some Texas Fusulinidae: Texas Univ., Bull. 3211, 105 p., 10 pls.

Wilson, L. R., 1962, Personal communication.

PLATE 1

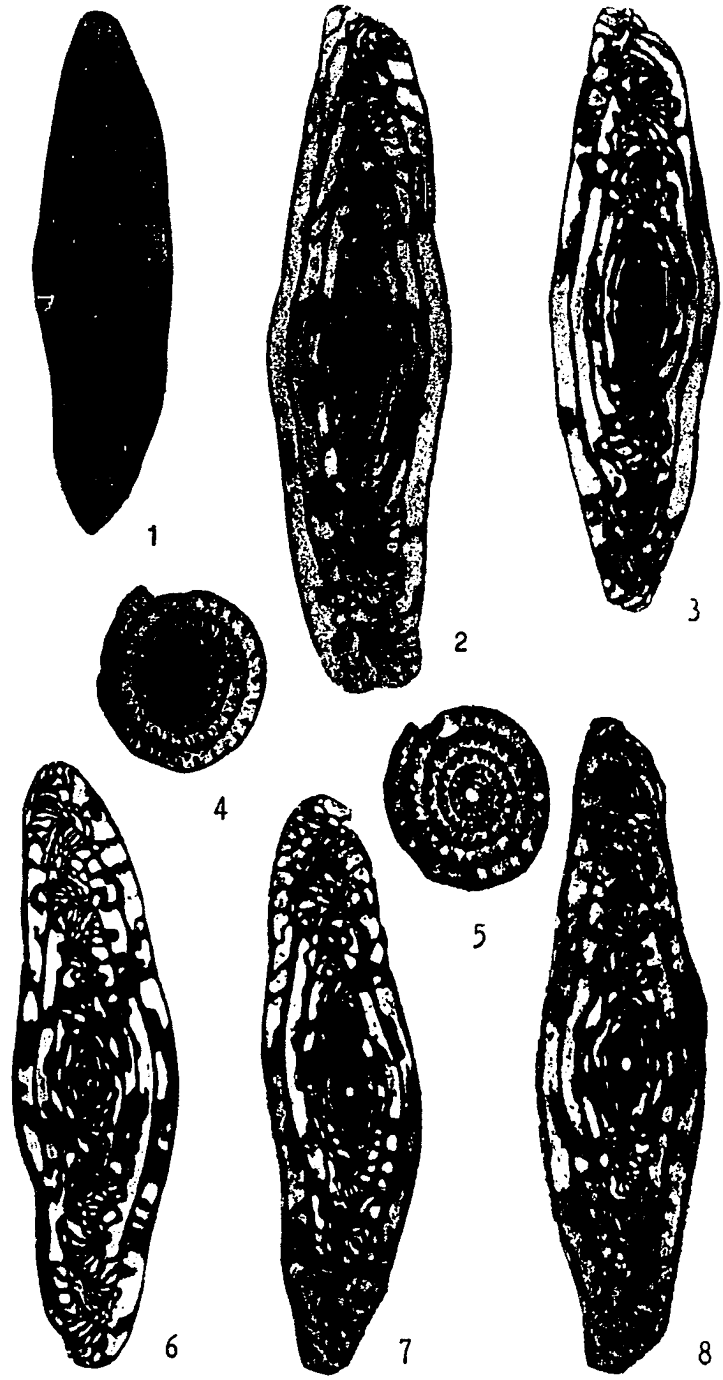


PLATE I

Figures		Page
1-4	_Fusulinella_ _dakotensis_ Thompson, 1936	53
	Measured section 1, unit 6, upper part of Bostwick Member SW$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 32, T. 5 S., R. 2 E., Carter County, Oklahoma.	
5-8	_Fusulinella_ _vacua_, new species	55
	Measured section 1, unit 7, upper part of Bostwick Member SW$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 32, T. 5 S., R. 2 E., Carter County, Oklahoma. Figure 6 is designated name bearer (holotype).	

All figures are unretouched photographs, X15.

Plate II

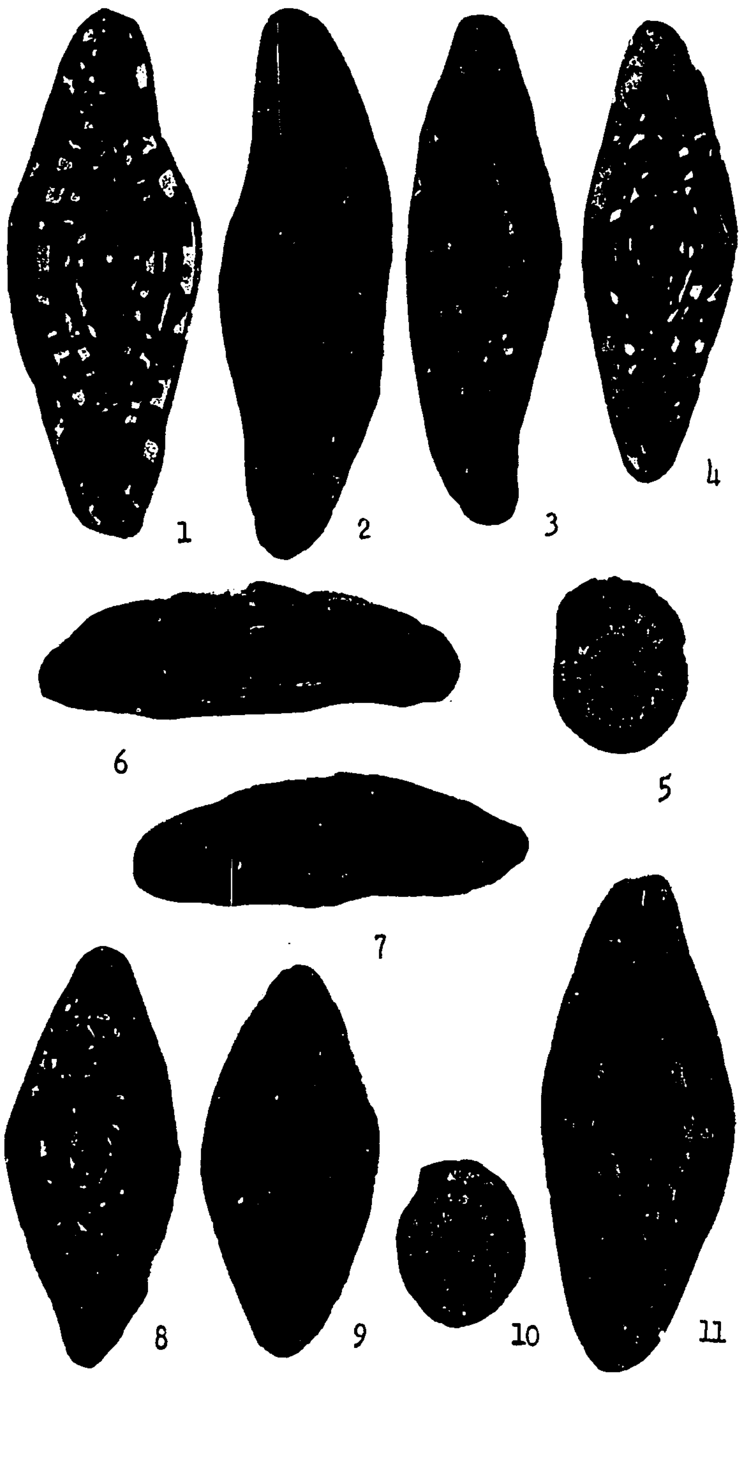


PLATE II

Figures		Page
1-5	*Fusulina mutabilis*, new species	62
	1,4 - 90 feet below the oolitic Lester Member, measured section 15, unit 1, NE$\frac{1}{4}$ NE$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 13, T. 4 S., R. 1 E., Carter County, Oklahoma.	
	2,3,5 - Oolitic Lester Member measured section 1, unit 6, NW$\frac{1}{4}$ NE$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 22, T. 6 S., R. 2 E., Love County, Oklahoma.	
	Figure 1 is designated name bearer (holotype).	
6-7	*Wedekindellina sp*	66
	Lower part of Frensley Member, measured section 1, unit 8, center of west line NE$\frac{1}{4}$ NE$\frac{1}{4}$ NE$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 22, T. 6 S., R. 2 E., Carter County, Oklahoma.	
8-11	*Fusulina insolita* Thompson, 1948	59
	150 feet below the oolitic Lester Member, measured section 1, unit 4a, NE corner NW$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 22, T. 6 S., R. 2 E., Love County, Oklahoma	

All figures are unretouched photographs, X15.

Plate III

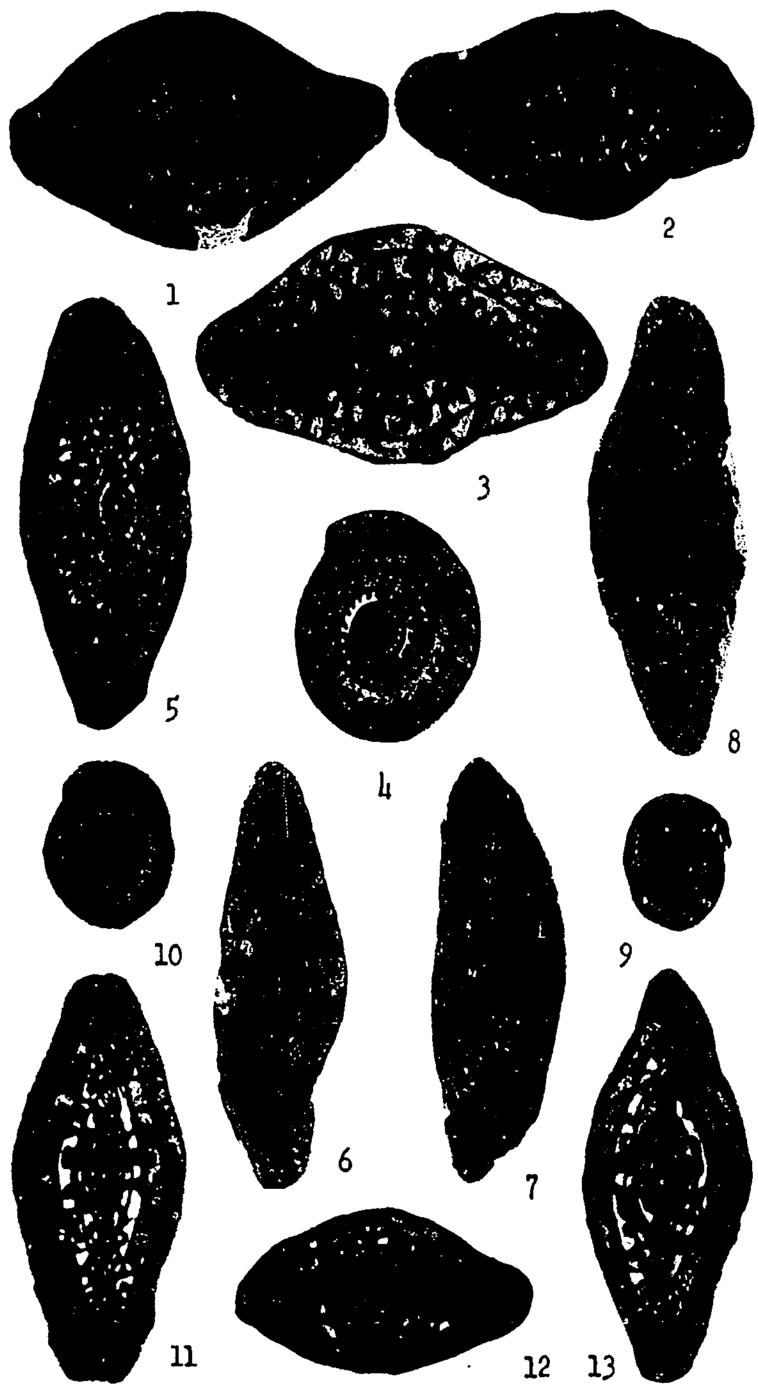


PLATE III

Figure Page

1-4 *Fusulina* cf. *F. novamexicana* Needham, 1937 70

Pumpkin Creek Member, measured section 1, unit 16, NW$\frac{1}{4}$ NE$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 23, T. 6 S., R. 2 E., Love County, Oklahoma.

5-9 *Fusulina plattensis* Thompson, 1936 67

Upper part of Frensley Member, measured section 1, unit 11, SW$\frac{1}{4}$ SE$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 15, T. 6 S., R. 2 E., Love County, Oklahoma.

10-13 *Fusulina pumila* Thompson, 1934 65

Lower part of Frensley Member, measured section 1, unit 8, NE$\frac{1}{4}$ NE$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 22, T. 6 S., R. 2 E., Love County, Oklahoma.

All figures are unretouched photographs, X15.

Plate IV

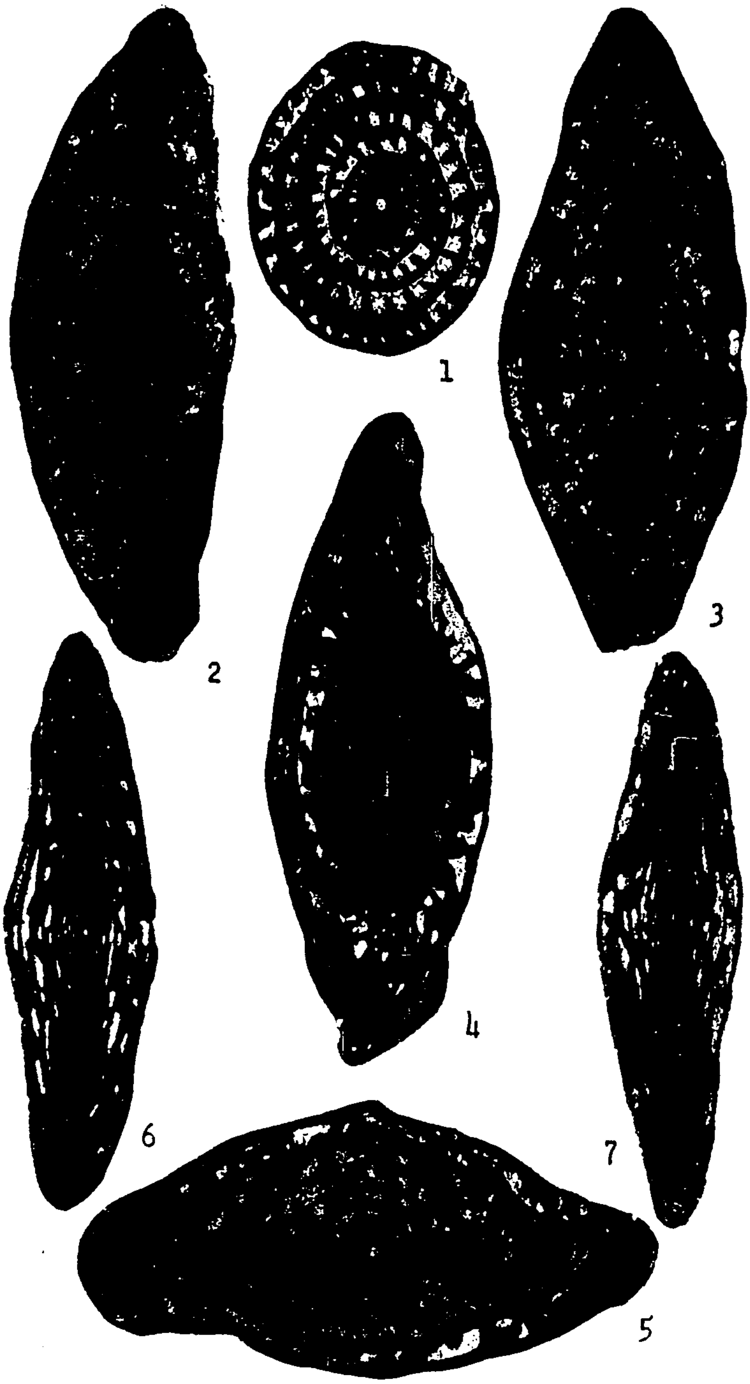


PLATE IV

Figure		Page
1-5	Fusulina euryteines Thompson, 1934	72
	Devils Kitchen Member, measured section 3, unit 1 (c, e, and f), NE$\frac{1}{4}$ NE$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 4, T. 6 S., R. 2 E., Love County, Oklahoma.	
6-7	Wedekindellina sp.	73
	Same formation and same locality as above.	

All figures are unretouched photographs, X15.

Plate V

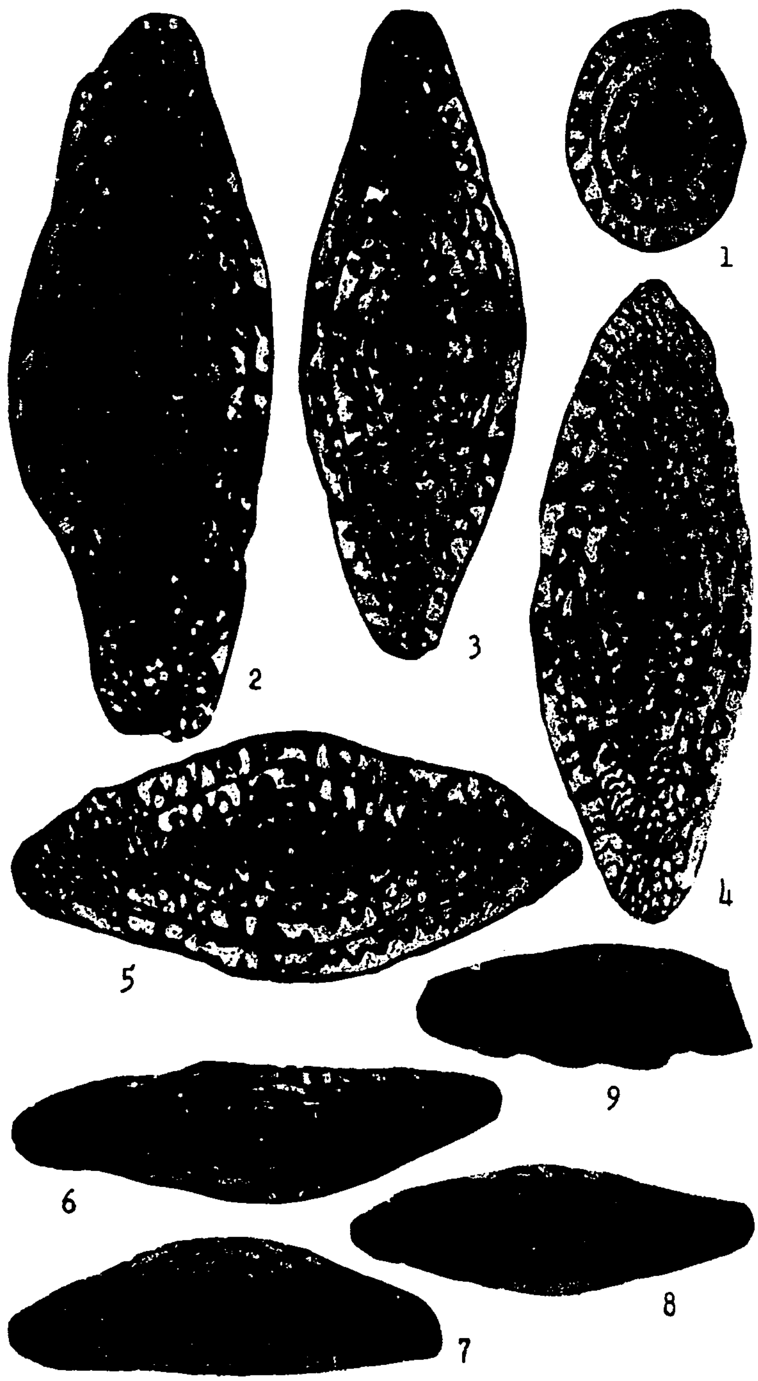


PLATE V

Figure		Page
1-5	Fusulina haworthi (Beede), 1916 emend.	79
	Upper part of Arnold Member, measured section 6, 12 feet below unit 4, NE¼ SE¼ SW¼ sec. 33, T. 5 S., R. 2 E., Carter County, Oklahoma.	
6-9	Wedekindellina sp.	
	6-7 Upper part of Arnold Member, same locality and same unit as above.	82
	8-9 Pumpkin Creek Member, measured section 2, unit 10, NE¼ NW¼ sec. 15, T. 6 S., R. 2 E., Love County, Oklahoma.	70

All figures are unretouched photographs, X15.

Plate VI

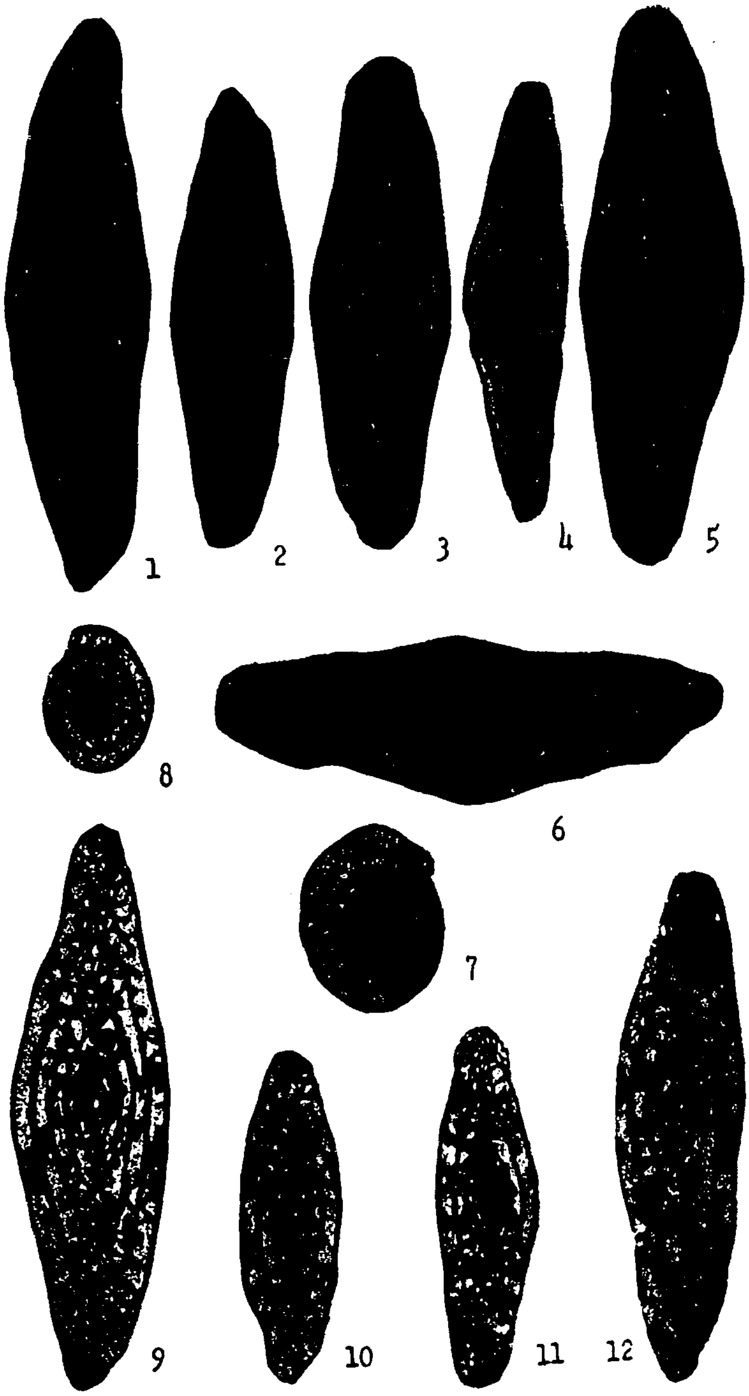


PLATE VI

Figure		Page
1-7	<u>Wedekindellina</u> ? <u>ardmorensis</u> Thompson, Verville, and Lokke, 1956	87
	1-3, 5-7 Confederate Member, measured section 10, unit 3, NE$\frac{1}{4}$ NW$\frac{1}{4}$ NE$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 17, T. 5 S., R. 2 E., Carter County, Oklahoma.	
	4 Confederate Member, measured section 17, unit 1, E$\frac{1}{2}$ SE$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 14, T. 5 S., R. 1 E., Carter County, Oklahoma.	
8-12	<u>Fusulina</u> <u>erugata</u>, new species	77
	Lower part of Arnold Member, measured section 7, unit 2, NE$\frac{1}{4}$ NW$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 4, T. 6 S., R. 2 E., Carter County, Oklahoma.	
	Figure 9 is designated name bearer (holotype).	

All figures are unretouched photographs, X15.

Plate VII

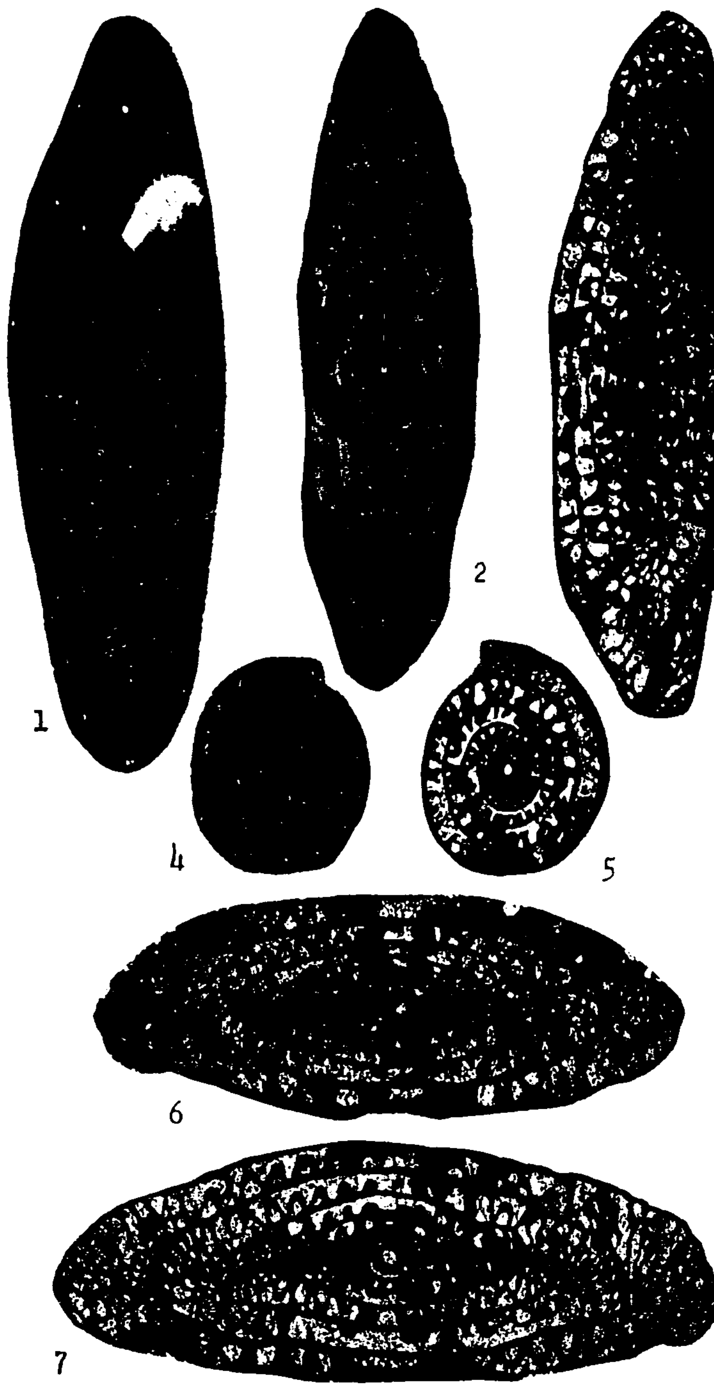


PLATE VII

Figure		Page
1-3,5	*Fusulina* aff. *F.* *whitakeri* Stewart, 1958. . .	83
	Unnamed limestone between Rocky Point Conglomerate and "type" Camp Ground Member, measured section 8, unit 3, SW$\frac{1}{4}$ NE$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 20, T. 5 S., R. 2 E., Carter County, Oklahoma.	
4,6-7	*Fusulina* *acme* Dunbar and Henbest, 1942 . . .	84
	Limestone in lower part of Camp Ground Member, measured section 9, unit 1, center of west line NW$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 21, T. 5 S., R. 2 E., Carter County, Oklahoma.	

All figures are unretouched photographs, X15.

Plate VIII

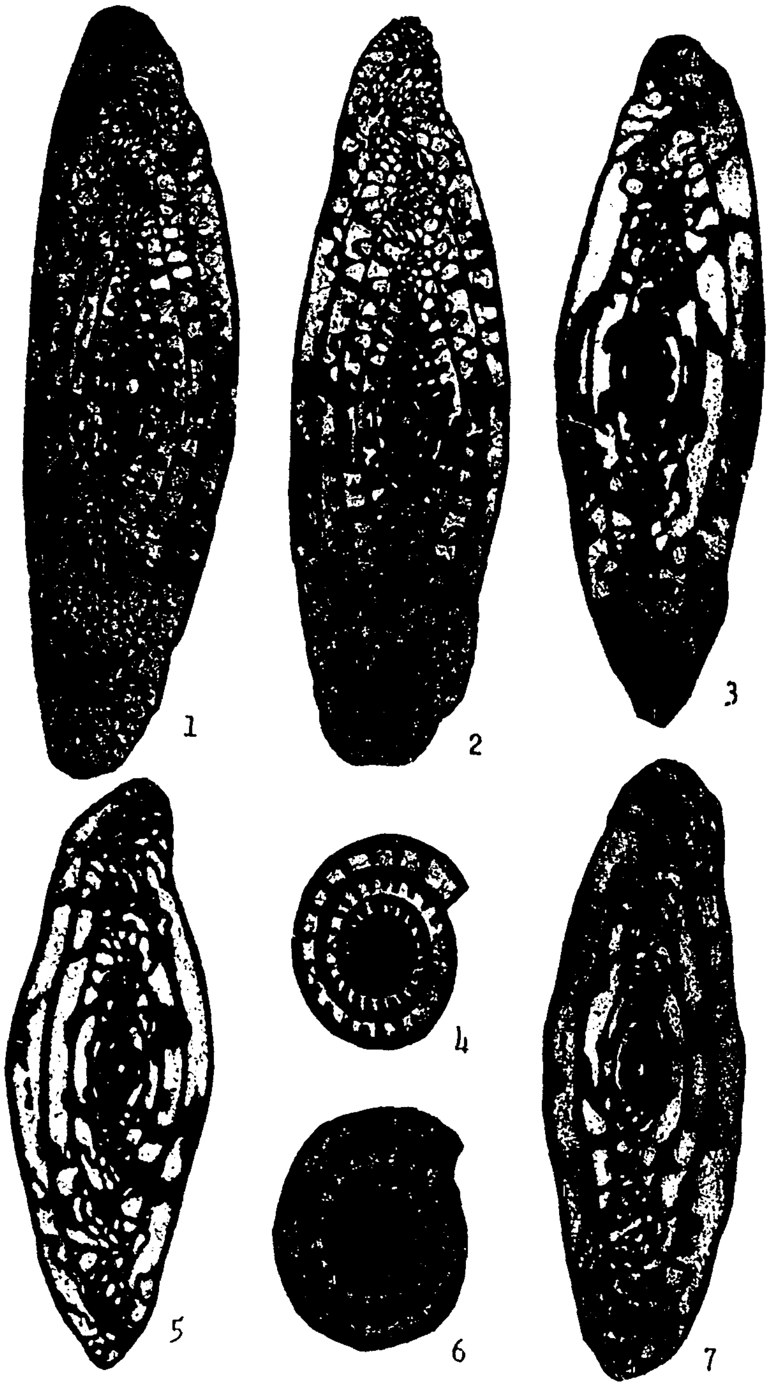


PLATE VIII

Figure		Page
1-2	Fusulina acme Dunbar and Henbest, 1942	84

Limestone in lower part of Camp Ground Member, measured section 9, unit 1, center of west line $NW\frac{1}{4}$ $SW\frac{1}{4}$ sec. 21, T. 5 S., R. 2 E., Carter County, Oklahoma.

3-7	Triticites tomlinsoni, new species	90

3-4, 6-7 Crinerville Member, measured section 10, unit 4, $NW\frac{1}{4}$ $NE\frac{1}{4}$ $SW\frac{1}{4}$ sec. 6, T. 5 S., R. 2 E., Carter County, Oklahoma.

5 Crinerville Member, measured section 18, unit 1, $SE\frac{1}{4}$ $NW\frac{1}{4}$ $SW\frac{1}{4}$ sec. 14, T. 5 S., R. 1 E., Carter County, Oklahoma.

Figure 7 is designated name bearer (holotype).

All figures are unretouched photographs, X15.

Plate IX

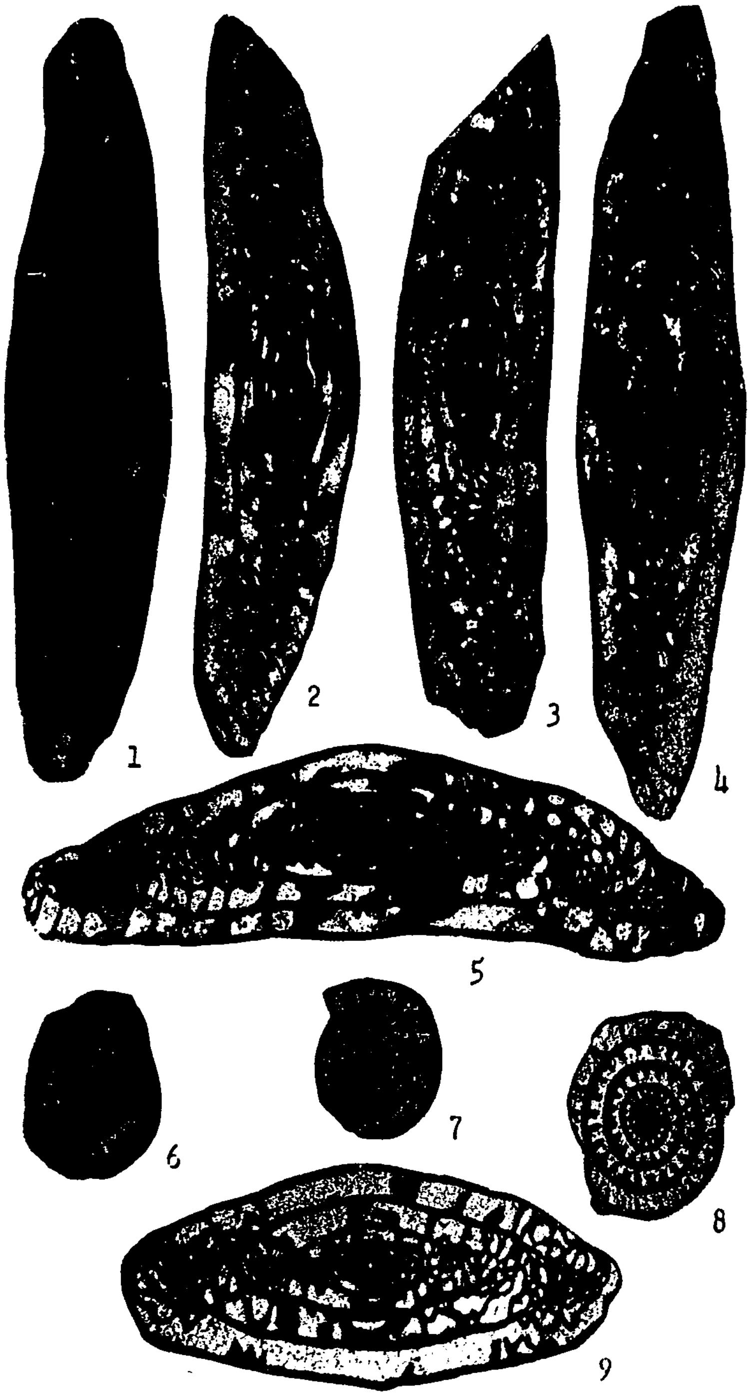


PLATE IX

Figure	Page

1-7 Triticites irregularis (Staff) emend. Dunbar and Condra, 1927 96

1,6 Anadarche Member, measured section 13, unit 1, SE$\frac{1}{4}$ SW$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 17, T. 5 S., R. 1 E., Carter County, Oklahoma.

2-5,7 Anadarche Member, measured section 10, unit 5, NW$\frac{1}{4}$ SW$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 8, T. 5 S., R. 2 E., Carter County, Oklahoma.

8 Triticites primarius Merchant and Keroher, 1939. . 95

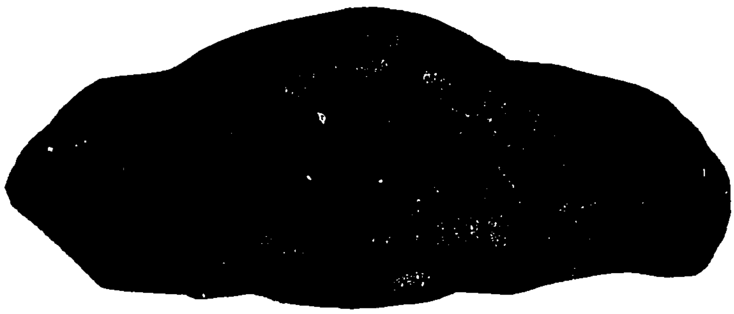
Daube Member, measured section 10, unit 6, SW$\frac{1}{4}$ SE$\frac{1}{4}$ SE$\frac{1}{4}$, sec. 16, T. 5 S., R. 2 E., Carter County, Oklahoma.

9 Triticites tomlinsoni, new species 90

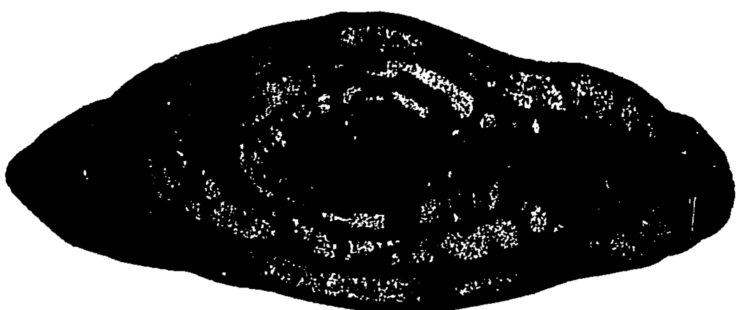
Crinerville Member, measured section 10, unit 4, NW$\frac{1}{4}$ NE$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 6, T. 5 S., R. 2 E., Carter County, Oklahoma.

All figures are unretouched photographs, X15.

Plate X

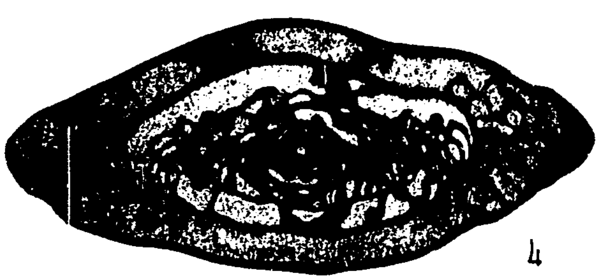


1



2

3



4

PLATE X

Figure		Page
1-3	Triticites newelli Burma, 1942 . . . . . Daube Member, measured section 14, unit 1, center of $NW\frac{1}{4}$ $SE\frac{1}{4}$ $NE\frac{1}{4}$ sec. 19, T. 5 S., R. 1 E., Carter County, Oklahoma.	98
4	Triticites tomlinsoni, new species . . . . Crinerville Member, measured section 10, unit 4, $NW\frac{1}{4}$ $NE\frac{1}{4}$ $SW\frac{1}{4}$ sec. 6, T. 5 S., R. 2 E., Carter County, Oklahoma.	90

All figures are unretouched photographs, X15.

Plate XI

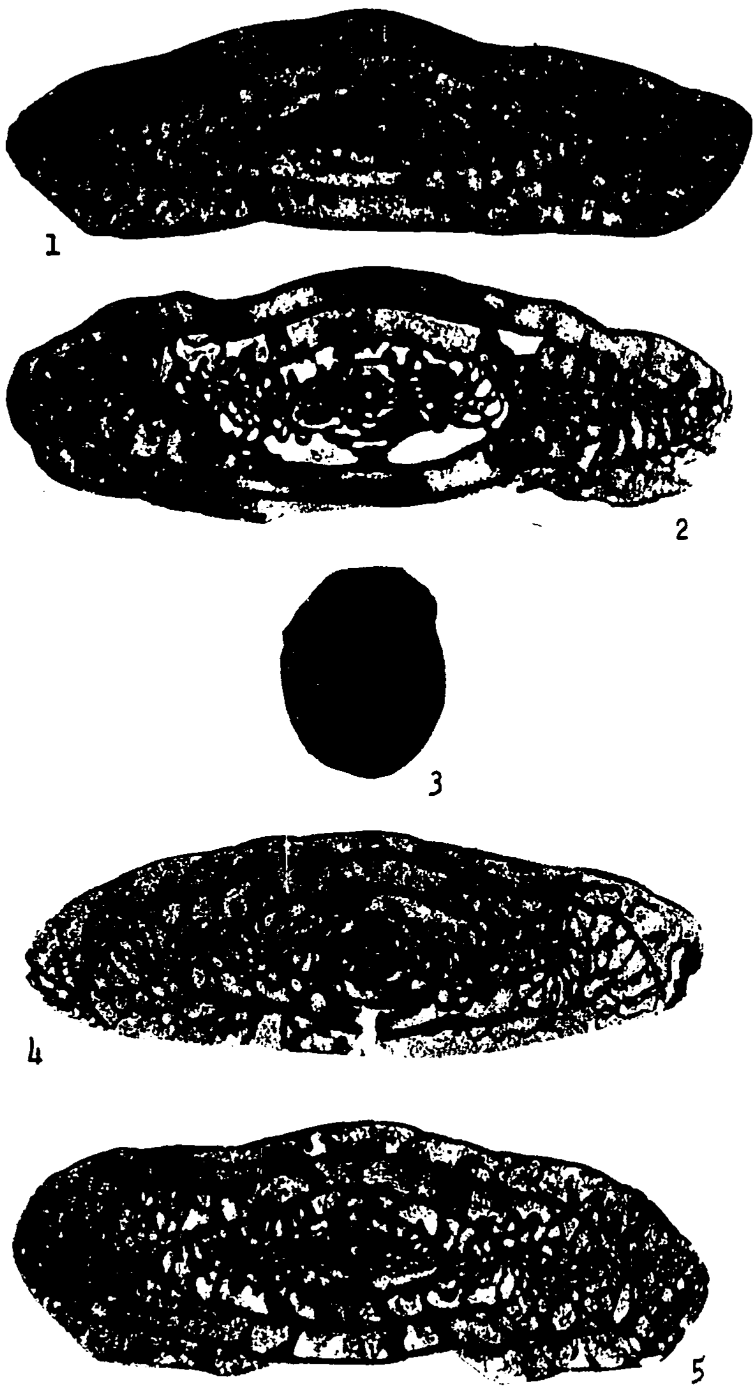


PLATE XI

All figures are unretouched photographs, X15.

APPENDIX I

STRATIGRAPHIC SECTIONS

Sections 1 through 18 were measured during the summer and fall of 1962. Outcrop measurements were made with Brunton compass, and Jacob Staff. All descriptions are field descriptions and in a general manner emulate the following format, which is a composite from several sources.

Description Format

Lithologic name. Common nomenclatorial terms such as sandstone and limestone were used in order to create least confusion in terminology.

Color. Both fresh and weathered appearance in qualitative terms are given.

Bedding. Terminology for the thickness of stratigraphic units followed that of Ingram (1954, p. 938) as follows:

Thickness of unit	Terms for thickness of Stratigraphic units
- .1	Thinly laminated
.1 - .4	Thickly laminated
.4 - 1.	Very thinly bedded
1.0 - 4.	Thinly bedded
4.0 -12.	Mediumly bedded
1.0 - 3 ft.	Thickly bedded
3.0 -	Very thickly bedded

Modified from Ingram

Coherence or hardness. The terminology of H. B. Stenzel was employed here as follows:

Hard or dense, rings when hit by hammer

Indurated, thuds when hit by hammer

Tough, difficult to pull apart with the pick

Plastic, easily molded in hand

Friable, poorly cemented sand or other clastic easily rubbed or broken free into loose particles

Loose, uncemented clastic particles.

Cement. Term used as defined by Folk (1954, p. 135). Refers to the agent binding adjacent grains.

Sorting. As used, this was an observational phenomenon made with 10X lens and should be understood to convey only a relative connotation.

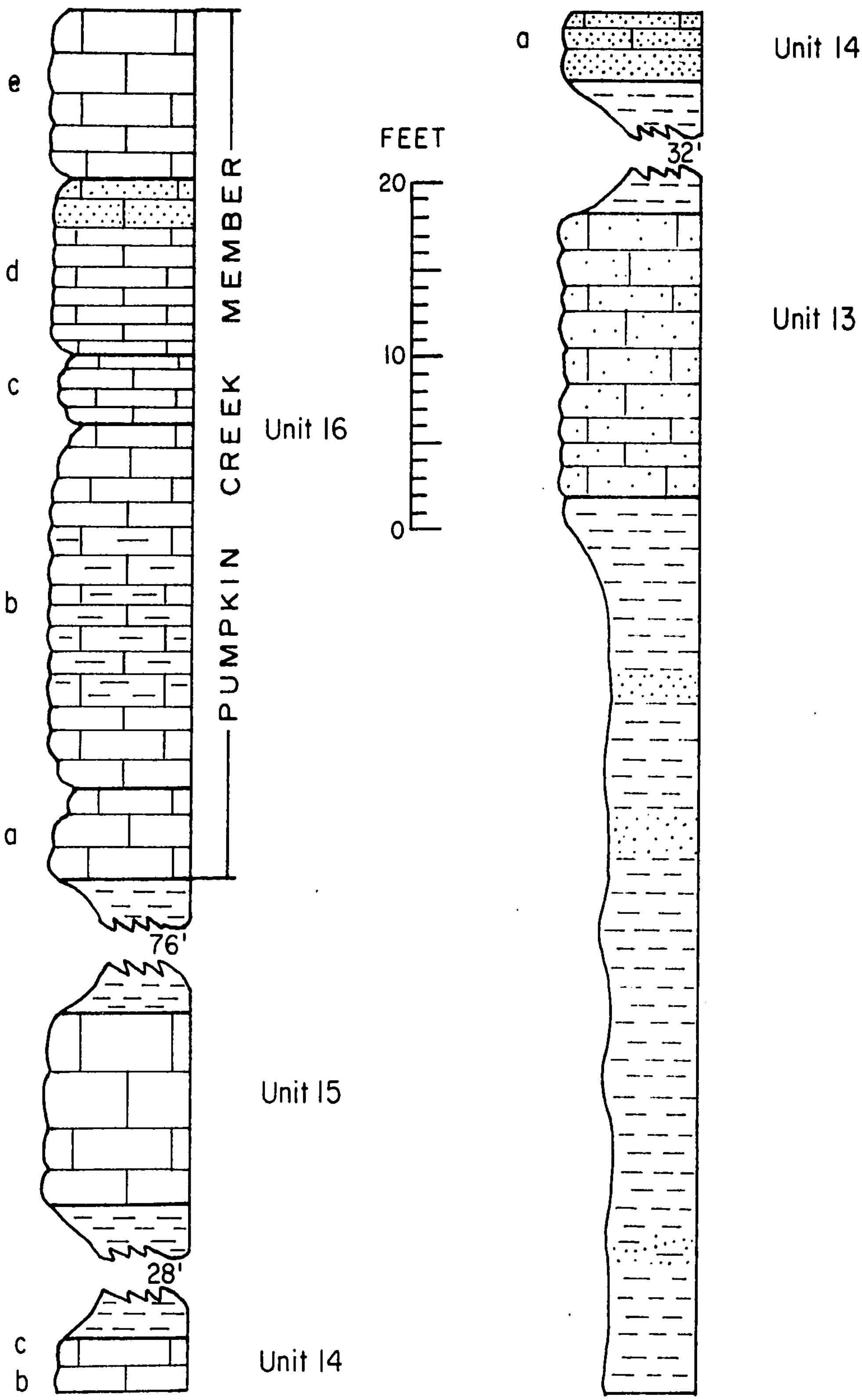
Grain Size. Phi (Ø) units were used to designate grain size range. Values were obtained by comparison to a standard set of sieved grains. For limestone, the crystallinity scale of Folk (1959, p. 147) was used with a simple modification of round-off.

MEASURED SECTION I

Location. NE$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 22, SE$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 15, and NW$\frac{1}{4}$ sec. 23, T. 6 S., R. 2 E., Love County, Oklahoma. Section 1 is 0.5 mile south of Lake Murray Park on State Scenic 77, and on the strike of the outcropping beds southeast along the north border of the meadow approximately 400 yards. The section is painted, with the numbers below 1-11 to the immediate southwest, and numbers above 1-11 offset another 250 to 275 yards southeast along strike and to the northeast. Section 1 is presented beginning at the top.

Unit		Thickness in Feet
16	Pumpkin Creek Member	
	Strike N. 60° W., dip 36° NE.	
e	Limestone; yellow-gray weathering gray with dark yellow blotches, medium- to thick-bedded, hard, sparry calcite-cemented, fine- to medium-crystalline. Skeletal framework is fragmental fossil debris, lower contact sharp but upper contact is mostly covered.	10
d	Limestone; brown weathering gray-brown, thin-bedded, hard, sparry calcite-cemented, moderately good sorting on the fragmental material, fine- to medium-crystalline. Upper 2 feet of this unit is sandy.	10
c	Limestone; yellow-brown weathering gray-brown, thin-bedded, hard, sparry calcite-cemented, fine- to medium-crystalline.	4
b	Limestone; yellow-brown weathering gray-brown,	

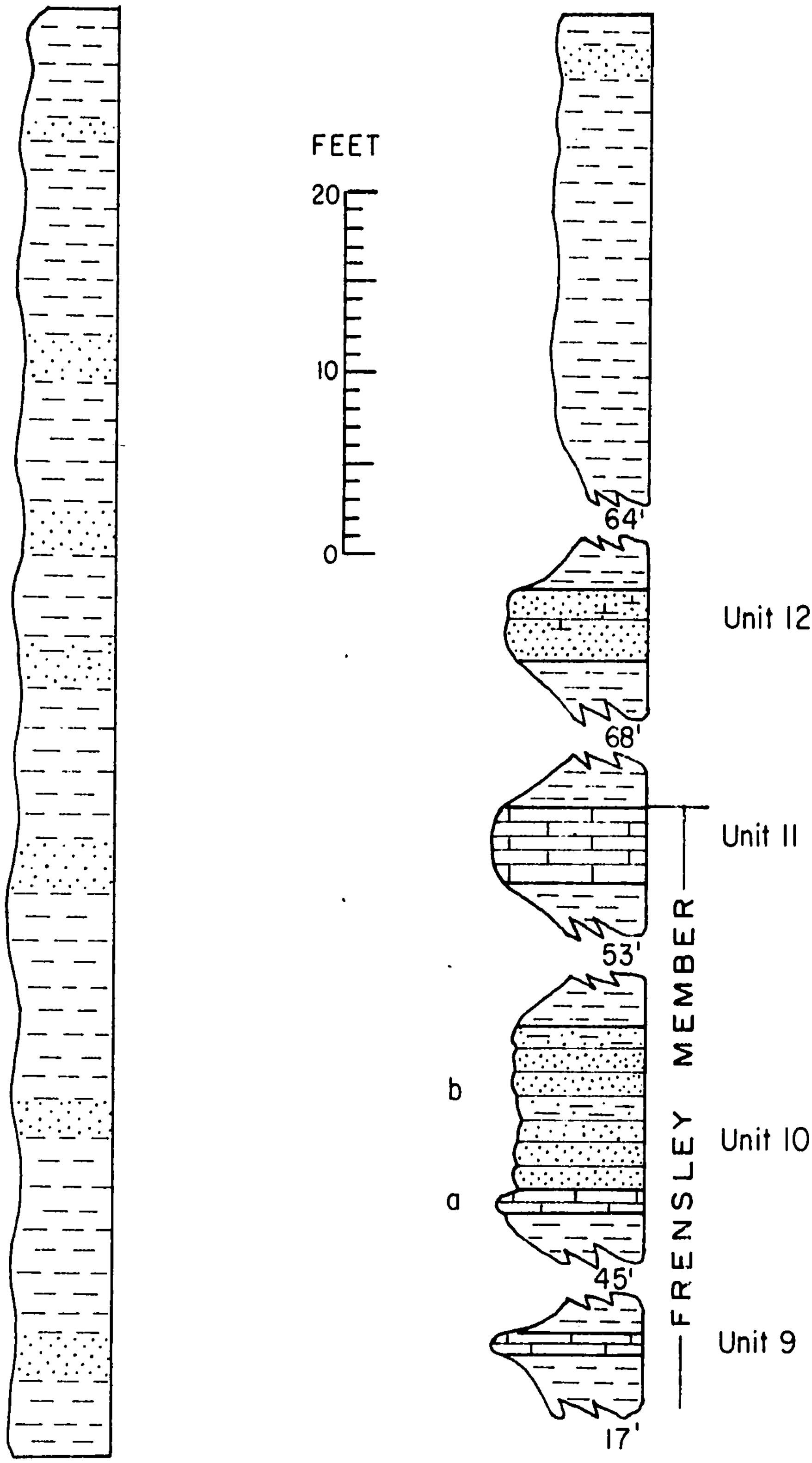
Section 1



e
d
c
b
a
PUMPKIN CREEK MEMBER
Unit 16
76'
Unit 15
28'
c
b
Unit 14
FEET
20
10
0
a
Unit 14
32'
Unit 13

	thin- to medium-bedded, hard, sparry calcite-cemented, fragmental material poorly sorted, fine- to medium-crystalline, clay intraclasts. Middle 10 feet shaly	21
a	Limestone; brown weathering gray-brown, medium-bedded, hard, sparry calcite-cemented, fine- to medium-crystalline. Fusulinids common. Upper 2 feet poorly cemented and contains much clay.	5
	Covered.	76
15	Strike N. 60° W., dip 38° NE.	
	Limestone; yellow-brown weathering dark gray-brown, thick-bedded to very thick-bedded, hard, fine-crystalline, contains quartz sand grains, subangular, of between 2 and 3Ø.	11
	Covered.	28
14	Strike N. 58° W., dip 40° NE.	
c	Limestone; red-brown weathering yellow-brown, medium- to thick-bedded, indurated, poorly sorted fragmental material, clay intraclasts, argillaceous, sparry calcite-cemented, coarse- to very coarse-crystalline. Rare fusulinids.	4
b	Limestone; red-brown weathering yellow-brown, medium-bedded, hard, moderate sorting on fragmental material, clay- and calcite-cemented, sandy (2 to 3Ø), fine- to medium-crystalline.	2
a	Sandstone; red-brown weathering yellow-brown, thin- to medium-bedded, hard to friable, clay- and calcite-cemented, rather poorly sorted, generally fine-grained (2 to 3Ø) but ranging on some of the chert flakes up to 0Ø. Clay intraclasts are common.	2
	Covered --probably shale	32
13	Strike N. 63° W., dip 38° NE.	
	Limestone; yellow-brown weathering to dirty yellow-tan, medium-bedded, hard, sparry calcite-cemented, sandy (2 to 3Ø), coarse-crystalline at bottom grading to medium-crystalline at top.	16

Section 1


FEET
20
10
0
64'
Unit 12
68'
Unit 11
53'
b
Unit 10
a
45'
Unit 9
17'
FRENSLEY MEMBER

Shale; yellow-brown weathering tan, thinly-laminated, silty. Few thin sandstone beds, yellow to yellow-tan, thin-bedded, friable, poorly cemented, fine-grained (3 to 4Ø). 156

Covered--probably shale. 64

12 Strike N. 70° W., dip 58° NE.

Sandstone; light tan-brown weathering brown, medium-bedded, indurated, calcareous-cement with ferruginous mixture, moderately sorted, fine-grained (2 to 3Ø). Southeast along strike becomes a near white calcareous sandstone in NW¼ sec. 23, but develops into a sandy limestone in NW½ sec. 22. 3.5

Covered -- but observable areas show shale; yellow-brown, thinly-laminated, with thin-bedded, fine-grained sandstone layers. 68

Offset approximately 275 yards to southeast along strike.

11-8 <u>Frensley Member</u>

11 Strike N. 50° W., dip overturned 80° SW due to hillside creep.

Limestone; brown weathering yellow-brown, thin- to very thin-bedded, hard to friable, sparry calcite-cemented to loose, medium- to coarse-crystalline. Approximately 1.5 feet above base is 6 to 8 inch fragmental shell, uncemented bioclastic zone. Lower contact well defined but upper contact gradational. Fusulines. 4

Covered -- probably shale. 53

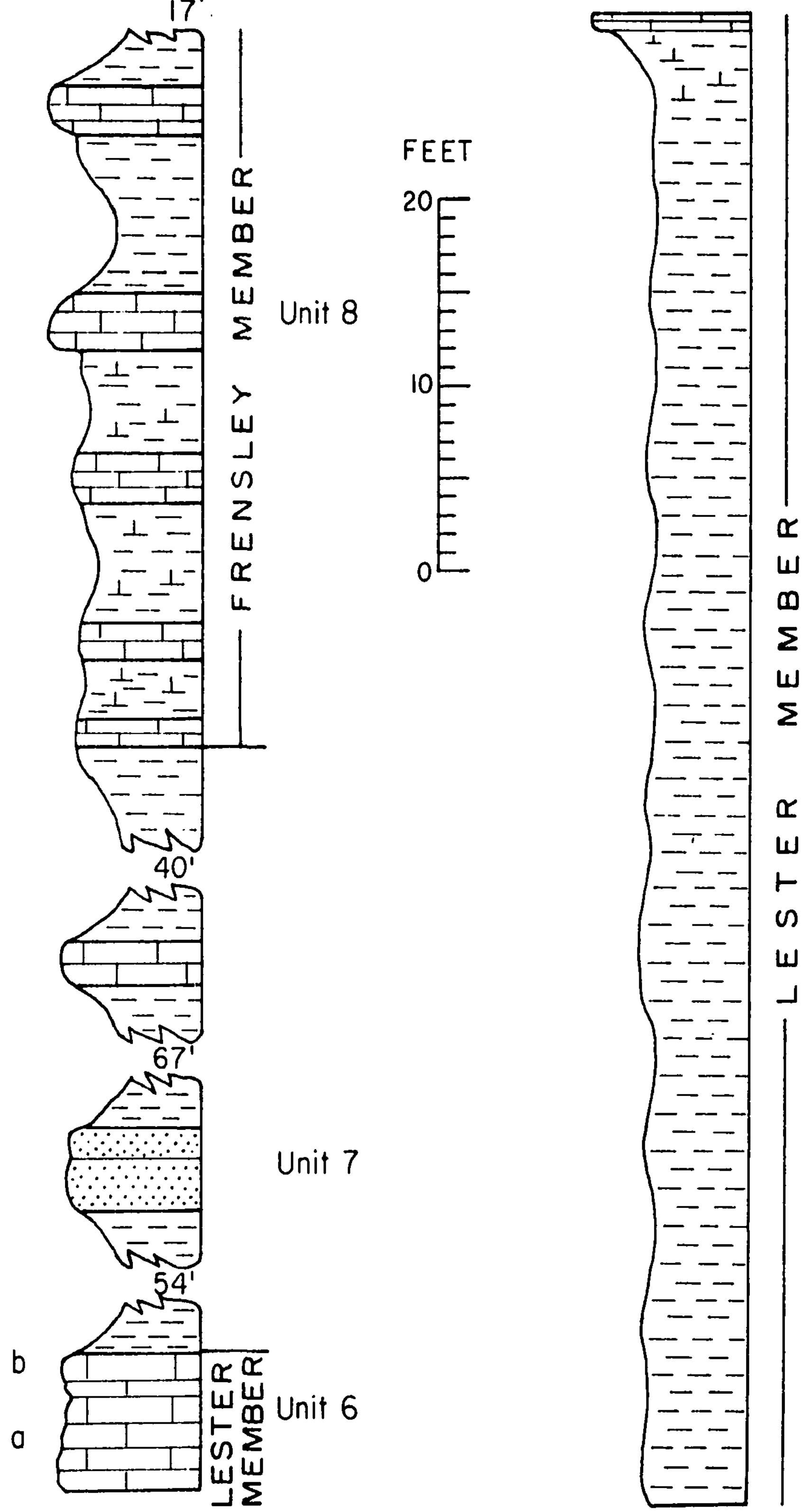
10 Strike N. 56° W., dip 58° NE.

b Siltstone; yellow-purple to tan, thin-bedded, with thin-parted, tan, calcareous shale. 9

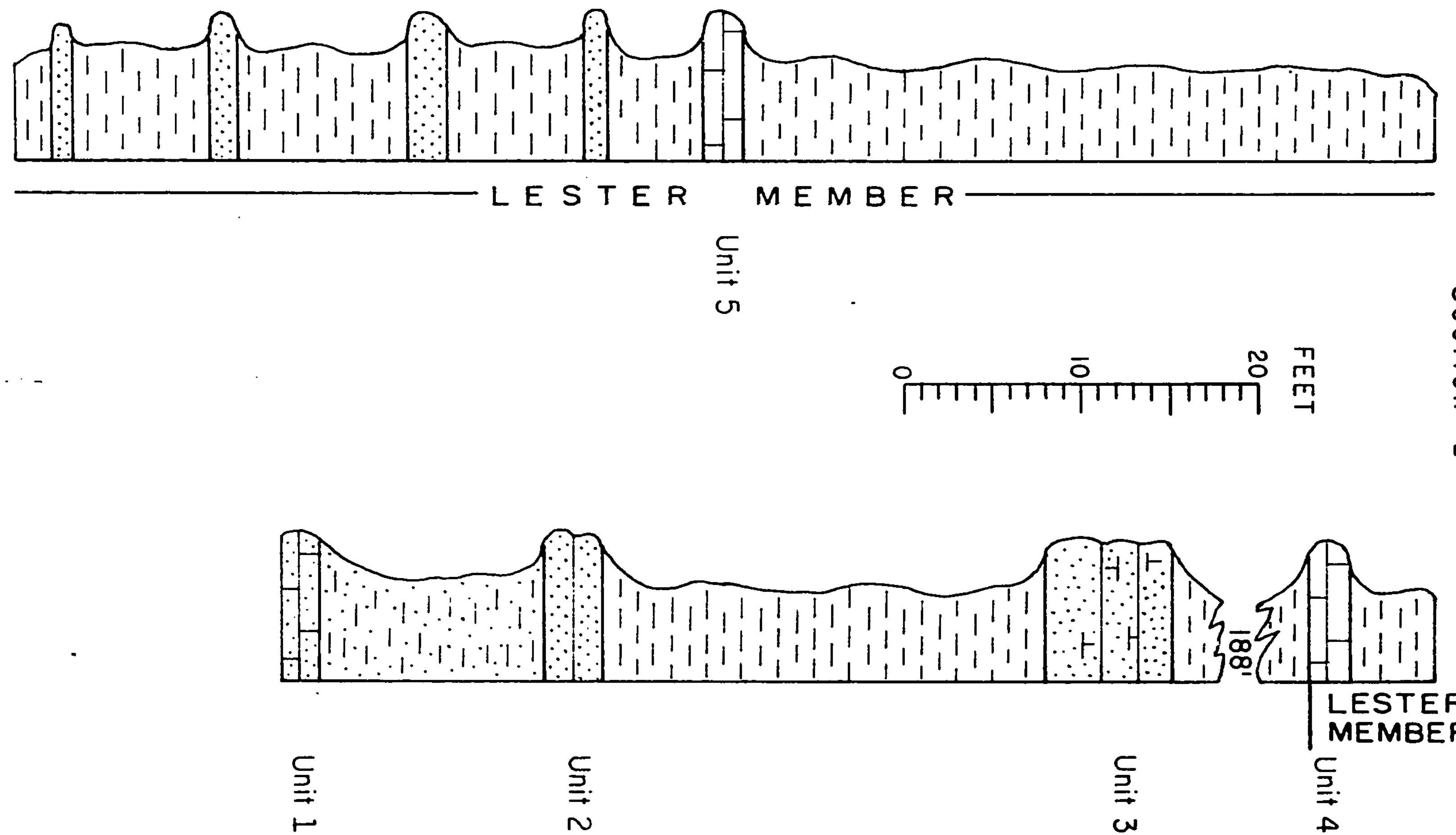
a Limestone; brown weathering gray-brown, medium-bedded, hard, sparry calcite-cemented, coarse-crystalline. Upper 4 inches becoming bioclastic hash. Upper and lower contacts well defined. Abundant "<u>Marginifera</u>" type brachiopods. 1

Covered -- probably shale. 45

Section 1


17'
FRENSLEY MEMBER
Unit 8
FEET
20
10
0
40'
67'
Unit 7
54'
b
a
LESTER MEMBER
Unit 6
LESTER MEMBER

9	Strike N. 58° W., dip 56° NE.	
	Limestone; brown weathering gray-brown, medium-bedded, hard, limonitic micritic- or microspar-cement, skeletal constituents broken small fragments of brachiopods, fine-crystalline. Upper and lower contacts sharp.	1
	Covered -- probably shale.	17
	Limestone; yellow-tan, weathering tan, thin- to medium-bedded, nodular and discontinuous, medium-crystalline.	2.5
	Shale; yellow-tan to gray-tan, weathering yellow-tan, thinly-laminated, soft, calcareous and sandy.	8
8	Strike N. 57° W., dip 56° NE.	
	Limestone; light brown weathering to gray-brown, medium-bedded, hard, limonitic sparry calcite-cemented, medium-crystalline. Abundant fusulinids. Unit becomes nodular in outcrop to southeast and picks up marly zone which abounds with fusulinids.	3
	Shale; calcareous, tan to yellow-tan, thinly-laminated, somewhat sandy in spots, with limestone; yellow-tan weathering tan, nodular, hard, limonitic sparry calcite-cemented, medium-crystalline. Rare fusulinids.	24
	Covered.	40
	Limestone; yellow-brown weathering to brown, medium-bedded, hard, limonitic sparry calcite-cement, coarse-crystalline, clay intraclasts, sandy (2 to 3Ø). Possible algal bands about some sand grains, may be oolitic. Zone crops out along State Scenic 77 as unconsolidated, fragmental, brachiopod hash.	2
	Offset 300 feet to the southeast.	
	Covered.	67
7	Strike N. 53° W., dip 52° NE.	
	Sandstone; white to yellow-gray weathering gray-white, thin- to thickly-bedded, friable, poorly cemented, moderately well sorted, fine-grained, (2	


LESTER MEMBER
Unit 5
Section 1
0
10
20
FEET
188'
LESTER MEMBER
Unit 1
Unit 2
Unit 3
Unit 4

to 3ϕ), subangular. Thickness varies along strike from 2 to 6 feet. 4

Covered. 54

6-4 <u>Lester Member</u>

6 Strike N. 53° W., dip 50° NE.

b Limestone; brown weathering yellow-brown, thin-bedded, hard, oolitic, limonitic sparry calcite-cement, coarse-crystalline. As a unit 6a and 6b show gradational upper and lower contacts. Slight ridge formed. 1

a Limestone; brown weathering brown-yellow, thin-bedded, hard, limonitic sparry calcite-cement, coarse-crystalline. 7

Shale; limonitic, silty toward bottom, calcareous toward top, yellow-tan, thinly-laminated. 118

5 Strike N. 57° W., dip 58° NE.

Limestone; brown weathering yellow-brown, medium- to thick-bedded, hard, limonitic sparry calcite-cemented, clay intraclasts, coarse-crystalline. In upper 1 foot 90% of all fossils and clay intraclasts covered by thick layers of <u>Osagia</u>? algae. Some clay clasts up to 4 X 1 inches. 2

Shale; yellow-tan, thinly-laminated, limonitic, silty, with sandstone; thin-bedded, siliceous-cement, fine grained. 44

4 Strike N. 55° W., dip 60° NE.

Limestone; brown weathering yellow-brown, ranges from thin- to thick-bedded, microcross-bedding lower 6 inches, hard, limonitic calcite-cemented, fine- to coarse-crystalline. 2

Covered -- probably shale because a strike valley is developed on this interval. 188

3 Strike N. 60° W., dip 60° - 70° NE.

Sandstone; tan weathering yellow-tan, thin- to thick-bedded, hard, calcareous limonitic clay-cement, moderate sorting, very fine-grained (3 to

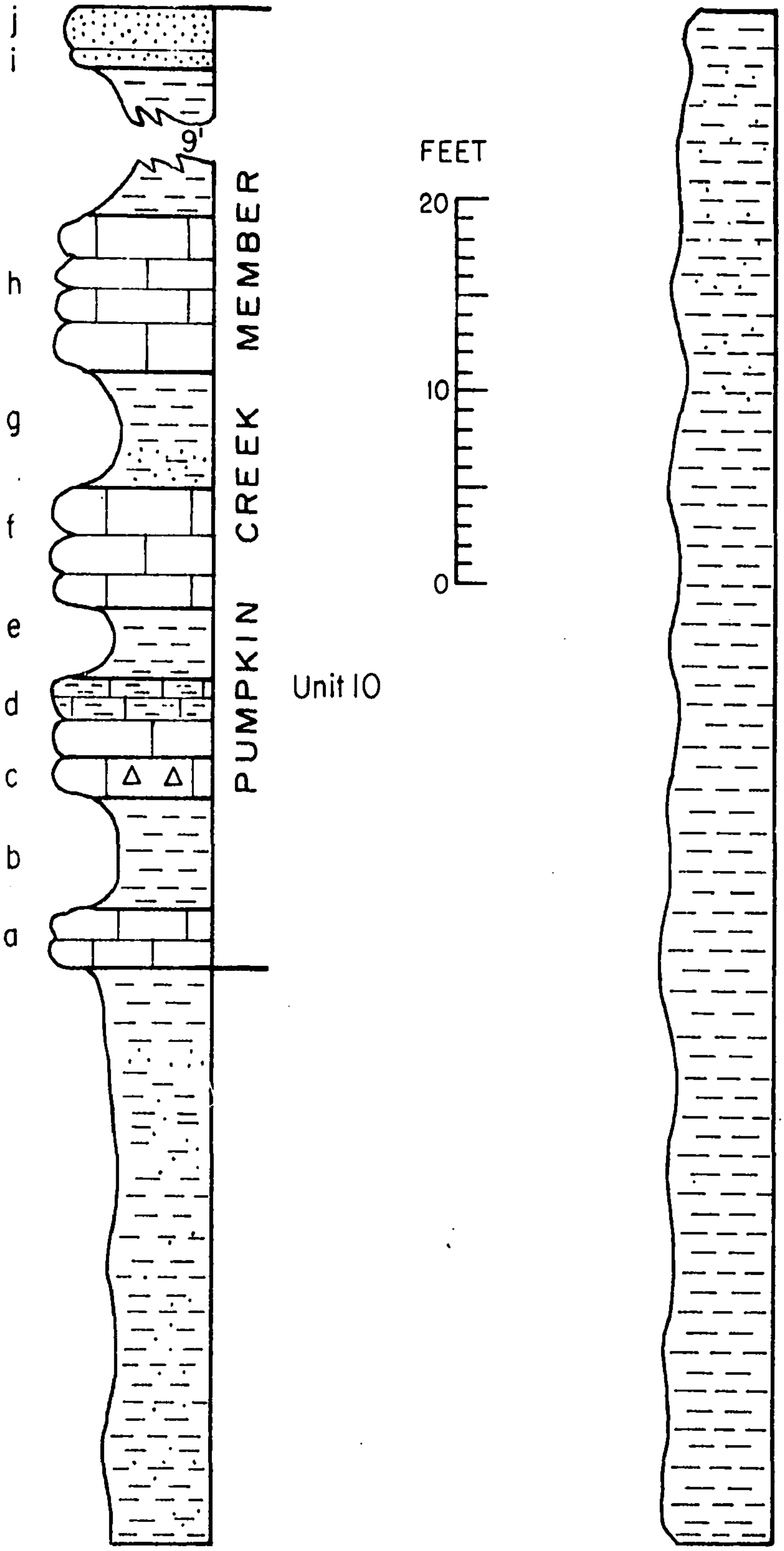
	4∅). Upper and lower contacts sharp. Bottom of beds show flow features.	7
	Shale; sandy (3 to 4∅), yellow-tan, limonitic silt nodules, upper 6 inches develops into flaggy sandstone about ½ to 1 inch in thickness.	25
2	Strike N. 60° W., dip 60° - 70° NE.	
	Sandstone; light-brown weathering yellow-tan, medium- to thick-bedded, hard, calcareous limonitic-cement, fairly good sorting, grain size between 2 and 3∅.	3
	Shale; limonitic, sandy, yellow-tan, very thinly-laminated, soft.	13
1	Strike N. 60° W., dip 60° - 70° NE.	
	Limestone; purple-brown weathering reddish-tan, medium- to thick-bedded, hard, fine-crystalline. Probably as much as 25% very fine-sand grains (3 to 4∅) present.	2

MEASURED SECTION 2

Location. $N\frac{1}{2}$ $NW\frac{1}{4}$ sec. 15 T. 6 S., R. 2 E., Love County, Oklahoma. Section 2 is northwest of turn off to Tucker Tower on State Scenic 77 a distance of approximately 400 yards. The location is the quarry immediately to the north. The section is painted, with the higher numbers in the quarry and the lower numbers to the west southwest. Section 2 is presented beginning at the top.

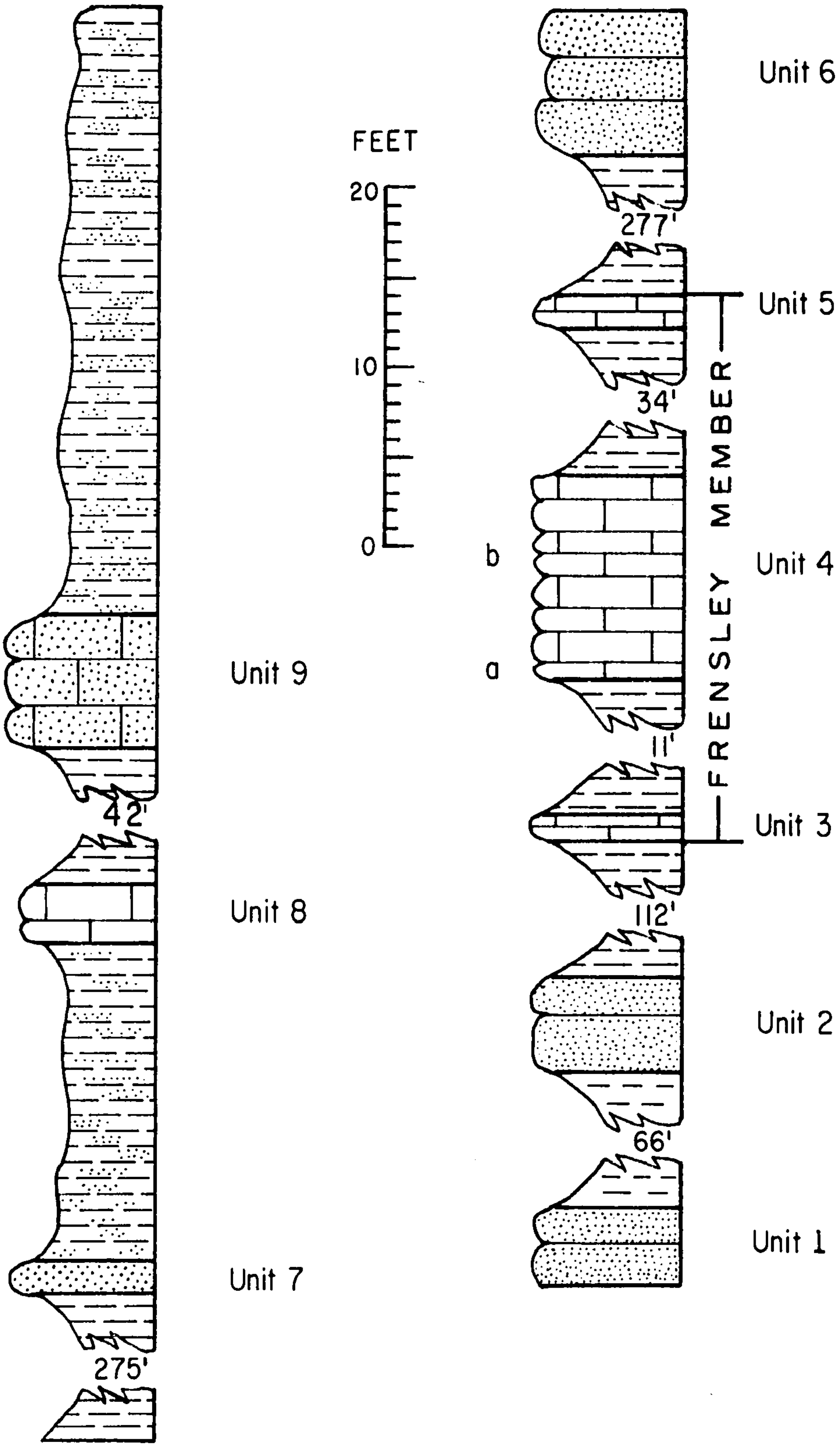
Unit		Thickness in feet
10	Pumpkin Creek Member	
	Strike N. 30° W., dip 60° NE.	
j	Sandstone; yellow-tan weathering tan, medium-bedded, moderately sorted, subangular, siliceous cement, friable to some extent, fine-grained (2 to 3ϕ).	2
i	Sandstone, yellow-gray weathering yellow-white, medium-bedded, siliceous cement, fine-grained (2 to 3ϕ).	1
	Covered.	9
h	Limestone; yellow-tan weathering yellow-gray, medium- to thick-bedded, hard, sparry calcite-cemented, coarse-crystalline. Lower contact well defined. Occasional chert pebble (-2 to -6ϕ).	8
g	Shale; yellow-tan, sandy in lower part becoming calcareous in upper, sand (2 to 3ϕ), thin limestone nodules upper 6 inches.	6

Section 2



f	Limestone; light yellow-tan weathering yellow-white, medium- to thick-bedded, medium- to fine-crystalline. Along strike unit changes to sandstone; yellow-tan weathering tan-white, calcareous cement, fine- to medium-grained (1 to 3Ø), with beds of very thinly-laminated gray to gray-green, sandy shales. Top and bottom contacts well defined.	6
e	Shale; yellow-tan, fossiliferous, upper 2.5 feet sandy (3 to 4Ø), bedding obscured by sand content.	4
d	Limestone; fragmental shell, yellow-brown, thick-bedded, friable, loose (not cemented), clay matrix, no sorting, bryozoan, brachiopod, fragmental hash. Patch reefing occurs in both directions along the strike. Reef limestone is fine-crystalline (micrite), containing large amplexizaphrentid horn corals, fenestrate bryozoans, and the colonial rugose coral <u>Michelinia</u>. Reef limestone is yellow-tan, thick-bedded, hard, micrite-cemented.	4
c	Limestone; brown-gray weathering dark gray-tan, thick-bedded, hard, sparry calcite-cemented, coarse-crystalline, chert pebbles of .5 to 1.0 inches (-2 to -6Ø). Bedding planes mass of crushed brachiopod shells belonging to <u>Hustedia</u> and <u>Composita</u>.	2
b	Shale; purple to yellow-tan, calcareous, soft, plastic, fossiliferous.	6
a	Limestone; gray to brown weathering gray-tan, thin- to medium-bedded, hard, sparry calcite-cemented, medium-crystalline. Bottom contact obscured.	2.5
	Shale; yellow-tan, sandy, thinly-laminated, soft, plastic, fossiliferous.	145
9	Strike N. 30° W., dip 60° NE.	
	Limestone; brown to tan weathering brown, medium- to thick-bedded, hard, sandy (1 to 2Ø), sparry calcite-cemented, coarse-crystalline. Rare fusulinids. Lower and upper contacts clearly defined.	6
	Covered.	42
8	Strike N. 30° W., dip 70° NE.	

Section 2


FEET
20
10
0
Unit 9
42'
Unit 8
Unit 7
275'
Unit 6
277'
Unit 5
34'
b
a
Unit 4
FRENSLEY MEMBER
11'
Unit 3
112'
Unit 2
66'
Unit 1

	Limestone; brown weathering yellow-brown, thick-bedded, hard, sandy, sparry calcite-cemented, coarse-crystalline.	3
	Shale; yellow-tan, sandy, thinly-laminated. About the middle of the unit are a few very thin-bedded, fine, limonite-cemented sandstones.	18
7	Strike N. 35° W., dip 60° NE.	
	Sandstone; brown weathering to tan-brown, medium-bedded, hard, fairly well sorted, limonite-cemented, medium-grained (1 to 2ϕ). Sand grains appear to have some form of growth about them.	1.5
	Covered.	275
6	Strike N. 35° W., dip ? NE.	
	Sandstone; tan weathering to reddish-black, thick-bedded, friable, limonitic-hematitic, fine-grained (2 to 3ϕ). Upper and lower contacts poorly defined.	8
	Covered.	277
5-3	Frensley Member	
5	Strike N. 28° W., dip 50° NE.	
	Limestone; brown weathering to yellow-tan, thick-bedded, hard, sparry calcite-cemented, coarse-crystalline. Upper 0.5 foot becoming marly.	1.5
	Covered.	34
4	Strike N. 32° W., dip 62° NE.	
b	Limestone; gray splotched weathering to gray-white, thin- to medium-bedded, nodular, hard, micritic calcite-cement, very fine-crystalline. Conspicuous brachiopod shells.	10
a	Limestone; gray weathering to gray-white, thick-bedded, hard, sparry-cement, fine-crystalline, sandy.	1
	Covered.	11
3	Strike N. 30° W., dip 68° NE.	

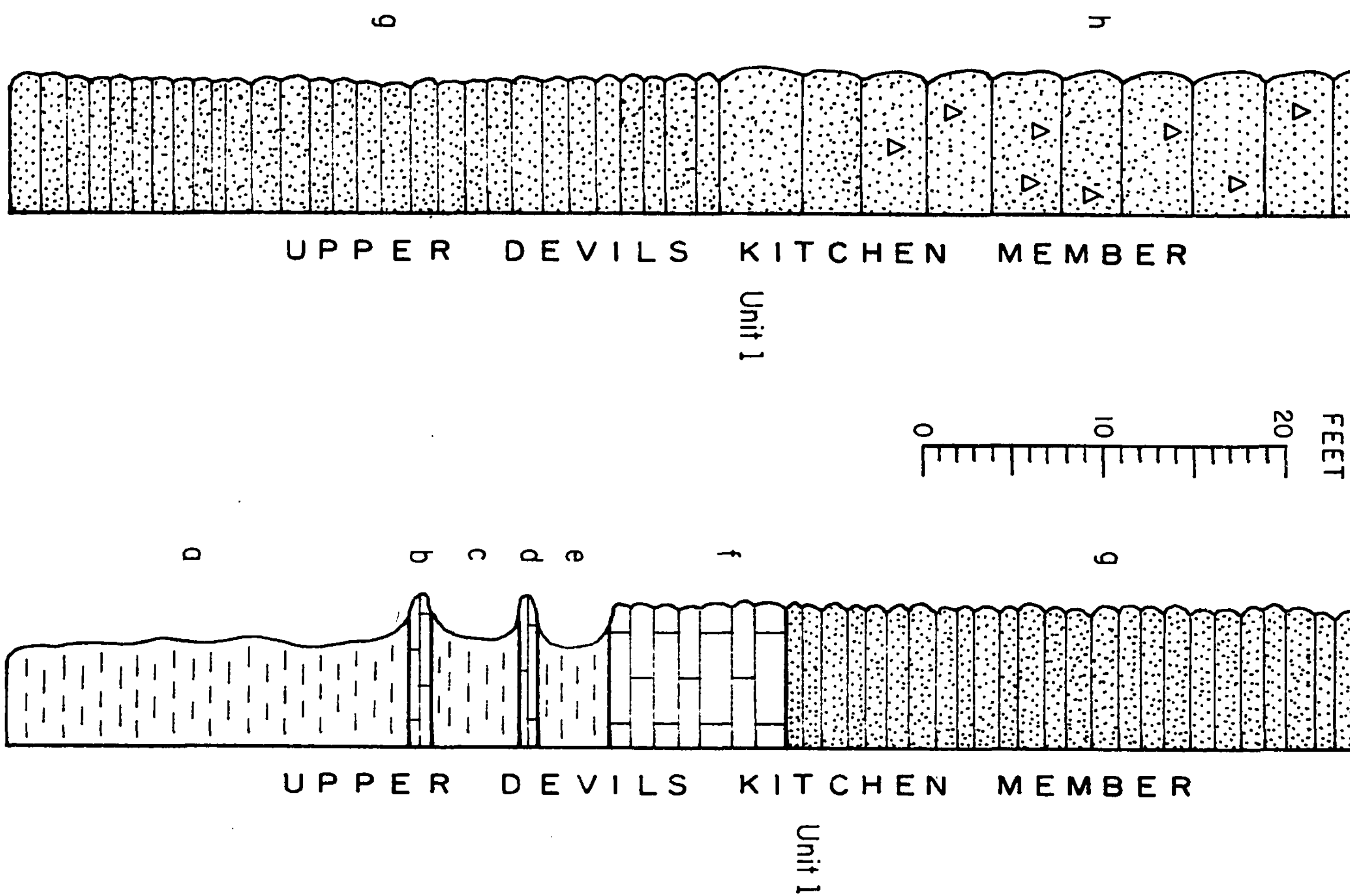
Limestone; gray weathering to gray-tan, medium-bedded, hard, micritic calcite-cemented, fine-crystalline. Abundant fusulinids at lower contact with a calcareous, soft, pliable, yellow-gray shale. 1

Covered. 112

2 Sandstone; yellow-tan weathering gray-brown, thick-bedded, friable, limonite-cemented, fine-grained (2 to 3Ø). 5

Covered. 66

1 Sandstone; yellow-tan, hematite streaked, weathering tan, thick-bedded, friable, subangular, well-sorted, fine-grained (2 to 3Ø). 4



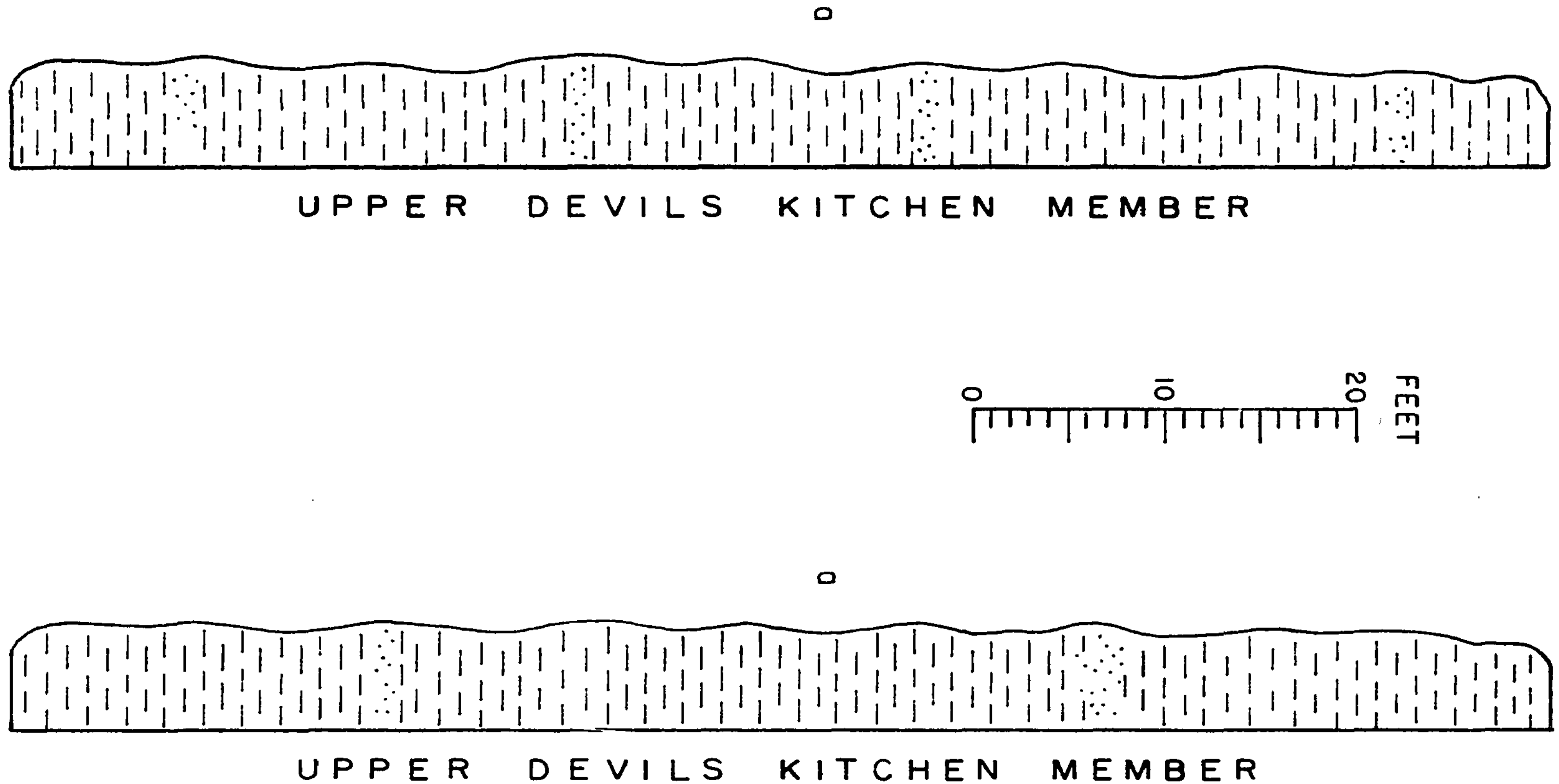
g
h
UPPER DEVILS KITCHEN MEMBER
Unit 1
0
10
20
FEET
a
b
c
d
e
f
g
UPPER DEVILS KITCHEN MEMBER
Unit 1

Section 3

MEASURED SECTION 3

<u>Location</u>. S½ SE¼ NW¼, NE¼ NE¼ SW¼, and W½ NW¼ SE¼ sec. 4, T. 6 S., R. 2 E., Love County, Oklahoma. Section 3 is 0.52 mile southeast on State Scenic 77 from its junction with paved road leading to Lake Murray Lodge. Section 3 is exposed on both sides of the paved road southeast for a distance of approximately 0.25 mile. Section 3 is presented beginning at the top.

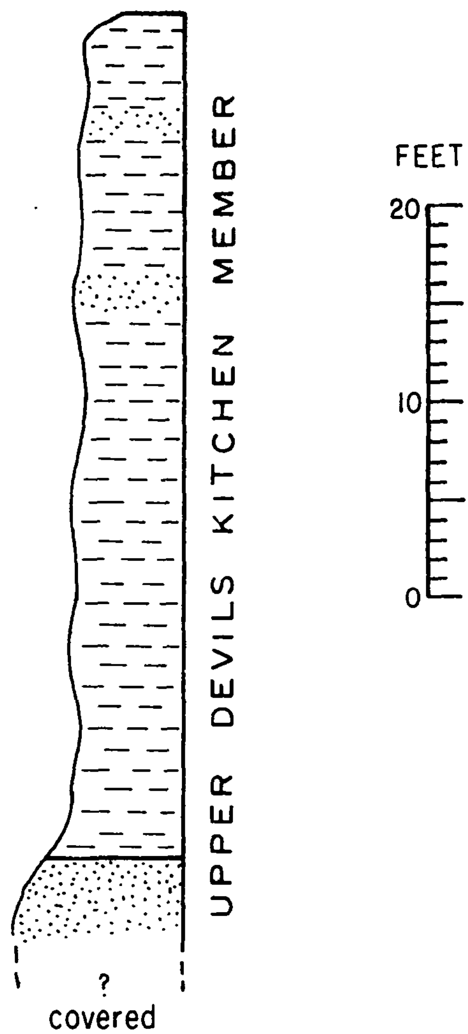
Unit		Thickness in feet
	<u>Upper Devils Kitchen Member</u>.	
1	Strike N. 40° W., dip 60° NE.	
h	Sandstone; yellow-tan weathering tan, thick-bedded, hard, chert pebbles, clay- and silica-cemented, poorly sorted, medium-grained (1 to 2Ø). Upper contact obscured by cover. Within 200 feet southeast along strike, this unit becomes a chert pebble conglomerate and remains such until it disappears beneath Cretaceous overlap in sec. 24, T. 6 S., R. 2 E.	41
g	Sandstone; yellow-brown weathering red-brown, very thin- to thin-bedded, few if any chert pebbles, hematitic, iron-cemented, medium-grained (1 to 2Ø) friable.	76
f	Limestone; yellow-gray weathering gray-white, thin- to medium-bedded, hard, nodular, micritic calcite-cement, fine- to very fine-crystalline. Upper 2 feet is thick-bedded but identical in composition.	10
e	Shale; calcareous, flaky, soft, gray-white, abundant <u>Mesolobus</u> and fusulinids.	4


UPPER DEVILS KITCHEN MEMBER
0 10 20
FEET
UPPER DEVILS KITCHEN MEMBER

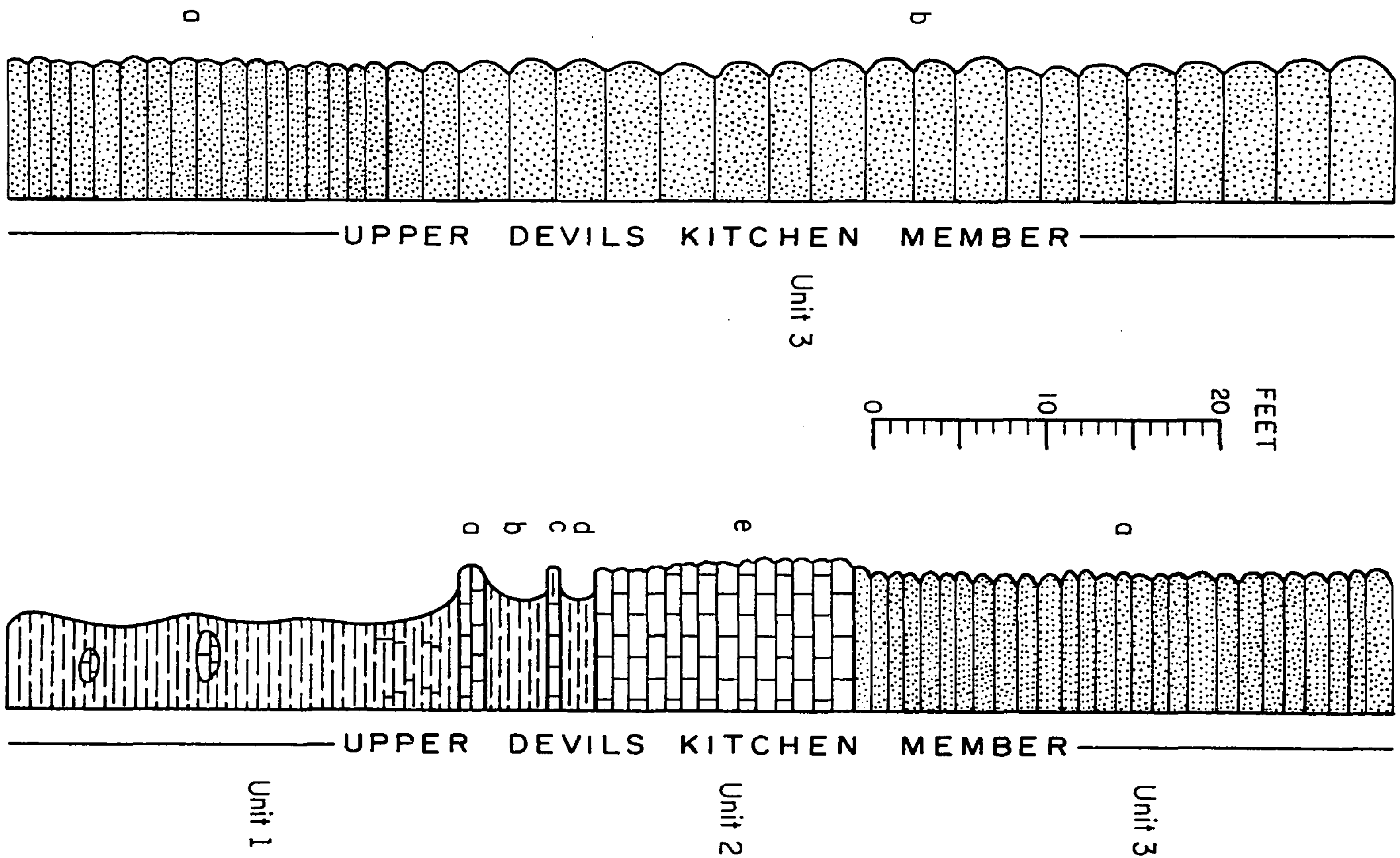
Section 3

d	Limestone; nodular, yellow-white weathering gray-white, thin-bedded, hard, micritic-cement, fine-crystalline.	0.8
c	Shale; yellow-tan weathering gray-tan, calcareous, soft, clay content high. Abundant fusulinids.	5.5
b	Limestone; gray-white weathering gray-tan, thin-bedded, hard, micritic calcite-cement, fine-crystalline.	0.8
a	Shale; yellow-red weathering red-brown, sandy, occasional thin beds of sandstone, subangular grains, fine-grained (2 to 3∅), with punky snow-balls of soft limestone in upper 50 feet.	225.

Section 3



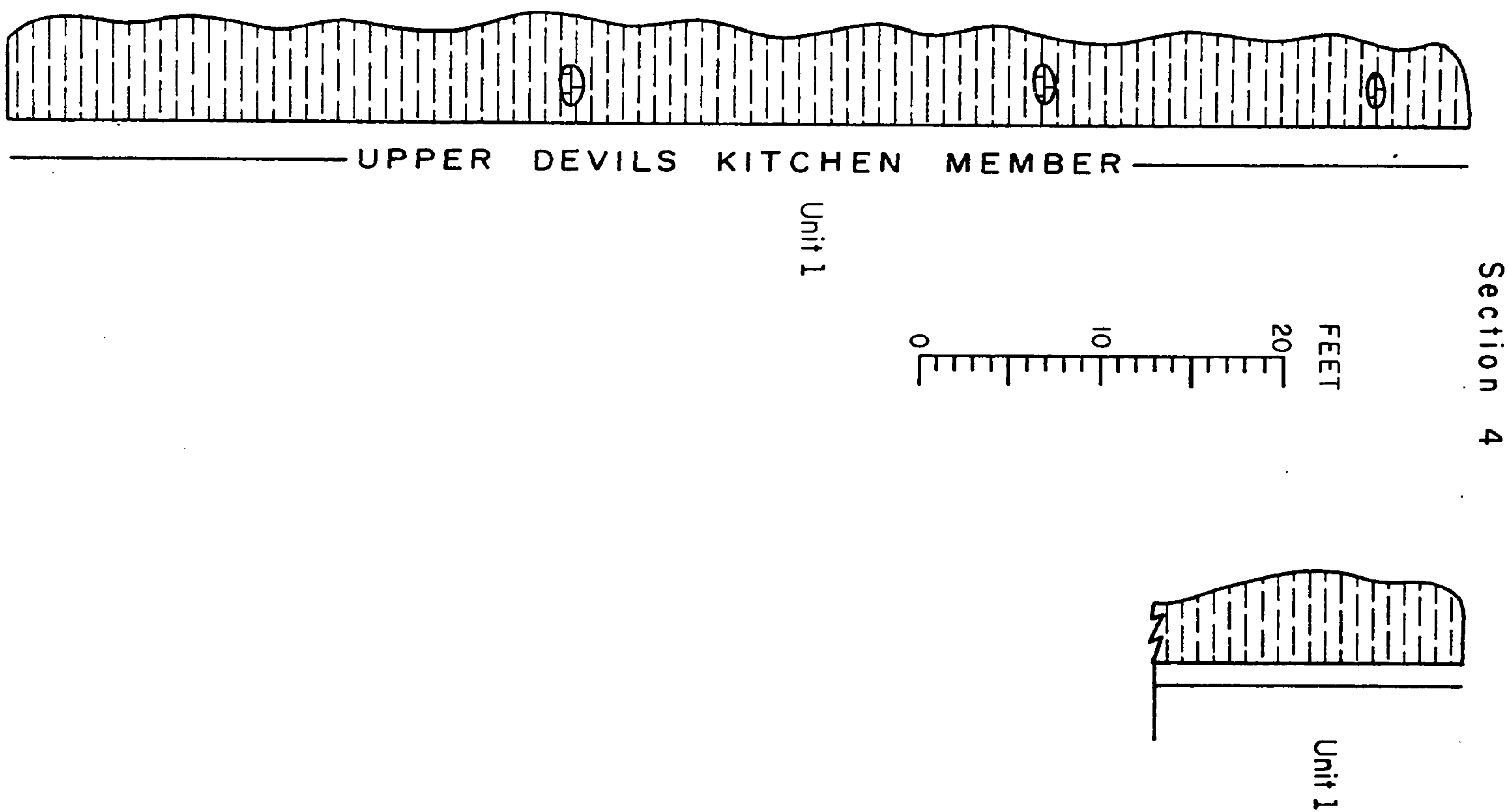
Section 4


a
b
UPPER DEVILS KITCHEN MEMBER
Unit 3
0
10
20
FEET
a
b
c
d
e
a
UPPER DEVILS KITCHEN MEMBER
Unit 1
Unit 2
Unit 3

MEASURED SECTION 4

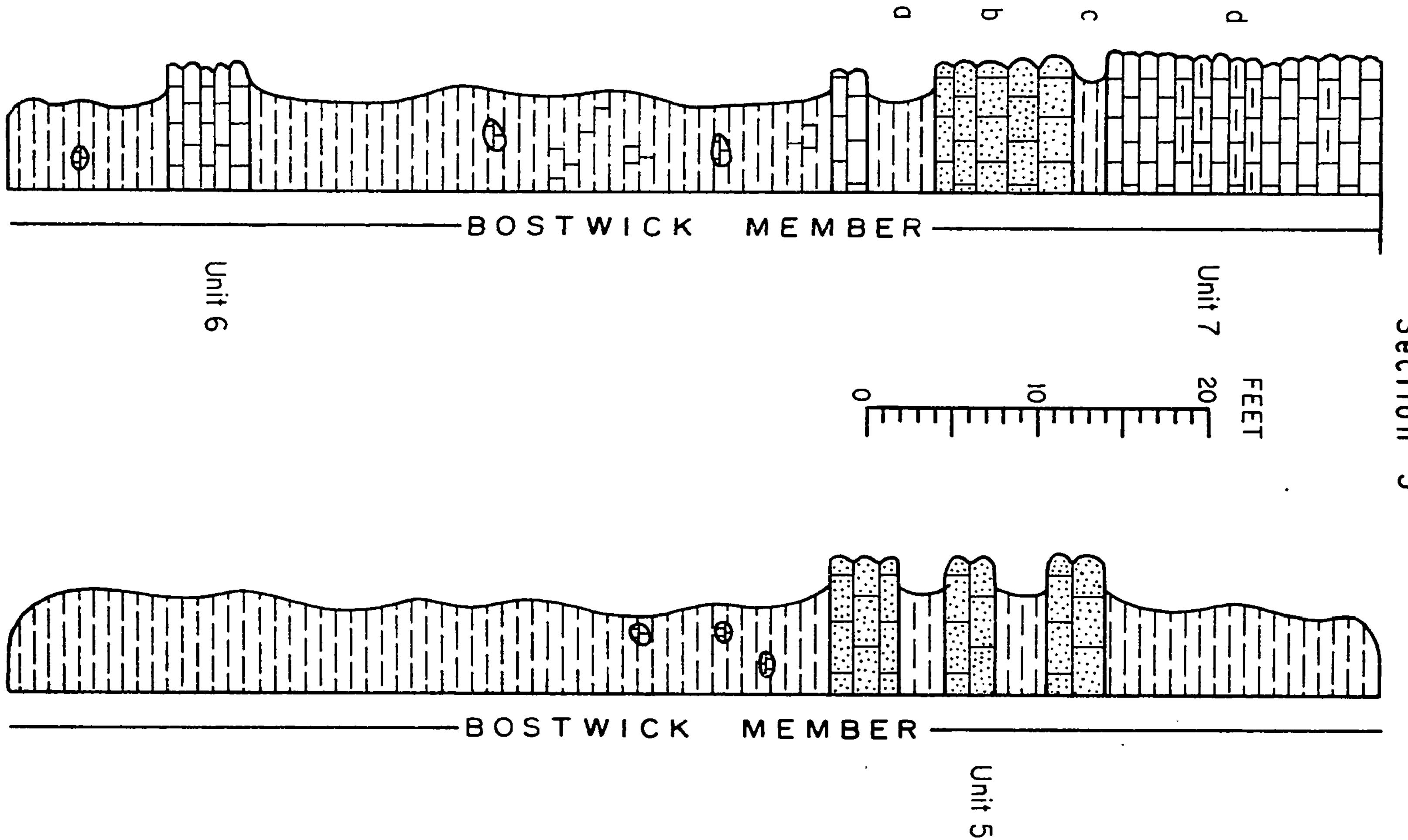
Location. S$\frac{1}{2}$ SE$\frac{1}{4}$ SE$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 32, T. 5 S., R. 2 E., Carter County, Oklahoma. Section is 2 miles east on State Scenic 77 from its junction with U. S. 77 8 miles south of Ardmore, Oklahoma. Begin clocking mileage at U. S. 77 and U. S. 70 junction at west edge of Ardmore. Section 4 is presented beginning with the top.

Unit		Thickness in feet
1-3	Upper Devils Kitchen Member	
3	Strike N. 35° W., dip 55° NE.	
b	Sandstone; yellow-brown weathering yellow-tan, thick- to very thick-bedded, hard to friable, clay- and silica-cemented, rather well sorted, medium-grained (1 to 2ø), white and yellow chert pieces up to $\frac{1}{4}$ to $\frac{1}{2}$ inches.	58
a	Sandstone; red-brown weathering reddish, very thin-bedded to thin-bedded, hematite stained, iron-cemented, medium-grained (1 to 2ø), friable. Contacts well defined.	53
2	Strike N. 35° W., dip 60° NE.	
e	Limestone; gray weathering to gray-white, nodular, thin-bedded, hard, micritic, fine-crystalline. Fusulinids abundant in shale partings.	15
d	Shale; gray-tan, soft, calcareous, thinly-laminated, fossiliferous, common fusulinids.	2
c	Limestone; nodular, gray weathering gray-white, thin-bedded, hard, micrite-cement, fine-crystalline.	0.3



UPPER DEVILS KITCHEN MEMBER
Unit 1
Section 4
0
10
20
FEET
Unit 1

b	Shale; yellow-tan weathering gray-tan, soft, pliable with apparent high clay content, thinly-laminated, fossiliferous.	4
a	Limestone; gray-tan weathering gray-white, thin-bedded, nodular, hard, micritic, fine-crystalline.	1
1	Shale; yellow-tan, calcareous in upper part, sandy toward bottom, thinly-laminated, poorly fossiliferous, contains limonitic nodules and calcareous nodules. Lower contact concealed.	120
	Covered.	



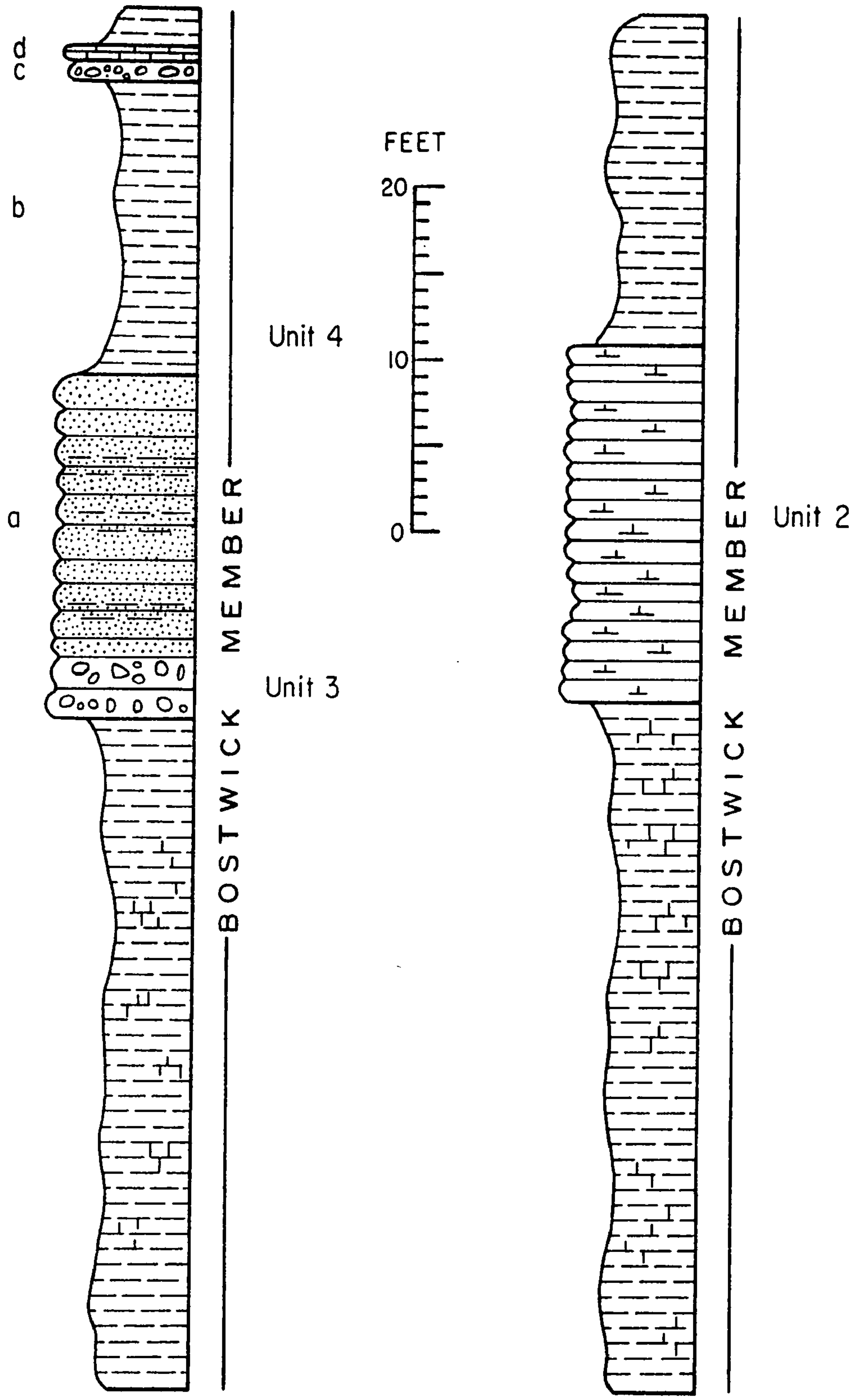
Section 5
a
b
c
d
BOSTWICK MEMBER
Unit 6
Unit 7
0
10
20
FEET
BOSTWICK MEMBER
Unit 5

MEASURED SECTION 5

Location. SW$\frac{1}{4}$ SW$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 32, T. 5 S., R. 2 E., and the north line of NW$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 5, T. 6 S., R. 2 E., Carter County, Oklahoma. Section 5 is 1.1 miles east of U. S. 77 and State Scenic 77 junction, 8 miles south of Ardmore, Oklahoma. Begin clocking mileage from U. S. 77 and U. S. 70 junction at west edge of Ardmore. Section 5 is presented beginning from the top.

Unit		Thickness in feet
1-7	Bostwick Member	
7	Strike N. 15° W., dip 74° NE.	
d	Limestone; blue-black to dark gray, thin-bedded, nodular, hard, fine-crystalline. Thick-laminated beds of shale between limestone beds are gray weathering gray-white, soft, highly calcareous, abundantly fossiliferous.	16
c	Shale; yellow-tan weathering chalky-tan, soft, calcareous, many limonitic sandstone concretions.	2
b	Limestone; brown weathering yellow-tan, hard, medium-bedded, sandy, sparry calcite-cement, medium-crystalline.	8
a	Shale; yellow-brown, very thinly-laminated, soft, calcareous. 4 feet from top is a 2 foot thin-bedded dark-gray, fine-crystalline limestone. Shale is fossiliferous and has many punky, white, soft, limestone balls throughout.	40
6	Limestone; thin-bedded to very thin-bedded, soft, punky, marly, light yellow-tan weathering white,	

Section 5



d
c
b
a
Unit 4
Unit 3
FEET
20
10
0
BOSTWICK MEMBER
Unit 2
BOSTWICK MEMBER

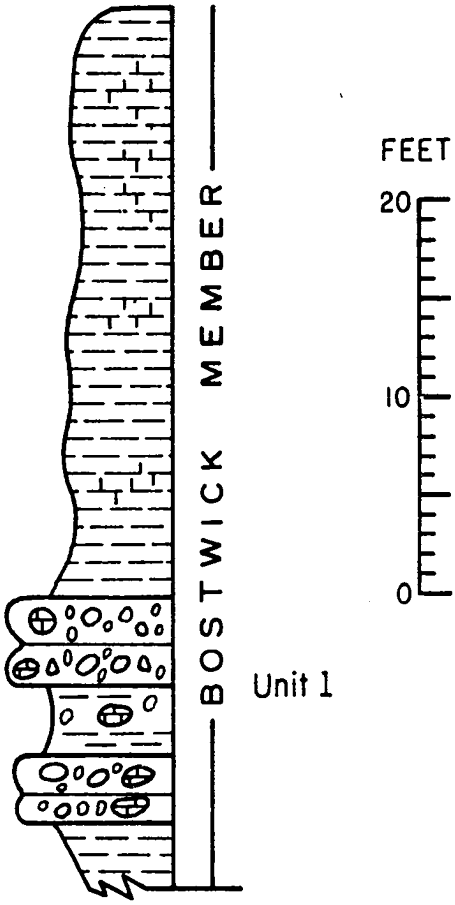
	fine-crystalline. Highly fossiliferous with cup corals, syringoporid type corals, fusulinids, bryozoans.	4.7
	Shale; blue-tan, platy, weathering bluish-tan, soft, punky calcareous concretions, fossiliferous.	25
5	Limestone; gray weathering gray-tan, medium-bedded, hard, fossiliferous, sandy, medium-crystalline. Limestone is in three beds with brownish-gray, calcareous, fossiliferous shale about 4.5 feet thick separating each limestone.	16
	Shale; gray-brown weathering gray-tan, calcareous, concretionary limestone upper 16 feet, limonitic, concretions in lower part. Shale is very thinly-laminated.	50
4d	Limestone; marly, shelly, uncemented, friable, thinly-laminated, poorly sorted fossil fragments, coquina hash.	0.6
c	Conglomerate; limestone pebble, matrix sandstone and calcareous, pebbles up to 2 inches in diameter average about $\frac{1}{2}$ inch, some chert is present.	0.8
b	Shale; dark gray-tan, blocky, limonite leaching, soft, pliable.	17
a	Sandstone; conglomeratic, yellow-tan, medium-grained, hard, medium-bedded, calcite-cemented, poorly sorted. Shale lenses, dark gray-tan, sandy, limonite stained, separate some of the sandstones. Usually conglomeratic in lower part of thicker sandstone beds.	16
3	Conglomerate; limestone and chert pebbles, limestone predominates, pebbles up to 3.5 inches in diameter, thick-bedded, cement is sandstone and calcite, size of pebbles decreases toward top.	3.5
	Shale; gray-tan, limonitic, calcareous punky snowballs, soft, very thinly-laminated. On south side of road the lower 10 feet is conglomeratic but on north side this conglomerate is not present.	58
2	Siltstone-Mudstone; very highly calcareous, black-to gray-black weathering dark gray, thin-bedded, hard, calcareous-cemented, very fine-grained.	21

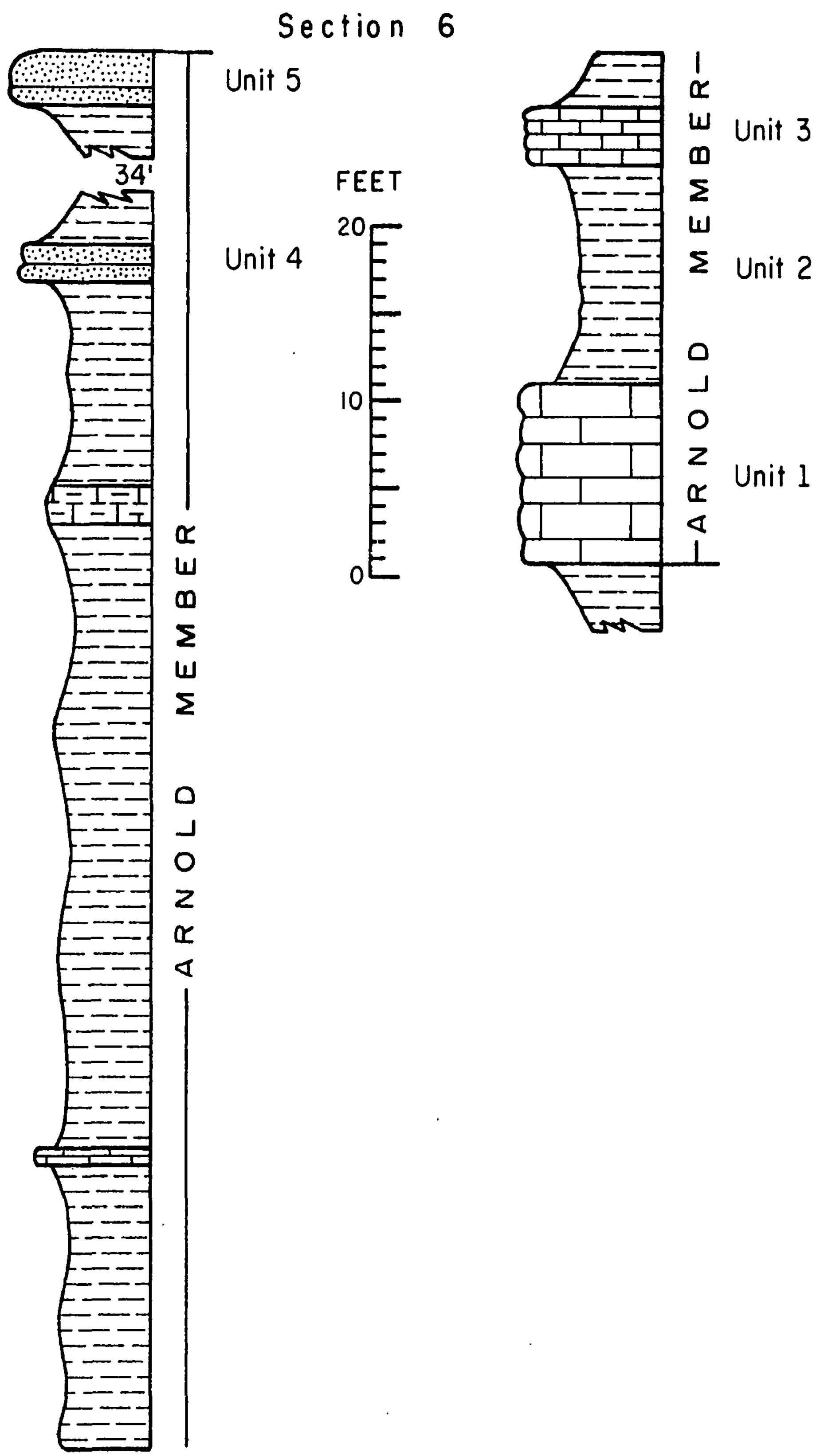
Shale; gray-tan to light gray, calcareous snowballs, pliable, clay content high, lower part becoming limonitic, silty in upper 20 feet. 70

1 Conglomerate; limestone and chert pebbles with limestone predominating, pebbles angular to subangular, average diameter of pebbles about ½ inch, matrix of sandstone, limonite, and calcite. About 3.5 feet of conglomeratic shale separate the two beds of conglomerate. 11

Covered.

Section 5




Section 6
Unit 5
34'
Unit 4
ARNOLD MEMBER
FEET
20
10
0
Unit 3
Unit 2
Unit 1
ARNOLD MEMBER

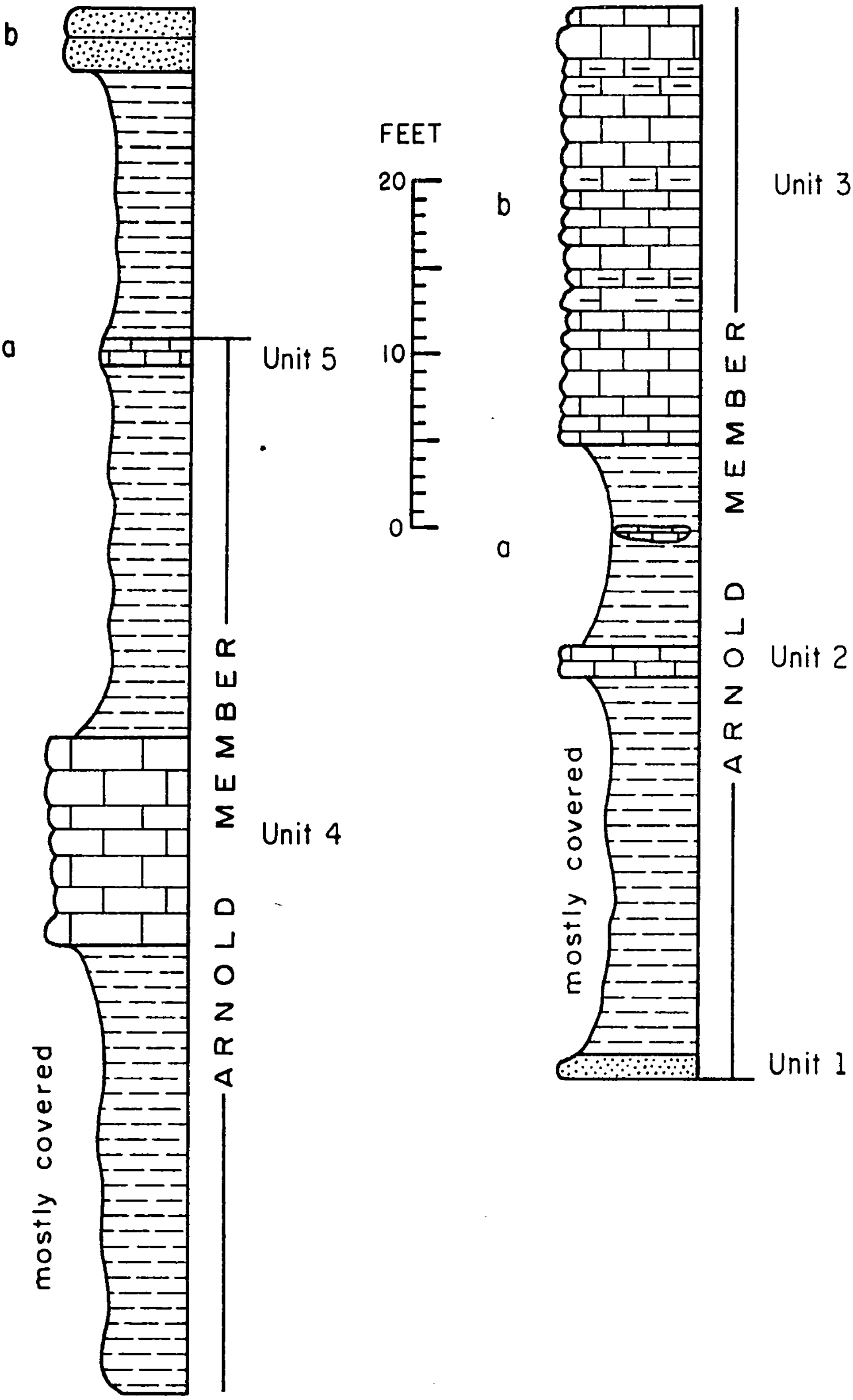
MEASURED SECTION 6

Location. NE$\frac{1}{4}$ SE$\frac{1}{4}$ SW$\frac{1}{4}$ and center west line SW$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 33, T. 5 S., R. 2 E., Carter County, Oklahoma. Section 6 may be found by traveling east 250 yards on paved road leading to Lake Murray Lodge from its junction with State Scenic 77. Turn north (left) on small dirt road just east of water tower and proceed for approximately 125 yards. Small ground level water tank should be immediately to the north of dead-end road. Section 6 is presented beginning with the top.

Unit		Thickness in feet
1-5	Arnold Member	
5	Strike N. 33° W., dip 52° NE.	
	Sandstone; gray-white weathering gray-white, medium-bedded, indurated, calcareous-cement, friable, poorly sorted, subangular, fine-grained (2 to 3ø).	3
	Covered.	34
4	Sandstone; gray-white weathering gray, medium-bedded, indurated, calcareous-cement, fine-grained (2 to 3ø).	2
	Covered, in general, but mostly shale, with possibly a thin limestone about 20 feet above base. At about 12 feet below top is a 2 foot zone of small, lumpy, micritic, limestone pebbles full of large fusulinas and wedekindellinas.	70
3	Limestone; highly fragmental, yellow-tan, thin-bedded,	

	indurated, sparry calcite-cement, coarse-crystalline. With highly calcareous, fossiliferous shale partings.	3
2	Shale; some covered but largely calcareous, clayey, yellow-tan, with some nodular limestone lenses.	12
1	Limestone; bluish-white to yellow-brown weathering white to tan, medium- to thick-bedded, hard, sparry calcite-cement, coarse-crystalline.	10
	Covered.	

Section 7



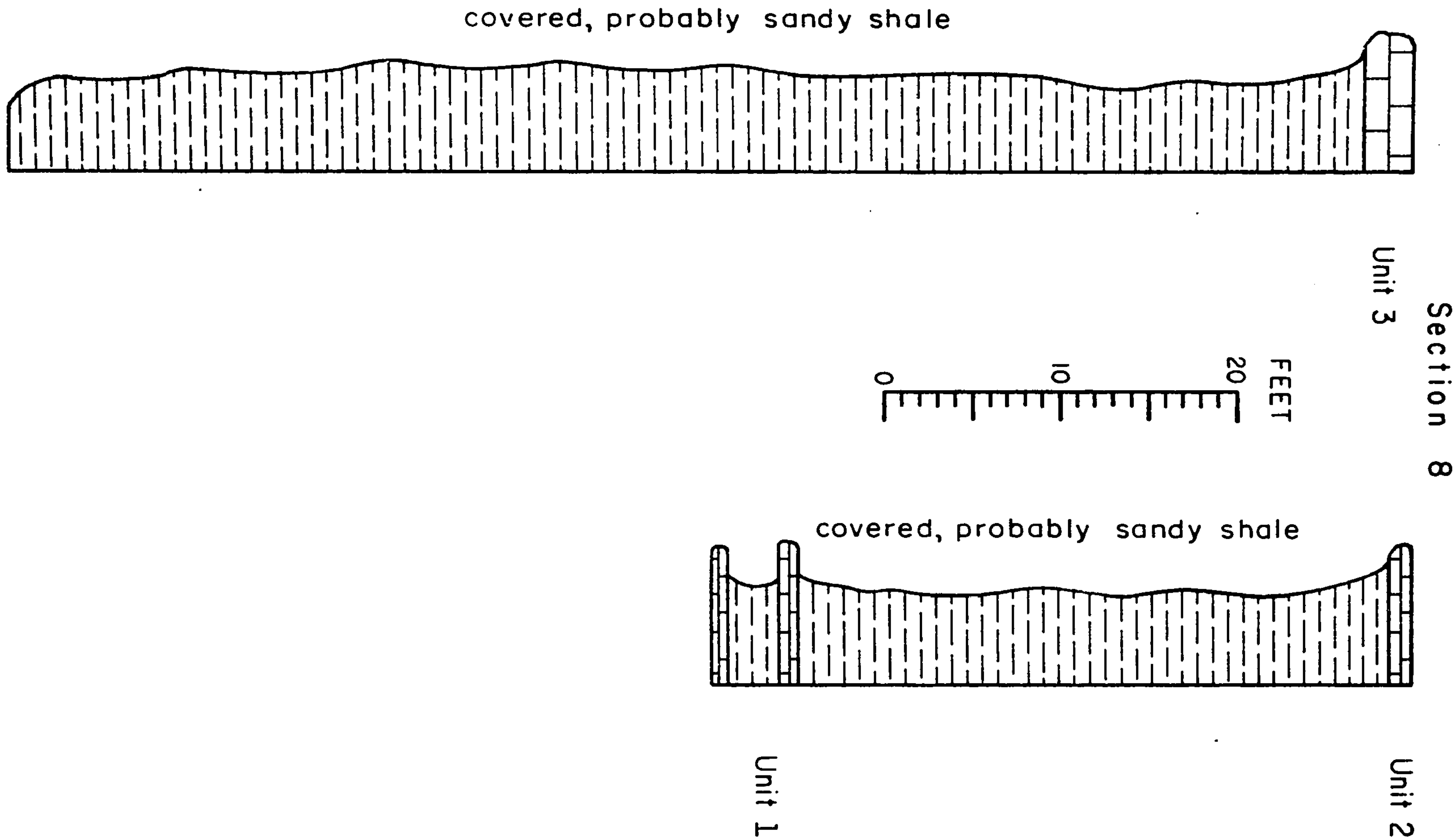
b
a
Unit 5
ARNOLD MEMBER
Unit 4
mostly covered
FEET
20
10
0
b
a
Unit 3
Unit 2
Unit 1
ARNOLD MEMBER
mostly covered

MEASURED SECTION 7

Location. NE$\frac{1}{4}$ NW$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 4, T. 6 S., R. 2 E., Carter County, Oklahoma. Section 7 may be located by traveling east 75 yards on paved road leading to Lake Murray Lodge from its junction with State Scenic 77. Turn south (right) on small paved road leading among cabins, keep left, continue .14 mile east. Turn south (right) on small poorly kept road and continue for about 165 yards. Section 7 is on the immediate left and right. Section 7 is presented beginning at the top.

Unit		Thickness in feet
1-5	Arnold Member	
	Strike N. 35° W., dip 58° NE.	
5b	Sandstone; yellow-white weathering gray-white, medium-bedded, friable, calcareous-cemented, sub-angular, fair sorting, fine-grained (2 to 3Ø)	4
a	Shale; principally covered, but about 20 feet above the base are 2 to 3 feet of nodular, micritic, hard, gray-white limestone pebbles with abundant *Fusulina* and *Wedekindellina*.	38
4	Limestone; gray weathering gray-white, medium-bedded, hard, micritic-cement, fine-crystalline, Upper approximately 2 feet is fragmental, highly crinoidal, shell limestone with a sparry calcite-cement.	12
	Covered, probably shale.	25
3b	Limestone; yellow-gray weathering gray-white,	

	thin- to medium-bedded, often nodular, very thin partings of shale, fossiliferous, sandy to marly, fine- to medium-crystalline, sparry calcite-cemented and some places micritic-cemented. Productid brachiopods common, rare fusulinids.	25
a	Shale; yellow-gray, thinly-laminated, calcareous, in middle of shale are several very thin-laminated to nodular, yellow-gray, sandy, limestones. Fusulinids common.	12
2	Limestone; yellow-gray weathering gray-white, thin-bedded, hard, sparry calcite-cemented, medium- to coarse-crystalline. Fusulinids abundant.	1.5
	Covered, probably shale.	22
1	Sandstone; yellow-gray weathering mottled gray, thin-bedded, friable, limonite-cemented, fine-grained (2 to 3∅).	0.5


covered, probably sandy shale
Unit 3
Section 8
0
10
20
FEET
covered, probably sandy shale
Unit 1
Unit 2

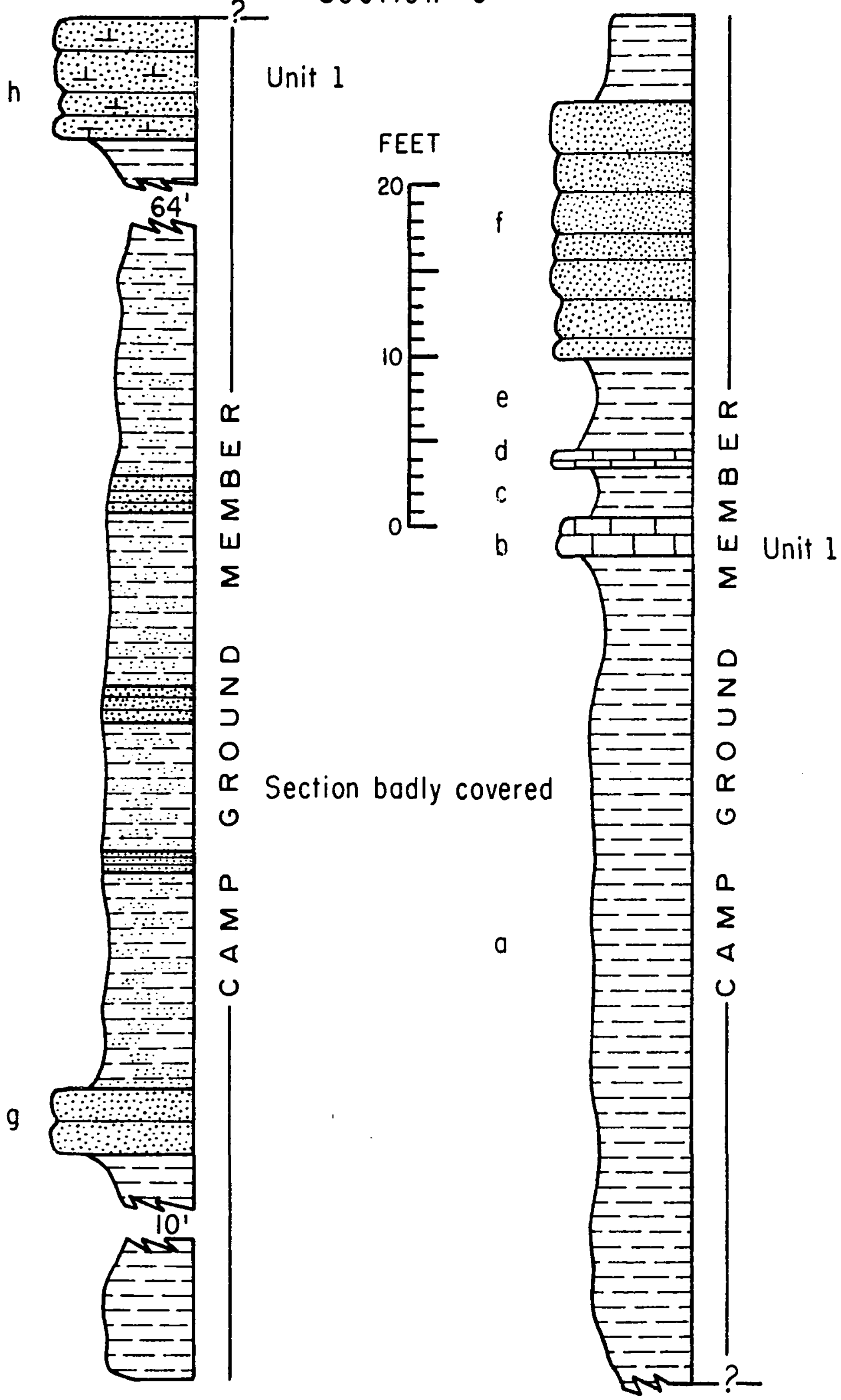
MEASURED SECTION 8

Location. Center west line $NE\frac{1}{4}$ $SE\frac{1}{4}$, and $NE\frac{1}{4}$ $NW\frac{1}{4}$ $SE\frac{1}{4}$ sec. 20, T. 5 S., R. 2 E., Carter County, Oklahoma. Section 8 may be reached by following State Scenic 77 north 3.1 miles from its junction with paved road leading to Lake Murray Lodge. Turn southeast (right) on poorly kept paved road for approximately 0.08 mile, bear south (right) at fork in road and follow dirt road south and southeast for 0.26 mile. Section 8 is exposed to the northeast with only unit 1 exposed in the clearing, other units are found in the dense growth of trees. Section 8 is presented beginning at the top.

Unit		Thickness in feet
3-1	Unnamed Limestones Between Rocky Point Member and Camp Ground Member.	
3	Strike N. 33° W., dip 60° NE.	
	Limestone; reddish-brown weathering reddish-brown, thick-bedded, hard, sparry calcite-cemented, coarse-crystalline, green clay intraclasts.	2
	Covered.	76
2	Strike N. 36° W., dip 60° NE.	
	Limestone; yellow-brown weathering reddish-brown, gray clay intraclasts, soft due to weathering, micritic-cement, fine-crystalline, thin- to medium-bedded.	1

	Covered, probably sandy shale.	34
1c	Limestone; reddish-brown weathering reddish, thin-bedded, clay intraclasts, micritic-cement, sandy (2 to 4Ø), fine-crystalline.	0.5
b	Shale; gray, sandy (3 to 4Ø), unfossiliferous, soft, thinly-laminated.	3
	Strike N. 33° W., dip 44° NE.	
a	Limestone; reddish-brown weathering reddish-tan, thin-bedded, soft due to extreme weathering, clay intraclasts, micritic-cement, fine-crystalline?, fusulinids common but poorly preserved.	0.5

Section 9



?
Unit 1
h
64'
FEET
20
10
0
f
e
d
c
b
Unit 1
a
g
10'
CAMP GROUND MEMBER
CAMP GROUND MEMBER
Section badly covered
?

MEASURED SECTION 9

Location. Center west line NW$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 21, T. 5 S., R. 2 E., Carter County, Oklahoma. Section 9 may be reached by traveling 3.1 miles north on State Scenic 77 from its junction with paved road leading to Lake Murray Lodge. Turn southeast (right) on poorly kept paved road, keep left at fork (0.08 mile), continue past picnic and camp area (0.22 mile), take right fork (0.38 mile), at extreme south-east end of circle turn right (0.46 mile) and continue for approximately 300 yards. Total mileage after turning off Scenic 77 should be about 0.54 mile. Section 9 is presented beginning at the top.

Unit		Thickness in feet
1	Camp Ground Member	
	Strike N. 34° W., dip 40° NE.	
h	Sandstone; yellow-tan weathering tan-white, medium- to thick-bedded, friable, calcareous-cemented, medium-grained (1 to 2Ø).	7
	Covered.	64
	Mostly covered but road and glades show yellow-red at base to yellow-tan at top, sandy, shale with thinly-bedded lenses of sandstone.	51
g	Sandstone; yellow-brown weathering yellow-tan, medium-bedded, friable, limonitic-cemented, fine-grained (2 to 3Ø). Rare fusulinids.	4
	Covered.	10

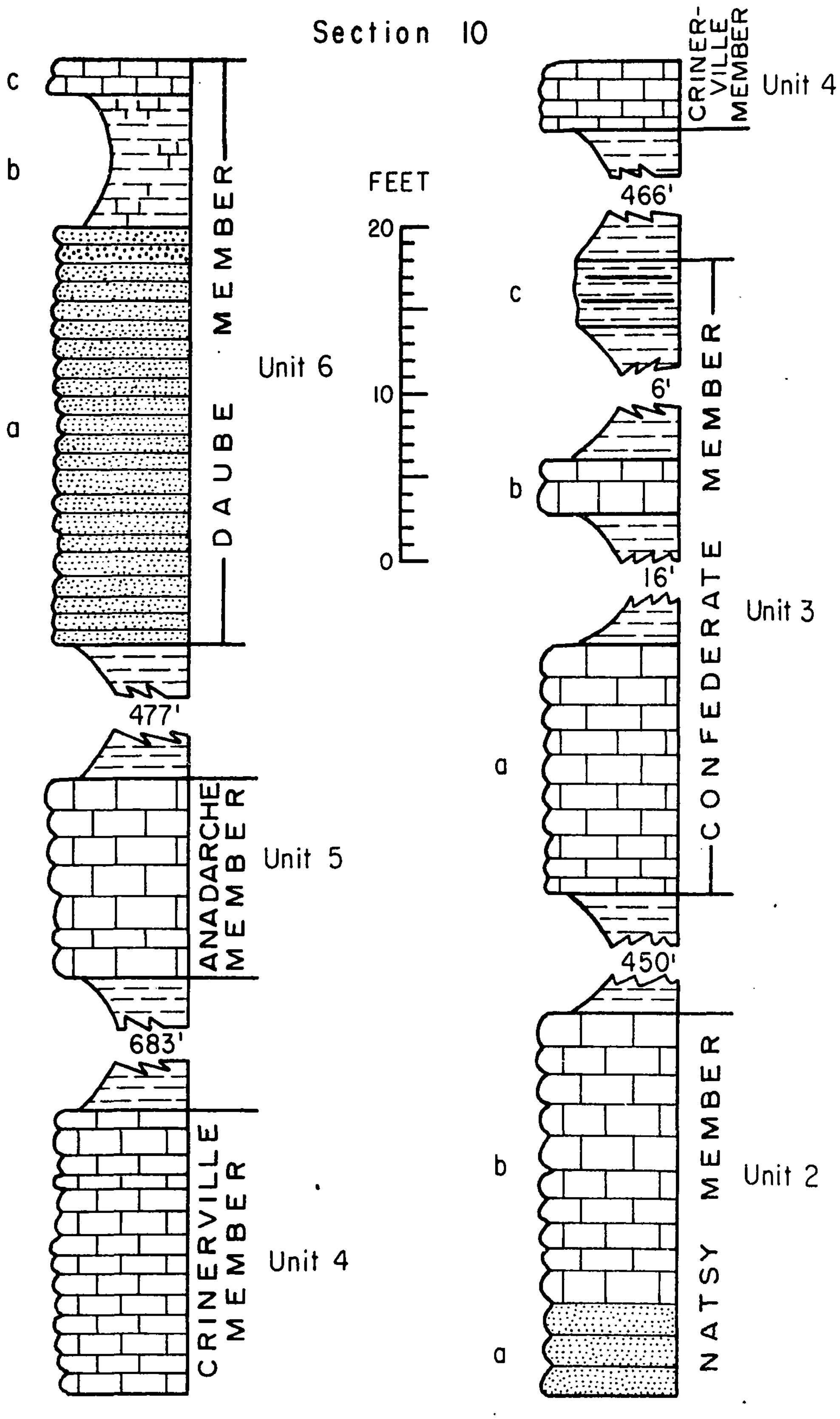
	Shale; yellow-tan, sandy, with very thin-bedded sandstone stringers.	10
f	Sandstone; yellow-tan weathering yellow-brown, medium-bedded to thick-bedded, clayey, subangular, fairly well sorted, medium-grained (1 to 2Ø).	15
e	Shale; thinly-laminated, yellow-tan, soft, becoming sandy at base, calcareous.	5
d	Limestone; yellow-brown weathering reddish-tan, thin-bedded, very badly weathered, sandy (1 to 2Ø), hard to punky, where fresh apparently sparry calcite-cemented, coarse-crystalline. Rare fusulinids.	1
c	Shale; yellow-brown, thinly-laminated, very sandy (2 to 3Ø). Contains in lower 1 foot a chonetid, crinoid stem, fusulinid zone.	3
b	Limestone; brown-gray weathering red-brown, thin-bedded, hard to punky, very deeply weathered, sandy (2 to 3Ø), sparry calcite-cemented, medium- to coarse-crystalline.	2
a	Shale; yellow-tan, sandy, becoming more calcareous toward bottom, 2 fragmental shell zones in upper 20 feet. <u>Wewokella</u> and <u>Mesolobus</u> in upper 5 feet.	50

Covered.

MEASURED SECTION 10

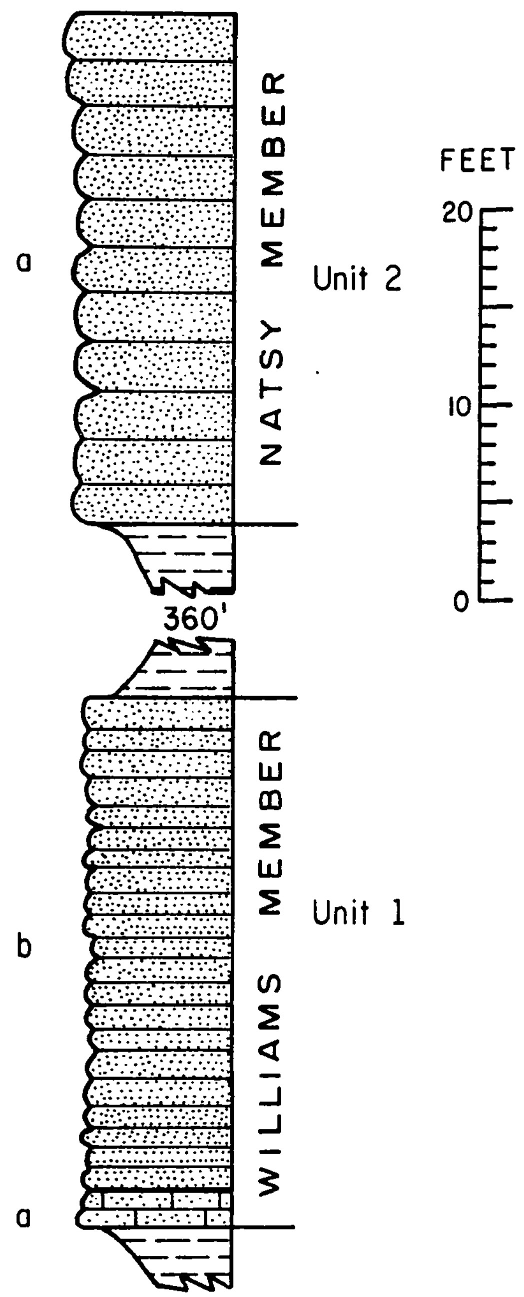
<u>Location</u>. Units 10-1 through 10-3 are located in sec. 17, T. 5 S., R. 2 E., Carter County, Oklahoma. These units may be located by traveling 3.25 miles on State Scenic 77 from the south edge of Ardmore (section line between T. 4 S., and T. 5 S.). This should position you on 10-1 with 10-2 in the road cut approximately 230 yards northeast up State Scenic 77. Unit 10-3 and 10-5 may be reached by traveling 2.65 south of Ardmore on State Scenic 77 and walking 660 yards northwest. Unit 10-3 is 210 yards to southwest in deep ravine and unit 10-5 is to the north northeast approximately 180 yards where a gully cuts through the soil cover of the pasture and exposes the limestone. Unit 10-4 (NW$\frac{1}{4}$ NE$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 6, T. 5 S., R. 2 E., Carter County, Oklahoma) may be located by traveling to the northwest corner of Rose Hill Cemetery at the south end of C Street SE at southern edge of Ardmore. Unit is exposed north up railroad track approximately 320 yards. Unit 10-6 may be located by traveling approximately 2.1 miles south on State Scenic 77 from south edge of Ardmore. Turn to southeast (left) and continue on asphalt road for 1.45 miles. Just before you crest hill, take small road south (right) over conglomerate ridge and continue to south and southwest for 0.5 mile. Unit 10-6 is located in SW$\frac{1}{4}$ SE$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 16, T. 5 S., R. 2 E. All units crop out in Carter County, Oklahoma. Section 10 is presented beginning at the top.

Section 10


c
b
a
DAUBE MEMBER
Unit 6
477'
ANADARCHE MEMBER
Unit 5
683'
CRINERVILLE MEMBER
Unit 4
FEET
20
10
0
CRINER-VILLE MEMBER
Unit 4
466'
c
6'
b
16'
CONFEDERATE MEMBER
Unit 3
a
450'
b
NATSY MEMBER
Unit 2
a

Unit		Thickness in feet
6	<u>Daube Member</u>	
	Strike N. 33° W., dip 25° NE.	
c	Limestone; brown weathering dull brown, medium-bedded, hard, micrite-cemented, fretted with brown curves of brachiopod shell, fine-crystalline.	2
b	Shale; calcareous, many small concretionary limestone pebbles, ferruginous, abundant productid brachiopods, yellow-brown and the limestone white. This unit becomes an interbedded, thin, nodular, limestone-shale NW along strike.	8
a	Sandstone; red to chocolate-brown, conglomeratic with chert pebbles, hemetitic- and limonitic-cement, thin-bedded, indurated, fine-grained.	25
	Covered.	477
5	<u>Anadarche Member</u>	
	Strike N. 38° W., dip 33° NE.	
	Limestone; blue-gray to gray, weathering gray-white, medium-bedded, hard, micritic-cemented, some encrusting algae, poorly fossiliferous with a few fusulinids and productid brachiopods. Spicules and large <u>Echinoconchus</u> present.	12
	Strike N. 35° W., dip 63° NE.	
	Limestone; yellow-brown to yellow-gray weathering gray-yellow, thin- to medium-bedded, hard, micritic-cement, abundant fusulinids, appears to have some sparry replacement in places, fine-crystalline. To southeast in sec. 18, this unit develops 30-40 feet of lower sandstone and limestone becomes a limestone conglomerate.	21
	Covered.	446
3	<u>Confederate Member</u>	
c	Carbonaceous Shale-Coal; peculiar leaf-like layers of carbonaceous material (lignite?), coal is in	

Section 10



a
NATSY MEMBER
Unit 2
FEET
20
10
0
360'
b
WILLIAMS MEMBER
Unit 1
a

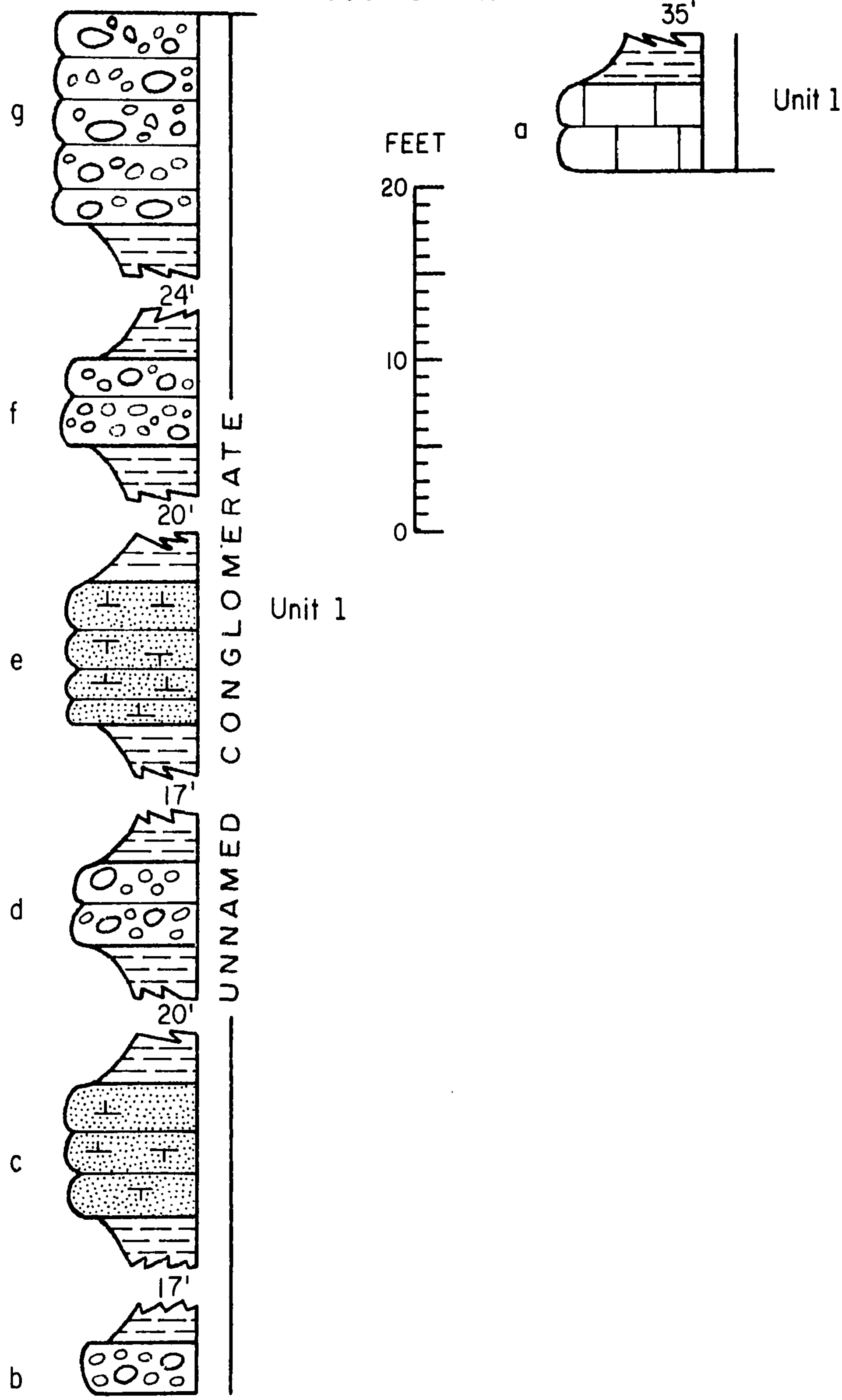
	vein-like bodies $\frac{1}{2}$ inch to feather edge associated throughout the leaf-like layers. Gray, soft, pliable clay beneath coal. X-ray analysis indicates clay is Illite-Chlorite.	4.5
	Covered.	6
	Strike N. 38° W., dip 42° NE.	
b	Limestone; fragmental, consolidated to unconsolidated, friable to hard, medium-bedded, gray-white weathering light gray, very coarse-crystalline. In places it is conglomeratic composed of limestone pebbles. NW across fault, cobbles are up to 6 inches in diameter. Thickness ranges from 2 to 4 feet.	3
	Covered.	16
a	Limestone; yellow-brown weathering brown to tan, medium-bedded, hard, micrite cemented, abundant fusulinids, fine-crystalline.	15
	Covered.	450
2	<u>Natsy Member</u>	
	Strike N. 40° W., dip 36° NE.	
b	Limestone; yellow-brown weathering tan-brown, medium-bedded, hard, micrite- or fine sparry-cement, fine- to medium-crystalline. Interbeds of gray-brown, calcareous, shale.	17
a	Sandstone; yellow-tan to off-white, weathering gray-tan, thick-bedded, indurated, ripple marked, limonite-clay cemented, fine-grained (2 to 3Ø).	32
	Covered, but is shale, gray-white with limonite concretions, and limonitic sandstones along road where exposed.	360
1	<u>Williams Member</u>	
	Strike N. 40° W., dip 42° NE.	
b	Sandstone; limonitic, yellow-brown weathering yellow-tan, indurated, thin- to medium-bedded, poorly sorted, limonite-cemented, fine-grained.	

Where thin-bedded, there is a considerable amount of sandy, limonitic shale. 25

a Limestone; medium-bedded, sandy, yellow-tan, hard abundant *Myalina* but very little other fossil material, sandy, fine-crystalline. 2

Covered.

Section II


35'
Unit 1
a
FEET
20
10
0
g
24'
f
20'
e
17'
d
20'
c
17'
b
UNNAMED CONGLOMERATE
Unit 1

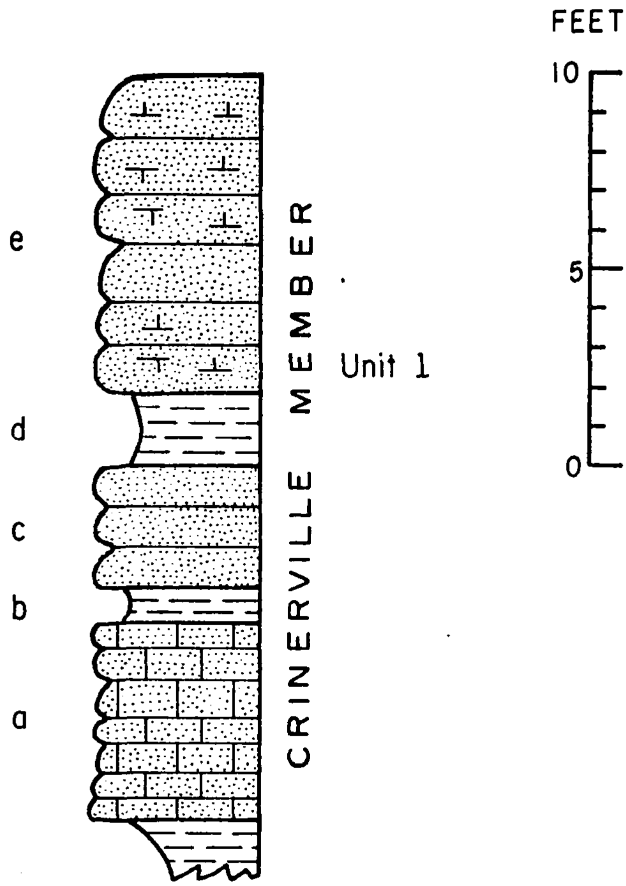
MEASURED SECTION 11

Location. West $\frac{1}{2}$ of SE$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 36, T. 5 S., R. 1 E., Carter County, Oklahoma. Section 11-1 may be reached by traveling south 6.7 miles from junction of U. S. 70 (west) and U. S. 77 in west edge of Ardmore. Turn west (right) and continue 0.8 mile. Then north at entrance to cemetery, continue to gate in fence line, continue through gate for approximately 200 yards. Lowest limestone conglomerate is exposed in small ravine approximately 100 yards to the southeast. Section is presented beginning at the top.

Unit		Thickness in feet
	Unnamed Conglomerate	
1	Strike N. 10° W., dip 55°SW.	
g	Conglomerate; zone composed of 3 or 4 thick-bedded units each 2 to 3 feet thick, pebbles and cobbles composed of limestone and chert, matrix of sandstone with calcareous-cement, hard and compact, poorly sorted, immature, grain size ranging from sand size to small cobbles. Beds separated by 1 to 2 foot covered areas.	12
	Covered.	24
f	Conglomerate; limestone and chert pebbles, grading into yellow-white weathering gray-white sandstone; fine-grained (1 to 2Ø), friable, calcareous-cement.	5
	Covered.	20

e	Sandstone; yellow-brown weathering reddish-brown, thick-bedded, friable, calcareous-cement, moderately sorted, subangular, fine-grained (2 to 3Ø).	8
	Covered.	17
d	Conglomerate; limestone and chert pebbles, grading into yellow-white weathering gray-white sandstone, fine-grained (1 to 2Ø), friable, calcareous-cement.	5
	Covered.	20
c	Sandstone; yellow-brown weathering reddish-brown, thick-bedded, friable, calcareous-cement, moderately sorted, subangular, fine-grained (2 to 3Ø).	8
	Covered.	17
b	Conglomerate; chert and limestone pebbles, some up to 2.5 inches long, chert is principally Woodford, thick-bedded, matrix is sandstone; yellow-brown, calcareous-cemented. Upper few inches sandstone.	2
	Covered.	35
a	Limestone; yellow-brown weathering yellow-tan, highly limonitic, thick-bedded, hard, micritic-cement, many badly weathered fusulinids, some very large horn corals of the amplexizaphrentid type. Upper contact obscured but appears to grade into limestone conglomerate of same color.	4.5

Section 12

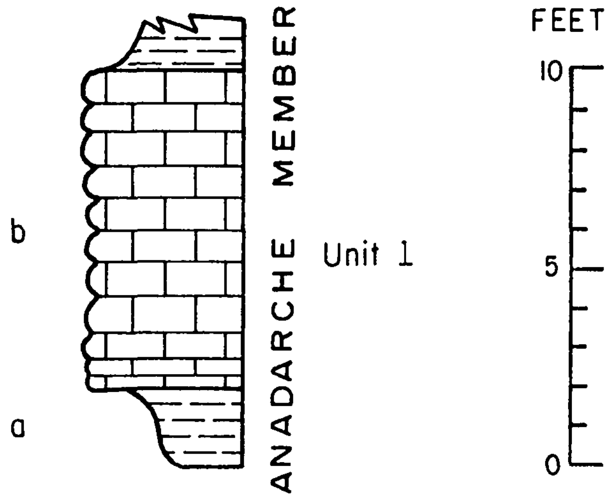


MEASURED SECTION 12

Location. SE$\frac{1}{4}$ SE$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 28, T. 5 S., R. 1 E., Carter County, Oklahoma. Section 12 may be reached by traveling 4.0 miles south on U. S. 77 from its junction with U. S. 70 (west) in west edge of Ardmore, turn west (right) and continue 2.0 miles, turn south (left) and continue 2.3 miles (2 sections, but road is crooked), turn west (right) and continue approximately 1.4 miles, road makes sharp turn north (right). Locality is in creek bottom east of house about 40 yards north of sharp bend in road. Section is presented beginning at the top.

Unit		Thickness in feet
1	Crinerville Member	
	Strike N. 32° W., dip 17° SW.	
e	Sandstone; gray-tan weathering gray-tan, thick-bedded, friable, calcareous-cement, subangular, fine-grained (2 to 3ϕ).	8
d	Shale; yellow-tan to gray-tan, sandy, thinly, laminated.	2
c	Sandstone; gray-tan weathering gray, medium- to thick-bedded, fine-grained (2 to 3ϕ).	3
b	Shale, dark gray- to gray-tan, sandy, soft, thin-ly-laminated.	1
a	Limestone; gray-tan to brown weathering gray-brown, thin-bedded, hard, sandy, ripple marked in places, shaly interbeds, micritic-cement, fine-crystalline. Abundant fusulinids.	5
	Covered; presumed to be shale.	

Section 13

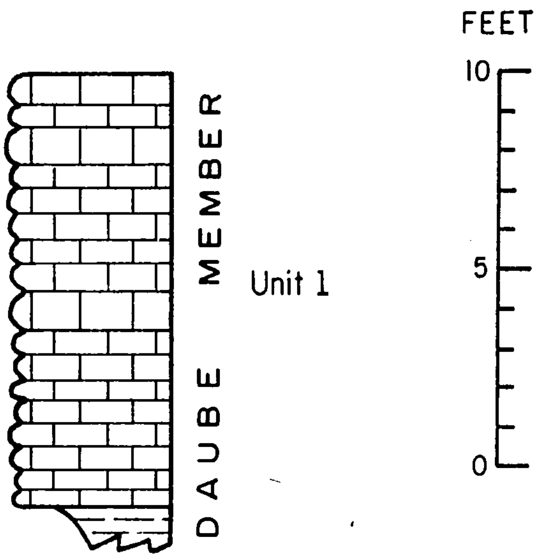


MEASURED SECTION 13

Location. $SE\frac{1}{4}$ $SW\frac{1}{4}$ $SE\frac{1}{4}$ sec. 17, T. 5 S., R. 1 E., Carter County, Oklahoma. Section 13 may be reached by traveling west on U. S. 70 for 5.0 miles from its junction with U. S. 77 on west edge of Ardmore. Turn south (left) onto dirt road and continue 4.0 miles, turn east (left) 0.7 mile and stop. Section 13 is small limestone ledge cropping out in pasture to the north. Section is presented beginning at the top.

Unit		Thickness in feet
1	Anadarche Member	
	Strike N. 40° W., dip 13° NE.	
b	Limestone; brown to gray weathering gray-brown, thin- to medium-bedded, hard, micritic-cement. Brachiopods stand out upon weathering as brown stringers. Some fusulinids. Upper contact covered.	7
a	Shale-Limestone; zone of nodular, tan-brown weathering brown, hard, micritic limestone with thin partings of calcareous, fossiliferous, shale. Shale has abundant bryozoans and common fusulines. Lower contact covered.	2

Section 14

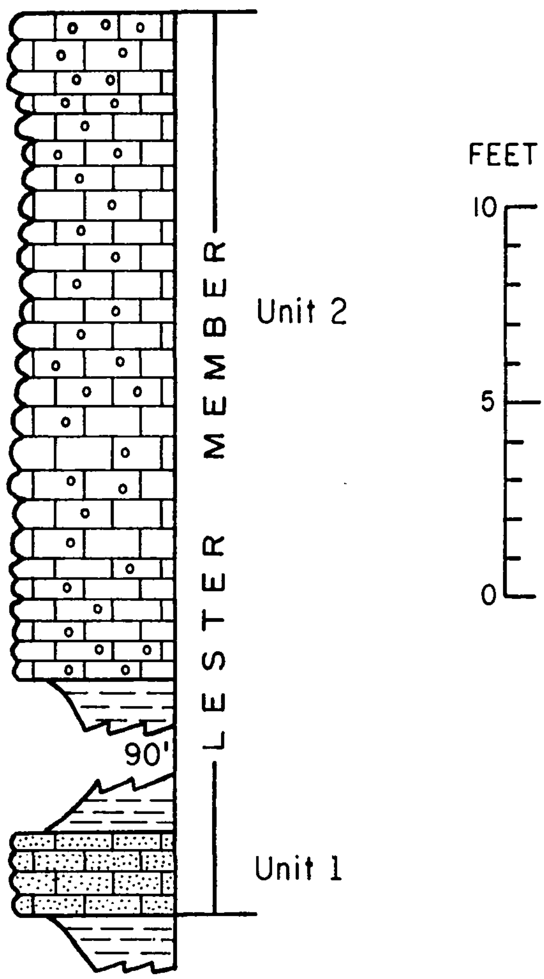


MEASURED SECTION 14

Location. Center of NW$\frac{1}{4}$ SE$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 19, T. 5 S., R. 1 E., Carter County, Oklahoma. Section 14 may be located by driving west 5.0 miles on U. S. 70 from its junction with U. S. 77 on west edge of Ardmore. Turn south (left) and continue for 4.25 miles. Last 0.25 mile is over an abandoned section line road. Unit crops out approximately 300 yards west of road. Section 14 is presented beginning at the top.

Unit		Thickness in feet
1	Daube Member	
	Strike N. 6° W., dip 18° SW.	
1	Limestone; brown-gray to tan weathering gray-white to tan, thin- to medium-bedded, hard, micritic-cement, fretted with brown curves of etched brachiopod shells, fine-crystalline. Profuse fusulinid fauna. Interbeds of shale, and thin nodular limestone, interbeds are thin- to thick-parted and covered badly with rubble.	11
	Covered.	

Section 15

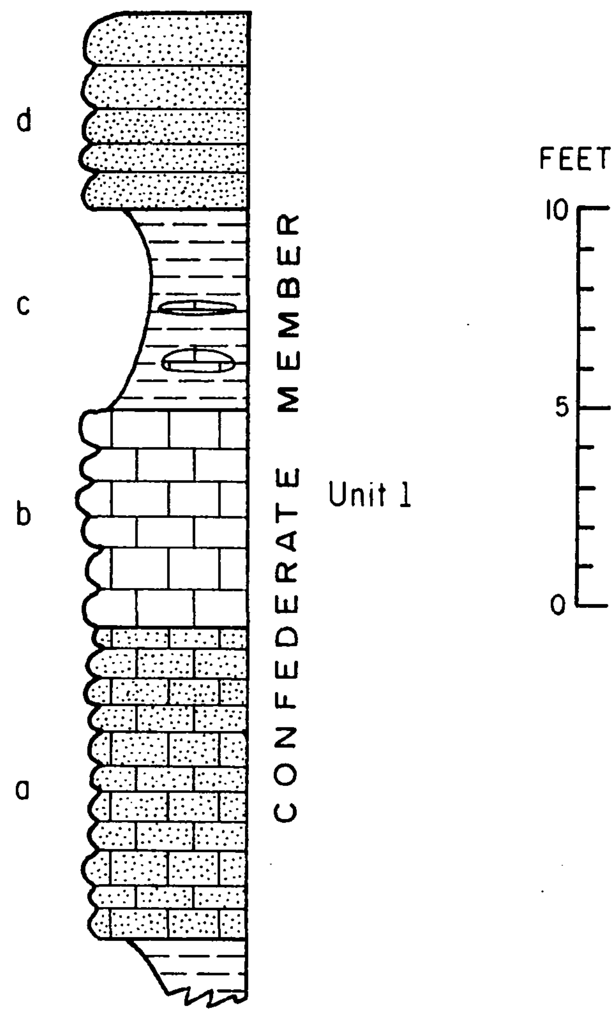


MEASURED SECTION 15

<u>Location</u>. NE$\frac{1}{4}$ NE$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 13, T. 4S., R. 1 E., Carter County, Oklahoma. Section 15 may be located by driving north 2.9 miles on U. S. 77 from its junction with U. S. 70 (west) on west edge of Ardmore. Section is presented beginning at the top.

Unit		Thickness in feet
2-1	<u>Lester Member</u> (<u>Type</u>)	
	Strike N. 70° W., dip 60° SW.	
2	Limestone; gray-tan to yellow-tan weathering gray-white, thin- to medium-bedded, hard, sparry calcite-cement, oolitic, coarse-crystalline. Abundant bryozoans.	17
	Covered; however, that exposed is limonitic, red-tan to gray-tan, calcareous shale.	90
	Strike N. 70° W., dip 57° SW.	
1	Limestone; gray-red to red-brown weathering red-tan, thin-bedded, hard to punky, sparry calcite cement, sandy (2 to 3%), possibly oolitic. Fusulinids abundant.	2
	Covered.	

Section 17

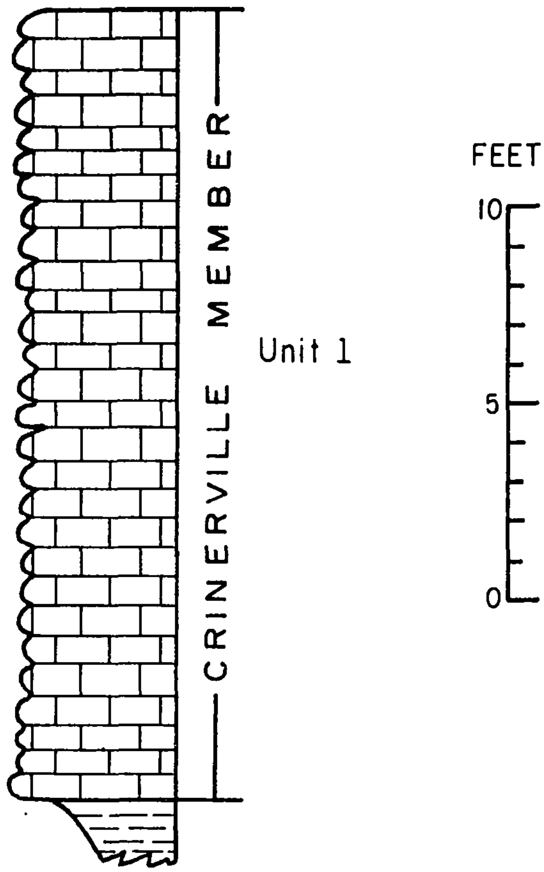


MEASURED SECTION 17

Location. Center of $E\frac{1}{2}$ $SE\frac{1}{4}$ $SW\frac{1}{4}$ sec. 14, T. 5 S., R. 1 E., Carter County, Oklahoma. Section 17 may be located by traveling 3.0 miles south on U. S. 77 from its junction with U. S. 70 (west) on west edge of Armore. Turn west (right) and continue for 1.0 mile, take diagonal road to southwest 1.1 miles (to next section line), turn south (left) and continue 0.25 mile, turn into drive and continue to house. Unit is exposed approximately 440 yards southeast of house on east side of small farm pond. Section is presented beginning at the top.

Unit		Thickness in feet
	Confederate Member	
1	Strike N. 16^{o} W., dip overturned 78^{o} NE.	
d	Sandstone; brown weathering brown-tan, conglomeratic, pebbles are composed of clay, older sandstone and limestone, contorted, cross-bedded, calcareous-cement, fine- to medium-grained (1 to 3Ø).	5
c	Shale; yellow-tan, thinly-laminated, calcareous, with several very thin-bedded limestone lenses.	5
b	Limestone; medium- to thick-bedded, brown to gray-brown, hard, pitted weathered surface, fossiliferous, sparry calcite-cemented, medium- to coarse-crystalline.	6
a	Sandstone; thin- to medium-bedded, gray-white weathering gray-white, hard, calcareous, very fine-grained (3 to 4Ø)	8
	Covered; however, approximately 50 to 60 feet below unit a, in a cow path, fusulinids were found.	

Section 18



MEASURED SECTION 18

Location. SE$\frac{1}{4}$ NW$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 14, T. 5 S., R. 1 E., Carter County, Oklahoma. Same directions as for section 17 on how to find locality. Locality is approximately 200 yards north northeast of farm house on poorly exposed ridge. Section 18 is presented beginning at the top.

Unit		Thickness in feet
	Crinerville Member	
	Strike N. 76° E., dip 13° NNW.	
1	Limestone; gray-white to tan-brown, weathering gray to gray-brown, hard, thin- to medium-bedded, sparry calcite-cemented, some beds sandy, upper brown beds tend to have finer matrix, medium- to coarse-crystalline.	20
	Covered.	

APPENDIX II

Measurements in mm of individual specimens

from samples as indicated.

FUSULINA INSOLITA Thompson   150' below "oolitic" Lester Member, Overbrook Anticline

	Radius Vector						Tectum & Diaphanotheca					
1	.091	.150	.252	.424	.636	.843	.004	.007	.010	.012	.016	.016
2	.148	.270	.430	.650	.860	.000	.004	.007	.010	.017	.000	.000
3	.165	.257	.390	.551	.740	.000	.006	.007	.010	.013	.017	.000
4	.107	.199	.319	.473	.000	.000	.005	.007	.010	.012	.016	.000
5	.119	.202	.314	.474	.000	.000	.005	.007	.009	.011	.015	.000
6	.094	.158	.263	.394	.578	.760	.004	.006	.008	.011	.012	.019
7	.130	.207	.326	.484	.694	.000	.004	.007	.009	.012	.016	.000
8	.086	.138	.197	.293	.408	.588	.004	.007	.008	.010	.014	.016
9	.127	.244	.377	.572	.808	.000	.004	.009	.010	.012	.017	.000
10	.119	.210	.351	.547	.746	.000	.004	.006	.010	.013	.014	.000
11	.105	.174	.288	.432	.638	.000	.004	.007	.009	.013	.015	.000
12	.119	.202	.393	.519	.720	.000	.000	.007	.009	.012	.015	.000
13	.100	.168	.248	.345	.512	.701	.004	.007	.010	.011	.012	.015
14	.111	.189	.301	.458	.648	.000	.005	.007	.008	.013	.015	.000
15	.120	.188	.286	.432	.637	.844	.004	.007	.008	.010	.013	.016
16	.103	.182	.280	.435	.614	.832	.005	.007	.009	.011	.015	.019
17	.118	.200	.320	.518	.773	.000	.005	.007	.010	.014	.015	.000
18	.112	.118	.297	.454	.640	.830	.000	.007	.009	.011	.014	.018
19	.089	.151	.264	.396	.600	.840	.005	.009	.009	.012	.013	.000
20	.090	.147	.250	.400	.600	.858	.004	.007	.008	.010	.013	.016
21	.078	.140	.246	.400	.608	.836	.004	.006	.009	.010	.013	.015
22	.135	.240	.406	.622	.851	.000	.005	.008	.011	.012	.014	.000
23	.126	.210	.355	.535	.801	.000	.005	.007	.009	.013	.014	.000
24	.089	.151	.264	.396	.600	.800	.004	.007	.010	.013	.017	.000
25	.118	.202	.330	.495	.720	.000	.005	.007	.010	.013	.014	.000
26	.092	.153	.249	.400	.614	.811	.005	.007	.010	.012	.013	.000
27	.100	.175	.265	.382	.556	.000	.005	.007	.010	.012	.015	.000
28	.104	.174	.240	.355	.522	.690	.005	.000	.008	.011	.013	.000
29	.100	.170	.288	.446	.676	.000	.005	.008	.009	.013	.018	.000
30	.088	.171	.317	.482	.696	.827	.005	.007	.009	.012	.016	.018
31	.094	.168	.280	.442	.665	.852	.004	.007	.009	.012	.014	.000
32	.116	.180	.312	.488	.714	.000	.005	.007	.010	.015	.017	.000

33	.130	.210	.320	.475	.672	.000	.006	.008	.010	.013	.017	.000
34	.100	.170	.269	.413	.581	.000	.005	.007	.009	.012	.013	.000
35	.114	.187	.286	.444	.618	.000	.005	.007	.010	.013	.014	.000
$\bar{x}$	.110	.186	.302	.458	.659	.794	.005	.007	.009	.012	.015	.017
s	.019	.032	.053	.076	.098	.080	.001	.001	.001	.001	.002	.002
UCL	.118	.201	.326	.493	.705	.873	.005	.007	.010	.013	.015	.018
LCL	.101	.172	.278	.423	.612	.724	.004	.007	.009	.012	.014	.015

	Spirotheca Thickness						Prol. Min.	Diam. Max.	Septal Count					
1	.010	.022	.030	.045	.044	.000	.072	.079	10	11	12	15	21	26
2	.013	.026	.030	.045	.000	.000	.133	.153	8	13	13	18	23	00
3	.015	.022	.037	.037	.040	.000	.182	.190	10	16	20	19	25	00
4	.015	.022	.037	.037	.048	.000	.097	.112	10	13	15	19	00	00
5	.020	.022	.029	.027	.032	.000	.117	.122	9	14	19	19	00	00
6	.014	.013	.021	.027	.030	.037	.091	.115	8	12	14	15	16	23
7	.015	.023	.028	.037	.037	.000	.123	.140	8	14	16	18	20	00
8	.012	.019	.020	.028	.031	.043	.078	.097	7	14	15	19	19	23
9	.019	.027	.031	.041	.042	.000	.112	.125	10	14	15	20	24	00
10	.017	.030	.037	.041	.041	.000	.123	.131	12	15	16	19	21	00
11	.013	.015	.024	.041	.043	.000	.096	.117	8	12	12	16	20	00
12	.000	.022	.037	.048	.039	.000	.109	.121	9	14	15	20	23	00
13	.013	.016	.022	.028	.032	.050	.091	.106	8	11	17	18	21	24
14	.015	.019	.028	.038	.037	.041	.101	.119	9	12	17	24	25	00
15	.017	.020	.027	.040	.037	.000	.112	.131	11	13	17	18	21	24
								$\bar{x}$	9	13	16	18	21	24
								s	001	001	002	002	003	001
								UCL	10	14	17	20	24	27
								LCL	8	12	14	17	19	21
16	.015	.023	.034	.035	.037	.040	.100	.100						
17	.018	.025	.036	.034	.055	.000	.142	.160						
18	.000	.021	.024	.035	.035	.037	.102	.123						
19	.017	.025	.037	.037	.037	.000	.111	.118						
20	.012	.022	.026	.034	.037	.044	.116	.128						
21	.011	.018	.021	.030	.044	.037	.096	.100						
22	.019	.029	.040	.032	.052	.000	.154	.156						

23	.012	.019	.028	.040	.034	.000	.148	.156
24	.016	.024	.030	.037	.044	.000	.112	.120
25	.013	.022	.029	.039	.037	.000	.144	.160
26	.015	.021	.032	.055	.060	.000	.110	.120
27	.020	.021	.031	.037	.044	.000	.098	.107
28	.017	.022	.027	.044	.037	.000	.100	.120
29	.016	.028	.035	.037	.052	.000	.114	.114
30	.015	.021	.037	.041	.041	.054	.108	.108
31	.014	.025	.035	.044	.040	.000	.106	.134
32	.015	.028	.037	.042	.050	.000	.086	.104
33	.017	.022	.028	.037	.037	.000	.122	.127
34	.012	.019	.028	.034	.037	.000	.106	.118
35	.016	.026	.034	.035	.037	.000	.096	.100
$\bar{x}$	.015	.022	.030	.037	.041	.043	.112	.124
s	.004	.004	.005	.006	.007	.006	.022	.022
UCL	.016	.042	.033	.040	.044	.050	.122	.134
LCL	.014	.020	.028	.035	.037	.035	.101	.114

Half Length

16	.138	.290	.548	.876	1.340	1.680
17	.161	.293	.573	.940	1.600	.000
18	.142	.277	.464	.808	1.220	1.780
19	.119	.286	.502	.857	1.220	1.790
20	.129	.254	.798	1.100	1.320	1.900
21	.122	.274	.506	.795	1.220	1.690
22	.184	.400	.773	1.060	1.680	.000
23	.180	.371	.570	.982	1.430	.000
24	.145	.303	.509	.753	1.030	1.490
25	.135	.290	.525	.900	1.370	.000
26	.122	.274	.506	.911	1.230	1.600
27	.128	.283	.470	.696	1.020	1.650

Tunnel Width

16	.066	.112	.172	.370	.000
17	.070	.134	.167	.268	.000
18	.065	.104	.145	.240	.430
19	.056	.108	.149	.198	.280
20	.048	.080	.140	.220	.320
21	.056	.093	.172	.267	.336
22	.068	.104	.208	.320	.000
23	.062	.080	.160	.180	.000
24	.060	.098	.160	.264	.360
25	.050	.094	.140	.240	.000
26	.051	.102	.120	.216	.292
27	.046	.070	.116	.160	.280
28	.056	.096	.062	.222	.320
29	.066	.094	.195	.290	.000
30	.048	.094	.184	.266	.320
31	.070	.104	.160	.258	.424
32	.058	.118	.200	.260	.436
33	.064	.094	.112	.182	.320
34	.062	.110	.138	.264	.410
35	.062	.100	.144	.230	.000
$\bar{x}$	.059	.099	.152	.246	.348
s	.008	.014	.034	.049	.058
UCL	.064	.109	.174	.278	.399
LCL	.054	.090	.130	.214	.297

Chomata Height

.040	.052	.080	.092	.000
.043	.066	.093	.118	.000
.037	.056	.074	.096	.096
.034	.064	.080	.104	.096
.028	.048	.056	.088	.096
.024	.056	.070	.067	.072
.044	.072	.088	.104	.000
.038	.064	.080	.120	.000
.036	.064	.080	.108	.120
.035	.048	.080	.104	.000
.038	.058	.072	.118	.136
.044	.048	.064	.116	.096

28	.171	.348	.522	.779	1.100	1.580
29	.184	.347	.541	.866	1.310	.000
30	.129	.291	.569	.933	1.250	.000
31	.138	.322	.621	.853	1.370	.000
32	.122	.296	.564	.966	1.350	.000
33	.193	.367	.580	.940	1.350	.000
34	.129	.302	.506	.921	1.370	1.810
35	.164	.348	.586	.827	1.320	.000
$\bar{x}$	.147	.311	.562	.888	1.305	1.730
s	.024	.039	.087	.112	.161	.124
UCL	.163	.337	.618	.961	1.411	1.887
LCL	.131	.285	.505	.815	1.200	1.572

.044	.040	.078	.098	.112
.035	.062	.080	.124	.000
.035	.052	.074	.112	.116
.029	.057	.072	.096	.110
.030	.062	.072	.102	.000
.048	.069	.088	.112	.000
.038	.048	.064	.088	.096
.042	.048	.080	.092	.116
.037	.057	.076	.103	.105
.006	.009	.009	.014	.017
.041	.062	.082	.112	.121
.033	.051	.070	.094	.090

__*Fusulina*__ cf. __*F. novamexicana*__ Needham   Pumpkin Creek Member

__Radius Vector__

1	.129	.203	.315	.473	.676	.000
2	.196	.286	.393	.547	.750	.976
3	.148	.209	.316	.448	.621	.844
4	.161	.264	.422	.628	.000	.000
5	.200	.296	.425	.621	.824	.000
6	.145	.235	.341	.506	.721	.966
7	.110	.180	.287	.425	.611	.000
8	.123	.257	.386	.564	.000	.000
9	.180	.268	.393	.528	.725	.914
10	.158	.254	.374	.570	.799	1.030
11	.200	.303	.457	.663	.000	.000
12	.142	.219	.345	.512	.744	.000
13	.138	.222	.345	.493	.699	.940
14	.145	.219	.338	.493	.686	.966
15	.161	.242	.357	.483	.679	.000
16	.219	.306	.451	.618	.873	.000
48	.190	.296	.448	.644	.917	.000
17	.126	.219	.312	.460	.638	.866
18	.128	.193	.302	.448	.644	.866

__Tectum & Diaphanotheca__

.006	.008	.009	.011	.016	.000
.007	.008	.010	.012	.015	.016
.005	.008	.010	.010	.013	.017
.006	.008	.009	.011	.000	.000
.006	.009	.011	.011	.012	.017
.006	.007	.009	.012	.014	.000
.007	.009	.010	.011	.013	.000
.006	.008	.010	.011	.000	.000
.006	.008	.011	.012	.015	.017
.006	.009	.010	.011	.013	.015
.006	.009	.011	.011	.000	.000
.005	.007	.010	.011	.014	.000
.006	.008	.009	.010	.012	.016
.006	.009	.010	.012	.013	.014
.006	.009	.010	.013	.015	.000
.006	.009	.011	.012	.016	.000
.006	.009	.011	.012	.015	.000
.006	.007	.009	.012	.014	.016
.006	.009	.011	.014	.013	.014

19	.135	.248	.380	.583	.811	1.110	.006	.008	.010	.012	.014	.016
20	.138	.235	.415	.612	.000	.000	.006	.009	.010	.012	.000	.000
21	.154	.232	.342	.496	.689	.905	.007	.008	.011	.012	.014	.016
22	.119	.196	.312	.476	.683	.886	.007	.009	.011	.013	.013	.014
23	.151	.251	.341	.570	.824	1.050	.006	.008	.010	.012	.014	.017
24	.135	.229	.367	.531	.750	.000	.006	.008	.010	.013	.015	.000
25	.113	.184	.293	.470	.676	.000	.007	.009	.011	.012	.014	.000
26	.144	.225	.322	.493	.708	.000	.007	.009	.011	.014	.016	.000
27	.173	.270	.380	.524	.750	1.000	.007	.009	.011	.015	.015	.017
28	.173	.280	.406	.576	.805	.000	.006	.008	.010	.013	.016	.000
29	.129	.193	.296	.444	.602	.834	.007	.010	.011	.013	.015	.018
30	.135	.216	.342	.512	.737	1.010	.006	.008	.099	.011	.013	.014
31	.129	.225	.322	.483	.692	.000	.007	.009	.011	.013	.017	.016
32	.113	.217	.309	.486	.699	.000	.006	.009	.011	.013	.016	.000
33	.132	.219	.322	.489	.673	.927	.007	.010	.013	.015	.019	.019
34	.145	.206	.322	.473	.673	.908	.006	.009	.011	.014	.017	.020
35	.129	.193	.293	.406	.567	.766	.007	.008	.010	.013	.016	.019
36	.145	.242	.380	.547	.776	1.000	.007	.009	.010	.013	.015	.017
37	.145	.225	.338	.509	.702	.937	.007	.010	.011	.012	.014	.016
38	.148	.254	.377	.538	.718	.966	.006	.009	.012	.014	.014	.016
39	.151	.242	.348	.489	.696	.024	.007	.008	.010	.011	.014	.015
40	.161	.245	.357	.515	.699	.887	.007	.010	.010	.013	.015	.000
41	.158	.264	.393	.560	.800	.000	.006	.009	.012	.013	.016	.000
42	.146	.238	.341	.483	.667	.000	.007	.009	.010	.013	.016	.000
43	.129	.193	.312	.473	.670	.000	.006	.009	.012	.015	.015	.000
44	.129	.209	.332	.506	.721	.000	.006	.009	.010	.012	.015	.000
45	.129	.232	.361	.525	.718	.000	.006	.009	.012	.012	.015	.000
46	.135	.216	.357	.522	.725	.000	.007	.009	.012	.013	.014	.000
47	.132	.216	.348	.506	.697	.911	.007	.009	.011	.014	.016	.000
$\bar{\bar{x}}$	.147	.234	.354	.519	.717	.936	.006	.009	.011	.012	.015	.016
s	.024	.033	.043	.058	.070	.075	.001	.001	.001	.001	.001	.002
UCL	.156	.247	.371	.542	.745	.983	.007	.009	.011	.013	.015	.017
LCL	.137	.221	.337	.497	.717	.893	.006	.008	.010	.012	.014	.015

	Half Length						Tunnel Width					
17	.219	.393	.605	.828	1.180	1.580	.060	.080	.105	.148	.194	.374
18	.158	.319	.541	.766	1.010	1.430	.053	.067	.092	.164	.215	.348
19	.248	.441	.686	.966	1.550	1.980	.060	.080	.112	.178	.310	.000
20	.219	.434	.795	1.320	.000	.000	.069	.104	.200	.272	.000	.000
21	.235	.374	.605	.896	1.150	1.690	.052	.072	.152	.172	.344	.000
22	.151	.290	.586	.924	1.260	1.780	.052	.064	.112	.212	.336	.000
23	.206	.367	.602	1.010	1.520	2.090	.062	.097	.180	.220	.444	.000
24	.248	.418	.644	1.040	1.430	.000	.058	.096	.136	.174	.280	.000
25	.155	.287	.473	.750	1.260	.000	.060	.080	.131	.211	.000	.000
26	.177	.386	.654	.998	1.370	.000	.062	.106	.160	.201	.270	.000
27	.241	.438	.641	.940	1.260	1.690	.064	.080	.111	.160	.252	.000
28	.219	.386	.596	.850	1.210	.000	.069	[illegible]	.140	.254	.360	.000
29	.167	.251	.421	.650	.966	1.560	.050	[illegible]	.128	.252	.290	.400
30	.184	.309	.554	.940	1.280	1.830	.062	.080	.142	.160	.320	.440
31	.209	.361	.538	.898	1.420	1.910	.056	.115	.160	.240	.300	.000
32	.145	.299	.573	.966	1.550	.000	.059	.096	.160	.268	.000	.000
33	.187	.345	.573	.886	1.210	1.590	.058	.080	.128	.194	.266	.000
34	.203	.364	.538	.892	1.280	1.930	.052	.080	.096	.160	.284	.348
35	.193	.351	.531	.757	1.130	1.590	.056	.080	.115	.187	.198	.300
36	.225	.380	.596	.889	1.250	1.900	.072	.118	.160	.170	.320	.000
37	.193	.348	.544	.733	1.090	1.670	.061	.080	.105	.172	.320	.000
38	.193	.367	.544	.802	1.103	1.650	.054	.100	.110	.198	.266	.000
39	.203	.345	.535	.753	1.110	1.640	.060	.080	.108	.170	.264	.000
40	.238	.393	.631	.895	1.230	1.680	.062	.080	.136	.240	.280	.000
41	.218	.396	.676	.979	1.550	.000	.068	.098	.148	.216	.000	.000
42	.184	.364	.605	.808	1.250	.000	.061	.098	.160	.220	.348	.000
43	.167	.296	.544	.950	1.450	.000	.058	.096	.240	.320	.000	.000
44	.174	.345	.528	.782	1.170	.000	.072	.080	.142	.223	.000	.000
45	.167	.322	.518	.805	1.160	1.660	.072	.114	.141	.188	.276	.000
46	.219	.419	.670	1.040	1.530	.000	.063	.099	.160	.254	.000	.000
47	.193	.361	.596	.834	1.200	1.710	.066	.089	.139	.240	.299	.000
$\bar{x}$	.198	.360	.585	.889	1.272	1.728	.061	.089	.139	.207	.293	.368
s	.029	.047	.071	.123	.163	.164	.006	.015	.032	.041	.054	.048
UCL	.212	.383	.620	.950	1.353	1.829	.064	.096	.155	.228	.325	.455
LCL	.184	.336	.551	.828	1.191	1.627	.057	.082	.123	.187	.261	.281

Chomata Height

17	.050	.091	.091	.122	.149	.144
18	.046	.085	.100	.136	.108	.104
19	.060	.124	.131	.140	.126	.000
20	.062	.106	.102	.115	.000	.000
21	.052	.062	.092	.109	.100	.000
22	.048	.080	.108	.096	.112	.000
23	.060	.104	.144	.144	.136	.000
24	.068	.092	.088	.088	.152	.000
25	.036	.064	.-97	.116	.000	.000
26	.068	.068	.092	.092	.106	.000
27	.052	.068	.080	.094	.112	.000
28	.064	.092	.112	.128	.096	.000
29	.042	.067	.091	.096	.130	.069
30	.046	.060	.114	.100	.140	.115
31	.040	.070	.098	.106	.000	.000
32	.044	.072	.098	.120	.104	.000
33	.051	.070	.102	.098	.136	.000
34	.044	.066	.098	.120	.152	.146
35	.039	.055	.068	.072	.100	.100
36	.056	.080	.092	.160	.108	.000
37	.059	.072	.080	.114	.128	.000
38	.050	.062	.074	.098	.108	.000
39	.056	.056	.090	.106	.112	.000
40	.048	.076	.102	.088	.112	.000
41	.051	.072	.093	.112	.000	.000
42	.053	.066	.088	.099	.102	.000
43	.040	.061	.095	.092	.000	.000
44	.048	.064	.080	.105	.110	.000
45	.054	.072	.108	.160	.128	.000
46	.054	.090	.080	.110	.000	.000
47	.045	.066	.086	.100	.120	.000
$\bar{x}$	.051	.075	.096	.111	.119	.113
s	.008	.016	.016	.021	.017	.029
UCL	.055	.083	.104	.121	.129	.148
LCL	.047	.067	.088	.101	.110	.077

Septal Count

1	11	17	21	20	22	00
2	14	20	21	27	32	34
3	13	16	20	25	29	31
4	9	15	20	21	00	00
5	11	17	22	28	21	00
6	10	15	17	23	23	00
7	9	15	19	23	29	31
8	10	17	20	24	00	00
9	12	18	25	20	29	39
10	12	18	21	25	27	30
11	10	19	23	23	00	00
12	11	15	19	21	24	00
13	10	17	22	25	29	31
14	11	20	23	27	29	32
15	11	20	22	28	31	00
16	13	18	24	31	34	00
48	9	17	21	21	25	00
$\bar{x}$	11	17	21	24	27	33
s	.001	.002	.002	.003	.004	.003
UCL	12	18	23	26	30	36
LCL	10	16	20	22	24	29

Proloculus Diameter

	Min.	Max.		Min.	Max.		Min.	Max.
1	.133	.147	14	.130	.153	27	.141	.166
2	.213	.229	15	.155	.190	28	.154	.177
3	.131	.154	16	.197	.209	29	.151	.154
4	.155	.172	48	.195	.208	30	.155	.182
5	.187	.205	17	.149	.169	31	.155	.182
6	.126	.134	18	.114	.122	32	.138	.145
7	.091	.105	19	.146	.168	33	.154	.164
8	.148	.156	20	.155	.164	34	.160	.171
9	.141	.170	21	.196	.198	35	.138	.160
10	.160	.180	22	.142	.150	36	.166	.170
11	.187	.208	23	.172	.206	37	.151	.168
12	.132	.139	24	.143	.160	38	.148	.178
13	.124	.135	25	.132	.146	39	.170	.179

26	.169	.171	45	.149	.160
40	.146	.146	46	.166	.174
41	.172	.178	47	.162	.173
42	.145	.160	$\bar{x}$	.154	.168
43	.162	.167	s	.023	.024
44	.150	.152	UCL	163	177
			LCL	145	158

FUSULINA EURYTEINES Thompson Devils Kitchen Member

	Radius Vector						Tectum & Diaphanotheca					
1	.145	.242	.393	.602	.847	1.110	.006	.008	.009	.012	.010	.015
2	.155	.251	.393	.583	.805	1.000	.006	.007	.010	.012	.013	.016
3	.180	.299	.415	.576	.818	1.110	.007	.010	.010	.011	.015	.016
4	.171	.270	.444	.692	.950	.000	.006	.009	.009	.013	.017	.000
5	.203	.325	.473	.673	.873	1.120	.007	.009	.009	.012	.013	.015
6	.155	.264	.409	.605	.831	.000	.006	.008	.010	.012	.016	.000
7	.200	.335	.509	.683	.914	1.180	.006	.007	.009	.012	.013	.016
8	.219	.303	.457	.644	.847	.000	.006	.008	.010	.013	.014	.018
9	.174	.280	.467	.673	.940	1.190	.006	.008	.009	.011	.013	.015
10	.171	.277	.454	.663	.000	.000	.006	.009	.012	.012	.000	.000
11	.158	.270	.451	.615	.902	.000	.006	.008	.010	.012	.013	.000
12	.177	.267	.405	.586	.805	.000	.006	.009	.011	.012	.013	.000
13	.171	.306	.480	.702	.966	1.230	.007	.010	.010	.012	.016	.017
14	.171	.254	.393	.560	.773	.000	.006	.008	.010	.012	.015	.000
15	.196	.325	.511	.728	.943	.000	.007	.008	.010	.011	.013	.000
16	.171	.325	.483	.689	.921	.000	.006	.009	.011	.013	.017	.000
17	.222	.345	.464	.625	.815	1.020	.006	.008	.010	.012	.015	.017
18	.177	.283	.428	.612	.815	1.060	.006	.008	.010	.012	.015	.015
19	.148	.248	.406	.605	.805	1.050	.006	.008	.011	.013	.013	.013
20	.177	.264	.390	.567	.808	1.050	.006	.008	.011	.014	.013	.018
21	.151	.270	.431	.644	.921	.000	.006	.009	.010	.012	.013	.000
22	.135	.232	.377	.551	.801	1.050	.006	.009	.012	.013	.014	.014
23	.138	.245	.386	.554	.766	1.050	.006	.008	.010	.011	.014	.017
24	.177	.274	.425	.596	.799	.000	.006	.009	.012	.014	.015	.000
25	.126	.209	.354	.493	.656	.895	.006	.008	.010	.012	.014	.014
26	.183	.283	.399	.554	.757	.966	.006	.008	.012	.013	.013	.017

27	.151	.280	.454	.647	.876	1.130	.007	.009	.011	.013	.015	.017
28	.157	.283	.464	.689	.908	.000	.007	.009	.010	.013	.016	.000
29	.164	.270	.406	.573	.799	1.100	.007	.009	.011	.013	.015	.016
30	.187	.293	.441	.676	.892	.000	.007	.009	.011	.014	.014	.017
31	.180	.293	.444	.663	.901	.000	.008	.009	.012	.013	.015	.000
32	.142	.242	.403	.589	.849	1.110	.008	.009	.012	.012	.016	.018
33	.171	.270	.419	.628	.886	.000	.006	.009	.011	.012	.016	.019
34	.167	.278	.396	.570	.801	1.080	.007	.009	.012	.013	.015	.019
35	.129	.242	.396	.634	.876	1.130	.006	.009	.010	.013	.016	.020
36	.132	.222	.345	.535	.740	.976	.007	.009	.013	.013	.014	.016
$\bar{x}$	.168	.276	.427	.619	.846	1.077	.006	.009	.011	.012	.014	.016
s	.023	.031	.040	.055	.069	.079	.001	.001	.001	.001	.001	.002
UCL	.178	.290	.445	.644	.877	1.124	.007	.009	.011	.013	.015	.017
LCL	.157	.261	.409	.594	.814	1.029	.006	.008	.010	.012	.014	.015

Half Length — Tunnel Width

	Half Length						Tunnel Width				
17	.283	.477	.747	1.080	1.670	2.350	.080	.148	.208	.285	.480
18	.277	.483	.815	1.180	1.680	2.300	.080	.108	.160	.234	.358
19	.264	.444	.631	.972	1.540	2.310	.076	.109	.166	.278	.426
20	.248	.434	.702	.982	1.410	2.100	.092	.119	.240	.297	.406
21	.261	.534	.885	1.260	1.840	.000	.080	.148	.186	.260	.000
22	.232	.474	.718	1.070	1.560	2.090	.070	.104	.188	.240	.352
23	.238	.470	.815	1.110	1.720	2.350	.076	.112	.192	.280	.376
24	.264	.547	.834	1.290	1.700	.000	.080	.130	.189	.288	.000
25	.235	.448	.696	1.070	1.680	2.390	.061	.094	.180	.254	.380
26	.290	.518	.776	1.130	1.540	2.330	.091	.160	.208	.330	.400
27	.274	.441	.750	1.380	1.770	2.620	.091	.114	.160	.320	.424
28	.254	.502	.840	1.290	1.930	.000	.120	.171	.266	.480	.000
29	.277	.506	.741	1.110	1.550	2.160	.080	.128	.188	.256	.418
30	.270	.541	.895	1.410	2.030	.000	.084	.116	.176	.416	.000
31	.290	.580	.873	1.220	1.790	.000	.086	.112	.176	.240	.360
32	.248	.464	.802	1.270	1.800	2.290	.068	.112	.190	.309	.416
33	.277	.502	.831	1.310	1.930	.000	.072	.128	.196	.280	.388
34	.248	.406	.592	.886	1.310	1.950	.062	.112	.188	.240	.448
35	.180	.348	.712	1.160	1.730	2.330	.080	.112	.153	.288	.420
36	.232	.393	.596	.824	1.320	1.930	.080	.108	.150	.196	.320
$\bar{x}$	.257	.476	.763	1.150	1.675	2.250	.080	.122	.188	.289	.398

s	.026	.057	.090	.158	.195	.185
UCL	.273	.310	.818	1.247	1.795	2.388
LCL	.241	.411	.707	1.053	1.555	2.112

.013	.020	.028	.064	.040
.088	.135	.205	.328	.426
.073	.110	.171	.249	.370

Septal Count

1	10	17	21	24	30	28
2	9	13	17	21	24	27
3	11	17	23	27	34	35
4	10	17	20	23	27	29
5	11	19	25	31	34	36
6	11	16	18	22	25	30
7	14	24	25	32	35	00
8	10	19	26	28	32	00
9	11	20	19	26	30	32
10	11	17	19	25	00	00
11	12	17	24	31	36	00
12	12	19	24	25	28	00
13	11	21	26	32	34	37
14	12	16	22	22	26	00
15	10	17	24	25	28	00
16	11	16	19	24	27	OC
x̄	11	18	22	26	30	32
s	001	003	003	004	004	004
UCL	12	20	24	29	33	36
LCL	10	16	20	24	27	28

Chomata Height

17	.080	.086	.080	.107	.102
18	.060	.094	.114	.099	.116
19	.060	.071	.090	.100	.094
20	.060	.080	.116	.120	.124
21	.061	.096	.112	.116	.000
22	.064	.069	.100	.124	.100
23	.058	.080	.080	.096	.096
24	.059	.067	.098	.094	.062
25	.058	.073	.086	.110	.120
26	.059	.048	.089	.080	.110
27	.056	.090	.112	.108	.000
28	.066	.100	.106	.100	.000
29	.056	.080	.084	.104	.104
30	.054	.070	.094	.128	.000
31	.064	.098	.132	.120	.112
32	.064	.092	.106	.140	.142
33	.061	.080	.112	.104	.120
34	.048	.064	.096	.128	.104
35	.046	.104	.116	.112	.128
36	.050	.080	.116	.120	.128
x̄	.059	.081	.102	.111	.110
s	.007	.014	.014	.014	.018
UCL	.063	.090	.111	.119	.123
LCL	.055	.072	.093	.102	.097

Prol. Diam.

	min.	max.		min.	max.		min.	max.
1	.160	.169	8	.195	.221	15	.183	.201
2	.122	.149	9	.151	.174	16	.149	.181
3	.172	.199	10	.169	.174	17	.178	.227
4	.169	.187	11	.140	.156	18	.136	.170
5	.167	.200	12	.154	.165	19	.131	.160
6	.153	.156	13	.179	.210	20	.154	.154
7	.214	.219	14	.184	.199	21	.113	.142

	min.	max.		min.	max.		min.	max.			
22	.134	.146	27	.184	.204	33	.204	.218	x̄	.168	.186
23	.172	.174	28	.160	.174	34	.207	.230	s	.024	.025
24	.153	.196	29	.195	.200	35	.186	.210	CL.	.179	.197
25	.164	.166	30	.192	.208	36	.160	.160	CL.	.157	.175
26	.170	.196	31	.196	.196	32	.171	.180			

FUSULINELLA DAKOTENSIS Thompson Bostwick Member

	Radius Vector							Tectum & Diaphanotheca						
1	.099	.149	.216	.314	.422	.577	.742	.005	.006	.009	.010	.010	.015	.021
2	.128	.182	.259	.347	.477	.645	.828	.004	.007	.008	.009	.010	.015	.017
3	.111	.166	.230	.236	.455	.614	.784	.004	.006	.009	.011	.013	.016	.018
4	.089	.013	.188	.260	.350	.494	.650	.004	.006	.008	.010	.013	.014	.019
5	.096	.155	.234	.347	.478	.673	.878	.005	.007	.009	.010	.014	.019	.017
6	.118	.176	.246	.338	.462	.637	.845	.005	.007	.009	.011	.012	.016	.016
7	.118	.177	.247	.347	.454	.615	.811	.005	.006	.009	.011	.013	.015	.017
8	.103	.160	.247	.363	.495	.644	.844	.005	.007	.009	.012	.015	.016	.016
9	.120	.177	.254	.382	.520	.672	.878	.005	.007	.009	.010	.014	.015	.019
10	.080	.126	.186	.270	.380	.532	.708	.004	.006	.007	.011	.013	.017	.021
11	.111	.167	.240	.338	.450	.606	.798	.005	.007	.009	.010	.012	.017	.019
12	.114	.180	.246	.359	.496	.648	.840	.005	.007	.010	.012	.011	.017	.017
13	.124	.190	.272	.368	.500	.664	.877	.004	.006	.008	.013	.013	.017	.021
14	.118	.171	.250	.336	.452	.592	.768	.005	.007	.009	.009	.013	.014	.018
15	.114	.168	.246	.326	.435	.587	.760	.004	.007	.008	.011	.013	.017	.020
16	.108	.173	.241	.336	.477	.620	.796	.005	.007	.009	.011	.015	.016	.020
17	.111	.166	.243	.346	.484	.662	.888	.005	.007	.010	.013	.016	.019	.020
18	.088	.126	.187	.280	.382	.518	.722	.005	.006	.007	.013	.012	.015	.019
19	.101	.166	.246	.342	.480	.655	.838	.005	.006	.011	.011	.014	.014	.017
20	.097	.160	.227	.298	.402	.526	.660	.005	.007	.009	.011	.013	.014	.016
21	.090	.148	.221	.302	.414	.552	.728	.005	.006	.009	.011	.012	.015	.019
22	.110	.168	.234	.327	.452	.612	.798	.005	.006	.010	.013	.015	.016	.020
23	.089	.134	.194	.268	.377	.526	.691	.005	.007	.009	.011	.013	.015	.019
24	.097	.140	.210	.302	.405	.553	.725	.005	.006	.009	.013	.014	.017	.020
25	.103	.155	.230	.336	.474	.651	.850	.005	.007	.009	.014	.014	.019	.019
26	.106	.163	.234	.330	.455	.631	.810	.004	.007	.010	.012	.014	.017	.015
27	.111	.172	.247	.348	.505	.677	.828	.004	.007	.010	.014	.016	.020	.022
28	.117	.182	.268	.365	.516	.698	.928	.005	.007	.009	.013	.017	.019	.022
29	.088	.138	.200	.280	.393	.539	.712	.005	.007	.009	.011	.015	.016	.019
30	.104	.172	.240	.350	.474	.624	.828	.006	.008	.012	.012	.015	.018	.020
31	.110	.172	.240	.336	.485	.622	.794	.004	.007	.009	.013	.013	.016	.017
32	.106	.154	.226	.314	.408	.560	.712	.005	.007	.010	.012	.014	.017	.019
33	.105	.157	.226	.338	.473	.638	.826	.005	.007	.009	.012	.015	.019	.022
34	.100	.148	.218	.286	.390	.540	.718	.004	.007	.009	.012	.013	.015	.021

35	.101	.152	.211	.294	.396	.538	.694	.004	.006	.008	.012	.013	.016	.018
36	.124	.180	.254	.344	.476	.616	.780	.005	.008	.010	.011	.013	.020	.022
37	.124	.161	.274	.372	.494	.633	.810	.004	.007	.011	.014	.016	.022	.000
$\bar{x}$	.106	.161	.233	.327	.450	.605	.788	.005	.007	.009	.012	.014	.017	.019
s	.012	.017	.023	.031	.045	.054	.069	.001	.001	.001	.001	.002	.002	.002
UCL	.112	.168	.243	.341	.470	.629	.818	.005	.007	.010	.012	.014	.017	.020
LCL	.101	.154	.223	.313	.430	.581	.757	.004	.006	.009	.011	.013	.016	.018

	Tunnel Width						Chomata Height					
16	.052	.104	.138	.200	.528	.840	.030	.030	.046	.073	.056	.074
17	.062	.094	.134	.240	.374	.640	.026	.030	.060	.067	.062	.093
18	.060	.094	.160	.256	.520	.000	.028	.034	.046	.050	.070	.000
19	.062	.080	.148	.220	.400	.000	.029	.033	.054	.070	.080	.000
20	.048	.080	.096	.140	.220	.400	.030	.034	.038	.046	.058	.072
21	.057	.072	.086	.140	.204	.400	.030	.036	.032	.040	.064	.068
22	.058	.080	.132	.186	.444	.600	.026	.038	.060	.051	.060	.072
23	.062	.091	.112	.208	.345	.680	.024	.029	.053	.069	.057	.080
24	.068	.072	.128	.274	.424	.600	.025	.041	.050	.060	.046	.045
25	.054	.080	.118	.198	.420	.800	.025	.030	.042	.073	.069	.036
26	.057	.100	.160	.264	.360	.000	.027	.035	.058	.066	.000	.000
27	.062	.094	.140	.228	.436	1.000	.033	.048	.050	.062	.072	.068
28	.064	.093	.124	.198	.360	.680	.038	.047	.052	.082	.074	.104
29	.046	.074	.116	.194	.456	.616	.026	.032	.038	.061	.080	.080
30	.064	.084	.146	.226	.360	.840	.036	.036	.040	.066	.030	.064
31	.056	.080	.131	.198	.320	.520	.027	.034	.049	.058	.054	.064
32	.058	.096	.126	.264	.372	.528	.030	.030	.044	.062	.069	.060
33	.048	.076	.128	.146	.272	.640	.028	.032	.048	.047	.072	.080
34	.052	.086	.096	.138	.240	.440	.029	.044	.044	.052	.076	.070
35	.054	.120	.120	.190	.320	.512	.024	.032	.040	.044	.052	.059
36	.066	.066	.114	.197	.292	.640	.032	.040	.040	.054	.062	.056
37	.052	.104	.176	.258	.320	.000	.026	.038	.041	.033	.056	.000
$\bar{x}$	.057	.087	.129	.207	.363	.632	.029	.036	.046	.059	.063	.069
s	.006	.013	.022	.042	.088	.161	.004	.006	.007	.012	.012	.016
UCL	.061	.095	.142	.233	.417	.745	.031	.039	.051	.066	.070	.080
LCL	.054	.079	.115	.182	.309	.519	.026	.032	.042	.051	.051	.058

	Spirotheca Thickness							Septal Count						
1	.010	.013	.019	.023	.025	.021	.028	12	16	18	21	25	27	30
2	.011	.016	.017	.023	.023	.024	.020	13	18	19	22	22	28	29
3	.013	.013	.016	.021	.028	.026	.031	11	15	19	21	23	23	25
4	.010	.013	.014	.019	.025	.027	.029	10	15	16	17	19	16	22
5	.013	.016	.018	.025	.026	.032	.028	11	15	17	19	22	24	27
6	.011	.015	.018	.018	.022	.030	.025	12	18	20	21	23	24	24
7	.012	.015	.018	.025	.024	.028	.017	11	18	20	23	23	25	28
8	.011	.015	.019	.025	.025	.028	.026	11	16	19	21	25	27	31
9	.014	.018	.024	.028	.025	.028	.024	9	18	19	22	26	24	24
10	.011	.014	.017	.021	.028	.035	.037	10	15	17	19	21	23	21
11	.012	.016	.015	.018	.022	.025	.025	10	18	17	20	22	24	27
12	.012	.017	.022	.023	.023	.025	.027	11	16	19	20	22	29	30
13	.012	.016	.019	.024	.028	.032	.030	11	18	22	26	24	28	30
14	.011	.017	.020	.022	.022	.026	.026	9	17	19	19	21	23	26
15	.013	.012	.015	.019	.024	.023	.035	10	17	18	20	23	25	29
							$\bar{x}$	11	17	19	21	23	25	27
							s	001	001	002	002	002	002	003
							UCL	12	18	20	22	24	27	29
							LCL	10	16	17	19	21	22	24

continue

								Half Length						
16	.014	.019	.019	.026	.032	.024	.021	.164	.320	.518	.924	1.330	1.870	2.600
17	.014	.017	.024	.028	.035	.024	.020	.177	.354	.564	1.020	1.530	2.200	2.860
18	.013	.016	.015	.025	.032	.026	.032	.109	.216	.377	.711	1.070	1.710	2.330
19	.012	.013	.019	.025	.032	.029	.026	.180	.363	.580	.863	1.610	2.130	2.660
20	.014	.016	.022	.020	.021	.025	.028	.135	.274	.457	.692	1.000	1.480	1.850
21	.014	.014	.022	.022	.028	.028	.028	.142	.278	.431	.589	.898	1.480	2.040
22	.013	.015	.023	.030	.022	.031	.031	.161	.290	.460	.692	1.050	1.530	2.130
23	.014	.015	.016	.025	.026	.032	.030	.126	.251	.437	.776	1.160	1.640	2.210
24	.016	.015	.027	.030	.023	.029	.021	.155	.293	.499	.840	1.220	1.780	2.330
25	.013	.016	.021	.024	.031	.031	.019	.173	.293	.531	.815	1.290	2.000	2.730
26	.011	.016	.017	.025	.029	.029	.015	.177	.334	.567	.933	1.350	1.950	.000
27	.014	.018	.022	.029	.026	.033	.022	.161	.322	.515	.750	1.170	1.930	2.580
28	.013	.016	.020	.030	.037	.030	.026	.142	.320	.554	.857	1.380	2.070	2.720
29	.012	.014	.019	.023	.037	.032	.024	.145	.258	.425	.644	1.040	1.500	2.080

30	.018	.020	.024	.021	.030	.034	.020	.145	.309	.467	.821	1.390	1.970	2.900
31	.012	.015	.026	.021	.027	.028	.017	.138	.284	.467	.750	1.150	1.570	2.240
32	.012	.015	.022	.025	.025	.030	.032	.145	.277	.434	.693	1.170	1.770	2.570
33	.011	.016	.019	.030	.032	.039	.022	.135	.283	.428	.734	1.040	1.720	2.450
34	.012	.014	.017	.022	.029	.032	.034	.129	.277	.441	.689	1.070	1.560	2.240
35	.012	.012	.017	.022	.026	.028	.026	.129	.267	.438	.715	1.100	1.660	2.230
36	.011	.015	.022	.028	.026	.034	.036	.164	.306	.538	.779	1.180	1.870	2.300
37	.012	.014	.018	.029	.029	.032	.000	.170	.328	.518	.853	1.370	1.990	.000
x̄	.013	.015	.020	.024	.027	.029	.026	.150	.295	.484	.779	1.208	1.790	2.403
s	.002	.002	.003	.004	.004	.004	.006	.019	.035	.057	.104	.179	.222	.289
UCL	.013	.016	.021	.026	.029	.031	.029	.162	.317	.519	.843	1.318	1.927	2.592
LCL	.012	.015	.018	.023	.025	.027	.024	.138	.274	.449	.715	1.097	1.653	2.213

Proloculus Diameter

1	.101	.117	10	.081	.085	19	.127	.130	28	.116	.138	37	.118	.135
2	.117	.137	11	.096	.117	20	.115	.146	29	.112	.116	x̄	.111	.126
3	.116	.132	12	.112	.132	21	.112	.123	30	.134	.142	s	.015	.016
4	.094	.108	13	.110	.145	22	.142	.148	31	.096	.112	UCL	.122	.138
5	.078	.093	14	.127	.139	23	.110	.120	32	.102	.118	LCL	.102	.114
6	.123	.146	15	.093	.108	24	.113	.118	33	.126	.184			
7	.114	.143	16	.097	.121	25	.120	.138	34	.104	.116			
8	.104	.118	17	.142	.152	26	.126	.139	35	.080	.104			
9	.115	.132	18	.101	.101	27	.131	.148	36	.118	.138			

FUSULINELLA VACUA, new species Bostwick Member

Radius Vector Tectum & Diaphanotheca

1	.103	.168	.249	.358	.494	.656	.840	.003	.006	.008	.010	.012	.016	.017
2	.116	.193	.280	.396	.570	.770	.966	.004	.007	.009	.011	.014	.017	.017
3	.109	.171	.248	.354	.506	.692	.911	.004	.006	.007	.013	.015	.016	.020
4	.109	.177	.274	.412	.580	.773	.000	.005	.006	.009	.010	.013	.017	.000
5	.128	.190	.276	.390	.564	.763	.000	.004	.007	.009	.012	.017	.018	.000
6	.119	.193	.270	.406	541	.702	.908	.004	.007	.009	.011	.013	.015	.018
7	.161	.238	.361	.531	.718	.000	.000	.004	.007	.009	.013	.016	.016	.000
8	.113	.193	.274	.377	.525	.708	.000	.005	.007	.010	.013	.013	.015	.000
9	.128	.184	.248	.348	473	.621	.805	.004	.006	.010	.011	.013	.014	.000

10	.138	.209	.306	.431	.589	.778	.998	.004	.006	.010	.011	.013	.015	.015
11	.119	.189	.290	.431	.628	.000	.000	.004	.007	.011	.014	.014	.000	.000
12	.144	.206	.289	.428	.596	.801	1.030	.005	.007	.011	.012	.014	.017	.000
13	.119	.193	.296	.425	.592	.779	.992	.005	.007	.009	.011	.015	.015	.000
14	.129	.190	.270	.396	.544	.715	.000	.005	.006	.009	.012	.016	.016	.000
15	.138	.209	.306	.435	.592	.000	.000	.004	.007	.011	.013	.016	.000	.000
16	.151	.222	.320	.441	.602	.000	.000	.005	.006	.011	.013	.019	.000	.000
17	.097	.167	.215	.370	.506	.715	.000	.006	.006	.010	.011	.015	.019	.000
18	.116	.171	.245	.348	.484	.666	.000	.006	.006	.009	.010	.013	.015	.000
19	.097	.161	.248	.354	.509	.686	.889	.005	.006	.008	.013	.014	.019	.000
20	.142	.203	.277	.380	.500	.660	.840	.004	.007	.007	.010	.012	.014	.000
21	.113	.177	.267	.397	.573	.792	.000	.004	.007	.009	.012	.014	.014	.000
22	.129	.190	.287	.422	.583	.763	.956	.004	.007	.009	.012	.015	.018	.000
23	.119	.184	.274	.396	.560	.757	.000	.006	.007	.009	.010	.013	.015	.000
24	.119	.190	.274	.390	.557	.773	.000	.005	.007	.010	.011	.017	.016	.000
25	.135	.219	.296	.419	.573	.757	.000	.005	.007	.010	.017	.016	.022	.000
26	.132	.200	.290	.406	.544	.718	.000	.005	.007	.009	.012	.016	.021	.000
27	.116	.180	.270	.390	.531	.724	.982	.004	.007	.010	.015	.017	.023	.000
28	.119	.187	.277	.409	.564	.731	.908	.004	.007	.011	.017	.017	.019	.000
29	.109	.180	.267	.380	.531	.721	.000	.005	.006	.009	.012	.013	.014	.000
30	.132	.196	.287	.399	.541	.708	.000	.005	.006	.011	.013	.014	.017	.000
31	.119	.176	.242	.354	.512	.692	.892	.005	.007	.010	.012	.014	.020	.000
32	.109	.171	.264	.374	.531	.702	.000	.004	.006	.010	.011	.015	.020	.000
33	.119	.196	.274	.390	.489	.657	.000	.005	.007	.010	.012	.013	.016	.000
34	.119	.190	.299	.425	.573	.763	.000	.005	.007	.010	.015	.015	.016	.000
35	.122	.187	.264	.396	.564	.000	.000	.005	.007	.010	.012	.016	.019	.000
36	.103	.171	.251	.361	.515	.699	.911	.005	.007	.009	.014	.015	.021	.000
37	.116	.187	.274	.403	.534	.712	.000	.006	.008	.010	.014	.015	.021	.000
38	.116	.180	.274	.393	.524	.696	.000	.006	.007	.010	.015	.017	.019	.000
39	.103	.164	.242	.364	.538	.708	.000	.005	.007	.009	.013	.016	.017	.000
$\bar{x}$	.121	.189	.275	.397	.550	.723	.922	.005	.007	.010	.012	.015	.017	.017
s	.014	.017	.025	.034	.046	.044	.065	.001	.001	.001	.002	.002	.002	.002
UCL	.127	.196	.286	.412	.570	.743	.968	.005	.007	.010	.013	.015	.018	.020
LCL	.115	.181	.264	.382	.530	.702	.875	.004	.006	.009	.012	.014	.016	.015

16	.066	.103	.160	.270	.516	.000	.034	.042	.052	.066	.090	.000
17	.080	.108	.160	.218	.358	.560	.041	.048	.054	.080	.080	.000
18	.056	.102	.129	.204	.344	.400	.030	.033	.046	.070	.090	.067
19	.066	.080	.136	.176	.296	.320	.036	.043	.043	.074	.096	.112
20	.069	.088	.120	.200	.260	.300	.030	.032	.051	.072	.084	.088
21	.074	.094	.184	.240	.520	.000	.032	.044	.048	.080	.060	.000
22	.080	.116	.182	.240	.506	.880	.042	.054	.068	.068	.088	.090
23	.052	.104	.160	.240	.348	.800	.033	.060	.074	.064	.100	.088
24	.080	.112	.140	.254	.440	.000	.035	.038	.062	.090	.100	.000
25	.080	.126	.205	.320	.560	.000	.037	.043	.066	.080	.092	.000
26	.060	.080	.152	.240	.440	.000	.036	.044	.040	.056	.072	.000
27	.070	.123	.131	.288	.592	.904	.033	.043	.064	.053	.066	.100
28	.080	.098	.160	.266	.480	.720	.030	.046	.080	.091	.072	.000
29	.059	.120	.140	.256	.386	.000	.032	.046	.062	.070	.089	.070
30	.064	.080	.148	.240	.433	.000	.036	.044	.059	.068	.072	.000
31	.059	.080	.102	.240	.305	.560	.022	.038	.054	.068	.060	.068
32	.069	.094	.148	.272	.420	.000	.034	.048	.056	.072	.094	.072
33	.070	.102	.136	.240	.254	.800	.038	.053	.068	.040	.056	.072
34	.076	.120	.178	.355	.355	.000	.034	.038	.062	.089	.096	.000
35	.072	.098	.184	.400	.580	.000	.038	.038	.038	.058	.090	.080
36	.080	.096	.182	.226	.437	.770	.034	.042	.054	.089	.104	.090
37	.080	.090	.130	.240	.277	.418	.035	.042	.070	.053	.074	.075
38	.060	.093	.131	.302	.382	.578	.044	.044	.050	.067	.053	.067
39	.056	.108	.148	.282	.480	.000	.032	.038	.058	.070	.062	.066
$\bar{x}$	.067	.101	.152	.259	.415	.616	.035	.043	.057	.070	.081	.081
s	.009	.014	.025	.049	.101	.211	.005	.006	.011	.013	.015	.014
UCL	.074	.109	.166	.287	.474	.803	.037	.047	.064	.078	.090	.091
LCL	.064	.092	.138	.230	.356	.430	.032	.040	.051	.063	.072	.069

	Spirotheca Thickness						Septal Count						
1	.013	.018	.022	.030	.028	.033	10	15	18	23	27	25	29
2	.019	.022	.022	.025	.027	.029	10	17	21	24	27	29	27
3	.014	.017	.023	.023	.033	.029	12	16	18	24	27	29	30
4	.014	.019	.026	.031	.033	.033	10	17	20	23	28	32	00
5	.014	.019	.023	.031	.034	.037	10	14	21	21	21	25	00
6	.013	.018	.024	.037	.028	.037	12	17	20	24	25	29	28
7	.018	.024	.027	.030	.032	.033	10	17	21	22	31	00	00

8	.020	.018	.022	.031	.031	.034	11	18	21	25	24	31	00
9	.013	.015	.019	.024	.025	.031	11	17	20	24	27	27	29
10	.013	.017	.024	.025	.028	.028	11	17	18	20	24	27	27
11	.016	.024	.031	.032	.032	.000	11	17	23	23	25	00	00
12	.016	.020	.030	.032	.037	.034	11	18	22	23	24	28	24
13	.016	.021	.026	.026	.031	.032	9	17	21	20	23	26	26
14	.014	.014	.022	.031	.028	.030	12	18	21	23	31	31	00
15	.017	.022	.027	.031	.031	.000	9	17	19	21	00	00	00
							$\bar{x}$ 11	17	20	23	26	28	28
							s 001	001	001	002	003	002	002
			continued				UCL 11	18	21	24	28	30	30
							LCL 10	16	19	21	24	26	25

<u>**Half Length**</u>

16	.017	.018	.022	.037	.043	.000	.206	.380	.621	.972	1.390	.000	.000
17	.017	.023	.024	.023	.044	.033	.193	.396	.663	1.070	1.480	2.070	.000
18	.017	.021	.023	.025	.039	.039	.161	.320	.573	.859	1.410	1.930	.000
19	.017	.020	.028	.025	.044	.052	.148	.303	.502	.811	1.160	1.660	2.180
20	.015	.021	.021	.024	.030	.037	.208	.335	.557	.847	1.190	1.550	2.130
21	.014	.019	.027	.032	.030	.025	.187	.370	.621	1.090	1.710	2.380	.000
22	.019	.021	.032	.032	.027	.032	.228	.463	.718	1.090	1.530	2.230	2.830
23	.022	.025	.028	.031	.032	.037	.219	.370	.686	1.130	1.730	2.500	.000
24	.019	.020	.026	.030	.033	.032	.209	.367	.628	1.070	1.530	2.280	.000
25	.014	.019	.028	.031	.037	.037	.229	.444	.667	1.180	1.920	2.620	.000
26	.015	.021	.018	.026	.030	.034	.203	.374	.596	.976	1.500	2.140	.000
27	.014	.019	.026	.027	.034	.031	.216	.399	.644	1.070	1.660	2.350	3.180
28	.019	.024	.028	.034	.041	.037	.196	.335	.522	.789	1.180	1.910	2.420
29	.016	.017	.024	.025	.032	.032	.219	.441	.644	1.010	1.540	2.350	.000
30	.016	.017	.026	.028	.026	.028	.193	.390	.637	.960	1.500	2.110	.000
31	.016	.019	.026	.034	.031	.034	.171	.300	.524	.824	1.260	1.740	2.400
32	.017	.017	.021	.027	.037	.037	.184	.348	.628	.966	1.540	2.210	.000
33	.018	.018	.024	.024	.024	.029	.170	.320	.628	.863	1.190	1.660	2.210
34	.019	.020	.025	.025	.030	.028	.209	.364	.586	1.010	1.460	2.030	.000
35	.018	.019	.026	.031	.034	.034	.177	.348	.587	1.260	1.610	2.190	2.760
36	.015	.018	.023	.037	.036	.039	.206	.399	.621	.950	1.360	1.970	2.520
37	.014	.020	.030	.034	.030	.037	.177	.293	.525	.840	1.250	1.840	2.540
38	.017	.022	.032	.030	.038	.038	.177	.345	.534	.911	1.380	1.940	.000

39	.016	.021	.018	.030	.035	.037	.167	.335	.576	.821	1.420	1.890	.000
x	.016	.020	.025	.029	.033	.034	.194	.364	.604	.974	1.454	2.067	2.517
s	.002	.003	.004	.004	.005	.005	022	.045	.056	.128	.193	.280	.330
UCL	.017	.021	.027	.031	.035	.036	207	.391	.637	1.049	1.567	2.236	2.890
LCL	.015	.019	.023	.028	.030	.032	.181	.338	.571	.899	1.341	1.899	2.160

Proloculus **Diameter**

1	.091	.127	10	.144	.162	19	.128	.160	28	.142	.170	37	.148	.160
2	.123	.135	11	.121	.149	20	.131	.152	29	.138	.152	38	.137	.163
3	.112	.122	12	.139	.168	21	.134	.160	30	.133	.160	39	.132	.146
4	.109	.124	13	.123	.149	22	.136	.140	31	.152	.174	x̄	.132	.152
5	.135	.164	14	.119	.135	23	.108	.109	32	.140	.154	s	.014	.018
6	.106	.130	15	.134	.156	24	.136	.154	33	.154	.186	UCL	.141	.165
7	.153	.190	16	.136	.160	25	.154	.180	34	.150	.172	LCL	.120	.139
8	.122	.147	17	.120	.134	26	.160	.169	35	.153	.166			
9	.119	.132	18	.112	.120	27	.148	.169	36	.140	.152			

FUSULINA MUTABILIS, new species 90' below "Type" Lester Member, Caddo Anticline

Radius Vector **Tectum & Diaphanotheca**

1	.090	.150	.216	.326	.468	.640	.004	.006	.007	.012	.010	.000
2	.080	.123	.206	.334	.491	.662	.004	.007	.008	.010	.011	.016
3	.095	.170	.246	.368	.520	.678	.005	.007	.009	.013	.013	.015
4	.088	.160	.243	.382	.524	.688	.005	.007	.009	.012	.014	.016
5	.106	.173	.284	.467	.648	.000	.005	.007	.010	.010	.011	.000
6	.087	.147	.222	.351	.536	.000	.005	.007	.010	.012	.013	.000
7	.090	.150	.233	.347	.540	.000	.005	.006	.010	.010	.000	.000
8	.080	.121	.190	.308	.482	.713	.005	.007	.009	.011	.012	.015
9	.102	.166	.248	.364	.533	.716	.004	.007	.008	.011	.013	.000
11	.086	.147	.214	.302	.470	.673	.004	.006	.009	.010	.013	.015
12	.098	.152	.223	.349	.510	.720	.005	.007	.010	.012	.013	.017
13	.108	.170	.240	.360	.521	.000	.005	.006	.009	.012	.013	.000
14	.082	.142	.246	.346	.542	.718	.005	.006	.009	.011	.014	.015
15	.094	.152	.232	.372	.554	.000	.005	.006	.009	.010	.013	.000
16	.116	.176	.234	.354	.509	.678	.005	.007	.008	.010	.013	.017

17	.083	.130	.194	.303	.437	.640	.005	.006	.009	.011	.013	.014
18	.092	.140	.218	.326	.475	.645	.005	.006	.008	.012	.013	.000
19	.094	.154	.234	.360	.498	.000	.005	.007	.009	.010	.013	.000
20	.097	.156	.250	.385	.553	.000	.004	.007	.010	.011	.014	.000
21	.112	.172	.250	.372	.547	.720	.005	.007	.010	.012	.013	.014
22	.090	.152	.218	.336	.494	.650	.005	.007	.009	.012	.014	.017
23	.094	.162	.245	.386	.546	.000	.006	.007	.009	.011	.015	.000
24	.096	.164	.240	.347	.490	.656	.006	.008	.009	.012	.013	.015
25	.096	.173	.232	.338	.544	.750	.005	.007	.011	.013	.015	.016
26	.090	.156	.248	.396	.566	.748	.006	.007	.009	.011	.014	.016
27	.074	.128	.209	.309	.485	.692	.005	.008	.010	.010	.011	.014
28	.080	.132	.202	.322	.472	.656	.006	.007	.009	.010	.013	.016
29	.090	.015	.243	.380	.531	.693	.005	.007	.009	.013	.013	.015
30	.078	.132	.211	.355	.524	.688	.005	.007	.011	.013	.013	.014
$\bar{x}$	.092	.152	.230	.353	.518	.687	.005	.007	.009	.011	.013	.015
s	.010	.016	.020	.034	.041	.034	.001	.001	.001	.001	.001	.001
UCL	.097	.160	.240	.370	.538	.707	.005	.007	.010	.012	.014	.016
LCL	.087	.144	.220	.336	.497	.667	.004	.006	.008	.011	.012	.014

	Tunnel Width						Chomata Height					
11	.046	.080	.106	.123	.196	.366	.046	.054	.088	.098	.088	.000
12	.060	.089	.141	.220	.372	.560	.034	.039	.062	.086	.090	.077
13	.052	.080	.136	.206	.320	.000	.030	.038	.072	.080	.064	.000
14	.046	.070	.096	.184	.258	.480	.030	.053	.066	.108	.080	.000
15	.048	.066	.106	.213	.400	.000	.030	.046	.072	.100	.100	.000
16	.046	.080	.126	.211	.302	.000	.038	.042	.067	.065	.074	.000
17	.064	.080	.112	.208	.288	.400	.030	.035	.052	.096	.096	.104
18	.060	.064	.128	.146	.240	.000	.032	.036	.056	.068	.080	.000
19	.062	.096	.108	.240	.320	.000	.026	.042	.064	.088	.080	.000
20	.051	.080	.112	.248	.344	.000	.034	.052	.080	.104	.000	.000
21	.060	.086	.143	.216	.320	.000	.034	.038	.072	.092	.070	.000
22	.052	.070	.116	.160	.320	.000	.041	.040	.061	.090	.094	.088
23	.048	.092	.168	.360	.000	.000	.030	.058	.065	.080	.000	.000
24	.055	.094	.120	.200	.240	.000	.034	.049	.066	.085	.093	.000
25	.058	.080	.096	.173	.278	.640	.038	.038	.064	.080	.108	.092
26	.049	.080	.133	.222	.320	.000	.034	.054	.066	.120	.120	.000
27	.051	.073	.120	.176	.250	.000	.030	.040	.062	.078	.120	.000

28	.046	.064	.097	.180	.256	.352	.027	.044	.068	.086	.096	.080
29	.052	.096	.136	.251	.320	.000	.030	.048	.066	.080	.072	.000
30	.056	.064	.112	.144	.296	.384	.033	.044	.068	.080	.086	.088
$\bar{\bar{x}}$	.053	.079	.121	.202	.297	.455	.033	.045	.067	.088	.089	.088
s	.006	.011	.018	.052	.050	.110	.005	.007	.008	.013	.016	.010
UCL	.057	.086	.132	.234	.328	.575	.036	.049	.072	.096	.100	.100
LCL	.049	.073	.109	.170	.266	.334	.030	.040	.062	.080	.079	.077

1	.012	.016	.023	.031	.031	.000		9	14	15	19	26	27
2	.013	.021	.029	.030	.029	.037		9	13	14	17	20	24
3	.020	.026	.029	.034	.037	.037		8	11	14	17	19	26
4	.020	.022	.030	.044	.042	.042		8	12	14	15	17	22
5	.018	.025	.032	.037	.035	.000		9	13	17	19	23	00
6	.018	.023	.031	.037	.037	.000		9	12	14	15	20	00
7	.020	.025	.030	.034	.000	.000		9	12	15	16	21	00
8	.016	.023	.028	.044	.042	.037		9	11	17	16	21	24
9	.024	.022	.031	.038	.044	.000		9	14	17	20	20	24
							$\bar{\bar{x}}$	9	12	15	17	21	25
							s	001	001	001	002	003	002
							UCL	9	14	17	19	23	27
							LCL	8	13	14	15	18	22

continued

Half Length

11	.019	.021	.032	.032	.037	.028	.122	.280	.470	.712	.985	1.590
12	.020	.022	.027	.037	.044	.041	.158	.303	.518	.824	1.290	1.890
13	.017	.024	.025	.026	.034	.000	.138	.332	.538	.831	1.310	.000
14	.018	.022	.027	.034	.044	.044	.145	.267	.477	.753	1.160	1.650
15	.019	.021	.030	.035	.039	.000	.135	.267	.444	.741	1.260	1.980
16	.021	.027	.027	.034	.036	.048	.145	.341	.586	.850	1.150	1.570
17	.017	.026	.030	.037	.040	.044	.138	.296	.464	.728	1.080	1.560
18	.014	.023	.026	.034	.032	.000	.132	.302	.567	.863	1.290	1.870
19	.020	.030	.037	.037	.042	.000	.135	.280	.489	.715	1.040	1.450
20	.017	.028	.033	.034	.040	.000	.132	.246	.524	.798	1.210	1.790
21	.021	.022	.028	.037	.048	.036	.138	.338	.611	.869	1.340	1.900
22	.014	.032	.034	.042	.043	.034	.148	.322	.576	.801	1.160	1.600

23	.016	.024	.037	.034	.037	.000	.148	.348	.698	1.120	1.560	.000
24	.023	.033	.037	.039	.039	.042	.135	.300	.508	.789	1.170	1.630
25	.016	.026	.031	.045	.044	.040	.154	.309	.547	.866	1.430	1.850
26	.018	.026	.033	.039	.046	.037	.145	.338	.595	.991	1.610	2.260
27	.018	.024	.033	.037	.041	.041	.103	.287	.441	.744	1.200	1.630
28	.019	.035	.032	.034	.043	.045	.122	.283	.486	.831	1.120	1.570
29	.018	.025	.034	.037	.032	.042	.154	.354	.618	.951	1.440	1.930
30	.020	.028	.028	.033	.037	.039	.119	.274	.444	.679	.966	1.450
$\bar{x}$	.018	.024	.030	.036	.039	.040	.137	.303	.530	.823	1.239	1.732
s	.003	.004	.004	.004	.005	.005	.013	.031	.069	.106	.175	.214
UCL	.020	.027	.032	.038	.042	.043	.146	.322	.573	.888	1.346	1.871
LCL	.017	.023	.029	.034	.037	.037	.129	.284	.487	.758	1.131	1.593

Proloculus Diameter

1	.088	.098	8	.066	.082	15	.088	.103	23	.118	.126	30	.080	.096
2	.063	.075	9	.096	.119	16	.080	.096	24	.106	.106	$\bar{x}$	.092	.102
3	.076	.087	11	.106	.120	17	.106	.110	25	.120	.122	s	.015	.013
4	.083	.094	12	.116	.116	18	.080	.090	26	.094	.097	UCL	.099	.108
5	.100	.102	13	.080	.098	19	.108	.117	27	.086	.086	LCL	.084	.095
6	.085	.098	14	.098	.110	20	.090	.100	28	.069	.080			
7	.087	.098	21	.102	.114	22	.078	.090	29	.108	.116			

FUSULINA MUTABILIS, new species "oolitic" Lester Member, Overbrook Anticline

	Radius Vector						Tectum & Diaphanotheca					
1	.118	.182	.306	.470	.660	.000	.004	.007	.010	.013	.021	.000
2	.104	.161	.245	.393	.547	.774	.005	.007	.010	.012	.015	.016
3	.093	.154	.226	.339	.484	.658	.006	.007	.009	.012	.015	.017
4	.091	.138	.217	.318	.470	.735	.005	.007	.009	.012	.014	.000
6	.102	.170	.288	.446	.650	.000	.005	.007	.009	.012	.014	.000
7	.116	.181	.269	.403	.553	.000	.006	.007	.008	.011	.014	.000
8	.098	.173	.274	.394	.536	.000	.005	.007	.009	.014	.017	.000
9	.104	.158	.250	.370	.540	.000	.005	.007	.008	.013	.015	.000
10	.095	.152	.246	.361	.530	.000	.005	.007	.010	.012	.015	.000
11	.096	.154	.232	.340	.476	.680	.005	.007	.009	.010	.013	.019

12	.106	.186	.292	.442	.590	.000	.005	.007	.010	.012	.017	.000
13	.094	.155	.229	.348	.508	.720	.004	.007	.009	.013	.015	.014
14	.090	.156	.276	.454	.000	.000	.005	.007	.010	.013	.000	.000
16	.080	.013	.207	.318	.494	.689	.005	.006	.009	.013	.016	.017
17	.076	.130	.216	.331	.487	.674	.004	.007	.009	.011	.014	.016
19	.109	.169	.268	.418	.000	.000	.005	.009	.010	.013	.015	.000
20	.095	.170	.264	.416	.570	.730	.005	.007	.010	.014	.015	.000
21	.083	.136	.235	.346	.533	.720	.005	.007	.009	.011	.016	.015
22	.102	.154	.224	.331	.472	.690	.005	.007	.009	.009	.014	.015
24	.088	.141	.234	.393	.613	.000	.005	.007	.009	.012	.014	.000
25	.087	.142	.234	.346	.508	.682	.005	.007	.009	.015	.015	.017
28	.107	.170	.253	.378	.550	.000	.006	.007	.009	.012	.014	.000
29	.108	.168	.264	.390	.555	.766	.005	.007	.012	.012	.017	.000
30	.088	.146	.226	.350	.516	.702	.005	.007	.010	.012	.013	.019
31	.113	.172	.246	.364	.533	.708	.005	.007	.010	.015	.015	.000
32	.080	.124	.207	.350	.475	.622	.004	.007	.009	.012	.014	.017
33	.085	.140	.214	.326	.490	.000	.006	.008	.009	.013	.014	.000
34	.114	.169	.240	.362	.530	.695	.005	.007	.009	.013	.012	.018
35	.101	.160	.240	.358	.510	.728	.005	.007	.011	.012	.014	.017
$\bar{x}$	.097	.157	.246	.374	.533	.704	.005	.007	.009	.012	.015	.017
s	.011	.017	.026	.042	.051	.038	.001	.001	.001	.001	.002	.002
UCL	.103	.165	.259	.396	.559	.730	.005	.007	.010	.013	.016	.018
LCL	.092	.148	.232	.353	.506	.679	.004	.006	.009	.012	.014	.016

16	.042	.066	.146	.160	.262	.024	.045	.074	.096	.000
17	.045	.080	.104	.149	.280	.038	.048	.062	.080	.088
19	.080	.100	.204	.400	.640	.030	.048	.096	.088	.116
20	.069	.104	.172	.304	.456	.034	.049	.076	.084	.108
21	.060	.072	.112	.184	.320	.029	.048	.062	.088	.074
22	.048	.070	.100	.160	.266	.030	.048	.052	.100	.100
24	.060	.085	.160	.236	.400	.030	.051	.068	.104	.104
25	.052	.068	.165	.240	.400	.028	.052	.061	.070	.080
28	.058	.080	.168	.308	.000	.038	.046	.080	.096	.077
29	.054	.092	.160	.216	.320	.036	.054	.064	.100	.108
30	.061	.092	.138	.188	.320	.032	.060	.067	.088	.096
31	.055	.080	.124	.160	.320	.030	.052	.063	.088	.088

32	.048	.072	.128	.140	.324
33	.043	.066	.112	.160	.346
34	.060	.096	.128	.240	.374
35	.052	.080	.132	.257	.000
$\bar{x}$	.055	.081	.141	.219	.359
s	.010	.012	.029	.072	.098
UCL	.062	.090	.161	.269	.432
LCL	.049	.073	.121	.169	.287

<u>Spirotheca Thickness</u>

1	.015	.026	.027	.037	.035	.000
2	.015	.024	.029	.038	.032	.040
3	.015	.017	.017	.022	.022	.034
4	.015	.014	.020	.030	.034	.000
6	.014	.020	.029	.037	.040	.000
7	.016	.016	.027	.034	.037	.000
8	.014	.018	.027	.026	.036	.000
9	.020	.019	.026	.037	.041	.000
10	.015	.016	.031	.034	.032	.000
11	.016	.019	.021	.023	.030	.037
12	.016	.022	.027	.041	.037	.000
13	.019	.023	.026	.031	.037	.036
14	.015	.020	.028	.047	.000	.000

Continued

16	.016	.021	.032	.030	.041	.025
17	.018	.018	.034	.044	.036	.037
19	.022	.028	.036	.037	.045	.000
20	.022	.024	.034	.042	.045	.000
21	.018	.021	.030	.032	.046	.025
22	.015	.022	.019	.026	.041	.044
24	.017	.020	.026	.030	.037	.000
25	.018	.023	.027	.041	.045	.045

.028	.042	.066	.072	.096
.026	.048	.056	.076	.100
.028	.046	.070	.100	.086
.033	.050	.076	.068	.000
.031	.049	.068	.087	.094
.004	.004	.011	.012	.013
.034	.052	.076	.095	.104
.028	.046	.061	.079	.085

<u>Septal Count</u>

	8	12	10	15	20	00
	9	12	16	19	22	29
	8	13	14	18	20	22
	9	12	17	21	21	18
	8	14	15	19	22	00
	11	16	21	21	26	32
	10	13	16	17	21	28
	9	14	14	20	21	00
	9	13	16	17	20	00
	8	13	14	13	18	21
	9	14	17	21	23	00
	9	13	15	17	20	27
	7	10	13	16	20	00
$\bar{x}$	9	13	15	18	21	25
s	001	001	003	002	002	005
UCL	10	14	17	20	23	30
LCL	8	12	13	16	20	20

.112	.218	.425	.750	1.110	1.640
.106	.273	.451	.882	1.210	1.470
.145	.309	.521	1.080	1.710	.000
.141	.332	.538	.899	1.440	1.910
.129	.277	.515	.725	1.150	1.680
.151	.290	.483	.741	1.160	1.720
.122	.225	.428	.766	1.210	.000
.120	.280	.522	.782	1.200	1.770

28	.018	.024	.026	.037	.035	.000	.180	.383	.677	.956	1.610	.000
29	.019	.022	.034	.034	.037	.000	.161	.300	.589	.892	1.290	.000
30	.019	.023	.034	.037	.037	.050	.132	.280	.486	.750	1.240	.000
31	.019	.022	.032	.039	.037	.000	.161	.312	.493	.809	1.400	.000
32	.014	.021	.025	.032	.036	.045	.106	.235	.431	.821	1.210	1.810
33	.018	.025	.028	.037	.045	.000	.119	.300	.435	.676	1.110	.000
34	.016	.021	.031	.035	.042	.046	.148	.296	.464	.805	1.250	1.900
35	.018	.024	.033	.034	.037	.040	.138	.274	.460	.786	1.560	2.090
$\bar{\bar{x}}$	.017	.021	.028	.035	.038	.039	.136	.287	.495	.820	1.304	1.777
s	.002	.003	.005	.006	.005	.008	.021	.041	.067	.101	.185	.179
UCL	.018	.023	.031	.038	.040	.045	.150	.315	.541	.890	1.432	2.437
LCL	.016	.019	.026	.032	.035	.033	.121	.258	.449	.750	1.175	1.603

<u>Proloculus</u> <u>Diameter</u>

1	.101	.117	9	.086	.095	17	.080	.098	28	.110	.128	35	.108	.117
2	.085	.100	10	.078	.087	19	.096	.112	29	.100	.109	$\bar{\bar{x}}$	.095	.107
3	.089	.105	11	.094	.105	20	.106	.106	30	.101	.114	s	.011	.011
4	.082	.092	12	.111	.122	21	.102	.102	31	.106	.120	UCL	.101	.113
6	.089	.097	13	.091	.101	22	.118	.126	32	.101	.107	LCL	.089	.101
7	.104	.116	14	.070	.086	24	.088	.111	33	.100	.106			
8	.091	.124	16	.094	.106	25	.080	.094	34	.096	.100			

FUSULINA PUMILA Thompson Lower Frensley Limestone Member

1	.071	.122	.170	.250	.339	.485	.004	.005	.006	.009	.010	.013
2	.080	.138	.209	.311	.470	.000	.004	.006	.008	.009	.011	.013
3	.056	.098	.167	.273	.428	.578	.004	.007	.007	.009	.013	.015
4	.065	.109	.170	.252	.350	.472	.004	.006	.006	.007	.012	.014
5	.078	.124	.199	.295	.405	.563	.005	.006	.007	.012	.013	.013
6	.077	.131	.216	.318	.464	.641	.004	.006	.008	.010	.011	.016
7	.085	.156	.234	.320	.468	.652	.004	.006	.009	.010	.013	.018
8	.063	.107	.172	.272	.390	.538	.004	.007	.007	.010	.013	.015
9	.074	.124	.198	.297	.422	.560	.004	.006	.007	.010	.011	.014
10	.059	.101	.160	.247	.350	.502	.005	.006	.006	.009	.012	.013
11	.060	.108	.165	.246	.378	.517	.003	.006	.008	.009	.011	.012
12	.074	.119	.198	.282	.419	.610	.003	.005	.008	.010	.014	.013

13	.065	.099	.147	.215	.318	.468	.005	.006	.007	.009	.013	.014
14	.072	.118	.176	.266	.380	.544	.004	.006	.007	.008	.008	.012
15	.072	.118	.196	.299	.417	.624	.004	.005	.008	.010	.014	.014
16	.088	.133	.189	.274	.391	.568	.004	.006	.008	.009	.012	.014
17	.070	.111	.170	.252	.400	.530	.005	.007	.009	.009	.014	.014
18	.076	.121	.187	.277	.414	.590	.005	.006	.008	.011	.013	.015
19	.078	.118	.177	.265	.425	.610	.005	.007	.008	.012	.013	.018
20	.082	.144	.209	.315	.457	.608	.006	.008	.009	.010	.012	.013
21	.065	.121	.204	.303	.465	.674	.004	.006	.008	.009	.014	.014
22	.066	.108	.179	.266	.379	.530	.004	.005	.007	.008	.011	.013
23	.080	.128	.196	.282	.412	.546	.005	.008	.010	.014	.014	.014
24	.054	.093	.156	.262	.414	.572	.005	.007	.008	.011	.011	.000
25	.056	.100	.168	.252	.359	.534	.005	.006	.008	.010	.012	.013
26	.074	.110	.166	.244	.384	.560	.004	.006	.007	.010	.011	.014
27	.069	.104	.160	.245	.374	.523	.005	.006	.010	.010	.014	.014
28	.066	.102	.156	.235	.338	.520	.004	.007	.008	.013	.014	.016
29	.066	.098	.152	.239	.357	.514	.004	.006	.008	.010	.011	.014
30	.066	.111	.160	.258	.420	.623	.005	.006	.008	.011	.012	.013
31	.063	.098	.160	.243	.354	.491	.004	.005	.007	.010	.013	.012
32	.074	.125	.188	.299	.440	.642	.004	.006	.008	.010	.012	.014
33	.058	.090	.143	.218	.320	.474	.005	.006	.008	.010	.013	.013
34	.061	.090	.136	.208	.308	.412	.005	.006	.007	.009	.010	.011
35	.080	.124	.191	.283	.422	.573	.003	.006	.008	.013	.012	.014
36	.072	.109	.160	.243	.362	.522	.005	.006	.007	.012	.012	.015
37	.006	.113	.160	.234	.367	.538	.004	.006	.007	.009	.010	.014
38	.065	.102	.170	.262	.377	.521	.005	.006	.007	.009	.012	.015
39	.063	.104	.172	.284	.433	.584	.005	.006	.008	.010	.011	.014
40	.054	.092	.147	.217	.323	.464	.004	.005	.008	.009	.012	.013
41	.072	.111	.157	.230	.310	.426	.005	.006	.009	.011	.013	.016
$\bar{\bar{x}}$	.069	.113	.175	.264	.390	.548	.004	.006	.007	.010	.012	.014
s	.009	.015	.022	.030	.046	.061	.001	.001	.001	.001	.001	.001
UCL	.073	.120	.185	.277	.410	.574	.005	.006	.008	.011	.013	.015
LCL	.066	.107	.166	.252	.371	.521	.004	.005	.007	.010	.012	.013

	Tunnel Width						Chomata Height					
14	.032	.050	.086	.146	.168	.000	.021	.035	.048	.069	.067	.000
15	.037	.058	.080	.126	.192	.000	.028	.047	.068	.080	.104	.000
16	.039	.067	.080	.142	.160	.000	.026	.037	.048	.067	.091	.078
17	.036	.068	.160	.240	.000	.000	.024	.032	.056	.072	.084	.000
18	.040	.068	.104	.100	.240	.360	.020	.034	.043	.053	.084	.078
19	.040	.080	.080	.152	.188	.376	.020	.030	.064	.080	.094	.106
20	.066	.070	.098	.136	.189	.000	.032	.040	.061	.080	.076	.068
21	.040	.062	.092	.146	.224	.000	.026	.036	.064	.074	.104	.000
22	.042	.050	.080	.124	.184	.320	.024	.052	.052	.064	.080	.068
23	.035	.058	.089	.152	.124	.211	.020	.034	.042	.072	.080	.076
24	.036	.065	.092	.148	.256	.000	.027	.034	.048	.088	.072	.000
25	.030	.060	.090	.130	.183	.268	.029	.034	.053	.062	.078	.096
26	.040	.066	.080	.120	.176	.320	.020	.036	.048	.080	.088	.096
27	.029	.046	.072	.080	.136	.176	.024	.031	.052	.072	.080	.086
28	.030	.054	.108	.120	.205	.272	.015	.038	.042	.068	.080	.080
29	.030	.052	.070	.112	.147	.200	.018	.027	.047	.066	.088	.080
30	.032	.058	.080	.116	.147	.253	.022	.031	.054	.080	.088	.104
31	.040	.048	.066	.110	.150	.200	.020	.036	.052	.077	.072	.088
32	.034	.050	.090	.178	.256	.268	.022	.034	.051	.074	.096	.096
33	.029	.056	.071	.110	.160	.200	.016	.036	.054	.080	.112	.080
34	.029	.056	.071	.106	.160	.278	.020	.024	.038	.067	.092	.104
35	.038	.062	.080	.136	.184	.288	.026	.040	.061	.071	.090	.096
36	.036	.060	.088	.126	.216	.260	.016	.024	.032	.068	.096	.080
37	.030	.058	.099	.124	.224	.360	.028	.034	.043	.074	.092	.088
38	.044	.056	.080	.120	.160	.229	.024	.031	.054	.060	.071	.080
39	.048	.064	.082	.146	.240	.000	.016	.036	.051	.088	.080	.000
40	.040	.060	.080	.112	.176	.220	.019	.026	.042	.068	.080	.080
41	.034	.054	.067	.106	.184	.220	.014	.020	.036	.047	.063	.080
$\bar{x}$	.037	.059	.086	.131	.186	.264	.022	.034	.050	.071	.085	.086
s	.007	.008	.018	.029	.036	.059	.005	.007	.009	.010	.012	.011
UCL	.041	.063	.095	.146	.205	.300	.024	.037	.055	.076	.091	.092
LCL	.033	.055	.077	.116	.167	.228	.020	.031	.046	.067	.079	.079

Spirotheca Thickness

1	.009	.012	.014	.017	.024	.028
2	.012	.019	.019	.034	.034	.030
3	.010	.019	.027	.032	.037	.032
4	.009	.012	.018	.020	.023	.029
5	.013	.016	.022	.028	.029	.033
6	.015	.020	.027	.027	.027	.038
7	.011	.019	.024	.035	.037	.020
8	.012	.016	.020	.025	.036	.034
9	.010	.015	.020	.023	.032	.041
10	.009	.013	.026	.027	.036	.030
11	.009	.015	.018	.036	.025	.026
12	.011	.015	.019	.028	.029	.026
13	.010	.014	.018	.026	.031	.031

continued

14	.010	.015	.018	.030	.026	.033
15	.009	.014	.019	.032	.028	.041
16	.013	.014	.018	.021	.027	.020
17	.012	.018	.020	.027	.026	.033
18	.013	.018	.018	.022	.028	.028
19	.011	.022	.025	.034	.028	.018
20	.016	.013	.018	.028	.028	.030
21	.012	.014	.021	.036	.031	.043
22	.009	.014	.017	.019	.028	.034
23	.014	.018	.021	.032	.036	.032
24	.011	.017	.030	.031	.029	.000
25	.010	.014	.015	.022	.034	.023
26	.010	.019	.018	.022	.031	.035
27	.010	.015	.025	.031	.036	.032
28	.009	.013	.021	.025	.025	.044
29	.010	.012	.016	.018	.027	.035

Septal Count

8	13	16	20	20	25
11	17	21	23	26	27
8	12	12	14	17	22
9	16	16	20	22	28
9	15	20	18	23	32
9	13	15	20	24	29
10	17	20	25	27	32
9	10	13	19	18	23
10	16	17	18	26	25
9	14	19	22	24	26
8	11	14	18	23	24
8	13	16	20	21	23
9	13	14	17	21	23
$\bar{x}$ 9	14	16	20	22	26
s01	02	03	03	03	03
UCL10	16	19	22	25	29
LCL 8	12	14	17	20	23

.090	.193	.322	.628	1.010	1.530	.000
.081	.196	.328	.500	.708	1.140	.000
.081	.171	.300	.508	.853	1.300	.000
.090	.180	.320	.531	.824	1.400	.000
.077	.151	.296	.547	.975	1.470	.000
.081	.180	.303	.547	.776	1.370	.000
.077	.209	.322	.460	.789	1.120	1.580
.096	.235	.386	.714	1.090	1.730	.000
.064	.180	.312	.522	.806	1.210	1.890
.077	.161	.312	.483	.811	1.050	1.490
.081	.177	.364	.676	.924	.000	.000
.064	.174	.345	.515	.779	1.110	.000
.071	.148	.258	.428	.839	1.200	.000
.064	.161	.286	.419	.488	.882	1.200
.058	.142	.225	.377	.782	1.190	1.599
.058	.122	.238	.419	.663	.949	1.470

30	.011	.021	.020	.031	.038	.029	.077	.177	.315	.557	.857	1.290	1.860
31	.011	.012	.018	.022	.023	.018	.071	.154	.290	.451	.683	1.010	1.470
32	.014	.014	.023	.026	.037	.041	.087	.167	.322	.586	.882	1.420	.000
33	.009	.016	.024	.025	.036	.038	.064	.138	.270	.419	.747	1.160	1.620
34	.010	.011	.013	.022	.026	.031	.064	.138	.261	.435	.712	.978	1.530
35	.012	.020	.021	.027	.031	.034	.071	.173	.320	.551	.801	1.150	1.700
36	.009	.014	.022	.025	.032	.039	.068	.154	.306	.499	.828	1.580	.000
37	.010	.012	.013	.018	.030	.027	.061	.151	.290	.467	.757	1.170	.000
38	.013	.020	.021	.025	.036	.041	.090	.171	.274	.455	.712	1.060	.000
39	.011	.015	.023	.032	.032	.034	.074	.187	.325	.602	.949	1.320	.000
40	.012	.014	.018	.023	.032	.032	.070	.158	.264	.412	.634	1.070	.000
41	.010	.011	.022	.024	.029	.034	.081	.155	.290	.483	.750	1.100	.000
$\bar{x}$	.011	.015	.020	.027	.030	.032	.075	.168	.302	.507	.807	1.221	1.587
s	.002	.003	.004	.005	.004	.006	.010	.024	.035	.082	.110	.204	.181
UCL	.012	.017	.022	.029	.032	.035	.081	.180	.320	.549	.863	1.328	1.741
LCL	.010	.014	.019	.024	.029	.029	.070	.156	.283	.465	.750	1.113	1.434

<u>Proloculus</u> <u>Diameter</u>

1	.056	.062	10	.054	.065	19	.048	.064	28	.064	.068	37	.046	.050
2	.072	.082	11	.054	.056	20	.086	.088	29	.048	.055	38	.066	.067
3	.052	.056	12	.058	.075	21	.068	.072	30	.052	.062	39	.072	.072
4	.066	.076	13	.065	.068	22	.075	.096	31	.072	.072	40	.062	.073
5	.069	.080	14	.070	.082	23	.062	.074	32	.082	.088	41	.061	.070
6	.071	.080	15	.058	.062	24	.056	.078	33	.064	.067	$\bar{x}$	.063	.071
7	.078	.099	16	.066	.066	25	.064	.080	34	.062	.067	s	.009	.011
8	.057	.067	17	.064	.070	26	.062	.062	35	.064	.066	UCL	.067	.076
9	.070	.074	18	.064	.080	27	.069	.074	36	.052	.054	LCL	.060	.067

FUSULINA PLATTENSIS Thompson upper Frensley Member

<u>Radius Vector</u> <u>Tectum & Diaphanotheca</u>

1	.062	.108	.184	.284	.444	.628	.004	.005	.009	.012	.013	.015
2	.094	.148	.230	.350	.490	.000	.004	.006	.009	.010	.014	.000
3	.057	.090	.143	.230	.355	.488	.004	.005	.007	.009	.013	.000

4	.082	.134	.208	.292	.400	.537	.004	.006	.008	.000	.012	.000
5	.067	.106	.154	.213	.302	.426	.004	.006	.009	.012	.012	.015
6	.084	.134	.212	.328	.485	.684	.004	.006	.010	.010	.013	.015
7	.090	.149	.230	.371	.526	.000	.004	.006	.008	.010	.011	.000
8	.080	.122	.187	.298	.454	.000	.004	.006	.008	.011	.013	.000
9	.077	.124	.188	.273	.420	.000	.004	.006	.009	.010	.014	.000
10	.069	.113	.183	.276	.400	.560	.004	.006	.008	.009	.013	.000
12	.062	.102	.164	.255	.388	.539	.004	.007	.008	.010	.011	.014
13	.096	.150	.220	.320	.459	.656	.004	.007	.009	.011	.013	.014
14	.076	.125	.192	.292	.423	.560	.005	.006	.009	.009	.012	.000
15	.094	.146	.224	.330	.493	.672	.005	.005	.007	.010	.011	.013
16	.070	.108	.165	.275	.425	.618	.005	.006	.009	.011	.011	.015
17	.089	.139	.204	.295	.384	.550	.005	.007	.009	.014	.014	.016
18	.084	.133	.212	.311	.472	.664	.004	.007	.009	.010	.014	.016
19	.078	.141	.235	.362	.511	.699	.004	.008	.010	.011	.000	.000
20	.078	.128	.203	.300	.458	.652	.005	.007	.010	.011	.011	.014
21	.080	.130	.192	.284	.400	.568	.004	.006	.008	.010	.011	.012
22	.080	.138	.228	.363	.558	.000	.004	.007	.010	.012	.014	.000
23	.073	.120	.189	.285	.427	.000	.004	.007	.010	.012	.013	.000
24	.070	.122	.200	.306	.477	.662	.004	.006	.009	.013	.012	.014
25	.108	.152	.240	.346	.472	.000	.005	.006	.007	.011	.016	.000
26	.080	.133	.237	.379	.560	.749	.005	.007	.010	.012	.016	.017
27	.075	.129	.192	.300	.422	.571	.005	.006	.009	.010	.016	.016
28	.080	.150	.255	.398	.586	.000	.006	.007	.010	.013	.015	.000
29	.089	.142	.240	.368	.522	.706	.005	.007	.010	.011	.013	.014
30	.070	.112	.175	.258	.378	.537	.004	.007	.010	.012	.012	.012
31	.084	.126	.192	.286	.396	.580	.005	.007	.009	.011	.011	.016
$\bar{x}$	.079	.128	.203	.307	.449	.605	.004	.006	.009	.011	.013	.015
s	.011	.016	.027	.044	.064	.080	.001	.001	.001	.001	.002	.002
UCL	.085	.136	.216	.230	.481	.654	.005	.007	.009	.012	.014	.016
LCL	.074	.120	.189	.285	.417	.556	.004	.006	.008	.010	.012	.014

Tunnel Width **Chomata Height**

12	.040	.064	.092	.136	.198	.000	.022	.030	.054	.066	.066	.075
13	.053	.069	.124	.176	.226	.000	.030	.046	.052	.068	.096	.000
14	.042	.062	.098	.184	.256	.000	.020	.041	.058	.074	.100	.000
15	.042	.069	.096	.160	.264	.000	.029	.038	.056	.056	.075	.000

16	.040	.068	.080	.176	.320	.000	.020	.026	.072	.074	.074	.000
17	.052	.080	.096	.160	.240	.000	.025	.029	.070	.073	.076	.000
18	.050	.068	.128	.196	.355	.000	.020	.040	.059	.074	.000	.000
19	.048	.080	.124	.176	.000	.000	.024	.038	.053	.072	.000	.000
20	.048	.066	.080	.120	.226	.286	.024	.034	.052	.080	.090	.080
21	.035	.066	.100	.184	.240	.000	.022	.039	.050	.059	.066	.000
22	.039	.069	.080	.179	.226	.000	.030	.045	.068	.076	.088	.000
23	.040	.070	.146	.208	.240	.000	.022	.054	.056	.080	.080	.000
24	.037	.066	.100	.160	.216	.000	.030	.041	.068	.064	.080	.000
25	.062	.080	.120	.256	.256	.000	.022	.046	.070	.080	.080	.000
26	.051	.080	.147	.172	.320	.000	.025	.060	.080	.092	.072	.068
27	.035	.054	.080	.116	.192	.000	.032	.044	.069	.076	.072	.000
28	.046	.096	.120	.288	.000	.000	.040	.050	.058	.087	.080	.000
29	.052	.080	.132	.208	.200	.400	.030	.042	.067	.080	.088	.108
30	.064	.064	.100	.180	.211	.301	.021	.030	.046	.062	.068	.088
31	.054	.080	.094	.128	.194	.000	.022	.031	.046	.055	.086	.080
$\bar{x}$	.046	.072	.107	.178	.243	.329	.026	.040	.060	.073	.080	.083
s	.007	.009	.022	.042	.046	.061	.055	.099	.010	.010	.010	.014
UCL	.050	.077	.120	.204	.274	.446	.029	.046	.066	.079	.086	.100
LCL	.041	.066	.094	.153	.215	.212	.022	.035	.054	.066	.073	.067

__Spirotheca Thickness__

1	.011	.013	.024	.029	.029	.037
2	.009	.016	.025	.031	.032	.000
3	.006	.012	.018	.026	.026	.000
4	.012	.014	.022	.000	.022	.000
5	.010	.015	.012	.019	.019	.025
6	.009	.014	.026	.037	.043	.037
7	.014	.016	.021	.022	.024	.000
8	.009	.017	.022	.021	.027	.000
9	.009	.016	.022	.030	.034	.000
10	.010	.015	.020	.017	.020	.000

continued

__Septal Count__

	9	13	16	19	19	23
	10	16	18	21	28	00
	7	14	16	17	20	25
	10	13	19	00	27	00
	8	13	17	20	24	25
	10	14	17	18	21	00
	9	18	21	21	25	00
	8	12	14	17	23	00
	8	15	16	19	20	00
	8	14	15	19	20	25
$\bar{x}$	9	14	17	19	23	25
s	001	002	002	002	003	001
UCL	10	16	18	20	25	26
LCL	8	13	15	18	20	23

12	.012	.016	.017	.024	.028	.034	.061	.177	.386	.644	.989	1.370
13	.014	.021	.026	.028	.031	.024	.132	.296	.589	.927	1.250	1.580
14	.014	.018	.022	.018	.031	.000	.097	.225	.403	.789	1.250	1.720
15	.017	.021	.026	.032	.034	.015	.090	.193	.377	.747	1.230	1.760
16	.010	.014	.025	.029	.031	.024	.077	.174	.335	.599	1.260	1.610
17	.016	.016	.016	.024	.034	.037	.119	.228	.403	.656	.995	1.400
18	.011	.017	.024	.028	.032	.027	.097	.235	.403	.782	1.310	1.920
19	.016	.021	.027	.034	.000	.000	.099	.235	.476	.837	1.290	1.750
20	.016	.021	.020	.028	.034	.030	.084	.177	.390	.644	1.090	1.430
21	.009	.010	.015	.015	.026	.012	.090	.187	.412	.618	1.100	1.530
22	.015	.024	.030	.032	.037	.000	.084	.177	.386	.627	1.050	.000
23	.014	.024	.027	.027	.028	.000	.077	.257	.457	.908	1.330	.000
24	.013	.019	.019	.032	.030	.037	.077	.228	.377	.663	.947	1.540
25	.015	.024	.022	.037	.022	.000	.116	.225	.393	.789	1.260	1.690
26	.015	.022	.025	.031	.026	.037	.087	.264	.522	.818	1.140	1.500
27	.016	.021	.031	.037	.037	.037	.106	.241	.380	.644	.918	1.360
28	.023	.023	.023	.037	.044	.000	.097	.200	.393	.792	1.370	.000
29	.015	.026	.031	.029	.036	.037	.103	.248	.444	.802	1.290	1.680
30	.010	.013	.015	.027	.031	.033	.061	.145	.312	.570	.940	1.310
31	.013	.016	.017	.022	.030	.037	.099	.242	.444	.779	1.090	1.430
$\bar{x}$	.012	.018	.022	.028	.030	.031	.093	.218	.414	.732	1.155	1.564
s	.003	.004	.005	.006	.006	.008	.018	.038	.062	.105	.146	.171
UCL	.015	.020	.025	.031	.033	.036	.104	.241	.452	.796	1.245	1.678
LCL	.011	.016	.020	.024	.027	.025	.082	.195	.376	.667	1.065	1.445

Proloculus Diameter

1	.058	.072	8	.067	.080	16	.074	.085	23	.089	.098	30	.073	.074
2	.090	.103	9	.052	.062	17	.080	.100	24	.078	.080	31	.065	.067
3	.053	.061	10	.065	.080	18	.080	.096	25	.096	.106	$\bar{x}$	.078	.087
4	.078	.089	12	.066	.080	19	.078	.078	26	.089	.098	s	.014	.014
5	.065	.075	13	.114	.116	20	.064	.076	27	.085	.088	UCL	.085	.095
6	.075	.097	14	.080	.080	21	.082	.082	28	.091	.103	LCL	.071	.080
7	.082	.097	15	.074	.080	22	.098	.098	29	.106	.110			

FUSULINA ERUGATA, new species Arnold Member

	Half Length						Tunnel Width				
33	.119	.222	.399	.799	1.360	1.740	.046	.072	.118	.201	.376
34	.129	.309	.518	.892	1.480	2.220	.049	.121	.203	.311	.000
35	.148	.248	.428	.779	1.370	1.850	.048	.075	.107	.194	.426
36	.097	.158	.334	.618	.966	1.710	.036	.054	.102	.137	.289
37	.100	.184	.328	.644	.972	1.720	.055	.081	.172	.274	.457
38	.129	.280	.525	.895	1.430	.000	.058	.093	.206	.320	.000
39	.106	.222	.457	.889	1.490	.000	.050	.103	.170	.226	.301
40	.090	.158	.316	.611	.940	1.540	.048	.081	.114	.160	.294
41	.081	.187	.390	.683	1.040	1.660	.049	.110	.171	.340	.460
42	.116	.254	.383	.628	1.030	1.660	.048	.066	.113	.178	.400
43	.126	.254	.554	.921	1.510	.000	.056	.108	.200	.364	.000
44	.109	.228	.457	.779	1.260	1.790	.057	.094	.184	.272	.370
45	.087	.177	.289	.428	.734	1.110	.039	.062	.097	.140	.251
46	.116	.258	.493	.879	1.530	2.100	.056	.098	.160	.358	.560
47	.081	.206	.435	.708	1.060	1.410	.040	.080	.134	.278	.288
48	.113	.225	.344	.553	.811	1.200	.043	.074	.098	.172	.240
49	.100	.184	.380	.795	1.230	.000	.050	.088	.138	.252	.540
50	.113	.203	.370	.689	1.250	2.080	.048	.094	.136	.211	.540
51	.135	.303	.515	.857	1.350	.000	.058	.091	.171	.252	.000
52	.103	.213	.464	.947	1.670	.000	.050	.096	.240	.320	.720
53	.080	.213	.393	.757	1.230	1.810	.050	.076	.124	.189	.440
54	.084	.189	.412	.811	1.190	1.630	.053	.068	.148	.256	.496
55	.113	.225	.383	.650	.966	1.560	.050	.073	.098	.152	.240
56	.132	.258	.451	.715	1.120	1.600	.048	.080	.140	.286	.240
57	.106	.225	.383	.609	1.020	1.360	.052	.076	.106	.160	.240
58	.097	.187	.348	.596	1.110	1.930	.052	.090	.129	.209	.344
59a	.071	.225	.390	.644	.966	1.490	.040	.080	.112	.192	.256
59b	.113	.232	.483	.831	1.460	.000	.056	.080	.131	.260	.540
60	.122	.229	.409	.782	1.240	1.760	.044	.096	.123	.226	.290
61	.106	.264	.564	1.050	1.580	.000	.080	.108	.206	.373	.000
62	.106	.264	.515	.917	1.450	.000	.054	.102	.184	.266	.300
63	.100	.187	.422	.750	1.180	1.670	.052	.080	.130	.200	.437
64	.138	.258	.486	.731	1.250	.000	.046	.090	.126	.300	.418

$\bar{x}$	.108	.225	.425	.753	1.220	1.678	.050	.086	.145	.243	.391
s	.019	.038	.071	.134	.235	.267	.008	.015	.038	.068	.121
UCL	.117	.243	.459	.816	1.331	1.831	.054	.093	.163	.275	.454
LCL	.099	.207	.391	.689	1.108	1.525	.047	.079	.127	.211	.328

<u>Radius</u> <u>Vector</u> / <u>Tectum</u> & <u>Diaphanotheca</u>

	Radius Vector						Tectum & Diaphanotheca					
1	.046	.101	.163	.268	.405	.608	.006	.008	.009	.013	.016	.000
2	.034	.073	.112	.160	.231	.362	.006	.008	.009	.010	.013	.015
3	.049	.107	.186	.298	.454	.621	.007	.009	.011	.014	.018	.000
4	.053	.102	.149	.209	.298	.394	.005	.007	.009	.010	.010	.012
5	.038	.101	.172	.265	.392	.556	.007	.008	.010	.013	.016	.015
6	.050	.102	.174	.276	.439	.632	.007	.007	.010	.011	.015	.000
7	.038	.086	.132	.186	.286	.417	.006	.007	.009	.012	.016	.000
8	.054	.094	.141	.234	.360	.000	.006	.008	.011	.014	.000	.000
9	.042	.080	.131	.187	.288	.396	.006	.008	.009	.010	.013	.014
10	.034	.089	.154	.235	.363	.509	.006	.010	.012	.013	.015	.000
11	.046	.106	.160	.218	.288	.418	.007	.010	.010	.014	.013	.017
12	.046	.096	.146	.248	.394	.566	.006	.009	.013	.014	.016	.000
13	.041	.102	.149	.232	.351	.495	.006	.008	.012	.014	.015	.000
33	.084	.134	.217	.328	.472	.624	.006	.008	.009	.011	.013	.017
34	.088	.145	.227	.356	.518	.000	.007	.009	.009	.011	.014	.000
35	.097	.140	.204	.291	.427	.611	.006	.007	.009	.012	.014	.018
36	.054	.096	.156	.250	.380	.510	.006	.007	.008	.010	.013	.013
37	.086	.144	.223	.338	.534	.000	.006	.007	.008	.010	.015	.000
38	.094	.155	.254	.393	.566	.000	.006	.007	.009	.010	.012	.016
39	.076	.130	.200	.322	.513	.695	.007	.009	.011	.012	.014	.015
40	.062	.098	.146	.243	.360	.480	.006	.008	.009	.011	.012	.015
41	.070	.118	.194	.304	.456	.640	.007	.009	.009	.011	.015	.014
42	.088	.127	.186	.294	.434	.000	.007	.009	.010	.011	.013	.000
43	.096	.155	.245	.359	.515	.000	.006	.009	.012	.014	.014	.000
44	.074	.119	.186	.296	.453	.614	.006	.008	.010	.011	.013	.015
45	.071	.106	.146	.232	.355	.502	.006	.007	.010	.010	.012	.015
46	.078	.132	.222	.364	.510	.688	.005	.008	.009	.011	.013	.015
47	.061	.106	.174	.281	.368	.537	.006	.008	.010	.010	.011	.015

48	.078	.118	.176	.260	.366	.503	.006	.007	.010	.012	.012	.014
49	.080	.138	.216	.312	.486	.000	.005	.007	.010	.010	.012	.000
50	.077	.118	.182	.274	.426	.608	.006	.008	.010	.013	.014	.015
51	.099	.154	.240	.362	.531	.000	.007	.011	.010	.012	.015	.000
52	.082	.126	.213	.340	.502	.000	.007	.008	.009	.012	.014	.000
53	.076	.125	.145	.287	.404	.592	.005	.007	.009	.010	.012	.014
54	.077	.121	.189	.294	.428	.579	.005	.007	.010	.013	.013	.016
55	.082	.118	.167	.260	.389	.542	.005	.006	.007	.009	.013	.014
56	.098	.147	.217	.320	.486	.649	.006	.008	.010	.012	.016	.016
57	.090	.134	.202	.310	.447	.632	.006	.008	.011	.012	.013	.016
58	.084	.131	.194	.302	.466	.665	.005	.008	.010	.013	.015	.018
59a	.072	.130	.198	.294	.408	.000	.005	.007	.009	.012	.013	.000
59b	.080	.124	.209	.325	.514	.000	.006	.008	.010	.011	.014	.000
60	.086	.147	.224	.338	.487	.666	.006	.009	.014	.014	.015	.016
61	.094	.150	.266	.418	.585	.000	.007	.008	.013	.014	.016	.000
62	.091	.140	.214	.332	.502	.000	.006	.008	.010	.012	.014	.000
63	.075	.120	.197	.304	.443	.000	.007	.009	.011	.012	.015	.000
64	.077	.126	.190	.287	.426	.592	.006	.009	.011	.012	.013	.015
$\bar{x}$	.071	.120	.187	.289	.428	.559	.006	.008	.010	.012	.014	.015
s	.020	.021	.035	.055	.080	.091	.001	.001	.001	.001	.002	.001
UCL	.078	.128	.201	.311	.460	.604	.006	.008	.011	.012	.014	.016
LCL	.063	.111	.173	.267	.397	.515	.005	.007	.009	.011	.013	.014

Septal Count

1	.009	.011	.015	.019	.026	.000
2	.010	.014	.015	.016	.019	.016
3	.008	.012	.016	.016	.018	.000
4	.010	.014	.015	.019	.023	.023
5	.009	.013	.015	.017	.024	.000
6	.009	.013	.017	.018	.018	.000
7	.010	.015	.019	.020	.020	.000
8	.009	.013	.013	.015	.019	.000
9	.008	.013	.016	.021	.024	.029
10	.008	.012	.015	.017	.021	.000

Proloculus Diameter

.085	.105
.077	.087
.096	.115
.098	.116
.079	.091
.101	.111
.088	.098
.093	.113
.083	.095
.065	.086

11	.010	.013	.014	.017	.016	.023	.085	.098
12	.009	.012	.016	.019	.108	.000	.079	.096
13	.009	.015	.015	.016	.020	.000	.089	.093
$\bar{x}$	9	13	15	18	20	23		
s	001	001	001	002	003	005		
UCL	10	14	17	19	23	31		
LCL	8	12	14	16	18	15		

Chomata Height

33	.030	.045	.066	.096	.067	.096	.111
34	.033	.044	.074	.116	.000	.097	.108
35	.016	.032	.051	.074	.090	.084	.103
36	.024	.034	.054	.077	.052	.066	.080
37	.028	.043	.078	.074	.106	.075	.086
38	.026	.066	.062	.093	.000	.078	.080
39	.021	.030	.074	.096	.092	.083	.090
40	.020	.026	.052	.062	.089	.075	.080
41	.016	.026	.064	.070	.068	.085	.085
42	.021	.033	.053	.086	.070	.084	.098
43	.022	.048	.069	.094	.000	.084	.098
44	.021	.040	.072	.096	.000	.080	.093
45	.016	.026	.050	.077	.070	.081	.092
46	.020	.050	.070	.076	.090	.075	.085
47	.021	.035	.052	.042	.062	.082	.091
48	.021	.030	.045	.054	.064	.100	.112
49	.020	.048	.066	.083	.117	.075	.083
50	.022	.024	.057	.092	.077	.096	.098
51	.025	.037	.064	.088	.000	.109	.109
52	.018	.040	.052	.081	.093	.102	.112
53	.022	.030	.041	.081	.094	.091	.101
54	.020	.030	.056	.072	.104	.095	.101
55	.018	.026	.050	.080	.101	.070	.083
56	.026	.040	.058	.096	.112	.101	.114
57	.022	.041	.056	.096	.108	.089	.093

58	.019	.035	.052	.074	.092	.069	.078
59a	.021	.040	.058	.070	.062	.080	.084
59b	.028	.038	.060	.096	.120	.075	.088
60	.026	.043	.054	.054	.080	.078	.083
61	.022	.068	.074	.075	.000	.079	.087
62	.017	.038	.088	.076	.098	.075	.098
63	.019	.042	.046	.067	.080	.095	.100
64	.022	.040	.057	.065	.106	.099	.108
$\bar{x}$	.022	.038	.060	.070	.088	.085	.096
s	.004	.010	.011	.015	.019	.011	.011
UCL	.024	.043	.065	.087	.098	.089	.100
LCL	.020	.034	.055	.072	.078	.081	.092

FUSULINA HAWORTHI (Beede) emend.

Arnold Member

	Radius Vector						Tectum & Diaphanotheca					
1	.112	.167	.251	.351	.486	.676	.007	.008	.011	.013	.013	.016
2	.151	.231	.360	.522	.728	.934	.007	.009	.011	.013	.015	.019
3	.151	.235	.341	.489	.650	.853	.006	.010	.011	.012	.018	.018
4	.116	.180	.274	.393	.563	.795	.007	.009	.012	.013	.014	.016
5	.122	.213	.322	.483	.667	.924	.006	.008	.012	.013	.014	.017
6	.106	.171	.242	.364	.525	.708	.006	.009	.011	.011	.014	.017
7	.113	.151	.222	.332	.515	.702	.006	.009	.010	.011	.013	.014
8	.122	.180	.290	.448	.705	.917	.006	.009	.011	.014	.018	.017
9	.126	.196	.299	.454	.720	1.000	.006	.008	.010	.011	.013	.016
10	.106	.161	.248	.383	.560	.750	.007	.008	.011	.013	.015	.019
11	.138	.222	.320	.454	.644	.911	.006	.009	.011	.014	.015	.020
12	.109	.177	.283	.434	.612	.844	.006	.008	.012	.013	.015	.018
13	.132	.193	.290	.448	.605	.818	.006	.008	.011	.013	.015	.018
14	.103	.158	.250	.377	.554	.776	.006	.009	.011	.013	.016	.022
15	.097	.164	.261	.396	.547	.744	.007	.008	.009	.013	.015	.017
16	.090	.138	.235	.364	.531	.747	.006	.008	.010	.012	.014	.017
17	.116	.187	.280	.435	.618	.821	.007	.009	.011	.013	.015	.017

18	.113	.167	.234	.364	.518	.728	.006	.009	.011	.012	.014	.017
19	.119	.184	.274	.406	.583	.795	.006	.010	.011	.013	.014	.015
20	.097	.151	.225	.332	.480	.654	.006	.009	.011	.015	.017	.017
21	.113	.171	.283	.428	.612	.831	.007	.009	.011	.012	.013	.017
22	.101	.167	.264	.393	.541	.747	.007	.009	.011	.014	.015	.015
23	.113	.174	.254	.367	.538	.744	.008	.009	.010	.012	.014	.018
24	.109	.171	.261	.364	.528	.712	.007	.009	.011	.012	.013	.014
25	.135	.202	.293	.406	.596	.802	.006	.010	.010	.013	.014	.015
26	.132	.228	.335	.480	.673	.895	.006	.009	.012	.014	.014	.017
27	.116	.184	.277	.386	.538	.000	.006	.008	.009	.012	.012	.000
28	.122	.180	.261	.364	.509	.689	.006	.009	.010	.011	.016	.017
29	.142	.200	.296	.409	.592	.824	.007	.009	.012	.013	.016	.019
30	.113	.177	.280	.441	.618	.844	.008	.008	.010	.011	.012	.014
31	.119	.187	.277	.419	.602	.824	.006	.008	.009	.010	.011	.014
32	.119	.193	.287	.406	.570	.750	.007	.007	.012	.016	.015	.018
33	.129	.200	.296	.405	.609	.799	.007	.009	.011	.014	.014	.018
34	.087	.155	.242	.361	.515	.721	.006	.009	.010	.011	.014	.015
35	.122	.193	.306	.441	.631	.834	.007	.009	.011	.013	.016	.000
36	.129	.209	.303	.425	.596	.821	.006	.009	.011	.012	.014	.018
37	.145	.222	.320	.493	.696	.911	.007	.009	.012	.013	.016	.016
38	.103	.164	.289	.399	.576	.821	.006	.009	.011	.013	.014	.017
$\bar{x}$	.118	.184	.280	.411	.588	.802	.006	.009	.011	.013	.014	.017
s	.016	.024	.032	.047	.065	.081	.001	.001	.001	.001	.002	.002
UCL	.125	.195	.294	.431	.617	.838	.007	.009	.011	.013	.015	.018
LCL	.111	.174	.265	.390	.560	.766	.006	.008	.010	.012	.014	.016

<u>Tunnel Width</u>

14	.044	.080	.120	.174	.222	.480
15	.060	.072	.116	.160	.240	.302
16	.050	.075	.117	.140	.320	.364
17	.049	.084	.132	.212	.340	.400
18	.056	.080	.126	.194	.320	.408
19	.062	.088	.128	.172	.266	.400
20	.057	.080	.102	.182	.286	.416
21	.040	.072	.126	.167	.272	.424

<u>Half Length</u>

.181	.338	.467	.692	1.070	1.460	2.000
.183	.309	.473	.759	1.130	1.630	2.170
.145	.283	.454	.696	1.040	1.540	2.400
.190	.312	.564	.998	1.440	2.020	2.790
.206	.338	.579	.886	1.310	1.980	2.760
.164	.316	.605	.837	1.150	1.770	.000
.132	.229	.435	.673	1.110	1.620	2.370
.190	.325	.470	.821	1.260	2.820	2.450

22	.046	.085	.118	.160	.222	.246	.158	.300	.496	.789	1.150	1.590	2.180
23	.057	.083	.087	.172	.256	.480	.158	.312	.515	.734	1.150	1.660	2.190
24	.056	.080	.120	.240	.280	.440	.161	.296	.467	.686	1.150	1.550	2.080
25	.060	.080	.112	.155	.275	.356	.174	.306	.540	.831	1.290	2.090	.000
26	.065	.080	.112	.200	.240	.280	.231	.405	.621	.979	1.440	1.930	2.580
27	.058	.070	.109	.160	.240	.000	.187	.287	.457	.776	1.160	1.630	.000
28	.040	.070	.100	.164	.192	.274	.177	.296	.470	.753	1.140	1.610	2.000
29	.062	.080	.130	.175	.293	.368	.183	.367	.570	.847	1.340	1.830	.000
30	.060	.098	.124	.254	.000	.600	.190	.354	.570	.914	1.490	2.150	.000
31	.064	.080	.134	.202	.303	.440	.174	.312	.493	.766	1.250	1.830	.000
32	.048	.080	.118	.190	.240	.352	.164	.338	.528	.805	1.160	1.590	2.120
33	.062	.090	.134	.256	.320	.600	.184	.341	.567	.940	1.370	1.990	.000
34	.048	.080	.098	.144	.320	.334	.132	.293	.506	.757	1.050	1.400	2.070
35	.053	.084	.116	.164	.270	.338	.161	.303	.531	.917	1.290	1.700	2.670
36	.053	.090	.126	.190	.340	.452	.177	.364	.592	.924	1.290	1.790	2.530
37	.045	.089	.120	.230	.280	.416	.155	.300	.531	.866	1.270	1.850	2.450
38	.062	.076	.116	.220	.354	.480	.142	.290	.547	.802	1.350	1.980	2.670
$\bar{\bar{x}}$	.054	.081	.118	.187	.279	.402	.172	.317	.522	.818	1.234	1.760	2.360
s	.008	.007	.012	.033	.043	.090	.023	.035	.052	.092	..126	.203	.267
UCL	.058	.085	.124	.205	.303	.452	.184	.336	.551	.869	1.303	1.872	2.533
LCL	.050	.077	.111	.169	.255	.352	.160	.298	.493	.767	1.165	1.649	2.187

	Septal	Count					Prol.	Diam.
1	.011	.017	.022	.024	.027	.029	.112	.120
2	.012	.018	.021	.026	.030	.029	.149	.187
3	.012	.019	.024	.027	.029	.030	.155	.178
4	.013	.017	.019	.024	.028	.032	.120	.140
5	.010	.016	.023	.026	.030	.036	.112	.116
6	.011	.016	.017	.019	.023	.027	.110	.116
7	.010	.018	.018	.023	.023	.028	.112	.134
8	.009	.017	.019	.025	.028	.026	.098	.102
9	.011	.016	.021	.025	.031	.032	.119	.137
10	.011	.015	.018	.022	.025	.027	.104	.112
11	.011	.018	.020	.024	.029	.033	.134	.149
12	.012	.018	.022	.022	.026	.031	.108	.118
13	.011	.018	.021	.026	.026	.031	.124	.145

$\bar{x}$	11	17	20	24	27	30
s	001	001	002	002	003	003
UCL	12	18	22	26	29	32
LCL	10	16	19	22	26	28

Chomata Height

14	.026	.054	.090	.078	.104	.080	.130	.143
15	.037	.051	.093	.093	.090	.124	.145	.148
16	.032	.050	.075	.090	.124	.092	.102	.117
17	.032	.048	.084	.102	.112	.112	.147	.142
18	.034	.050	.080	.084	.120	.140	.142	.154
19	.030	.048	.088	.104	.112	.089	.158	.170
20	.029	.043	.066	.076	.086	.086	.120	.130
21	.030	.053	.072	.094	.108	.120	.147	.168
22	.037	.049	.093	.094	.107	.114	.120	.130
23	.038	.050	.066	.104	.134	.160	.134	.142
24	.027	.043	.075	.102	.090	.106	.118	.128
25	.034	.046	.083	.123	.120	.124	.138	.142
26	.048	.073	.097	.122	.088	.108	.160	.165
27	.036	.056	.068	.098	.140	.000	.137	.152
28	.030	.047	.062	.080	.100	.120	.110	.134
29	.035	.059	.066	.124	.098	.106	.186	.186
30	.032	.065	.088	.092	.144	.136	.139	.160
31	.036	.040	.048	.080	.100	.100	.117	.130
32	.038	.059	.059	.088	.104	.100	.117	.130
33	.034	.054	.070	.122	.104	.108	.152	.152
34	.036	.050	.077	.101	.132	.109	.118	.126
35	.044	.060	.084	.091	.104	.122	.153	.174
36	.040	.058	.072	.100	.112	.112	.129	.147
37	.040	.060	.080	.124	.128	.120	.128	.150
38	.030	.055	.090	.104	.080	.096	.140	.152
$\bar{x}$	.035	.053	.077	.099	.110	.112	.130	.143
s	.005	.007	.012	.015	.017	.018	.019	.021
UCL	.037	.057	.084	.107	.119	.122	.139	.152
LCL	.032	.049	.070	.091	.100	.102	.122	.134

FUSULINA aff. F. WHITAKERI Stewart Unnamed Limestone between Rocky Point Member and Camp Ground Member

	Half Length							Tunnel Width					
16	.225	.422	.628	1.180	1.780	2.510	.000	.068	.080	.142	.320	.420	.522
17	.209	.364	.538	.892	1.460	2.120	2.980	.064	.080	.146	.200	.240	.440
18	.248	.477	.737	1.070	1.610	2.250	.000	.064	.090	.160	.246	.360	.000
19	.174	.296	.589	.908	1.370	2.110	.000	.054	.072	.108	.160	.240	.480
20	.177	.386	.605	.947	1.710	2.610	.000	.062	.092	.124	.186	.320	.000
21	.229	.451	.856	1.200	1.870	2.700	.000	.066	.089	.160	.248	.336	.000
22	.161	.348	.544	.866	1.240	1.890	.000	.067	.080	.128	.240	.301	.000
23	.276	.534	.875	1.610	2.250	2.860	.000	.069	.108	.192	.374	.437	.000
24	.174	.338	.586	.953	1.430	1.990	.000	.058	.072	.104	.198	.320	.524
25	.164	.313	.544	.976	1.540	2.110	2.940	.048	.058	.088	.139	.260	.338
26	.158	.309	.660	.940	1.490	2.280	2.870	.056	.064	.102	.205	.320	.400
27	.184	.364	.711	1.120	1.610	2.430	3.030	.064	.080	.144	.216	.260	.432
28	.247	.434	.779	1.230	1.970	2.440	.000	.060	.103	.184	.192	.298	.530
29	.194	.390	.631	.844	1.180	1.490	1.930	.052	.102	.106	.165	.302	.344
30	.257	.531	.756	1.220	1.700	2.140	.000	.060	.092	.121	.176	.292	.340
31	.167	.370	.721	1.140	1.700	2.360	3.120	.052	.080	.142	.224	.444	.760
32	.206	.406	.689	1.210	1.860	2.500	.000	.068	.098	.186	.240	.296	.352
33	.209	.390	.602	.976	1.590	2.230	.000	.059	.098	.132	.261	.467	.000
34	.164	.370	.612	1.040	1.580	2.130	2.670	.044	.080	.123	.194	.307	.480
35	.238	.518	.891	1.260	1.870	2.370	.000	.080	.112	.232	.320	.600	.000
36	.193	.377	.538	.940	1.540	2.310	.000	.052	.070	.118	.200	.347	.496
37	.209	.431	.782	1.300	1.960	2.690	.000	.062	.098	.178	.227	.312	.560
38	.235	.431	.702	1.160	1.950	.000	.000	.054	.102	.176	.304	.000	.000
39	.193	.383	.580	.818	1.260	1.770	2.250	.060	.080	.128	.240	.320	.360
$\bar{x}$	.204	.401	.673	1.075	1.647	2.273	2.724	.060	.087	.143	.228	.339	.460
s	.034	.066	.108	.185	.262	.316	.421	.008	.014	.035	.056	.084	.111
UCL	.223	.438	.734	1.178	1.793	2.454	3.151	.065	.095	.162	.260	.387	.537
LCL	.185	.365	.612	.972	1.500	2.093	2.297	.056	.079	.123	.197	.291	.383

	Radius Vector						Tectum & Diaphanotheca					
1	.122	.180	.287	.419	.602	.845	.007	.008	.011	.011	.017	.021
2	.126	.196	.296	.441	.628	.847	.007	.010	.011	.013	.015	.020
3	.145	.212	.320	.480	.660	.869	.007	.009	.013	.014	.018	.021
4	.158	.254	.396	.567	.782	.000	.006	.009	.012	.017	.019	.000
5	.119	.193	.287	.403	.573	.802	.007	.009	.011	.013	.017	.019
6a	.167	.248	.367	.531	.760	.972	.007	.011	.012	.016	.018	.000
6b	.103	.167	.242	.354	.518	.000	.004	.007	.011	.013	.024	.024
7	.093	.161	.245	.341	.457	.627	.007	.009	.012	.014	.017	.019
8	.113	.180	.293	.470	.650	.805	.006	.009	.012	.016	.017	.019
9	.129	.213	.322	.440	.618	.000	.007	.009	.012	.016	.018	.000
10	.119	.187	.283	.419	.644	.000	.008	.008	.011	.014	.017	.000
11	.151	.245	.367	.528	.730	.000	.007	.010	.011	.015	.019	.000
12	.145	.235	.341	.483	.689	.918	.006	.012	.013	.016	.020	.024
13	.135	.200	.296	.412	.551	.718	.007	.010	.012	.013	.019	.022
14	.129	.184	.280	.403	.586	.000	.007	.010	.013	.014	.021	.000
15	.126	.196	.316	.441	.644	.889	.006	.010	.013	.015	.018	.021
16	.161	.242	.348	.499	.708	.953	.007	.011	.013	.014	.016	.021
17	.116	.180	.270	.397	.576	.792	.006	.009	.013	.018	.020	.022
18	.138	.216	.335	.489	.676	.869	.007	.010	.014	.016	.017	.019
19	.093	.142	.213	.322	.493	.728	.007	.008	.011	.015	.017	.021
20	.103	.177	.261	.370	.522	.705	.007	.009	.011	.014	.020	.021
21	.148	.232	.351	.506	.702	.950	.007	.010	.011	.014	.018	.026
22	.106	.164	.258	.380	.563	.766	.006	.008	.012	.016	.018	.022
23	.161	.254	.361	.518	.725	.937	.006	.009	.010	.012	.017	.020
24	.100	.161	.261	.393	.583	.789	.007	.008	.011	.013	.018	.022
25	.103	.145	.232	.367	.531	.692	.007	.009	.012	.013	.015	.021
26	.097	.155	.232	.354	.541	.731	.006	.009	.011	.013	.017	.019
27	.116	.167	.258	.386	.573	.732	.007	.010	.012	.016	.018	.021
28	.148	.229	.341	.502	.728	.982	.006	.009	.013	.016	.019	.020
29	.113	.187	.299	.409	.564	.763	.006	.010	.013	.016	.018	.021
30	.151	.219	.322	.444	.644	.886	.007	.013	.013	.018	.020	.020
31	.074	.144	.248	.373	.544	.734	.008	.010	.013	.015	.019	.022
32	.125	.200	.312	.470	.692	.911	.007	.010	.012	.016	.018	.021
33	.119	.193	.296	.480	.673	.870	.007	.009	.012	.016	.020	.024
34	.093	.151	.225	.357	.506	.708	.007	.009	.011	.015	.019	.021

35	.151	.216	.380	.512	.676	.000	.007	.010	.012	.015	.017	.000
36	.100	.158	.245	.360	.528	.731=	.007	.010	.012	.014	.019	.022
37	.119	.174	.264	.416	.621	.000	.006	.008	.012	.013	.018	.020
38	.122	.209	.322	.480	.728	.000	.007	.009	.012	.014	.017	.000
39	.119	.177	.267	.403	.592	.786	.007	.009	.013	.015	.017	.019
$\bar{x}$	.124	.194	.296	.433	.620	.818	.007	.009	.012	.015	.018	.021
s	.023	.032	.047	.062	.081	.094	.001	.001	.001	.002	.002	.002
UCL	.134	.207	.316	.459	.654	.864	.007	.010	.012	.015	.019	.022
LCL	.114	.180	.276	.406	.585	.772	.006	.009	.011	.014	.017	.020

Septal Count

1	.011	.018	.022	.024	.030	.029
2	.009	.018	.023	.025	.029	.034
3	.010	.020	.022	.025	.028	.030
4	.014	.020	.026	.029	.033	.000
5	.010	.016	.018	.025	.029	.031
6a	.010	.022	.022	.028	.029	.030
6b	.010	.017	.022	.023	.025	.000
7	.011	.018	.021	.021	.030	.032
8	.009	.017	.021	.025	.000	.034
9	.013	.021	.019	.022	.030	.000
10	.009	.017	.021	.024	.027	.000
11	.012	.018	.023	.023	.026	.031
12	.011	.020	.020	.025	.030	.031
13	.011	.018	.021	.025	.030	.033
14	.012	.014	.017	.021	.027	.000
15	.010	.018	.018	.024	.029	.032
$\bar{x}$	11	18	21	24	29	32
s	001	002	002	002	002	002
UCL	12	20	23	26	30	33
LCL	10	17	19	23	27	30

Prol. Diam.

.123	.131
.119	.140
.126	.155
.149	.193
.106	.117
.165	.173
.112	.125
.100	.123
.098	.112
.120	.135
.135	.142
.151	.166
.153	.156
.134	.147
.121	.146
.120	.129

Chomata Height

16	.046	.070	.054	.088	.136	.078	.162	.172
17	.045	.068	.120	.104	.128	.126	.117	.146
18	.044	.064	.072	.124	.115	.000	.147	.172
19	.021	.048	.080	.102	.123	.160	.126	.143
20	.048	.056	.090	.086	.118	.000	.122	.142
21	.052	.080	.090	.123	.133	.000	.146	.166
22	.024	.050	.080	.108	.124	.000	.138	.148
23	.056	.066	.080	.093	.136	.000	.160	.171
24	.044	.058	.092	.098	.144	.140	.142	.156
25	.036	.050	.096	.104	.098	.142	.142	.154
26	.028	.048	.080	.128	.092	.138	.120	.120
27	.029	.050	.092	.112	.100	.124	.150	.158
28	.046	.076	.112	.144	.132	.112	.150	.150
29	.048	.058	.074	.094	.108	.118	.154	.168
30	.036	.054	.080	.120	.152	.132	.142	.165
31	.032	.052	.090	.104	.080	.110	.094	.118
32	.043	.052	.080	.104	.126	.110	.124	.148
33	.044	.044	.120	.132	.108	.000	.132	.139
34	.032	.049	.092	.092	.080	.075	.115	.122
35	.038	.084	.098	.064	.062	.000	.146	.168
36	.036	.048	.060	.080	.120	.112	.134	.152
37	.034	.048	.078	.112	.076	.105	.149	.150
38	.060	.060	.080	.112	.000	.000	.123	.138
39	.042	.055	.080	.112	.128	.080	.134	.148
$\bar{x}$	.038	.057	.084	.100	.109	.113	.133	.148
s	.008	.010	.019	.023	.026	.024	.018	.018
UCL	.042	.062	.094	.111	.123	.128	.140	.156
LCL	.035	.052	.074	.088	.095	.097	.125	.140

FUSULINA ACME Dunbar and Henbest

Camp Ground Member

Half Length

17	.231	.457	.844	1.340	2.170	3.130	.000
18	.231	.435	.689	1.180	1.780	2.490	3.250
19	.200	.357	.644	1.230	1.770	2.610	3.360
20	.231	.470	.876	1.350	2.140	3.220	.000
21	.167	.348	.644	1.010	1.510	2.230	2.980
22	.251	.486	.723	1.060	1.880	2.560	3.220
23	.170	.367	.560	.867	1.520	2.240	.000
24	.258	.470	.879	1.260	2.090	2.780	.000
25	.216	.428	.708	1.090	1.590	2.390	3.140
26	.219	.399	.676	.998	1.880	2.050	.000
27	.235	.431	.805	1.350	1.930	2.530	.000
28	.190	.345	.605	1.020	1.590	2.250	3.020
29	.187	.345	.644	1.020	1.550	2.260	.000
30	.161	.325	.551	.943	1.420	1.970	2.640
31	.193	.361	.609	1.150	1.760	2.500	3.170
32	.203	.444	.773	1.060	1.570	2.150	3.040
33	.206	.412	.773	1.210	1.810	2.470	3.320
34	.296	.547	.934	1.410	2.090	2.990	.000
35	.241	.413	.644	1.050	1.680	2.390	.000
36	.238	.419	.741	1.160	1.610	2.300	3.320
37	.213	.348	.734	1.030	1.550	2.230	2.900
38	.203	.415	.683	1.050	1.450	1.840	.000
39	.209	.409	.705	1.050	1.630	2.230	3.030
40	.248	.547	1.060	1.610	2.100	.000	.000
41	.248	.438	.702	1.160	1.780	2.380	3.150
42	.264	.460	.847	1.440	2.080	.000	.000
43	.229	.412	.718	1.280	1.890	2.760	3.400
44	.219	.423	.750	1.100	1.580	2.220	.000
45	.232	.370	.628	1.050	1.660	2.280	3.040
46	.232	.399	.824	1.220	1.960	2.840	.000
$\bar{x}$	.221	.416	.732	1.159	1.767	2.439	3.124
s	.030	.056	.114	.165	.224	.332	.196
UCL	.236	.444	.789	1.241	1.879	2.611	3.259
LCL	.206	.388	.675	1.076	1.655	2.267	2.988

Tunnel Width

17	.070	.106	.206	.400	.680	1.040
18	.068	.094	.134	.240	.340	.604
19	.053	.088	.134	.240	.344	.800
20	.068	.124	.186	.360	.620	.000
21	.062	.091	.110	.218	.336	.540
22	.067	.116	.160	.234	.361	.736
23	.058	.100	.130	.196	.268	.520
24	.062	.086	.165	.270	.000	.000
25	.064	.094	.110	.240	.328	.500
26	.060	.086	.160	.230	.352	.450
27	.080	.144	.192	.384	.680	.000
28	.064	.096	.136	.170	.275	.560
29	.062	.092	.144	.204	.374	.560
30	.058	.080	.136	.148	.250	.424
31	.056	.068	.148	.218	.400	.720
32	.070	.092	.147	.246	.388	.620
33	.068	.096	.160	.216	.400	.560
34	.066	.103	.183	.270	.440	.000
35	.060	.102	.171	.262	.444	.000
36	.064	.088	.142	.278	.440	.742
37	.070	.080	.107	1.780	.320	.574
38	.067	.090	.176	.302	.380	.800
39	.070	.104	.131	.220	.320	.454
40	.070	.132	.228	.380	.000	.000
41	.056	.090	.160	.222	.274	.480
42	.070	.132	.186	.280	.000	.000
43	.068	.080	.188	.280	.480	.600
44	.064	.080	.120	.188	.360	.600
45	.060	.088	.154	.236	.400	.000
46	.080	.114	.193	.300	.520	.000
$\bar{x}$	.065	.098	.157	.307	.399	.614
s	.006	.018	.030	.284	.114	.148
UCL	.068	.107	.171	.449	.459	.702
LCL	.062	.089	.142	.166	.339	.525

	Radius Vector						Tectum & Diaphanotheca					
1	.191	.272	.370	.498	.682	.870	.009	.012	.013	.017	.019	.023
2	.209	.322	.441	.566	.792	1.010	.008	.011	.012	.014	.018	.022
3	.182	.274	.375	.516	.698	.880	.009	.010	.014	.015	.018	.026
4	.165	.228	.348	.500	.708	.981	.010	.012	.015	.016	.018	.024
5	.123	.178	.282	.390	.549	.755	.010	.011	.014	.016	.018	.025
6	.138	.212	.320	.494	.654	.885	.008	.011	.014	.014	.019	.023
17	.164	.251	.380	.547	.750	.966	.009	.010	.014	.016	.019	.024
18	.148	.213	.316	.477	.683	.911	.010	.011	.014	.016	.021	.028
19	.097	.151	.251	.396	.615	.847	.008	.011	.014	.017	.022	.025
20	.164	.251	.386	.547	.766	.992	.008	.012	.014	.016	.021	.026
21	.106	.171	.245	.361	.524	.708	.009	.012	.012	.016	.020	.023
22	.180	.261	.351	.496	.650	.850	.008	.010	.015	.016	.020	.022
23	.119	.196	.296	.412	.576	.831	.008	.012	.014	.018	.020	.023
24	.135	.209	.302	.457	.683	.934	.008	.011	.014	.017	.018	.025
25	.138	.222	.322	.475	.644	.882	.008	.011	.014	.017	.018	.025
26	.135	.209	.312	.464	.663	.892	.009	.011	.016	.020	.023	.026
27	.167	.250	.367	.547	.718	.940	.009	.012	.014	.017	.022	.023
28	.103	.164	.261	.386	.557	.782	.008	.012	.015	.016	.024	.025
29	.097	.151	.242	.351	.583	.786	.008	.011	.014	.018	.020	.024
30	.090	.155	.248	.377	.538	.750	.008	.010	.013	.014	.017	.020
31	.103	.164	.242	.341	.496	.657	.009	.010	.012	.013	.017	.021
32	.106	.167	.261	.396	.589	.786	.008	.010	.012	.016	.020	.028
33	.151	.232	.320	.499	.718	.960	.008	.010	.014	.016	.018	.022
34	.167	.248	.377	.547	.760	1.000	.009	.012	.014	.016	.021	.025
35	.113	.184	.280	.435	.621	.886	.008	.012	.016	.016	.021	.024
36	.145	.225	.341	.502	.670	.879	.009	.010	.013	.016	.020	.026
37	.145	.213	.300	.419	.573	.799	.008	.010	.012	.017	.020	.024
38	.135	.203	.325	.477	.631	.850	.009	.011	.013	.016	.019	.022
39	.145	.225	.322	.451	.573	.760	.008	.012	.013	.015	.018	.021
40	.174	.273	.396	.586	.776	.000	.010	.013	.014	.019	.022	.000
41	.167	.242	.345	.493	.644	.856	.008	.012	.013	.016	.019	.022
42	.154	.267	.415	.586	.828	.000	.008	.012	.014	.019	.021	.000
43	.132	.200	.316	.477	.712	.937	.009	.010	.014	.017	.018	.022
44	.132	.200	.290	.419	.576	.773	.010	.010	.011	.016	.016	.020
45	.135	.219	.322	.487	.683	.911	.008	.012	.014	.016	.020	.022
46	.180	.258	.367	.528	.715	.918	.010	.013	.016	.016	.022	.028

x̄	.143	.218	.323	.469	.656	.865	.009	.011	.014	.016	.020	.024
s	.030	.041	.052	.067	.082	.087	.001	.001	.001	.002	.002	.002
UCL	.156	.237	.347	.500	.693	.906	.009	.012	.014	.017	.021	.025
LCL	.129	.200	.300	.439	.619	.825	.008	.011	.013	.016	.019	.023

Septal Count

Prol. Diam.

1	.012	.020	.025	.022	.030	.037	.193	.203
2	.016	.020	.022	.027	.028	.030	.209	.216
3	.013	.109	.022	.026	.027	.034	.210	.231
4	.012	.018	.023	.026	.030	.036	.169	.193
5	.009	.016	.018	.023	.028	.028	.121.	.128
6	.009	.017	.022	.021	.028	.027	.145	.161

x̄	12	18	22	24	28	32
s	003	002	002	002	001	004
UCL	17	21	26	29	31	40
LCL	8	15	18	20	26	24

17	.044	.054	.080	.099	.116	.109	.170	.201
18	.035	.068	.124	.118	.140	.121	.194	.199
19	.034	.061	.076	.120	.146	.100	.104	.154
20	.048	.080	.117	.100	.000	.000	.160	.170
21	.029	.051	.070	.073	.080	.067	.140	.147
22	.044	.054	.088	.088	.128	.072	.178	.198
23	.039	.069	.071	.071	.128	.130	.136	.165
24	.038	.062	.094	.120	.128	.000	.147	.182
25	.038	.051	.088	.064	.072	.128	.185	.190
26	.146	.072	.112	.140	.160	.126	.182	.200
27	.038	.066	.108	.090	.064	.000	.240	.240
28	.038	.064	.090	.120	.116	.134	.140	.141
29	.027	.048	.078	.102	.080	.066	.121	.134
30	.030	.052	.060	.096	.096	.120	.170	.201
31	.028	.042	.056	.072	.072	.112	.132	.140
32	.026	.044	.080	.088	.062	.124	.144	.148
33	.045	.054	.066	.088	.120	.000	.160	.160

34	.048	.067	.080	.120	.140	.000	.148	.164
35	.040	.050	.076	.106	.112	.000	.152	.171
36	.041	.070	.092	.112	.121	.104	.134	.144
37	.024	.045	.072	.090	.115	.160	.151	.151
38	.030	.050	.098	.094	.090	.000	.166	.170
39	.040	.052	.062	.096	.100	.100	.154	.160
40	.048	.052	.068	.066	.000	.000	.198	.206
41	.045	.067	.100	.094	.112	.109	.236	.240
42	.054	.056	.120	.160	.000	.000	.210	.228
43	.045	.060	.080	.112	.123	.132	.160	.176
44	.040	.058	.091	.098	.102	.128	.160	.173
45	.042	.056	.060	.120	.120	.000	.192	.204
46	.030	.037	.054	.068	.100	.110	.148	.209
							min.	max.
x̄	.038	.057	.084	.100	.109	.113	.164	.179
s	.008	.010	.019	.023	.026	.024	.033	.032
UCL	.042	.062	.094	.111	.123	.128	.179	.193
LCL	.035	.052	.074	.088	.095	.097	.149	.164

WEDEKINDELLINA? ARDMORENSIS Thompson, Verville, and Lokke Confederate Member

	Half Length							Tunnel Width					
17	.196	.366	.589	.883	1.390	1.850	.000	.046	.078	.141	.227	.373	.000
18	.131	.251	.415	.621	1.010	1.530	2.020	.038	.075	.104	.138	.190	.359
19	.156	.304	.484	.778	1.200	1.570	2.030	.043	.067	.128	.259	.406	.000
20	.131	.294	.474	.821	1.150	1.690	2.230	.050	.055	.088	.149	.266	.359
21	.147	.268	.458	.687	1.180	1.670	2.360	.043	.066	.095	.163	.260	.428
22	.144	.268	.441	.719	1.020	1.500	2.120	.049	.057	.081	.125	.215	.289
23	.114	.268	.503	.677	1.140	1.580	.000	.040	.060	.113	.189	.293	.000
24	.111	.239	.455	.746	1.260	1.650	2.120	.050	.081	.142	.197	.325	.000
25	.157	.307	.523	.771	1.210	1.880	2.230	.045	.073	.127	.179	.285	.439
26	.156	.301	.562	.906	1.330	2.110	.000	.046	.081	.153	.280	.394	.000
27	.124	.301	.546	.853	1.310	1.850	.000	.044	.077	.163	.238	.424	.000
28	.121	.268	.497	.759	1.190	1.830	2.360	.045	.076	.117	.157	.293	.373

29	.118	.258	.392	.670	1.170	1.850	2.230	.041	.062	.106	.162	.248	.520
30	.141	.317	.553	.869	1.430	1.960	0.000	.050	.081	.128	.222	.309	.528
31	.163	.301	.484	.909	1.300	1.850	2.350	.058	.068	.145	.215	.373	.443
32	.141	.301	.497	.853	1.280	1.890	.000	.046	.072	.124	.234	.372	.000
33	.124	.255	.487	.860	1.260	1.810	2.230	.049	.072	.126	.183	.346	.378
34	.128	.245	.428	.687	.964	1.370	1.980	.050	.065	.096	.163	.315	.386
35	.111	.242	.383	.567	.903	1.310	1.880	.045	.061	.081	.163	.244	.441
36	.118	.222	.425	.726	1.150	1.610	2.140	.036	.057	.102	.163	.305	.000
37	.134	.271	.428	.706	1.100	1.620	2.090	.051	.071	.126	.159	.292	.359
38	.157	.311	.474	.785	1.270	1.600	2.290	.055	.072	.147	.230	.407	.610
39	.111	.275	.458	.716	1.090	1.530	2.060	.049	.064	.103	.133	.208	.311
40	.114	.261	.451	.795	1.140	1.520	.000	.044	.069	.125	.215	.348	.000
41	.128	.245	.425	.778	1.260	1.750	2.290	.044	.065	.103	.191	.281	.407
42	.121	.268	.428	.765	1.080	1.520	2.020	.041	.068	.128	.163	.290	.447
43	.124	.278	.477	.746	1.100	1.640	2.060	.047	.063	.103	.187	.334	.000
44	.124	.252	.468	.687	1.130	1.640	2.320	.047	.073	.111	.177	.298	.407
45	.131	.264	.464	.804	1.240	1.810	.000	.055	.075	.130	.187	.350	.000
46	.114	.229	.379	.624	.981	1.610	2.270	.049	.045	.107	.163	.303	.488
$\bar{x}$	.133	.273	.468	.759	1.175	1.687	2.167	.047	.068	.118	.187	.312	.420
s	.020	.033	.052	.098	.126	.179	.138	.005	.009	.021	.038	.060	.078
UCL	.143	.289	.494	.802	1.237	1.776	2.248	.049	.073	.129	.206	.342	.469
LCL	.123	.257	.443	.716	1.112	1.597	2.086	.044	.064	.108	.168	.282	.370

	Radius Vector							Tectum & Diaphanotheca						
1	.065	.098	.141	.213	.319	.435	.615	.006	.007	.009	.010	.013	.015	.021
2	.069	.114	.183	.268	.383	.540	.710	.006	.007	.010	.012	.016	.019	.021
3	.065	.105	.160	.242	.347	.513	.697	.007	.008	.009	.010	.014	.020	.022
4	.056	.092	.141	.216	.327	.451	.631	.006	.007	.010	.011	.014	.018	.021
5	.072	.118	.167	.252	.373	.549	.745	.006	.007	.009	.012	.014	.017	.022
6	.085	.134	.209	.311	.448	.598	.000	.007	.008	.012	.014	.018	.020	.000
7	.082	.134	.206	.327	.438	.578	.762	.006	.008	.010	.013	.016	.020	.022
8	.082	.147	.206	.304	.428	.598	.759	.006	.008	.010	.014	.016	.018	.022
9	.085	.131	.186	.268	.373	.497	.676	.006	.007	.010	.013	.015	.019	.020
10	.075	.128	.196	.298	.448	.660	.876	.005	.006	.009	.013	.015	.017	.020
11	.072	.118	.196	.291	.402	.582	.765	.006	.007	.009	.012	.012	.016	.019

12	.088	.147	.216	.310	.425	.585	.772	.006	.007	.010	.014	.015	.021	.023
13	.072	.124	.186	.288	.402	.536	.726	.005	.007	.010	.012	.014	.000	.000
14	.069	.131	.213	.327	.468	.695	.000	.006	.007	.009	.011	.015	.019	.000
15	.078	.127	.199	.297	.415	.615	.837	.006	.007	.010	.014	.016	.019	.000
16	.078	.121	.164	.249	.370	.526	.719	.006	.008	.009	.011	.016	.018	.018
17	.088	.143	.212	.301	.441	.586	.000	.005	.008	.009	.013	.015	.018	.000
18	.071	.118	.173	.229	.311	.438	.582	.006	.007	.010	.014	.016	.019	.021
19	.082	.131	.199	.314	.435	.569	.739	.006	.007	.010	.014	.016	.019	.020
20	.072	.124	.190	.275	.389	.533	.697	.005	.007	.009	.012	.015	.019	.019
21	.085	.124	.190	.279	.409	.589	.778	.005	.007	.011	.013	.017	.019	.021
22	.072	.111	.173	.252	.343	.500	.697	.005	.008	.013	.014	.016	.019	.023
23	.078	.121	.186	.255	.376	.565	.000	.006	.007	.011	.013	.016	.020	.000
24	.091	.141	.202	.288	.409	.589	.768	.005	.009	.011	.014	.017	.019	.00
25	.107	.157	.222	.327	.455	.638	.827	.006	.008	.010	.014	.014	.021	.025
26	.095	.137	.206	.298	.432	.625	.000	.007	.008	.010	.013	.016	.018	.021
27	.091	.150	.222	.320	.435	.568	.000	.006	.007	.010	.013	.016	.019	.000
28	.082	.124	.193	.278	.405	.559	.739	.005	.007	.009	.012	.017	.022	.023
29	.075	.114	.173	.255	.376	.546	.732	.004	.006	.009	.011	.016	.021	.022
30	.092	.137	.222	.314	.445	.611	.808	.005	.007	.010	.014	.018	.019	.022
31	.101	.160	.225	.324	.464	.602	.736	.005	.008	.010	.013	.017	.017	.022
32	.088	.144	.213	.311	.455	.631	.000	.004	.008	.009	.012	.018	.022	.000
33	.072	.121	.186	.284	.383	.517	.703	.005	.007	.009	.012	.016	.020	.022
34	.078	.118	.170	.252	.356	.504	.690	.004	.007	.009	.010	.015	.017	.020
35	.075	.114	.164	.235	.350	.500	.693	.004	.007	.010	.012	.015	.018	.019
36	.065	.105	.164	.252	.389	.556	.726	.006	.008	.011	.013	.017	.020	.021
37	.075	.121	.180	.252	.363	.513	.674	.005	.007	.010	.012	.015	.016	.021
38	.111	.147	.196	.278	.392	.540	.710	.005	.007	.012	.013	.015	.018	.021
39	.082	.128	.186	.261	.350	.455	.628	.005	.007	.010	.013	.015	.017	.020
40	.075	.114	.177	.265	.396	.556	.000	.004	.006	.010	.013	.017	.019	.000
41	.072	.118	.180	.268	.412	.579	.772	.005	.007	.009	.011	.016	.018	.024
42	.075	.111	.164	.239	.363	.481	.638	.004	.008	.010	.014	.015	.019	.021
43	.065	.111	.186	.284	.435	.608	.788	.004	.006	.009	.013	.016	.021	.022
44	.082	.131	.203	.294	.438	.587	.778	.005	.008	.010	.013	.017	.018	.020
45	.088	.128	.190	.291	.428	.595	.000	.005	.008	.010	.014	.017	.020	.000
46	.067	.108	.157	.239	.340	.481	.631	.005	.007	.009	.012	.015	.019	.019

x̄	.079	.126	.189	.278	.399	.556	.725	.005	.007	.010	.013	.016	.019	.021
s	.011	.015	.021	.031	.041	.058	.065	.001	.001	.001	.001	.001	.002	.001
UCL	.084	.132	.197	.290	.415	.579	.754	.006	.008	.010	.013	.016	.019	.022
LCL	.075	.120	.180	.265	.382	.533	.696	.005	.007	.009	.012	.015	.018	.020

Septal Count — Prol. Diam.

								Prol. Diam.
1	.008	.012	.016	.016	.018	.020	.018	.069
2	.009	.012	.016	.014	.015	.018	.020	.076
3	.008	.013	.014	.017	.019	.020	.024	.066
4	.008	.012	.014	.015	.019	.021	.022	.059
5	.010	.013	.015	.016	.015	.018	.018	.087
6	.009	.014	.015	.016	.018	.020	.000	.072
7	.008	.013	.016	.016	.020	.022	.019	.083
8	.008	.013	.016	.019	.021	.021	.020	.080
9	.008	.014	.016	.016	.018	.020	.020	.094
10	.008	.013	.015	.017	.020	.021	.020	.081
11	.008	.012	.013	.013	.019	.021	.020	.067
12	.007	.013	.016	.016	.018	.019	.018	.087
13	.009	.014	.016	.016	.017	.018	.018	.088
14	.008	.014	.015	.016	.020	.020	.000	.082
15	.008	.012	.016	.017	.020	.020	.020	.082
16	.009	.012	.015	.017	.017	.021	.020	.089

x̄	8	13	15	16	18	20	20
s	001	001	001	001	002	001	002
UCL	9	13	16	17	20	21	21
LCL	8	12	15	15	17	19	19

Chomata Height

17	.024	.037	.054	.050	.072	.000	.104
18	.016	.023	.016	.047	.060	.042	.100
19	.020	.024	.039	.050	.060	.000	.095
20	.028	.025	.056	.047	.077	.101	.089
21	.020	.028	.071	.098	.085	.000	.100
22	.022	.031	.031	.043	.057	.090	.090
23	.020	.024	.024	.051	.119	.000	.086

24	.021	.025	.023	.052	.060	.057	.094
25	.018	.025	.054	.063	.101	.039	.113
26	.021	.109	.044	.055	.100	.000	.108
27	.020	.030	.050	.049	.000	.000	.102
28	.021	.038	.047	.077	.102	.122	.077
29	.025	.023	.045	.067	.077	.041	.081
30	.020	.030	.059	.059	.063	.000	.118
31	.028	.036	.050	.063	.044	.061	.120
32	.026	.026	.031	.050	.054	.000	.079
33	.024	.035	.053	.057	.067	.050	.092
34	.020	.028	.056	.073	.079	.067	.090
35	.020	.020	.029	.061	.065	.073	.079
36	.021	.029	.065	.081	.053	.000	.084
37	.025	.024	.033	.063	.054	.043	.096
38	.022	.024	.047	.033	.083	.037	.122
39	.018	.038	.048	.036	.048	.084	.078
40	.019	.027	.043	.071	.058	.000	.098
41	.019	.024	.054	.081	.054	.000	.106
42	.020	.031	.063	.072	.087	.000	.094
43	.020	.025	.041	.081	.073	.000	.098
44	.019	.030	.041	.075	.120	.000	.081
45	.022	.030	.041	.081	.073	.000	.110
46	.014	.026	.033	.063	.095	.077	.097
$\bar{x}$	.021	.028	.045	.062	.074	.066	.090
s	.003	.006	.013	.015	.021	.025	.014
UCL	.023	.030	.051	.069	.084	.084	.096
LCL	.020	.025	.038	.054	.063	.047	.084

WEDEKINDELLINA? ARDMORENSIS Thompson, Verville, and Lokke

Confederate Member,
Pleasant Hill Syncline

Radius Vector

1	.077	.121	.174	.246	.345	.454
2	.078	.124	.199	.287	.400	.000
3	.096	.157	.240	.350	.000	.000

Tectum & Keriotheca

.007	.009	.010	.012	.015	.017
.007	.009	.011	.014	.020	.022
.008	.010	.013	.013	.015	.000

5	.080	.123	.196	.279	.405	.000	.006	.009	.010	.013	.017	.000
6	.078	.133	.209	.305	.450	.573	.007	.008	.010	.013	.015	.017
7	.070	.114	.172	.232	.323	.444	.006	.009	.010	.012	.017	.021
8	.064	.104	.162	.246	.360	.488	.006	.008	.010	.013	.018	.000
9	.066	.106	.162	.237	.344	.500	.006	.008	.010	.013	.017	.022
10	.080	.118	.180	.270	.382	.530	.007	.009	.011	.011	.016	.020
11	.068	.126	.187	.262	.373	.514	.007	.008	.010	.013	.016	.021
12	.072	.111	.168	.249	.354	.504	.006	.007	.011	.013	.017	.019
13	.062	.096	.148	.230	.324	.469	.006	.008	.010	.013	.015	.018
14	.080	.127	.180	.254	.355	.494	.006	.007	.009	.012	.015	.021
$\bar{x}$	.075	.120	.183	.265	.368	.497	.007	.008	.010	.013	.016	.020
s	.009	.015	.024	.034	.037	.038	.001	.001	.001	.001	.001	.002
UCL	.083	.133	.204	.295	.402	.538	.007	.009	.011	.013	.018	.022
LCL	.067	.107	.162	.235	.334	.456	.006	.008	.010	.012	.015	.018

	Half Length						Chomata Height				
6	.113	.309	.580	1.060	1.540	2.160	.026	.032	.048	.058	.068
7	.084	.242	.441	.747	1.180	1.690	.020	.029	.048	.054	.064
8	.084	.222	.370	.666	1.060	1.460	.028	.038	.049	.056	.066
9	.077	.177	.320	.580	.998	1.500	.018	.029	.044	.060	.000
10	.103	.222	.412	.676	1.100	1.510	.025	.034	.043	.059	.055
11	.119	.251	.379	.644	1.060	1.580	.021	.027	.042	.056	.064
12	.087	.228	.405	.730	1.280	1.750	.020	.035	.040	.056	.060
13	.084	.193	.322	.576	1.060	1.630	.017	.032	.058	.058	.068
$\bar{x}$	.093	.228	.398	.703	1.136	1.631	.021	.031	.047	.058	.064
s	.015	.038	.079	.146	.180	.228	.004	.004	.005	.002	.005
UCL	.107	.264	.473	.841	1.307	1.847	.026	.036	.053	.061	.071
LCL	.080	.193	.324	.565	.966	1.415	.017	.027	.040	.055	.058

	Septal Count							Prol. Diam.	
1	.009	.013	.016	.019	.021	.023	.029	.072	.079
2	.009	.015	.016	.018	.020	.026	.000	.075	.086
3	.008	.011	.014	.015	.018	.020	.026	.098	.100
5	.009	.013	.016	.018	.019	.023	.000	.079	.092

x̄	9	13	16	18	20	23	28
s	001	001	001	002	001	002	002
UCL	10	16	17	20	21	27	33
LCL	8	10	14	15	18	19	22

Tunnel Width

6	.035	.053	.098	.160	.260	.090	.090
7	.046	.056	.076	.141	.264	.056	.062
8	.034	.054	.080	.140	.240	.074	.080
9	.039	.045	.080	.138	.248	.073	.083
10	.040	.062	.089	.080	.240	.073	.080
11	.044	.080	.080	.160	.221	.072	.080
12	.046	.055	.093	.176	.276	.068	.074
13	.044	.052	.080	.132	.228	.074	.078
14	.044	.067	.080	.122	.240	.072	.102
						min.	max.
x̄	.041	.058	.084	.139	.246	.075	.084
s	.005	.010	.007	.028	.018	.010	.011
UCL	.047	.070	.093	.171	.267	.084	.093
LCL	.036	.046	.075	.106	.225	.066	.074

TRITICITES TOMLINSONI, new species Crinerville Member, Overbrook Anticline

Half Length

19	.189	.379	.631	1.180	2.120	.000
20	.160	.389	.772	1.410	2.040	.000
21	.199	.399	.876	1.400	2.330	3.650
22	.206	.389	.732	1.190	2.270	2.850
24	.206	.491	.883	1.440	2.260	.000
25	.196	.389	.680	1.230	2.030	.000
26	.199	.386	.755	1.410	2.420	.000
27	.154	.307	.638	1.080	1.960	2.550
28	.206	.383	.811	1.570	2.500	3.340
29	.150	.294	.464	.925	1.690	2.490

Tunnel Width

.051	.100	.205	.596	.000
.083	.144	.272	.599	.000
.072	.112	.275	.494	.972
.067	.104	.255	.529	.000
.082	.173	.390	.000	.000
.059	.143	.298	.658	.000
.056	.125	.281	.544	.000
.060	.132	.275	.429	.860
.069	.143	.319	.780	.000
.041	.072	.175	.330	.797

30	.190	.402	.857	1.610	2.390	3.270	.077	.154	.261	.000	.000
31	.190	.399	.654	1.130	2.050	2.730	.048	.085	.165	.402	.000
32	.164	.327	.659	1.060	1.750	2.660	.048	.085	.175	.365	.530
33	.164	.314	.572	1.080	2.020	2.940	.059	.078	.159	.410	.000
34	.177	.366	.916	1.580	2.620	3.470	.072	.109	.233	.617	.000
35	.232	.396	.710	1.270	2.130	2.890	.082	.107	.231	.457	.000
36	.150	.366	.778	1.210	1.921	2.520	.079	.131	.305	.599	.000
37	.164	.320	.559	1.040	1.600	2.390	.068	.096	.185	.000	.728
38	.173	.392	.785	1.560	2.660	.000	.063	.137	.297	.763	.000
39	.157	.340	.556	1.010	1.920	2.850	.062	.124	.209	.507	.000
40	.190	.327	.608	1.070	1.790	2.840	.072	.120	.250	.550	.000
41	.199	.376	.654	1.120	1.900	2.910	.080	.096	.215	.418	.903
42	.177	.327	.654	1.160	1.740	2.620	.062	.110	.239	.478	.000
43	.186	.396	.611	1.170	2.030	2.660	.076	.133	.244	.569	.000
44	.173	.366	.589	1.000	1.770	2.760	.071	.118	.192	.533	.000
45	.177	.340	.631	1.010	1.640	2.790	.053	.108	.179	.369	.638
46	.137	.294	.530	1.010	1.510	.000	.069	.106	.154	.305	.607
47	.173	.370	.654	1.270	2.230	3.330	.081	.146	.282	.698	.000
48	.164	.360	.703	1.290	2.110	.000	.069	.150	.305	.555	.000
49	.167	.363	.745	1.200	2.270	2.980	.073	.114	.207	.541	.813
50	.196	.360	.667	1.110	1.750	2.570	.071	.102	.209	.362	.679
51	.173	.314	.562	.935	1.700	2.580	.067	.093	.181	.407	1.210
52	.186	.373	.631	1.040	1.700	2.400	.071	.144	.286	.539	.775
53	.212	.418	.697	1.700	2.590	.000	.076	.163	.447	.845	.000
54	.163	.314	.562	1.200	2.220	2.730	.086	.176	.427	.813	.000
55	.164	.317	.530	.905	1.510	2.460	.081	.114	.163	.370	.772
56	.164	.363	.634	1.120	1.950	2.660	.069	.118	.203	.388	.788
57	.173	.327	.576	1.020	1.830	2.680	.072	.149	.294	.473	.650
$\bar{x}$	.179	.361	.669	1.203	2.024	2.813	.068	.121	.248	.523	.781
s	.020	.040	.109	.207	.311	.324	.011	.026	.071	.140	.166
UCL	.188	.379	.717	1.294	2.165	2.977	.073	.133	.280	.587	.914
LCL	.170	.344	.621	1.112	1.887	2.649	.064	.110	.217	.458	.649

	Septal Count						Prol. Diam.
1	.011	.015	.015	.018	.028	.025	.154
2	.010	.014	.017	.021	.021	.024	.143

3	.009	.013	.016	.022	.023	.022	.109
4	.009	.013	.014	.018	.019	.022	.128
5	.010	.015	.015	.018	.023	.025	.151
6	.009	.013	.018	.023	.026	.026	.132
7	.010	.016	.018	.020	.023	.020	.148
8	.011	.017	.019	.018	.022	.023	.178
9	.008	.015	.018	.018	.019	.022	.141
10	.010	.015	.018	.020	.020	.020	.136
11	.010	.014	.017	.020	.019	.019	.163
12	.009	.013	.014	.017	.017	.020	.119
13	.009	.013	.015	.017	.022	.022	.116
14	.011	.014	.016	.019	.019	.000	.125
15	.009	.015	.017	.020	.022	.000	.154
16	.010	.014	.017	.018	.020	.022	.130
17	.010	.013	.015	.020	.021	.022	.099
18	.009	.015	.017	.019	.021	.023	.098
23	.009	.015	.017	.020	.023	.021	.120
$\bar{x}$	10	14	16	19	21	22	
s	001	001	001	002	003	002	
UCL	10	15	17	20	23	24	
LCL	9	14	15	18	20	21	

Chomata Height

19	.048	.048	.060	.109	.000	.131
20	.038	.070	.091	.066	.000	.106
21	.049	.054	.083	.080	.072	.156
22	.035	.061	.076	.090	.000	.134
24	.051	.045	.051	.072	.000	.147
25	.022	.050	.083	.092	.000	.117
26	.050	.056	.090	.100	.000	.145
27	.044	.055	.056	.080	.042	.115
28	.030	.066	.097	.052	.000	.148
29	.035	.046	.051	.059	.077	.080
30	.030	.056	.113	.000	.000	.135
31	.042	.041	.067	.100	.000	.128
32	.026	.056	.093	.093	.000	.120

33	.035	.057	.094	.000	.000	.118
34	.041	.069	.110	.124	.000	.094
35	.030	.052	.088	.091	.000	.147
36	.038	.053	.033	.079	.000	.167
37	.020	.046	.076	.091	.059	.124
38	.045	.061	.090	.096	.000	.166
39	.039	.040	.071	.037	.000	.116
40	.036	.065	.111	.069	.040	.124
41	.036	.040	.072	.088	.058	.131
42	.033	.047	.065	.000	.000	.159
43	.039	.070	.121	.000	.000	.130
44	.028	.053	.041	.085	.000	.130
45	.034	.045	.066	.109	.081	.132
46	.024	.056	.077	.000	.000	.098
47	.038	.049	.090	.113	.000	.150
48	.041	.043	.078	.089	.000	.163
49	.037	.057	.124	.098	.024	.091
50	.033	.057	.068	.097	.046	.146
51	.029	.049	.096	.104	.096	.111
52	.039	.053	.073	.058	.057	.163
53	.033	.062	.089	.076	.000	.179
54	.048	.091	.098	.073	.000	.163
55	.018	.043	.063	.067	.096	.111
56	.044	.055	.073	.091	.067	.134
57	.034	.067	.065	.104	,044	.137
$\bar{x}$	.036	.055	.080	.086	.061	.133
s	.008	.011	.021	.019	.021	.022
UCL	.040	.059	.089	.095	.079	.141
LCL	.032	.050	.071	.077	.043	.125

	Radius Vector						Tectum & Keriotheca					
1	.131	.209	.337	.549	.765	1.050	.010	.018	.034	.041	.041	.057
2	.127	.206	.330	.497	.746	.981	.010	.018	.026	.041	.047	.057
3	.104	.177	.268	.409	.634	.893	.010	.014	.021	.033	.047	.071
4	.111	.203	.334	.517	.778	1.070	.012	.017	.026	.037	.046	.057

5	.140	.219	.363	.569	.837	1.100	.009	.015	.026	.038	.049	.049
6	.131	.222	.360	.517	.782	1.070	.010	.015	.026	.038	.053	.053
7	.128	.216	.363	.576	.863	1.110	.011	.017	.031	.047	.054	.060
8	.157	.242	.376	.562	.788	1.080	.014	.018	.026	.037	.057	.060
9	.128	.203	.314	.481	.703	.981	.009	.012	.022	.033	.057	.056
10	.131	.206	.294	.474	.680	.956	.012	.014	.020	.033	.039	.047
11	.114	.193	.307	.500	.742	.000	.010	.013	.022	.041	.049	.000
12	.105	.160	.245	.419	.661	.919	.010	.018	.022	.029	.049	.052
13	.111	.203	.347	.533	.778	1.020	.011	.018	.022	.033	.055	.056
14	.118	.203	.321	.507	.752	.000	.010	.015	.022	.039	.047	.000
15	.128	.222	.376	.595	.896	.000	.013	.017	.021	.041	.057	.000
16	.111	.183	.275	.419	.621	.863	.009	.013	.019	.037	.049	.060
17	.092	.137	.222	.356	.543	.795	.009	.014	.022	.026	.039	.049
18	.105	.170	.262	.422	.641	.981	.009	.017	.022	.038	.046	.053
23	.118	.206	.353	.549	.827	.000	.010	.016	.029	.034	.052	.052
19	.121	.190	.301	.504	.755	1.000	.012	.017	.023	.040	.049	.056
20	.114	.196	.337	.569	.886	.000	.013	.019	.037	.043	.060	.000
21	.118	.203	.334	.517	.788	1.150	.012	.020	.026	.049	.071	.068
22	.131	.219	.343	.559	.821	1.100	.010	.016	.036	.065	.061	.065
24	.157	.239	.366	.587	.840	.000	.010	.020	.031	.035	.053	.000
25	.134	.213	.340	.543	.827	.000	.010	.018	.032	.041	.056	.000
26	.114	.190	.320	.543	.834	.000	.010	.022	.029	.078	.057	.000
27	.095	.180	.311	.491	1.000	.000	.013	.022	.035	.037	.058	.000
28	.121	.209	.356	.589	.840	.000	.013	.021	.030	.048	.057	.064
29	.108	.167	.262	.419	.625	.863	.011	.018	.020	.037	.053	.061
30	.154	.242	.392	.628	.893	.000	.012	.020	.035	.055	.052	.000
31	.118	.190	.288	.471	.719	.994	.010	.016	.024	.037	.044	.056
32	.098	.164	.268	.448	.703	1.080	.011	.014	.027	.042	.045	.052
33	.095	.164	.271	.455	.703	1.020	.009	.016	.027	.036	.058	.056
34	.128	.209	.350	.359	.860	1.140	.010	.015	.026	.056	.059	.000
35	.144	.216	.343	.523	.788	.000	.010	.019	.023	.056	.056	.000
36	.128	.206	.350	.523	.772	.981	.011	.025	.032	.036	.043	.055
37	.101	.167	.284	.451	.674	.909	.013	.020	.024	.032	.061	.061
38	.131	.235	.360	.579	.863	.000	.010	.016	.033	.051	.061	.000
39	.101	.164	.262	.432	.687	.916	.012	.017	.024	.041	.053	.062
40	.130	.203	.327	.520	.762	1.090	.010	.019	.026	.037	.044	.044
41	.114	.186	.301	.471	.716	1.020	.010	.020	.041	.056	.069	.000

42	.108	.170	.304	.507	.755	1.040	.011	.022	.031	.056	.068	.061
43	.131	.203	.327	.500	.736	1.060	.011	.018	.033	.040	.042	.040
44	.137	.209	.327	.523	.762	1.040	.012	.015	.029	.044	.059	.067
45	.088	.157	.245	.392	.628	.916	.011	.016	.023	.031	.054	.054
46	.114	.180	.294	.451	.634	.899	.013	.021	.040	.051	.063	.061
47	.118	.203	.320	.504	.772	1.090	.011	.019	.024	.031	.048	.057
48	.134	.222	.337	.510	.775	.000	.016	.023	.031	.046	.047	.000
49	.118	.193	.314	.533	.798	1.120	.010	.019	.022	.049	.049	.047
50	.134	.206	.320	.491	.713	1.030	.009	.016	.018	.035	.049	.000
51	.118	.196	.304	.477	.729	.968	.011	.020	.025	.052	.051	.057
52	.141	.226	.350	.559	.755	1.050	.008	.016	.025	.037	.051	.060
53	.179	.262	.412	.625	.909	.000	.008	.017	.041	.050	.057	.000
54	.118	.193	.337	.520	.798	1.090	.010	.016	.030	.042	.060	.071
55	.092	.147	.245	.399	.615	.883	.011	.016	.028	.033	.046	.061
56	.111	.180	.275	.461	.680	.935	.008	.012	.028	.036	.049	.054
57	.111	.196	.314	.513	.759	1.030	.013	.016	.031	.047	.050	.050
$\bar{x}$	.121	.198	.318	.502	.758	1.007	.011	.017	.027	.042	.053	.057
s	.018	.025	.041	.063	.088	.086	.002	.003	.006	.009	.007	.007
UCL	.127	.207	.333	.524	.789	1.043	.011	.018	.029	.045	.055	.059
LCL	.115	.189	.304	.479	.727	.971	.010	.016	.025	.038	.050	.054

TRITICITES TOMLINSONI, new species — Crinerville Member, Pleasant Hill Syncline

	Radius Vector						Tectum & Keriotheca					
1	.118	.188	.294	.485	.741	.000	.010	.011	.019	.037	.051	.000
2	.144	.234	.367	.572	.812	.000	.010	.015	.028	.037	.043	.000
3	.103	.164	.257	.412	.620	.864	.008	.016	.018	.028	.037	.058
4	.093	.166	.281	.480	.716	.984	.008	.013	.022	.034	.041	.049
5	.144	.219	.330	.525	.772	.952	.010	.016	.021	.032	.037	.054
6	.097	.160	.265	.414	.646	.898	.009	.014	.023	.035	.050	.054
7	.093	.167	.277	.467	.747	1.050	.010	.013	.025	.033	.048	.059
8	.084	.145	.235	.393	.628	.886	.007	.011	.018	.028	.039	.052
9	.109	.190	.322	.528	.857	.000	.006	.012	.019	.034	.055	.052
10	.071	.126	.216	.341	.564	1.180	.007	.010	.020	.025	.037	.057
11	.097	.171	.270	.457	.708	1.020	.007	.010	.020	.025	.037	.057

12	.090	.161	.261	.431	.686	.979	.008	.010	.022	.039	.047	.060
13	.113	.193	.328	.522	.799	.000	.009	.012	.022	.031	.050	.000
14	.113	.177	.274	.422	.644	.908	.008	.015	.021	.030	.056	.058
15	.113	.203	.341	.564	.815	1.130	.010	.017	.026	.032	.053	.052
$\bar{x}$	.105	.178	.288	.468	.717	.986	.008	.013	.021	.032	.047	.055
s	.020	.028	.042	.066	.085	.101	.001	.003	.003	.004	.007	.004
UCL	.120	.198	.318	.515	.778	1.073	.009	.015	.024	.035	.052	.058
LCL	.091	.158	.258	.420	.656	.900	.007	.011	.019	.030	.042	.052

	Half Length						Chomata Height				
7	.245	.335	.667	1.370	2.320	3.270	.030	.040	.064	.112	.049
8	.138	.322	.576	1.200	2.130	3.070	.023	.041	.068	.120	.055
9	.164	.338	.660	1.340	1.350	3.490	.038	.051	.071	.129	.000
10	.087	.177	.338	.640	1.450	2.420	.030	.034	.031	.106	.137
11	.148	.309	.547	1.200	1.850	2.580	.031	.031	.054	.108	.062
12	.138	.290	.560	1.080	2.130	2.700	.030	.037	.054	.074	.037
13	.167	.309	.676	1.430	2.030	.000	.031	.051	.047	.080	.000
14	.135	.290	.489	.779	1.290	2.060	.022	.037	.063	.075	.060
15	.145	.348	.683	1.140	1.900	2.660	.030	.045	.066	.079	.000
$\bar{x}$	.152	.302	.577	1.131	1.939	2.781	.029	.041	.057	.098	.067
s	.042	.051	.113	.266	.364	.469	.004	.007	.013	.021	.036
UCL	.192	.350	.684	1.384	2.285	3.256	.034	.047	.070	.118	.109
LCL	.112	.254	.470	.878	1.593	2.306	.025	.034	.045	.078	.024

	Septal Count						Prol. Diam.
1	.008	.015	.015	.016	.017	.000	.131
2	.008	.015	.015	.017	.019	.000	.134
3	.007	.013	.014	.014	.018	.016	.117
4	.007	.012	.012	.013	.018	.022	.096
5	.008	.011	.015	.015	.017	.018	.141
6	.008	.011	.013	.015	.018	.019	.094

x̄	8	13	14	15	18	19
s	001	002	001	001	001	003
UCL	8	15	16	17	19	23
LCL	7	10	12	13	17	15

	Tunnel Width					Prol. Diam.
7	.063	.108	.210	.517	1.000	.117
8	.054	.092	.165	.378	.720	.100
9	.080	.154	.278	.640	.000	.132
10	.042	.064	.160	.320	.540	.103
11	.045	.070	.140	.288	.576	.109
12	.056	.114	.232	.480	.760	.094
13	.061	.118	.266	.442	.000	.125
14	.066	.103	.203	.352	.640	.107
15	.062	.116	.240	.294	.000	.135
x̄	.059	.104	.210	.412	.706	.116
s	.011	.028	.048	.118	.166	.016
UCL	.070	.130	.256	.524	.906	.127
LCL	.048	.079	.165	.301	.506	.104

TRITICITES IRREGULARIS (Staff) emend. Anadarche Member

	Half Length						Tunnel Width				
17	.098	.203	.435	.726	1.290	2.180	.039	.081	.133	.233	.432
18	.117	.300	.562	1.180	2.050	.000	.054	.081	.176	.461	.000
19	.181	.327	.598	.948	1.670	2.480	.051	.101	.172	.429	.000
20	.104	.252	.458	.798	1.250	2.220	.061	.081	.122	.236	.569
21	.160	.291	.474	.850	1.510	2.310	.063	.098	.163	.354	.569
22	.162	.284	.517	.932	1.740	2.740	.065	.095	.171	.378	.630
23	.124	.252	.477	.916	1.600	2.450	.061	.109	.142	.265	.569
24	.166	.314	.556	1.170	2.170	.000	.061	.082	.191	.343	.650
25	.147	.317	.618	1.140	2.040	.000	.049	.092	.159	.386	.000
26	.144	.310	.611	1.000	1.940	3.110	.044	.102	.155	.325	.732
27	.115	.245	.457	.912	1.450	2.750	.054	.081	.146	.274	.663

28	.141	.268	.451	.847	1.530	2.480	.052	.089	.163	.244	.500
29	.128	.226	.441	.893	1.510	2.420	.038	.065	.091	.203	.325
30	.114	.222	.419	.654	1.350	2.430	.037	.081	.120	.215	.407
31	.134	.262	.458	.893	1.600	2.250	.061	.091	.163	.267	.000
32	.141	.268	.533	1.030	1.690	2.660	.062	.114	.209	.386	.754
33	.134	.252	.481	.899	1.720	2.500	.048	.098	.145	.277	.521
34	.131	.245	.409	.765	1.530	2.540	.049	.081	.128	.244	.407
35	.118	.255	.458	.853	1.600	2.830	.060	.091	.163	.358	.650
36	.121	.245	.468	1.030	1.720	2.600	.050	.079	.157	.305	.386
37	.141	.271	.435	.932	1.620	2.720	.054	.081	.163	.325	.650
38	.137	.301	.556	.997	2.090	.000	.061	.112	.182	.439	.732
39	.137	.281	.464	.974	1.710	2.960	.060	.110	.151	.280	.569
40	.131	.294	.507	1.010	1.870	3.050	.069	.095	.234	.465	.853
41	.170	.288	.697	1.290	2.390	2.640	.069	.098	.210	.439	.714
42	.137	.268	.549	1.110	1.980	.000	.066	.098	.237	.455	.000
43	.137	.262	.468	.965	2.150	3.120	.053	.098	.142	.338	.700
44	.124	.281	.487	.968	1.760	2.780	.067	.089	.154	.366	.593
45	.153	.311	.624	1.090	1.710	2.740	.068	.096	.259	.520	.000
46	.150	.291	.608	1.020	1.960	2.840	.070	.115	.201	.374	.000
47	.127	.265	.474	.942	1.590	2.780	.049	.102	.163	.285	.691
$\bar{x}$	.136	.273	.508	.959	1.735	2.676	.056	.093	.167	.338	.594
s	.019	.030	.072	.137	.272	.329	.009	.012	.036	.084	.133
UCL	.146	.287	.543	1.026	1.869	2.852	.061	.099	.184	.379	.669
LCL	.127	.258	.473	.892	1.602	2.500	.052	.087	.149	.296	.520

	Radius Vector						Tectum & Keriotheca					
1	.092	.157	.262	.416	.655	.900	.008	.012	.023	.032	.045	.046
2	.097	.177	.301	.468	.713	.000	.007	.012	.023	.032	.045	.000
3	.107	.164	.252	.382	.600	.000	.008	.013	.020	.030	.040	.000
4	.085	.140	.212	.327	.508	.761	.007	.010	.018	.024	.040	.046
5	.110	.190	.289	.409	.638	.000	.007	.013	.018	.030	.043	.000
6	.107	.190	.294	.458	.671	.949	.007	.014	.026	.033	.043	.054
7	.062	.108	.186	.294	.428	.589	.007	.009	.017	.028	.034	.039
8	.082	.131	.199	.294	.422	.602	.008	.011	.018	.022	.040	.042
9	.088	.157	.255	.383	.569	.811	.007	.011	.020	.030	.041	.054

10	.088	.137	.216	.317	.494	.000	.008	.010	.016	.029	.037	.000
11	.098	.157	.252	.376	.569	.808	.007	.011	.022	.028	.041	.055
12	.065	.111	.183	.278	.415	.600	.007	.009	.013	.020	.031	.042
13	.082	.131	.203	.281	.432	.000	.007	.009	.016	.022	.034	.000
14	.065	.105	.183	.307	.497	.697	.008	.010	.016	.024	.037	.049
15	.092	.150	.255	.389	.592	.821	.008	.013	.021	.028	.049	.052
16	.095	.154	.258	.409	.641	.000	.009	.012	.021	.033	.041	.000
17	.085	.131	.209	.284	.415	.602	.008	.012	.016	.024	.024	.044
18	.075	.131	.239	.370	.546	.000	.008	.011	.026	.041	.046	.000
19	.095	.173	.258	.376	.559	.775	.008	.015	.022	.040	.051	.051
20	.092	.141	.219	.327	.477	.690	.007	.009	.017	.031	.042	.054
21	.092	.137	.213	.314	.448	.667	.010	.014	.018	.024	.046	.045
22	.108	.154	.245	.379	.533	.768	.010	.017	.024	.029	.037	.050
23	.095	.147	.222	.327	.477	.680	.007	.009	.021	.020	.045	.041
24	.088	.141	.222	.337	.491	.000	.010	.018	.020	.032	.045	.046
25	.082	.137	.222	.337	.566	.762	.007	.014	.016	.024	.043	.000
26	.078	.127	.192	.317	.494	.713	.008	.014	.020	.034	.038	.044
27	.081	.124	.196	.301	.448	.654	.008	.014	.022	.037	.033	.000
28	.072	.124	.203	.311	.455	.667	.008	.011	.022	.029	.041	.051
29	.062	.101	.177	.288	.464	.661	.007	.013	.018	.025	.037	.048
30	.075	.114	.180	.275	.432	.667	.008	.011	.018	.027	.041	.037
31	.088	.137	.216	.317	.490	.680	.010	.016	.024	.041	.046	.049
32	.083	.144	.229	.366	.536	.778	.011	.012	.022	.033	.042	.062
33	.098	.157	.229	.337	.484	.700	.011	.012	.020	.030	.035	.046
34	.078	.124	.186	.281	.425	.611	.009	.010	.016	.024	.035	.036
35	.075	.128	.196	.327	.513	.788	.008	.012	.019	.031	.047	.052
36	.075	.121	.199	.301	.468	.667	.008	.012	.016	.028	.048	.049
37	.085	.141	.219	.324	.494	.706	.008	.014	.024	.031	.046	.048
38	.078	.141	.239	.350	.526	.000	.012	.017	.022	.028	.043	.000
39	.101	.164	.252	.347	.500	.758	.010	.012	.021	.028	.047	.057
40	.085	.137	.229	.330	.494	.716	.010	.016	.023	.031	.049	.063
41	.114	.180	.284	.438	.654	.916	.006	.011	.029	.047	.057	.061
42	.105	.170	.265	.409	.602	.000	.008	.011	.025	.034	.046	.000
43	.075	.131	.226	.370	.546	.840	.007	.011	.024	.037	.042	.057
44	.088	.141	.216	.308	.507	.703	.006	.011	.015	.029	.035	.047
45	.098	.160	.265	.415	.576	.752	.008	.014	.021	.035	.044	.055
46	.098	.167	.268	.392	.576	.807	.009	.013	.020	.038	.042	.054
47	.078	.124	.206	.311	.487	.706	.007	.010	.016	.033	.040	.057

x̄	.087	.143	.228	.346	.522	.729	.008	.012	.020	.030	.042	.050
s	.013	.021	.032	.050	.075	.089	.001	.002	.003	.006	.006	.007
UCL	.092	.151	.241	.366	.551	.769	.009	.013	.021	.032	.044	.053
LCL	.082	.134	.215	.326	.492	.689	.008	.011	.019	.028	.039	.046

Septal Count							Prol. Diam.
1	.010	.014	.017	.022	.020	.019	.098
2	.011	.011	.016	.022	.021	.000	.102
3	.009	.012	.020	.019	.020	.000	.120
4	.009	.012	.016	.018	.019	.019	.085
5	.010	.014	.019	.021	.023	.023	.121
6	.012	.016	.018	.019	.023	.021	.118
7	.008	.013	.012	.015	.020	.020	.066
8	.008	.013	.015	.017	.018	.016	.093
9	.008	.013	.016	.020	.022	.023	.080
10	.007	.013	.018	.017	.020	.000	.085
11	.010	.014	.017	.019	.022	.021	.100
12	.009	.012	.014	.020	.022	.020	.075
13	.008	.013	.015	.018	.018	.000	.080
14	.008	.012	.015	.018	.021	.022	.067
15	.010	.017	.017	.020	.023	.021	.081
16	.010	.015	.017	.019	.024	.000	.082
x̄	9	13	16	19	21	20	
s	001	002	002	002	002	002	
UCL	10	14	18	20	22	22	
LCL	8	12	15	18	20	19	

Chomata Height							
17	.020	.027	.035	.049	.071	.000	.080
18	.029	.041	.059	.059	.000	.000	.096
19	.037	.030	.070	.043	.000	.000	.121
20	.021	.046	.059	.066	.104	.000	.078
21	.024	.024	.029	.081	.081	.069	.114
22	.015	.020	.033	.000	.073	.000	.102

23	.019	.042	.050	.054	.063	.000	.089
24	.021	.037	.053	.081	.069	.000	.098
25	.024	.028	.060	.081	.000	.000	.116
26	.024	.028	.062	.074	.061	.000	.089
27	.020	.033	.073	.067	.092	.000	.075
28	.028	.056	.056	.071	.091	.000	.092
29	.019	.030	.067	.100	.065	.000	.071
30	.017	.033	.059	.107	.000	.000	.076
31	.019	.021	.061	.101	.000	.000	.102
32	.030	.039	.065	.060	.065	.000	.098
33	.024	.030	.039	.049	.054	.000	.090
34	.020	.023	.049	.063	.054	.000	.081
35	.020	.033	.073	.069	.047	.000	.095
36	.020	.033	.039	.093	.058	.000	.093
37	.026	.036	.059	.073	.039	.000	.076
38	.022	.050	.060	.096	.046	.000	.101
39	.021	.037	.053	.063	.094	.000	.099
40	.020	.026	.057	.097	.065	.000	.108
41	.020	.042	.065	.101	.109	.000	.104
42	.017	.033	.039	.060	.000	.000	.098
43	.016	.034	.073	.085	.077	.000	.107
44	.020	.027	.061	.041	.054	.000	.072
45	.033	.053	.063	.058	.000	.000	.094
46	.017	.046	.065	.000	.000	.000	.092
47	.014	.045	.052	.059	.071	.000	.097
$\bar{x}$	.021	.035	.056	.072	.070	.000	.093
s	.005	.009	.012	.019	.019	.000	.015
UCL	.024	.039	.062	.082	.080	.000	.098
LCL	.019	.030	.050	.063	.059	.000	.087

TRITICITES IRREGULARIS (Staff) emend.

Anadarche Member, Brock Anticline

Tectum & Keriotheca

1	.007	.009	.013	.026	.024	.000
2	.009	.011	.014	.023	.037	.037
3	.008	.010	.013	.019	.031	.040
4	.009	.011	.014	.022	.035	.046
5	.007	.011	.017	.024	.034	.000
6	.009	.011	.014	.018	.028	.000
7	.007	.010	.018	.028	.037	.000
8	.006	.008	.019	.025	.033	.037
9	.010	.015	.018	.024	.037	.041
10	.010	.012	.020	.026	.033	.042
11	.011	.014	.019	.023	.031	.037
12	.008	.016	.021	.026	.037	.000
13	.011	.017	.020	.023	.026	.037
14	.007	.011	.029	.023	.035	.043
$\bar{x}$	.009	.012	.017	.024	.033	.040
s	.016	.027	.029	.027	.043	.033
UCL	.010	.014	.019	.026	.036	.043
LCL	.007	.010	.015	.022	.030	.037

Radius Vector

1	.086	.139	.212	.334	.480	.672
2	.086	.142	.203	.329	.493	.674
3	.102	.154	.226	.334	.488	.692
4	.099	.162	.257	.374	.570	.000
5	.086	.144	.235	.374	.556	.000
6	.074	.118	.186	.272	.418	.000
7	.090	.160	.263	.409	.581	.000
8	.076	.115	.194	.198	.459	.667
9	.092	.160	.250	.377	.560	.784
10	.112	.160	.238	.367	.533	.728
11	.094	.138	.212	.305	.449	.608
12	.100	.156	.232	.337	.506	.000
13	.080	.125	.188	.274	.441	.640
14	.075	.110	.186	.286	.461	.658
$\bar{x}$	.089	.142	.220	.334	.499	.680
s	.011	.018	.027	.043	.053	.051
UCL	.098	.155	.240	.365	.549	.729
LCL	.081	.128	.200	.302	.461	.632

Chomata Height

8	.016	.037	.041	.062	.102	.067
9	.016	.030	.054	.066	.074	.000
10	.022	.034	.044	.054	.063	.075
11	.023	.036	.060	.060	.067	.000
12	.019	.033	.047	.049	.000	.000
13	.019	.024	.037	.062	.086	.086
14	.026	.033	.050	.074	.082	.000
$\bar{x}$	.020	.032	.048	.061	.079	.076
s	.004	.004	.008	.008	.014	.010
UCL	.024	.037	.056	.070	.096	.094
LCL	.016	.028	.039	.052	.062	.058

Tunnel Width

8	.032	.055	.100	.180	.400	.720
9	.045	.080	.135	.282	.499	.576
10	.036	.064	.128	.292	.600	.000
11	.052	.080	.102	.192	.560	.000
12	.048	.104	.260	.520	.000	.000
13	.027	.059	.104	.196	.360	.640
14	.028	.066	.101	.220	.440	.000
$\bar{x}$	.038	.073	.133	.269	.476	.645
s	.010	.017	.058	.119	.092	.071
UCL	.049	.091	.196	.399	.588	.782
LCL	.027	.054	.070	.138	.365	.509

	Septal Count						Prol. Diam.
1	.009	.014	.019	.021	.023	.025	.091
2	.009	.015	.019	.021	.024	.025	.101
3	.010	.016	.017	.022	.024	.027	.114
4	.010	.015	.017	.022	.025	.028	.101
5	.009	.013	.017	.021	.024	.000	.089
6	.010	.013	.015	.020	.020	.025	.085
7	.010	.014	.016	.018	.024	.023	.093
$\bar{x}$	10	14	17	21	23	26	
s	001	001	001	001	002	002	
UCL	10	16	19	22	25	28	
LCL	9	13	16	19	22	23	

	Half Length						
8	.122	.232	.470	.863	1.610	2.240	.101
9	.132	.305	.518	.911	1.630	2.680	.100
10	.161	.344	.595	.844	1.680	3.160	.109
11	.154	.273	.460	.837	1.450	2.600	.104
12	.129	.258	.531	.837	1.670	2.610	.084
13	.113	.267	.403	.789	1.370	2.020	.087
14	.145	.267	.435	.779	1.810	2.620	.085
$\bar{x}$	.137	.278	.487	.837	1.603	2.581	.096
s	.017	.036	.065	.045	.148	.360	.009
UCL	.156	.318	.559	.886	1.765	2.955	.103
LCL	.118	.238	.416	.788	1.440	2.168	.089

TRITICITES PRIMARIUS Merchant and Keroher Daube Member, Overbrook Anticline

	Half Length						Tunnel Width				
17	.227	.507	1.020	2.140	3.530	.000	.081	.175	.309	.813	.000
18	.216	.466	1.060	2.200	3.600	.000	.110	.215	.407	.000	.000
19	.147	.376	.791	1.880	3.330	.000	.081	.163	.376	.754	.000

20	.157	.385	.719	1.340	2.190	.000	.081	.130	.276	.569	1.080
21	.239	.460	.740	1.350	2.450	3.910	.081	.138	.220	.620	1.130
22	.134	.303	.583	1.040	1.820	3.430	.061	.110	.203	.545	1.020
23	.167	.379	.661	1.330	2.330	3.160	.081	.163	.271	.691	.000
24	.140	.292	.548	1.060	1.840	3.300	.067	.100	.198	.488	1.020
25	.192	.367	.659	1.610	3.180	.000	.081	.133	.244	.731	.000
26	.170	.327	.598	1.190	2.370	.000	.067	.108	.220	.407	1.060
27	.147	.360	.625	1.210	2.210	.000	.070	.120	.225	.589	.000
28	.215	.523	1.010	2.220	3.370	.000	.130	.138	.541	1.090	.000
30	.167	.441	1.060	1.840	3.040	.000	.081	.198	.609	.976	.000
31	.177	.552	1.090	1.980	2.880	.000	.093	.187	.299	.748	.000
32	.111	.278	.513	1.020	1.800	1.060	.067	.088	.207	.516	.894
33	.134	.340	.687	1.650	2.360	.000	.081	.163	.295	.894	.000
34	.215	.455	.958	1.940	2.760	.000	.081	.162	.333	.975	.000
35	.239	.458	.857	1.770	2.980	.000	.109	.105	.382	.000	.000
36	.157	.386	.654	1.430	2.510	.000	.069	.126	.244	.691	.000
$\bar{x}$	.176	.403	.781	1.589	2.661	3.372	.084	.151	.309	.712	1.034
s	.039	.080	.194	.403	.580	.331	.017	.038	.110	.185	.080
UCL	.201	.453	.904	1.846	3.027	3.817	.094	.174	.377	.832	1.130
LCL	.158	.352	.657	1.333	2.294	2.927	.073	.128	.241	.591	.938

	Radius Vector						Tectum & Keriotheca					
1	.108	.190	.304	.497	.716	.938	.012	.015	.024	.043	.057	.073
2	.128	.219	.389	.638	.948	1.230	.013	.018	.029	.044	.061	.061
3	.137	.222	.383	.638	.961	.000	.012	.019	.031	.051	.060	.000
4	.124	.229	.402	.602	.860	.000	.011	.019	.030	.049	.062	.000
5	.144	.235	.402	.631	.952	.000	.012	.018	.028	.041	.059	.000
6	.098	.160	.271	.428	.647	.000	.009	.013	.020	.037	.051	.000
7	.111	.213	.370	.611	.827	.000	.011	.018	.028	.045	.057	.000
8	.101	.170	.320	.507	.736	.000	.009	.015	.023	.042	.060	.000
9	.118	.206	.350	.556	.804	.000	.010	.017	.026	.039	.053	.000
10	.095	.177	.294	.468	.697	.000	.009	.013	.018	.035	.049	.000
11	.108	.199	.304	.468	.700	.000	.011	.016	.021	.036	,946	.053
12	.105	.196	.340	.546	.791	.000	.010	.016	.024	.040	.050	.056
13	.114	.203	.337	.513	.746	.000	.011	.015	.022	.040	.000	.000

14	.111	.206	.350	.592	.889	.000	.009	.015	.024	.041	.054	.062
15	.118	.196	.320	.540	.820	.000	.013	.016	.024	.041	.058	.000
16	.147	.262	.428	.641	.918	.000	.013	.019	.028	.043	.056	.000
17	.114	.203	.373	.612	.909	.000	.009	.017	.032	.051	.063	.000
18	.156	.268	.447	.683	.932	.000	.010	.016	.030	.046	.059	.000
19	.098	.196	.350	.572	.000	.000	.009	.016	.024	.048	.000	.000
20	.088	.164	.291	.477	.697	.916	.000	.012	.020	.035	.053	.000
21	.124	.213	.311	.448	.706	1.010	.010	.015	.021	.033	.055	.058
22	.092	.154	.268	.432	.644	.948	.010	.012	.029	.044	.050	.064
23	.092	.150	.258	.441	.661	.000	.011	.017	.024	.048	.052	.000
24	.114	.180	.281	.484	.683	.945	.008	.013	.021	.050	.060	.073
25	.098	.186	.311	.542	.831	.000	.010	.016	.034	.049	.058	.000
26	.088	.163	.281	.461	.687	.961	.010	.020	.023	.048	.057	.067
27	.092	.167	.281	.438	.687	.916	.010	.016	.024	.033	.052	.000
28	.143	.249	.419	.680	.000	.000	.011	.021	.038	.048	.000	.000
30	.108	.222	.405	.654	.948	.000	.010	.020	.042	.050	.068	.000
31	.108	.212	.356	.546	.778	1.000	.009	.016	.027	.045	.053	.057
32	.082	.150	.242	.399	.618	.867	.010	.014	.024	.039	.049	.049
33	.088	.190	.337	.546	.768	.000	.011	.015	.032	.049	.055	.000
34	.137	.245	.405	.654	.958	.000	.010	.022	.039	.052	.060	.000
35	.131	.213	.343	.543	.775	.000	.010	.018	.039	.052	.065	.000
36	.092	.164	.291	.513	.768	.000	.008	.015	.022	.033	.054	.000
$\bar{x}$	.112	.199	.338	.543	.790	.973	.010	.017	.027	.043	.056	.061
s	.019	.031	.053	.081	.107	.099	.002	.003	.006	.006	.006	.008
UCL	.121	.214	.362	.580	.841	1.062	.011	.018	.030	.046	.058	.068
LCL	.103	.185	.313	.506	.740	.884	.010	.015	.024	.041	.053	.055

	Septal Count						Prol. Diam.
1	.009	.016	.017	.019	.024	.021	.114
2	.008	.014	.018	.021	.021	.022	.133
3	.011	.017	.020	.021	.024	.000	.157
4	.009	.015	.018	.020	.019	.021	.125
5	.010	.018	.018	.021	.024	.000	.146
6	.008	.012	.016	.020	.020	.018	.108
7	.008	.012	.016	.020	.020	.018	.098

8	.008	.015	.016	.020	.024	.000	.112
9	.010	.016	.018	.021	.023	.000	.129
10	.008	.014	.017	.018	.023	.000	.097
11	.008	.015	.020	.023	.022	.022	.115
12	.008	.014	.015	.019	.019	.000	.104
13	.008	.015	.018	.021	.021	.000	.120
14	.008	.015	.018	.021	.021	.000	.120
15	.010	.014	.017	.019	.021	.000	.122
$\bar{x}$	9	15	17	20	22	21	
s	001	002	001	001	002	002	
UCL	10	16	18	21	24	23	
LCL	8	14	16	19	21	19	

Chomata Height

17	.048	.070	.107	.112	.000	.149
18	.046	.071	.120	.099	.000	.163
19	.051	.063	.101	.000	.000	.127
20	.039	.058	.067	.098	.116	.122
21	.040	.033	.073	.093	.108	.138
22	.030	.047	.000	.049	.066	.120
23	.020	.037	.113	.085	.000	.114
24	.042	.069	.121	.160	.000	.108
25	.037	.060	.108	.160	.000	.130
26	.048	.057	.105	.114	.136	.122
27	.029	.050	.061	.071	.000	.122
28	.045	.073	.104	.106	.000	.188
30	.039	.105	.098	.000	.000	.141
31	.038	.067	.098	.114	.000	.114
32	.027	.035	.065	.081	.057	.115
33	.034	.068	.081	.089	.000	.120
34	.044	.049	.106	.120	.000	.135
35	.042	.061	.081	.120	.000	.145
36	.037	.064	.108	.126	.000	.124

$\bar{x}$	.039	.060	.095	.103	.097
s	.008	.016	.019	.029	.034
UCL	.043	.070	.107	.122	.142
LCL	.034	.050	.083	.084	.051

TRITICITES NEWELLI Burma

Tunnel Width

9	.046	.108	.132	.240	.520
10	.062	.100	.196	.420	.880
11	.080	.148	.256	.462	.870
12	.066	.128	.190	.438	.600
13	.070	.108	.208	.320	.720
14	.061	.080	.128	.250	.640
15	.064	.092	.186	.352	.640
16	.080	.102	.196	.360	.760
17	.096	.176	.260	.560	.960
18	.062	.160	.260	.480	.000
19	.080	.140	.240	.424	.880
20	.056	.104	.176	.400	.620
21	.060	.100	.176	.365	.720
22	.062	.088	.178	.349	.600
23	.062	.088	.178	.320	.640
$\bar{x}$	.067	.114	.196	.383	.718
s	.012	.029	.042	.086	.133
UCL	.076	.135	.227	.444	.817
LCL	.058	.093	.166	.321	.619

Radius Vector

1	.157	.283	.451	.705	.992	.000
2	.116	.213	.345	.509	.750	1.060
3	.138	.241	.393	.576	.811	1.130
4	.116	.187	.322	.493	.734	.000
5	.145	.222	.345	.522	.789	1.120
6	.093	.158	.261	.409	.644	.917

.127
.019
.136
.118

Daube Member, Brock Anticline

Chomata Height

.038	.062	.068	.080	.104
.038	.064	.086	.094	.054
.050	.066	.080	.112	.112
.040	.060	.080	.096	.108
.050	.062	.080	.096	.112
.024	.054	.064	.088	.110
.041	.056	.074	.106	.000
.044	.070	.080	.082	.000
.028	.050	.096	.092	.080
.036	.060	.084	.102	.074
.056	.072	.084	.112	.000
.031	.053	.086	.086	.096
.030	.050	.070	.088	.100
.024	.048	.068	.080	.088
.037	.048	.069	.088	.093
.038	.058	.078	.093	.094
.010	.008	.009	.011	.018
.045	.064	.084	.101	.108
.031	.053	.071	.086	.080

Tectum & Keriotheca

.009	.016	.024	.038	.044	.000
.008	.020	.026	.036	.052	.064
.009	.017	.025	.036	.052	.058
.009	.015	.023	.039	.048	.060
.010	.014	.023	.034	.043	.054
.009	.016	.024	.034	.048	.064

7	.097	.167	.293	.464	.738	1.060
8	.106	.177	.267	.393	.580	.837
9	.106	.171	.267	.396	.564	.811
10	.084	.142	.264	.412	.667	.992
11	.148	.241	.357	.531	.750	1.020
12	.084	.164	.303	.500	.779	1.100
13	.151	.241	.367	.553	.811	1.130
14	.087	.145	.242	.380	.586	.863
15	.116	.183	.261	.464	.669	.892
16	.126	.228	.380	.557	.805	1.100
17	.161	.258	.396	.580	.828	1.140
18	.129	.225	.361	.560	.821	1.090
19	.164	.270	.444	.653	.933	1.320
20	.113	.193	.315	.495	.731	1.030
21	.093	.167	.273	.422	.654	.944
22	.074	.138	.238	.396	.602	.866
23	.100	.171	.274	.447	.699	1.030
$\bar{x}$	.118	.199	.323	.496	.736	1.022
s	.027	.043	.063	.087	.109	.126
UCL	.134	.225	.360	.548	.802	1.102
LCL	.101	.174	.285	.445	.671	.904

.011	.017	.024	.036	.056	.061
.008	.016	.020	.032	.046	.060
.009	.015	.021	.030	.048	.062
.009	.018	.022	.040	.054	.068
.009	.015	.029	.040	.049	.058
.008	.016	.024	.044	.060	.072
.009	.020	.028	.038	.056	.068
.010	.014	.020	.032	.044	.052
.010	.017	.025	.035	.054	.059
.010	.016	.025	.043	.052	.070
.009	.015	.032	.044	.056	.060
.008	.016	.028	.044	.053	.061
.008	.017	.026	.037	.050	.064
.009	.016	.024	.036	.060	.065
.008	.015	.024	.032	.044	.050
.008	.012	.020	.028	.040	.053
.008	.012	.023	.032	.039	.048
.009	.016	.024	.037	.050	.061
.001	.002	.003	.005	.006	.006
.009	.017	.026	.039	.053	.064
.008	.015	.023	.034	.046	.057

Septal Count

1	.011	.021	.023	.022	.025	.000
2	.010	.016	.018	.022	.024	.027
3	.009	.017	.020	.021	.024	.022
4	.010	.013	.017	.023	.026	.027
5	.009	.019	.020	.026	.026	.029
6	.009	.013	.015	.017	.023	.025
7	.008	.015	.021	.019	.025	.026
8	.007	.014	.016	.020	.023	.027
$\bar{x}$	9	16	19	21	25	26
s	001	003	003	003	001	002
UCL	10	19	21	24	26	29
LCL	8	13	16	19	23	24

Prol. Diam.

.148	.178
.116	.128'
.111	.119
.116	.116
.128	.150
.080	.094
.080	.102
.090	.100

Half Length

9	.135	.303	.480	.744	1.190	2.090	3.380	.140	.156
10	.103	.280	.598	1.000	1.780	2.930	.000	.088	.104
11	.210	.369	.643	1.100	1.790	2.720	3.560	.148	.149
12	.145	.393	.644	1.130	1.950	2.790	.000	.100	.102
13	.189	.370	.615	1.030	1.790	2.750	3.660	.146	.156
14	.145	.276	.456	.792	1.320	2.280	3.450	.096	.096
15	.161	.322	.557	.615	1.790	2.430	3.260	.154	.168
16	.180	.383	.621	1.010	1.650	2.700	.000	.152	.174
17	.219	.379	.644	1.290	2.080	3.010	.000	.174	.192
18	.167	.338	.692	1.300	2.090	3.050	.000	.140	.190
19	.231	.489	.779	1.310	2.230	3.330	.000	.184	.203
20	.155	.315	.592	1.090	1.650	2.680	3.680	.132	.138
21	.140	.281	.515	.918	1.960	3.330	5.030	.100	.101
22	.106	.216	.386	.759	1.420	2.380	3.300	.090	.101
23	.129	.258	.435	.911	1.610	2.370	.000	.076	.086
$\bar{x}$	.161	.331	.577	1.000	1.753	2.721	3.665	.121	.134
s	.039	.068	.106	.213	.292	.365	.573	.032	.037
UCL	.189	.380	.653	1.154	1.962	2.982	4.246	.140	.154
LCL	.133	.283	.501	.847	1.544	2.459	3.084	.102	.115