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PENNSYLVANIAN FUSULINIDS IN THE ARDMORE BASIN LOVE AND CARTER COUNTIES, OKLAHOMA

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PENNSYLVANIAN FUSULINIDS IN THE ARDMORE BASIN LOVE AND CARTER COUNTIES, OKLAHOMA

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ABSTRACT

The Ardmore basin is principally a Pennsylvanian feature that lies south of the Arbuckle Mountains region in south-central Oklahoma. It is largely a clastic province with occasional thin, but widespread, fossiliferous limestones exposed in the Overbrook, Brock, and Caddo anticlines and the Pleasant Hill syncline. The study of the fauna, comprising seventeen species (of which *Fusulinella vacua, Fusulina mutabilis, Fusulina erugata,* and *Triticites tomlinsoni* are new), has led to the discrimination of seven fusulinid biozones which are correlated with those of other areas in the Midcontinent region. The suggested correlations are given in terms of relative-time continuity, not rock continuity. The biozones are based upon a biologic scale, which subdivides only the fusulinid evolutionary continuum and is completely independent of lithologic implications.

One consequence of this study is the confirmation of the Desmoinesian age of the so-called "Bostwick" or "pseudo-Bostwick" conglomerate adjacent to the Criner uplift.

Speciation within the Fusulinidae is based upon degree of relationship among the several morphological variables in a general time series. For this reason statistical discrimination was used to a large extent in speciation of the Ardmore basin fauna.

INTRODUCTION†

Pennsylvanian rocks crop out in the Ardmore basin in the Brock, Overbrook, and Caddo anticlines and in the Pleasant Hill syncline. Neither the Brock anticline nor the Pleasant Hill syncline, which are adjacent to the Criner Hills uplift, contains Pennsylvanian rocks older than Desmoinesian, either on the surface or in the subsurface. The Caddo and Overbrook anticlines, which are removed from the effect of the Criner Hills, contain Pennsylvanian rocks as old as the Springer Group. The Pennsylvanian of the Ardmore basin attains its maximum surface thickness in the southeastern outcrops of the Overbrook anticline where many of the limestone beds are abundantly fossiliferous.

Nomenclature. — The current lithostratigraphic nomenclature of the Ardmore basin has been reluctantly adopted by the writer, although it is confusing in regard to biologic zones, time, and lithology. However, rather than open a Pandora's box of new geologic names, the areas of confusion are simply pointed out in the discussion on lithostratigraphy. The history of the nomenclature and previous investigations is summarized in text-figure 2.

Rock-stratigraphic correlation within the basin is, in many cases, based upon fossil (primarily fusulinid) similarity, both on the surface and in the subsurface, rather than upon lithologic evidence. Fusulinids have been used reliably for both local and intercontinental correlation (in the "relative" time sense) because the time necessary for a genus to establish itself geographically is geologically insignificant compared to the total generic range. Thus the first occurrence of a fusulinid genus is essentially simultaneous (geologically speaking) throughout its areal distribution. Nevertheless, the correlation of rock units (formations, members, etc.) by means of a time yardstick (in this case fusulinid species) is an erroneous practice. It seems to the writer that stratigraphy is better served by an independence of lithologic and biologic elements because of such problems as: (1) vertical variation in rock-unit fossil species due to species crossing rock boundaries, (2) horizontal species variation within a given lithologic unit owing to environmental influences, (3) overlapping ranges of similar species in areas of more continuous carbonate development, and (4) fossil similarities not demonstrating physical rock con-

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† Much of the content of this section was presented at the Ninth Geological Symposium, Norman, Oklahoma, February 1966, and published in May 1966 (Waddell, 1966).

tinuity. Some fusulinid species are so similar that, even in the ideal situation, they are separated with difficulty from species in rocks above or below. The Ardmore basin circumstance is a case in point; here thin fossiliferous rock units are separated by thick, nonfossiliferous clastic units, and yet species are similar. Clearly then, it is impossible to correlate thin rock units upon the basis of fusulinid species.

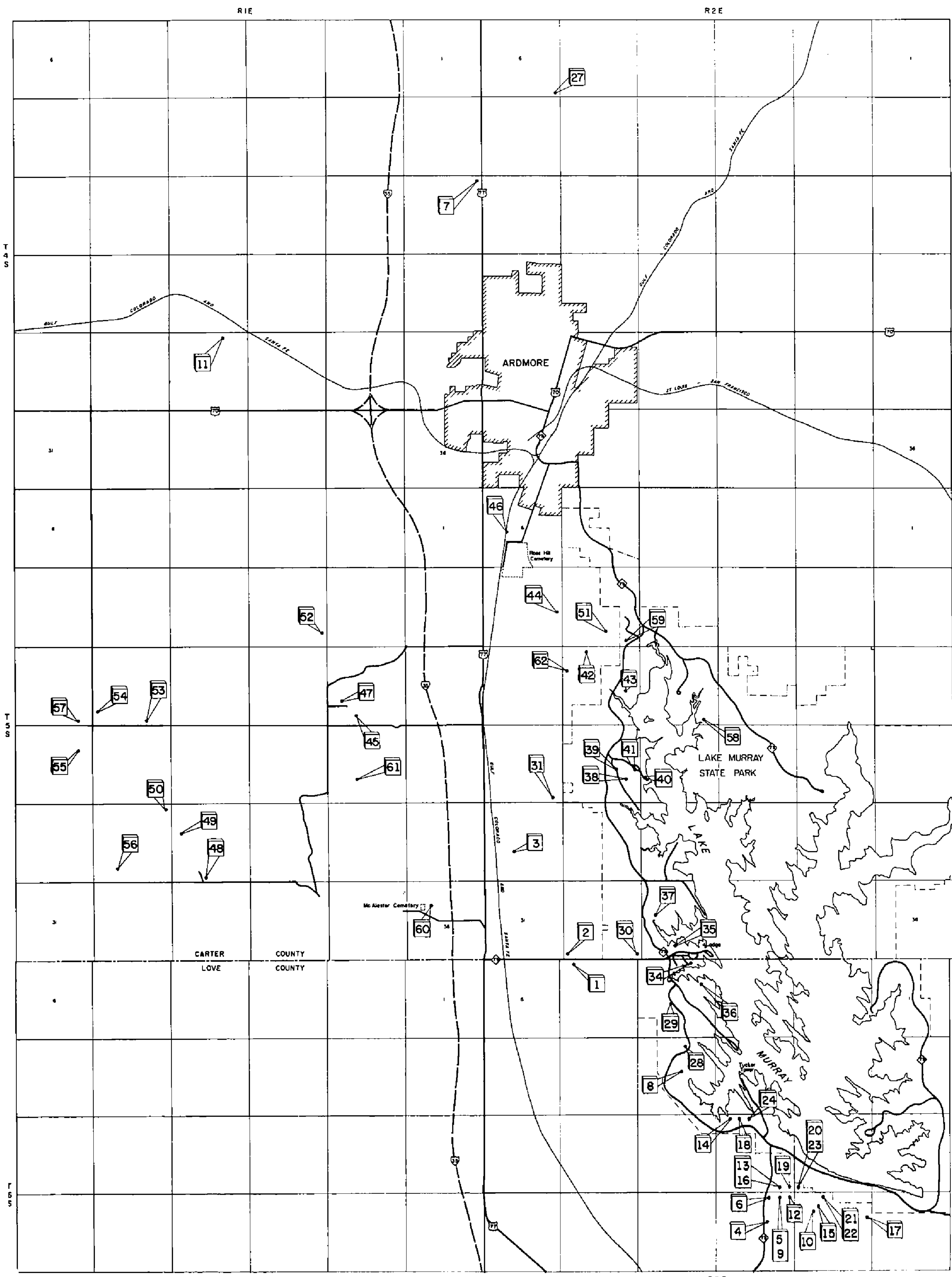
Present report. — The present report deals with biostratigraphic relationships resulting from the detailed study of more than 2,000 thin sections of fusulinids from some 62 geographic localities within the Ardmore basin. The problem was to describe the fusulinid faunas, synthesize the faunal and lithologic associations, and present a geochronologic framework within which physical parameters might be correlated. All of the fusulinid spec-

Text-figure 1. Index map of Ardmore basin area, Love and Carter Counties, Oklahoma, showing locations of fusulinid fossil-collecting localities.

STRATIGRAPHIC AND GEOGRAPHIC POSITIONS OF FUSULINID FOSSIL LOCALITIES IN THE SOUTHERN ARDMORE BASIN

LOCALITY NUMBER	LOCATION SEC.	T-S	R-E
	Bostwick Member		
1	NE NW NW 5	6	2
2	SW SW SW 32	5	2
3	NE SW 30	5	2
4	SW NE 22	6	2
5	NW NE NE 22	6	2
	Lester Member		
6	NE cor. NW NE 22	6	2
7	NE NE NE 13	4	1
8	SW SW NE 9	6	2
9	NW NE NE 22	6	2
10	C NW 23	6	2
11	NE NW NE 28	4	1
	Frensley Member		
12	NE NE NE 22	6	2
13	SW SE SE 15	6	2
14	NE NW NW 15	6	2
15	SW NE NW 23	6	2
16	SW SE SE 15	6	2
17	NE SE NE 23	6	2
	Between Frensley and Pumpkin Creek Members		
18	NW NE NW 15	6	2
19	SE SE SE 15	6	2
20	SW SW SW 14	6	2
21	N½ NE NW 23	6	2
	Pumpkin Creek Member		
22	N½ NE NW 23	6	2
23	SW SW SW 14	6	2
24	NE NE NW 15	6	2
27	SE SE SE 6	4	2
28	C NW NE 9	6	2
	Devils Kitchen Member		
29	NE NE SW 4	6	2
30	SE SE SE 32	5	2
31	S½ SE SE 19	5	2
	Arnold Member		
34	NE NW NE 4	6	2
35	NE SE SW 33	5	2
36	NW SE NE 4	6	2
37	SE SW NW 33	5	2
	Between Rocky Point and Camp Ground Members		
38	SW NE SE 20	5	2
39	NE NW SE 20	5	2
	Camp Ground Member*		
40	SW NW SW 21	5	2
41	NE NE SE 20	5	2
	Confederate Member		
42	NW NE NW 17	5	2
43	NW NE SE 17	5	2
44	NE NE SE 7	5	2
45	SE SW 14	5	1
	Crinerville Member		
46	NW NE SW 6	5	2
47	SE NW SW 14	5	1
48	SE SE SW 28	5	1
49	C SW NW 28	5	1
50	NE NE NE 29	5	1
	Anadarche Member		
51	NW SW SE 8	5	2
52	NE SE SE 10	5	1
53	SE SW SE 17	5	1
54	NW SW SW 17	5	1
	Daube Member		
55	NW SE NE 19	5	1
56	NW SE SW 29	5	1
57	SW SE SE 18	5	1
58	SW SE SE 16	5	2
59	SW SE SE 8	5	2
	Desmoinesian conglomerate		
60	NW SE NW 36	5	1
	Camp Ground Member		
61	S½ NE SW 23	5	1
62	NW SW NW 17	5	2

*See also numbers 61, 62.


R1E
R2E
T 4 S
T 5 S
T 6 S
ARDMORE
LAKE MURRAY STATE PARK
LAKE
MURRAY
CARTER COUNTY
LOVE COUNTY
McAlester Cemetery
Rose Hill Cemetery
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imens were collected in situ from calcareous shales or from limestones, the geographic and stratigraphic positions of which were carefully recorded. All geographic locations are indicated in text-figure 1.

The fauna has been compared directly with large faunas from the Pennsylvanian of the Bend arch of Texas and from eastern Oklahoma. The knowledge gained from the comparison of the faunas is recorded in that part of the introduction dealing with zonation and in the section concerned with correlation with surrounding areas.

The Pennsylvanian biozonation presented in this report (text-fig. 3) is based upon a biologic scale, subdivides only the fusulinid evolutionary continuum, is completely independent of lithologic implications, and coincides with a lithologic boundary only through fortuitous circumstance. It is thought that this approach will give the geologist the latitude necessary for the correlation of physical parameters within a geochronologic framework and free him from the inaccuracies engendered by fossil-defined formational nomenclature.

Fusulinid biozonation. — Zone I, the lowest stratigraphic fusulinid biozone in the Ardmore basin, is recognized by the occurrence of a *Fusulinella* fauna. The base of the zone is near the base of the Bostwick Member where *Fusulinella dakotensis* first occurs, and its top is above the Bostwick where the youngest specimens of *Fusulinella vacua* are found. The Bostwick Member is the only named rock unit in the zone. The so-called "Bostwick" or "pseudo-Bostwick" of the Pleasant Hill syncline definitely does not contain the Zone I fauna (Waddell, 1966). In Texas, the Zone I fauna is found only in the uppermost part of the Marble Falls Formation. The *Fusulinella prolifica* fauna of the eastern Oklahoma Atoka Formation is related to the Zone I fauna.

Zone II is characterized by one of the most primitive *Fusulina* faunas to be found in the Midcontinent region and by the presence of *Wedekindellina.* The zone is recognized by the presence of *Fusulina insolita* and *Fusulina mutabilis* in the lower one-half and by *Fusulina pumila, Wedekindellina* sp. A, and *Fusulina plattensis* in the upper one-half. Named rock units of this zone include the Lester Member and the Frensley Member.

The fusulinid fauna comprising Zone II is earliest Desmoinesian in age. Zone II rocks crop out in well-exposed ridges west of Anadarche Creek in the Overbrook anticline, where common to abundant fusulinids occur. Zone II rocks crop out in both the northeast and southwest limbs of the Caddo anticline. The base of Zone II occurs from 90 feet to 150 feet below the Lester Member of Tomlinson (1929). For cartographic convenience the "Atokan"-Desmoinesian boundary in the Ardmore basin should be placed at the base of the lower Lester Member. The top of the zone is the top of the highest limestone unit at the Frensley Member type locality.

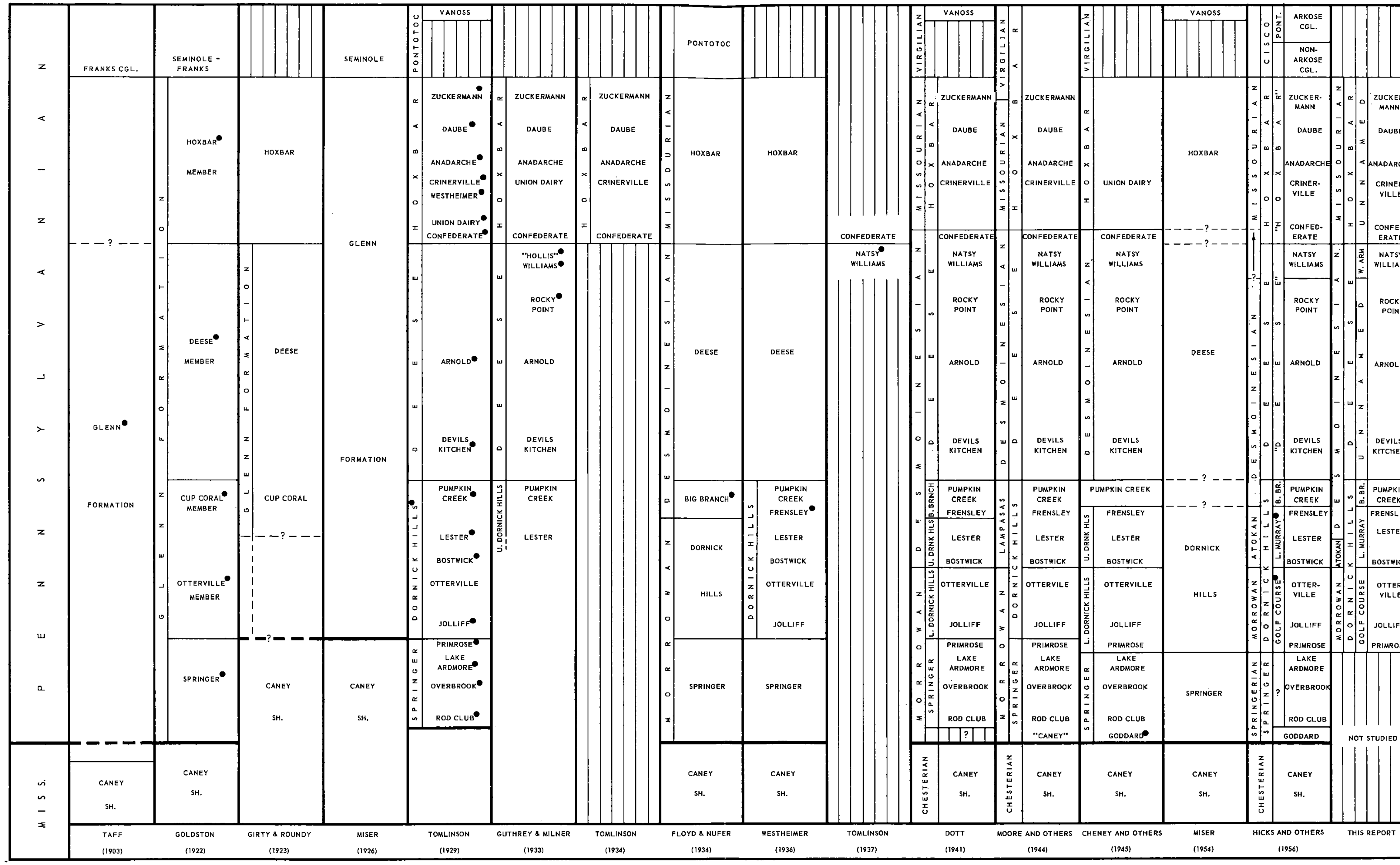
The relationship of Zone II to the north-central Texas region is partly obscured as a result of the "Caddo" limestone's having no outcrop expression. Core analysis of several wells, each containing different "Caddo" sections, indicates that the "Caddo" does contain the Zone II fauna. No outcropping rocks, of which I am aware, contain the Zone II fauna in either the Arkoma basin or the Northeast Oklahoma shelf.

Fusulinids of Zone III form a closely related group that is widespread and important in the subsurface of the Ardmore basin and northern Texas. Zone III is distinguished by the presence of *Fusulina* cf. *F. novamexicana, Wedekindellina* sp. B, *Fusulina euryteines,* and *Wedekindellina* sp. C. Its fauna is typically early Desmoinesian in age. In the southeastern part of the Overbrook anticline, in the maximum outcrop area, the base of the zone is approximately 250 feet beneath the Pumpkin Creek Member. The top of the zone is placed at the top of a thin, discontinuous limestone, overlying the Devils Kitchen Member, in the Caddo anticline north of Ardmore.

In north-central Texas, Zone III fusulinids are found in the thin limestone units from the Kickapoo Falls Member through the Brannon Bridge Member. In the Ardmore basin the Pumpkin Creek Member and the Devils Kitchen Member constitute the only named rock units. In northeastern Oklahoma this zone includes rocks of the middle and upper parts of the Krebs Group.

Zone IV, in terms of contrasting faunal elements, is the most distinctive of the faunal zones in the Desmoinesian of the Ardmore basin. It is characterized by specialized, yet rather primitive, *Fusulina,* as well as advanced forms of the genus, and by both primitive and advanced forms of *Wedekindellina. Fusulina* sp. A, *Fusulina* sp. B, and *Wedekindellina* sp. D occur in the thin limestones in the thick shale sequence underlying the Arnold Member and overlying Zone III. *Fusulina erugata* (similar to *Fusulina* sp. B), *Fusulina haworthi,* and *Wedekindellina* sp. E are found in the upper part of the zone. *Wedekindellina* sp. E is the youngest representative of true *Wedekindellina* in the Ardmore basin.

In northern Texas, Zone IV begins above the Brannon Bridge Member and continues through



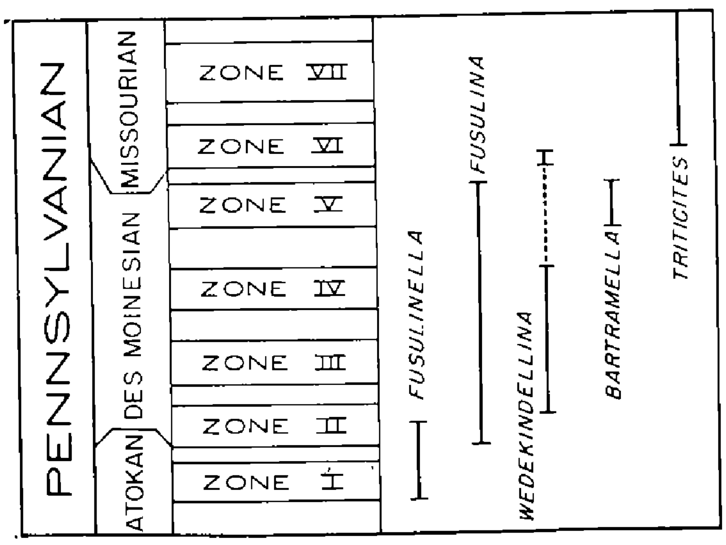
Text-figure 2. Review of stratigraphic nomenclature of the Ardmore basin. Solid black circle indicates first proposal or publication of name.

approximately the Santo Member. On the eastern shelf of the Midland basin and in the Palo Duro basin the section is well developed. In southern Oklahoma the Arnold Member is the only named rock unit, although the subsurface lower "*Fusulina*" sand may be equivalent to the upper part of the zone. Zone IV is represented in northeastern Oklahoma by the uppermost rocks of the Krebs Group and the lower part of the Cabaniss Group.

Zone V is identified by the occurrence of *Fusulina* aff. *F. whitakeri* and *Fusulina acme.* These species of the genus *Fusulina* indicate a late Desmoinesian age for the zone. In the down-dip subsurface of the eastern Midland basin and north-central Texas, core information indicates that the genus *Bartramella* is an element in the Zone V fauna. It has not, however, been found on the surface in either Texas or Oklahoma. Whether it occurs down-dip in the subsurface of southern Oklahoma is unknown to me, although it would be surprising if it did not.

In the Ardmore basin, Zone V contains only one named rock unit, the Camp Ground Member. It is expected that the zone will expand upward with discovery of fusulinids in the overlying Williams and Natsy Members. The morphological advancement of Zone V species is found in the Village Bend-Capps rocks of northern Texas and in the Marmaton Group of northeastern Oklahoma.

Zone VI is characterized by *Wedekindellina? ardmorensis* and by *Triticites tomlinsoni.* The rocks within this biozone are early Missourian in age and are widespread throughout the subsurface and surface of the western and southern Midcontinent. In the Ardmore basin, *Wedekindellina? ardmorensis* has been collected as much as 75 feet below the Confederate Member. Thus the base of the Confederate Member as a base of the Missourian is a convenient cartographic boundary only. Based upon the stratigraphic occurrence of *Wedekindellina* of the group *ultimata* in the subsurface of northern Texas, however, the compromise boundary may be well justified. The top of the zone is placed at the top of the Crinerville Member. In north-central Texas the zone includes the Salesville, Keeche Creek, and lower Palo Pinto units. In northeastern and east-central Oklahoma



Text-figure 3. Fusulinid biozones of the Pennsylvanian System in southern Oklahoma.

the rocks underlying the Belle City are closely equivalent to Zone VI.

The youngest fusulinid outcrop zone in the Ardmore basin is Zone VII and is identified by elongate species of *Triticites. Triticites irregularis* is characteristic of the lower part of the zone whereas *Triticites primarius* and *Triticites newelli* define the upper part. The fauna of Zone VII is early and middle Missourian in age. In Oklahoma the zone includes the Anadarche Member and the Daube Member. The subsurface County Line limestone is within this zone. In north-central Texas, rocks of the upper Palo Pinto Member through at least the Winchell Member are included in Zone VII. Zone VII is overlapped and cut out by the Vanoss Conglomerate of Virgilian age in the Overbrook anticline and by the Trinity sandstones and conglomerates of Cretaceous age in the Brock anticline. It is expected that Zone VII may be more extensive in the subsurface of southern Oklahoma than on the surface.

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LITHOSTRATIGRAPHY

General Relations and Nomenclature

Rock units of Pennsylvanian age crop out in the Ardmore basin in Carter and Love Counties adjacent to two major Oklahoma uplifts: the Arbuckle Mountains to the north and the Criner Hills to the southwest. These rocks reflect an apparently uninterrupted, marine depositional history throughout Late Mississippian and a part of Pennsylvanian time, except locally. The names and generalized lithologic character of the formations and members in each of the groups (above the Golf Course Formation) are shown in text-figure 4. The distribution of the fusulinids within these rock units is shown in plate XIII.

Rock-stratigraphic nomenclature in the area was initially set up by Taff (1903). Goldston assigned the principal large division names in 1922. The nomenclature was revised by Tomlinson (1929) who clarified many ambiguities and miscorrelations. Individual studies of various rock-stratigraphic and time-stratigraphic units have been made by W. M. Guthrey and C. A. Milner (unpublished map, 1933), Tomlinson (1934), Floyd and Nufer (1934), Westheimer (1936), Dott (1941), Cheney (1945), Bennison (1954), Hicks and others (1956), and Tomlinson and McBee (1959, 1962).

The Ardmore basin depositional history began with the deposition of the Late Mississippian-Early Pennsylvanian (?) "Springer Group," which is characterized in the lower half by dark-gray, soft, noncalcareous, clayey shale and in the upper half by the same shale with extensive sandstone members. The Dornick Hills Group is composed largely of shales, thin limestones, and minor limestone conglomerates. The Deese Group is represented by a thick development of sandstones and shales and by some widespread and locally lenticular chert-pebble conglomerates. The Hoxbar Group is essentially a shale and thin-limestone sequence, although sandstone and conglomerate become increasingly abundant in upper Hoxbar strata. The proportion of each rock type within a particular group differs from place to place within the basin; however, the groups are readily identifiable.

A maximum thickness of 17,000 to 18,000 feet of predominantly clastic rocks containing a few thin limestones, occurs within the Ardmore basin. Such thicknesses and the clastic nature of the sedimentary rocks indicate that this basin underwent continuous subsidence throughout Pennsylvanian time. Jacobsen (1959, p. 108) considered the rate of sedimentation for Primrose through Arnold rocks to be 500 feet per million years and the rest of the Pennsylvanian to be 750 feet per million years. This, however, is somewhat misleading because the "sedimentary package" was ignored. The sedimentary sequence from the top of the Pumpkin Creek Member to at least the top of the Camp Ground Member must be considered as a "sedimentary package." Any computed sedimentation rate which ignores this package of sandstones and shales, although possibly pertinent, is at best uncertain.

Dornick Hills Group

The Dornick Hills Group (Hicks and others, 1956, p. 4, footnote 1; Harlton, 1956, p. 138) consists mainly of shales, thin limestones, lenticular limestone conglomerates, and some sandstones. Limestones are largely medium to coarse crystalline with fragmental fossil debris (mostly grainstones and a few packstones) and at places some sandy grainstones. The only noteworthy exceptions are the calcite mudstones and the calcite mud mounds in the upper parts of the Bostwick Member and Pumpkin Creek Member, respectively. Older conglomerates (Jolliff Member) are principally Mississippian in character and contain pebbles of Sycamore Limestone with some Woodford Chert (Tomlinson, 1929). Younger conglomerates (Bostwick Member) are principally Ordovician in character and contain pebbles as old as late Arbuckle. The matrix material in the conglomerates is commonly quartz sandstone and/or calcite. These conglomerates are lenticular fanglomerate-like deposits that are thickest near the Criner Hills. Jacobsen (1959, p. 58-65) indicated that the sandstones are quartzose graywackes, composed of angular to subangular quartz grains.

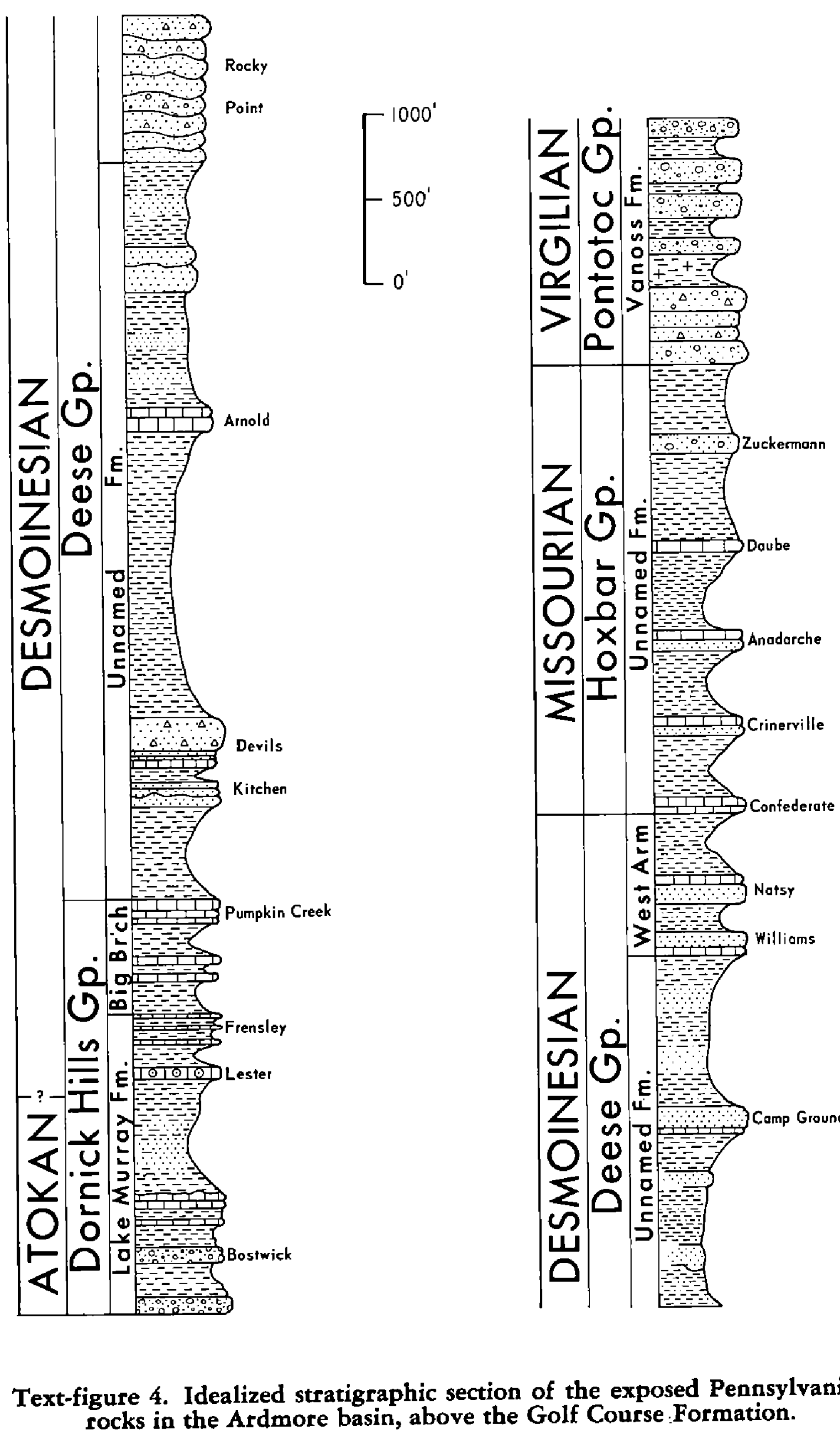
GOLF COURSE FORMATION

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 [Formation] . . . 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.

The Golf Course Formation has little to recommend it as a formation because it is based upon inferred age and is in reality neither a biostratigraphic zone nor a formation. Rock-stratigraphic units should be recognized and defined upon the basis of lithologic character, whether homogeneous or heterogeneous, and should be completely independent of time concepts.

Primrose Member.—The Primrose Sandstone Member was proposed and described by Tomlinson (1929, p. 19). It is a thin-bedded quartz sandstone with interbeds of shale. The sandstones contain thin lenticular intraclasts of dark shale. The absence of the Primrose Member south of Ardmore was thought by Tomlinson and McBee (1959, p.



Text-figure 4. Idealized stratigraphic section of the exposed Pennsylvanian rocks in the Ardmore basin, above the Golf Course Formation.

18) to be due to pre-Jolliff erosion. Elias (1956, p. 97) correlated the Primrose with the Union Valley Sandstone.

Unnamed unit. — Up to 1,200 feet of shales overlies the Primrose north of Ardmore (Tomlinson and McBee, 1959, p. 19). In NW¼ sec. 34, T. 3 S., R. 4 E., Elias (1956, p. 99) measured 707 feet of gray, sideritic shale above the Primrose Member and below the supposed Jolliff equivalent. The name Gene Autry Shale was given to this shale sequence by Elias. Because of the uncertainty of the upper contact (Jolliff equivalent), the name has not been generally accepted. South of Ardmore much of this shale is missing owing to pre-Jolliff erosion (Tomlinson and McBee, 1959, p. 18).

Jolliff Member. — The Jolliff limestones and conglomerates were named and described from southwest of Ardmore by Tomlinson (1929, p. 29). The Jolliff is composed of coarse conglomerates as much as 30 feet thick and of gray to tan shales with thin-bedded to nodular limestones. The conglomerates are composed mainly of pebbles of Sycamore Limestone (Mississippian) and Woodford Chert (Mississippian), according to Tomlinson and McBee (1959). Rocks as old as Viola (Late Ordovician) are uncommon but present. These conglomerates are lenticular and locally disappear or grade into limestones along strike. The Jolliff limestones are the first mappable limestones to appear in the Pennsylvanian rocks of the basin. A large and varied coral fauna is present in the Jolliff (P. K. Sutherland, oral communication). Colonial rugose corals of Morrowan age have been found.

Unnamed unit. — From 500 to 800 feet of dark-gray to black shales overlies the Jolliff south of Ardmore. Because the Jolliff per se does not crop out north of Ardmore, the relationship of the shale overlying the Jolliff to the south to the 1,200 feet of shales overlying the Primrose Member and below the Otterville Member to the north cannot be definitely established. Tomlinson and McBee (1959, p. 20) thought that the section overlying the Jolliff south of Ardmore finds its equivalent in the upper shales of the 1,200-foot shale section overlying the Primrose north of Ardmore. If Elias' correlation of his supposed Jolliff equivalent north of Ardmore is correct, then 800 feet of shale south of Ardmore converges to 100 feet of shale north of Ardmore. Although convergence is established in many formations from south to north in the basin, a factor of eight times seems excessive. It is evident that the stratigraphic relationships are not entirely known.

Otterville Member. — The name Otterville Limestone is retained for Station 4062 of Girty and Roundy (1923, p. 343), as suggested by Tomlinson and McBee (1959, p. 20, footnote 7). The Otterville ranges from 10 to 20 feet in thickness and in most places consists of fragmental fossil material set in a clear sparry calcite matrix (grainstone). In the upper 3 to 4 feet oöliths are common. Conglomerates occur south of Ardmore in Love County but are not extensive. Paleontological work by Girty and Roundy (1923) has established a Morrowan age for the Otterville macrofauna.

LAKE MURRAY FORMATION

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 Formation, 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 *Fusulinella,* entirely unknown in true Morrowan rocks, that stamps the Lake Murray as a separate unit in geological history.

Here, as with the Golf Course Formation, a paleontologic criterion has been presented to designate a formation, although fossil-determined rock boundaries have no foundation. Harlton's Lake Murray Formation is clearly a biostratigraphic zone.

Unnamed unit. — South of Ardmore approximately 475 feet of light yellow-tan shales overlies the Otterville Member. It has not been definitely established whether this shale belongs to the Morrowan Series or the "Atokan" Series.

Bostwick Member. — The Bostwick Member (Tomlinson, 1929, p. 30) forms the most conspicuous natural topographic feature of any extent south of Ardmore in the Ardmore basin and can be traced continuously along the northeast flank of the Overbrook anticline for approximately 15 miles. 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 older limestone as old as late Arbuckle (Early Ordovician) in a matrix of quartz sandstone and calcite. The conglomerate lenses are thickest in the vicinity of sec. 32, T. 5 S., R. 2 E., and sec. 5, T. 6 S., R. 2 E., and decrease in thickness and in pebble size toward the northwest and southeast, indicating fanlike deposits that originated from the Criner Hills. Except where exposed in a road cut or gulley, the Bostwick lithology can be interpreted only from surface float along the ridge. The conglomerate lenses and the upper nodular limestone are more resistant to weathering and form traceable float surfaces.

Dark-gray to black, fine-crystalline, nongrain-supported limestone (mudstone) constitutes the top of the Bostwick at measured section 5. Toward the southeast this limestone loses its nodular character and, in NE¼ sec. 22, T. 6 S., R. 2 E., becomes medium bedded to thick bedded. Within the shale partings associated with the nodular to thin-bedded limestone are found rugose corals, brachiopods, bryozoans, gastropods, and fusulinids. The upper nodular calcite mudstone is characterized by *Fusulinella vacua,* new species, at fossil localities 1, 2, 3, and 5. The species occurs sparsely in the unit at fossil locality 4. Approximately 50 to 60 feet below the upper blue-black, nodular calcite mudstone is a poorly cemented "fossil fragment zone," the major particulate constituent of which is syringoporid corals. Commonly found in this highly fossiliferous bed are rugose corals, bryozoans, fusulinids, and some brachiopods and gastropods. The fusulinid *Fusulinella dakotensis* characterizes this bed at fossil localities 1 and 2.

Adjacent to the Criner Hills, in sec. 36, T. 5 S., R. 1 E., a thick chert-limestone conglomerate (appendix A, measured section 10) occurs approximately 40 feet above a discontinuously exposed, deeply weathered, brown to tan, micritic limestone. The conglomerate is mappable into secs. 24, 25, T. 5 S., R. 1 E. The limestone below is questionably mappable into sec. 25 upon the basis of a thin line of vegetation. Rocks of this interval have been considered as the west limb of the Overbrook anticline and indicated as of probable Bostwick ("Atokan") equivalence by Tomlinson (1929, p. 32; 1948, pl. III), Jacobsen (1959, p. 33), and Tomlinson and McBee (1959, p. 26; 1962, p. 480). Frederickson (1957) considered this conglomerate to be equivalent to Deese rocks exposed on the northeast limb of the Overbrook anticline. A collection of fusulinids was obtained from the limestone underlying the conglomerate mass in C SE¼ NW¼ sec. 36, T. 5 S., R. 1 E., which are of definite Desmoinesian age (Waddell, 1966, p. 125). Isolated outcrops of chert-limestone conglomerate unconformably overlie various lower Paleozoic rocks on the east side of the Criner Hills. These conglomerates are in turn overlapped by overlying Pennsylvanian rocks. The Desmoinesian conglomerate in secs. 24, 25, 36, T. 5 S., R. 1 E., is probably to be correlated with those in secs. 15, 22, 35, T. 5 S., R. 1 E.; at least the "Atokan" equivalence of the latter is rejected. Further, these conglomerates support a thesis of continued spasmodic uplift in the Criner Hills area well into Desmoinesian time and lend support to Ramay's assertion (1957b, p. 45) that "the oldest rocks that covered the Criner Hills are probably middle Deese in age."

Unnamed unit. — Approximately 750 feet of shale 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. In sec. 22, T. 6 S., R. 2 E., several feet of variegated shales occurs with thin sandstone beds and concretionary limonitic zones. Three distinct sandy limestones, or calcareous quartz sandstones, occur in the upper 200 feet and are mappable for approximately 2 miles along strike in secs. 22, 23, T. 6 S., R. 2 E.

Lester Member. — The Lester Member (Tomlinson, 1929, p. 32) at its type locality, in sec. 13, T. 4 S., R. 1 E. (measured section 14), is an oölitic, sparry calcite-cemented limestone (grainstone). The grain support is principally oöliths and bryozoan fragments, although fragments of gastropods, brachiopods, and crinoids are incorporated. Southeastward from the type locality increasing amounts of quartz sand grains occur in the Lester Member. The Lester Member in NW¼ NE¼ NE¼ sec. 22, T. 6 S., R. 2 E. (measured section 1), is a sandy, fossiliferous, thin- to medium-bedded grainstone containing only a few oöliths. *Fusulina mutabilis,* new species, is found but is uncommon.

At measured section 14, approximately 90 feet below the Lester Member, as defined by Tomlinson, is a deeply weathered, yellow-tan, sandy, fossiliferous grainstone. The most common fossils are bryozoans and the fusulinid *Fusulina mutabilis.* At measured section 1, south of Ardmore, 150 feet below the Lester Member, is a weathered, tan, sandy, nonoölitic grainstone. Fossils collected from this limestone include cephalopods, rugose corals, brachiopods, pelecypods, gastropods, and fusulinids. It is remarkable that even the larger corals and brachiopods (not excluding other smaller fossils) are completely encased by algal (*"Osagia"*) growths as much as ⅛-inch thick. The fusulinid *Fusulina insolita* is uncommon in this limestone, having been found only at C NW¼ NE¼ NE¼ sec. 22 and NE cor. NW¼ NE¼ sec. 22, T. 6 S., R. 2 E.

Based upon the primitive fusulinids found within and below the Lester Member, lowering of the Desmoinesian lower time-stratigraphic boundary to include the Lester Member was suggested to C. W. Tomlinson in 1959. This proposal was formally published by Tomlinson and McBee in 1962. In their report an editorial footnote by C. C. Branson (Tomlinson and McBee, 1962, p. 479, footnote 10) reads:

> 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.

The writer feels strongly that series and systemic boundaries are not mappable units and do not necessarily conform to mappable lithologic units. Although both the Lake Murray and Big Branch "formations" were incorrectly based upon paleontological evidence initially, redefinition on further paleontological evidence does not constitute an improvement over the original error. Rock-stratigraphic units are not time bounded, neither are time-stratigraphic units rock bounded.

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 discontinuously mappable toward the northwest along strike.

Frensley Member. — The Frensley Member was proposed by Westheimer (1936). In proposing this member he 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 limestones 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 SE¼ sec. 30, T. 3 S., R. 2 E.

It is apparent that Westheimer's evidence for removing the Frensley from the Pumpkin Creek Member was based upon the paleontology of the chalky limestone 400 to 500 feet below the main Pumpkin Creek ledge south of Ardmore in NE¼ sec. 15, T. 6 S., R. 2 E. Unfortunately Westheimer chose as a type section a supposed equivalent outcrop of better exposed rock north of Ardmore in SE¼ SW¼ SE¼ sec. 30, T. 3 S., R. 2 E. The type section proposed by Westheimer was found to be in Pumpkin Creek rocks (Waddell, 1959). A new type section was proposed at the suggestion of C. W. Tomlinson and formally introduced by Tomlinson (1959, p. 317).

The redesignated Frensley locality is in NE¼ NE¼ sec. 22 and SE¼ SE¼ sec. 15, T. 6 S., R. 2 E., where four limestones occur in approximately 150 feet of stratigraphic section (measured section 1). The lower limestone ranges from 1 to 3 feet in thickness and along strike changes composition from a slightly sandy, medium-crystalline, fossiliferous grainstone to a marly, nodular, fine-crystalline, poorly cemented limestone. Both *Fusulina pumila* and *Wedekindellina* sp. A are common in this unit, having been collected at fossil localities 12, 13, 14, and 15. The fusulinid occurrences are as widespread as the good outcrops of the lower part of the Frensley Member. The presence of *Wedekindellina* sp. A in the lower part of the Frensley marks the earliest occurrence of the genus found in the Ardmore basin by the writer. The third limestone is a medium- to coarse-crystalline, sandy, fossiliferous grainstone, with the top 4 inches becoming a poorly cemented fossil "hash." Approximately 9 feet of calcareous siltstone-claystone and interbedded gray shale overlies the grainstone. Along strike this unit increases in calcareous content and in some localities it is a nodular, fine-crystalline mudstone (micritic limestone). This 10-foot unit is probably equivalent to Westheimer's "nodular, dense limestone" below the Pumpkin Creek ledge in NE¼ sec. 15, T. 6 S., R. 2 E., although the intervening area between outcrops (about 1 mile) is covered by alluvium, and the beds cannot be traced. The brachiopods *Neospirifer, Composita,* and *Desmoinesia* characterize the fauna of the above rocks. The upper limestone is a thin- to very thin-bedded, medium- to coarse-crystalline, fossiliferous grainstone. Approximately 2 feet above the base is a 6- to 8-inch, uncemented, fragmental shell zone. The fusulinid *Fusulina plattensis* was collected from two of the better exposures of this bed at fossil localities 13 and 17.

The Frensley beds are, in general, poorly exposed. Limestones which must be equivalent to the Frensley of the new type area lie above the sandstone overlying the upper Lester Member and below the three prominent limestones below the Pumpkin Creek in NE¼ NW¼ NW¼ sec. 15, T. 6 S., R. 2 E. (measured section 2). However, the only limestone bed confidently correlated to the new type section is the lower one (bed 1), and this upon the basis of paleontology *(Fusulina pumila* and *Wedekindellina* sp. A), not lithology. Limestone float can be traced into sec. 30, T. 5 S.,

R. 2 E.; however, one cannot be certain beds have not been crossed.

BIG BRANCH FORMATION

Tomlinson (1929, p. 28-34) recognized the sedimentary package comprising the rocks from the base of the Jolliff limestone-conglomerate to the top of the Pumpkin Creek Limestone and called this rock sequence (shale, containing thin beds of limestone conglomerate, limestones, and some sandstones) the Dornick Hills Formation. The only possible improvement that could be made on the original Dornick Hills (and this is debatable) would be (1) to group together the Jolliff, Otterville, and Bostwick limestones and limestone conglomerates and (2) to group the shales with thin limestones above the top of the Bostwick and below the top of the Pumpkin Creek. The principal objections to Tomlinson's Dornick Hills were that it crossed time boundaries and was too thick. Both objections are invalid in the writer's opinion. However, the Big Branch Formation was proposed by Floyd and Nufer, in a paper given before the Tulsa Geological Society in November 1934, for the upper 700 feet or so of the Dornick Hills. The name was published without description in the abstract of the paper in the Tulsa Geological Society Digest (Floyd and Nufer, 1934). The following description is quoted from a letter from Nufer published by Harlton (1956, p. 140):

> The type locality was given as exposures along the Big Branch of the Washita River in NW sec. 11, T. 3 S., R. 2 E. Here complete exposures were found of the upper part of the formation and included the limestone 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.

Floyd and Nufer were correct in recognizing a Desmoinesian age for the rocks of the upper Dornick Hills (now a group). However, to flog a dead horse, such paleontological evidence is no criterion for proposing formations. Harlton (1956, p. 141-142) modified the original description by raising the base of the Big Branch to the top of the Frensley (based upon paleontological evidence) because of a belief of the "Atokan" age of the latter. Tomlinson and McBee (1962, p. 479, footnote 9) shifted the formation boundary down to include about 200 feet of shale below the Lester Member (again based upon paleontological evidence). What then constitutes the Big Branch "Formation"? Since one definition is as objectionable as another, it makes little apparent difference. The writer has reluctantly followed Harlton (1956, p. 138-142) from necessity.

Unnamed unit.— Approximately 630 feet of yellow-gray to tan shales with yellow-brown, fine- to medium-grained quartz sandstone beds overlies the Frensley Member. Within the upper 200 feet of this shale unit occur three sandy limestone beds which range in thickness from 2 to 6 feet in NE¼ NW¼ sec. 15, T. 6 S., R. 2 E. (measured section 2). These limestone units thicken toward the southeast and, in SW¼ sec. 14, SE¼ sec. 15, and NW¼ sec. 23, T. 6 S., R. 2 E., are as much as 12 feet thick. The uppermost and thickest of these sandy limestones contains a rare fusulinid fauna considered to be similar to that of the overlying Pumpkin Creek.

Pumpkin Creek Member.— The Pumpkin Creek Member (Tomlinson, 1929, p. 33) is well exposed in NE¼ NW¼ sec. 15, T. 6 S., R. 2 E. (measured section 2), and along strike toward the southeast to where it is overlapped by the Cretaceous Trinity Group. The Pumpkin Creek ranges from 40 to 60 feet in thickness in secs. 14, 15, 23, T. 6 S., R. 2 E., but thins toward the northwest to about 20 to 30 feet in NE¼ NE¼ sec. 28, T. 4 S., R. 1 E., where it is overlapped by the Pontotoc Group. North of Ardmore on the northeast flank of the Caddo anticline the Pumpkin Creek was measured to be about 40 feet thick. The lithology ranges from a thin- to medium-bedded, medium- to coarse-crystalline, locally cherty, fossiliferous grainstone to a quartz sand, thin- to medium-bedded, calcite-cemented limestone (grainstone?) to a fine-crystalline, nodular- to thin-bedded calcite mudstone (mudstone-micrite). About 16 feet above the base at measured section 2 is a poorly cemented to loose, broken, poorly sorted, fragmental, fossil-hash unit. Within this unit along strike small mud mounds occur. The mound structures are small domal bodies as much as 2 feet high and 6 feet long and contain fenestrate bryozoans, large amplexizaphrentid rugose corals, and the colonial coral *Michelinia,* in a fine-crystalline calcite mudstone (micritic) matrix. The uncemented to poorly cemented unit can be traced into sec. 23, T. 6 S., R. 2 E., although no mud mounds were observed.

At fossil localities 22 and 23, *Fusulina* cf. *F. novamexicana* and *Wedekindellina* sp. B occur sparsely in the lower 10 to 15 feet of the formation. At fossil locality 24 the same two species occur sparsely within and below the uncemented, fragmental unit. *Wedekindellina* also occurs in the upper part of the section at this locality. At fossil locality 28, the limestone has shaled out (total thickness about 20 feet), and the two species are found sparsely throughout the outcrop. North of Ardmore the *Fusulina* species is common at fossil locality 27 and in SE¼ SW¼ SE¼ sec. 30 and SW cor. sec. 20, T. 3 S., R. 2 E. Few specimens of the *Wedekindellina* species were found.

Deese Group

The Deese Group, as used in this paper, is identical with the Deese Formation proposed by Tomlinson (1929, p. 35). It is bounded by the top of the Pumpkin Creek Member at the base and by the base of the Confederate Member at the top. The Deese Group is characterized lithologically by quartz sandstones, sandy shales, chert conglomerates, and a few thin limestones. The group has a maximum thickness of about 7,000 feet south of Ardmore in the southeast exposures of the Overbrook anticline.

UNNAMED FORMATION

Since the untimely elevation of Tomlinson's formation names to group rank (Hicks and others, 1956, p. 4, footnote 1; Harlton, 1956, p. 138), Deese rocks have been assigned either to the "Deese formation" or to no formation at all (except for Harlton's West Arm Formation in uppermost Deese rocks). The writer prefers not to propose new formation names and has referred the majority of Deese Group rocks to an unnamed formation. This is in preference to referring to Deese Group and "Deese formation."

Unnamed unit. — Between the Pumpkin Creek Member and the overlying Devils Kitchen is approximately 700 feet of sandy shales and fine-grained, thin- to thick-bedded quartz sandstone.

Devils Kitchen Member. — The Devils Kitchen Member (Tomlinson, 1929, p. 35) is divisible into a lower sandstone as much as 200 feet thick, a middle shale as much as 225 feet thick with 10 to 20 feet of limestone at the upper limit, and an upper unit of thin-bedded sandstone either overlain by thick-bedded sandstone containing chert pebbles or chert conglomerate, which has a maximum thickness of approximately 200 feet. Most of the Devils Kitchen outcrops expose the middle shale and overlying sandstones. Schacht (1947, p. 27-29) indicated a probable source somewhere in the Ouachitas for the conglomerate. Jacobsen (1959, p. 116), however, indicated that the apparent outcrop thickening and coarsening of the conglomerate phase toward the southeast presented only two dimensions of a three-dimensional body. He further indicated that "none of the distinctive chert lithologies of the Ouachita Mountains were recognized in Devils Kitchen pebbles," and expressed doubt that the source area was the Ouachita Mountains.

The upper 21 feet of the middle Devils Kitchen shale in terms of lithology is as follows: lower 6 to 8 inches nodular, gray-white weathering, unfossiliferous calcite mudstone (micrite); 5 to 6 feet soft, gray-tan, fossiliferous, calcareous shale; 6 to 10 inches nodular, silty, unfossiliferous calcite mudstone; 4 feet yellow-tan, fossiliferous calcareous shale; and 10 feet nodular to thin-bedded, yellow-gray to gray-white; poorly fossiliferous calcite mudstone with fossiliferous, gray calcareous shale partings. Brachiopods, gastropods, crinoids, foraminifers, ostracodes, and bryozoans are common in the shales. The fusulinids *Fusulina euryteines* and *Wedekindellina* sp. C are found abundantly in the shale units and in the shale partings of the upper limestone unit, but only sparsely in the upper micritic limestone. These fusulinid species were found at fossil localities 29, 30, and 31.

The upper Devils Kitchen unit consists of two phases. Immediately overlying the upper limestone, in sec. 4, T. 6 S., R. 2 E., and sec. 32, T. 5 S., R. 2 E. (measured sections 3, 4), is about 75 feet of thin-bedded, hematitic, red-brown, medium-grained quartz sandstone containing a few isolated chert pebbles. Overlying this thin-bedded sandstone is 50 to 80 feet of thick-bedded, fine- to medium-grained quartz sandstone containing many chert pebbles. In NE¼ NE¼ SW¼ sec. 4, T. 6 S., R. 2 E. (measured section 3), the chert conglomerate phase appears and thickens toward the southeast. It is possible that the upper thick-bedded sandstone with many chert pebbles and the chert conglomerate are, at least in part, equivalent facies. The conglomeratic phase is limited to the Overbrook anticline, and, in general, becomes less important as a distinct phase or as a constituent in the sandstone toward the north and west.

Unnamed unit. — Overlying the Devils Kitchen and below the Arnold Member is approximately 1,750 feet of shales with quartz sandstone beds. At least one sandstone unit is as much as 50 feet thick south of Ardmore. North of Ardmore two collections were made within this sequence of rocks (Tomlinson, 1959, p. 314, locs. 38, 41). *Fusulina* sp. A was found in the lower thin limestone in sec. 28, T. 3 S., R. 2 E. *Fusulina* sp. B and *Wedekindellina* sp. D were found in the upper thin-bedded limestone in sec. 33, T. 3 S., R. 2 E. South of Ardmore no limestone beds were found within this interval, although an old unpublished map, compiled by W. M. Guthrey and C. A. Milner in 1933, indicates fossiliferous limestone beds which are now covered by Lake Murray.

Arnold Member. — The Arnold Member (Tomlinson, 1929, p. 38), as a physical zone of shale containing thin limestone beds and only a few sandstone beds, has a maximum thickness of 140 feet south of Ardmore. If the limits of the unit were placed at the bottom of the lowest limestone and at the top of the highest limestone, the range in thickness would be from about 25 feet to about 75 feet. The typical Arnold (limestone) lithology ranges from a medium- to coarse-crystalline, thin- to medium-bedded, blue-gray to gray-tan, sandy, fossiliferous, sparry calcite-cemented limestone to a fine-crystalline, nodular to thin-bedded, gray to white calcite mudstone (micrite). *Fusulina erugata,* new species, occurs throughout the Arnold Member in the Overbrook anticline. *Fusulina haworthi* and *Wedekindellina* sp. E occur only in the uppermost part of the Arnold "zone" (south of Ardmore) and may not be considered by some geologists as having actually come from the Arnold Member. Outcrops which best express the physical and biological relationships of this member (zone?) crop out in NE¼ SE¼ NE¼ and NE¼ NW¼ NE¼ sec. 4, T. 6 S., R. 2 E. (measured section 6), and NE¼ SE¼ SW¼ and SE¼ SW¼ NW¼ sec. 33, T. 5 S., R. 2 E.

Unnamed unit. — Overlying the Arnold Member is 1,400 feet of red and gray shale with thick quartz sandstone beds. Tomlinson and McBee (1959, p. 32) correlated the lower sandstone beds above the Arnold Member with the "*Fusulina* sand" of the subsurface to the northwest. This may also include the writer's limestone-nodule zone about 30 to 50 feet above the uppermost limestone bed in the Arnold "zone."

Rocky Point Member. — The Rocky Point Member of W. M. Guthrey and C. A. Milner (unpublished map; spelled "Rockpoint" on map) is well exposed in E½ SW¼ SW¼ sec. 28, T. 5 S., R. 2 E., where about 70 feet of fine- to medium-grained, tan, thick-bedded quartz sandstone with associated red-yellow to gray, sandy shale crops out. Chert pebbles occur within the sandstone beds as clasts and as distinct conglomeratic beds. Chert pebbles decrease in size and quantity toward the northwest and north as does the chert of the Devils Kitchen Member. Tomlinson and McBee (1959, p. 32) considered the Ouachita Mountains as a source for the chert pebbles, whereas Jacobsen (1959, p. 110-111) favored local basin-margin fault scarps as a sediment source.

Unnamed unit — Overlying the Rocky Point Member, and below the Camp Ground Member, is about 1,900 feet of gray-tan, silty to sandy shales and yellow-tan, fine- to medium-grained, thin- to thick-bedded quartz sandstones. Approximately 900 feet above the Rocky Point Member, in SW¼ NE¼ SE¼ and NE¼ NW¼ SE¼ sec. 20, T. 5 S., R. 2 E. (measured section 7) three limestone beds occur through some 130 feet of silty shale and are the only limestone beds which now crop out in the northeast flank of the Overbrook anticline between the Arnold and Camp Ground Members. The lower bed is a medium-bedded, green-clay-intraclast-bearing, reddish-brown, fossiliferous, sandy grainstone that becomes a blue-green, silty shale northwest along strike. The medial bed is about 1 foot thick, sandy, slightly fossiliferous and has gray-clay intraclasts. The upper zone consists of two beds, 6 inches thick, separated by 3 feet of shale. The limestone beds are sandy, clay-intraclast-bearing, fossiliferous packstones (grain supported, calcite mud filled), the carbonate of which is iron rich. The fusulinid *Fusulina* aff. *F. whitakeri* is common in the upper limestone "zone" throughout the extent of the outcrops at measured section 7.

Camp Ground Member. — The name Camp Ground Member was first used in the literature by Ramay (1957b, p. 45). The type section is in NW¼ SW¼ sec. 21, T. 5 S., R. 2 E. (C. W. Tomlinson, oral communication, 1959; measured section 8). Ramay (1957a, p. 15-17) indicated that about 65 feet of coarse-grained quartz sandstone, poorly cemented, fossiliferous limestone, and shale constitutes the Camp Ground Member in the Pleasant Hill syncline. At the type section three thin, sandy, fossiliferous, crinoid-fusulinid packstones occur within the basal 6 feet of calcareous shale. In the Pleasant Hill syncline in S½ NE¼ SW¼ sec. 23, T. 5 S., R. 1 E., the limestone and shale beds are much more fossiliferous and have yielded many crinoid crowns (some with arms intact), brachiopods, sponges *(Wewokella),* bryozoans (especially *Prismopora*), pelecypods, gastropods, rugose corals, a few fusulinids, and some trilobites and straight cephalopods. *Fusulina* *acme* has been found at fossil localities 40, 41, 61, and 62. The fusulinids from the unnamed limestones (within the unnamed shales) below the Camp Ground and those from the lower part of the Camp Ground indicate an upper Desmoinesian (Marmaton Group) age for these rocks.

Unnamed unit. — South of Ardmore, the rocks which overlie the Camp Ground Member are reddish-brown to yellow-tan, silty shales with thin- to thick-bedded quartz sandstones and are approximately 575 feet thick. Tomlinson and McBee (1959, p. 33-34) postulated that equivalent rocks occur within the Warren Ranch Member north of Ardmore.

WEST ARM FORMATION

The West Arm Formation was proposed by Harlton (1960, p. 220-221). 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 Williams Member (Guthrey and Milner, 1933) marks the base of the West Arm Formation . . . [and] constitutes a distinct succession as shown by its lithologic features, its areal extent, and especially its faunal aspect. . . The entire sequence of the proposed West Arm Formation is recognized by its clearly defined top and base.

Williams Member. — The Williams Member (W. M. Guthrey and C. A. Milner, 1933, unpublished map) in NW¼ SE¼ sec. 17, T. 5 S., R. 2 E. (measured section 9) is composed of about 20 to 30 feet of yellow-tan, calcareous quartz sandstone overlain by 2 feet of medium-bedded, fine-grained, yellow-brown, sandy, *Myalina*-rich limestone which is in turn overlain by 25 feet of limonitic, thin- to medium-bedded, fine-grained quartz sandstone and tan shale. In the Pleasant Hill syncline in sec. 23, T. 5 S., R. 1 E., Ramay (1957a, p. 18) mapped 18 feet of thin-bedded, coarsely crystalline limestone (some *Myalina* present) as the Williams. Along the south line of SW¼ NW¼ NW¼ sec. 9, T. 5 S., R. 1 E., if the rock unit has been correlated correctly, the Williams Member contains common specimens of *Mesolobus* sensu stricto but no fusulinids. The occurrence of *Mesolobus* in this rock unit marks the highest stratigraphic occurrence known to the writer of the genus south of Ardmore in either the Overbrook anticline or the Pleasant Hill syncline. Tomlinson and McBee (1959, p. 35) indicated that both fusulinids and *Mesolobus* have been found in a rock unit tentatively correlated with the Williams Member in W½ sec. 26, T. 3 S., R. 2 E., and that the occurrence of *Mesolobus* in this unit is the highest known to them in the Ardmore basin.

Correlation of the Williams away from the type section (S½ sec. 17, T. 5 S., R. 2 E.) has been based principally upon stratigraphic position below known correlatives in the Hoxbar Group or above known correlatives in the Deese Group because of rapid lateral facies change in upper Deese rocks. The rocks tentatively correlated as Williams by Ramay (1957a), by Tomlinson and McBee (1959), and by me may in fact be unrelated to the Williams unit at the type section in a strict time sense. Neither *Mesolobus* nor fusulinids have been found at the type locality to my knowledge.

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 limonitic nodules and a few thin-bedded, fine-grained quartz sandstones. About 50 feet above the Williams are two or three thin zones containing productid-brachiopod fragments (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) consists of 15 to 17 feet of thin- to medium-bedded, gray-tan to yellow-brown, fossiliferous packstone overlying 32 feet of thick-bedded, yellow-tan, fine-grained quartz sandstone. W. M. Guthrey and C. A. Milner (1933, unpublished map) indicated that the unit becomes conglomeratic toward the southeast in the area now covered by Lake Murray. Chert conglomerate is found in the unit correlated as Natsy north of Ardmore in several localities (Tomlinson and McBee, 1959, p. 36). No fusulinids have been found at the type locality of the Natsy, nor at outcrops along strike, on the Overbrook anticline.

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 beds of yellow-gray, fine-grained, calcite-cemented quartz sandstones.

HOXBAR GROUP

The Hoxbar Group, in the Overbrook anticline, consists of the thick shale and thin limestone beds overlying the predominantly sandy shale and sandstone of the Deese Group. The base of the Hoxbar

Group is the base of the Confederate Member. The top is marked by an unconformity with the overlapping Vanoss Formation. The youngest rocks of the Hoxbar Group are shales, sandstones, and at least two limestones in SE¼ SE¼ SW¼ sec. 23, T. 5 S., R. 2 E., which overlie the Zuckermann Member. In the subsurface the County Line limestone is one of the principal markers. It has a maximum thickness of 250 feet and apparently represents the upper half of the surface Hoxbar. Parker (1956, p. 176) correlated the "County Line" in part with the Anadarche Member, and Hoard (1956, p. 190) correlated a part with the Daube Member. I assign all rocks of the Hoxbar Group to the Missourian Series because I have been unable to demonstrate conclusively that upper Hoxbar rocks belong to the Virgilian Series.

The youngest Hoxbar rocks crop out in the Overbrook anticline. In the Pleasant Hill syncline the Daube Member most certainly crops out and beds as young as Zuckermann may be present (Tomlinson and McBee, 1959, p. 44). In the Brock anticline the Daube Member crops out on the west limb as the youngest mappable Hoxbar unit, whereas on the east limb the Anadarche is the youngest unit and is thrown against the older Paleozoic rocks in a series of fault slices.

UNNAMED FORMATION

Rather than refer to Hoxbar Group and "Hoxbar formation" (see discussion under unnamed formation, Deese Group) the rocks of the Hoxbar Group are considered to be in an unnamed formation.

Confederate Member. — The Confederate Member (Tomlinson, 1929, p. 39-40) in NE¼ NW¼ sec. 17, T. 5 S., R. 2 E., is composed of some 15 feet of thin-bedded to nodular, yellow-tan to brown, foraminiferal, partially recrystallized packstone; 16 feet of mostly covered tan, calcareous shale; and 2 feet of very coarse-crystalline (probably detrital) limestone which grades into limestone conglomerate toward the northwest. Fusulinids, corals, and brachiopods are found in the shale and the lower limestone. *Wedekindellina? ardmorensis* was found at fossil localities 42, 43, and 44. Locally, in some of the thin limestone beds this fusulinid constitutes the grain support of the limestone.

Within the next 10 feet above the upper fragmental limestone unit is approximately 4.5 feet of gray-black carbonaceous shale with veins of coal (possibly an asphaltic residue) as much as 0.5 inch thick. L. R. Wilson (1962, oral communication) stated that spores obtained from the shale show affinities to those of both the Desmoinesian and the Missourian Series. Associated with the shale and coal(?) are perfectly formed crystals of selenite gypsum.

In the Pleasant Hill syncline the Confederate Member consists of approximately 10 feet of calcareous, yellow-tan to gray, fine-grained quartz sandstone; 6 to 8 feet of medium- to thick-bedded, sandy, crinoidal grainstone; 5 feet of covered rock, probably shale; and 5 feet of conglomeratic, sandy limestone to calcareous sandstone. In the shale some 70 feet below the Confederate Member, at fossil locality 45, *Wedekindellina? ardmorensis* was found, although it was not present in the limestone.

In the Brock anticline the Confederate lithology is mapped in secs. 34, 35, T. 5 S., R. 1 E.

Unnamed unit. — Approximately 450 feet of gray-tan shales with thick beds of fine-grained, yellow-tan quartz sandstone overlie the Confederate Member.

Crinerville Member. — The Crinerville Member (Tomlinson, 1929, p. 42-43) near its type section in the Brock anticline in SE¼ SE¼ SW¼ sec. 28, T. 5 S., R. 1 E. (measured section 11), consists of 5 feet of gray to brown, thin-bedded, sandy, ripple-marked, fossiliferous, incompletely recrystallized packstone, overlain by 15 feet or more of yellow-tan, sandy shale with thick beds of gray-tan, fine-grained, calcite-cemented quartz sandstone. The upper sandstone, 8 feet or more thick, is poorly exposed and may well be double the measured thickness. In the Pleasant Hill syncline in SE¼ NW¼ SW¼ sec. 14, T. 5 S., R. 1 E. (measured section 16), the Crinerville consists of 20 feet of gray to tan, thin- to medium-bedded, fossiliferous, sandy, partially recrystallized packstone. In the Overbrook anticline in NW¼ NE¼ SW¼ sec. 6, T. 5 S., R. 2 E., 21 feet of thin-bedded to nodular, yellow-gray, fossiliferous packstone is considered as the Crinerville Member. Toward the southeast, in sec. 17, T. 5 S., R. 2 E., a thick sandstone (30 feet or more) is developed 20 to 30 feet below a limestone conglomerate. This limestone conglomerate contains fusulinids in its matrix similar to those from the limestone to the northwest and probably represents the same stratigraphic interval.

Triticites tomlinsoni, new species, is abundant at all sampled localities of the Crinerville Member (fossil localities 46-50).

In the Brock anticline the algae *Epimastopora* and *"Osagia"* are common in the Crinerville Member. *Epimastopora* decreases in abundance toward the southeast and *"Osagia"* is not present except in the Brock anticline.

Unnamed unit. — Approximately 650 feet of covered shale and calcite-cemented, thin quartz sandstones overlies the Crinerville.

Anadarche Member. — The Anadarche Member of Tomlinson (1929, p. 43) is about 200 feet thick. The uppermost limestone bed, however, is the only sufficiently persistent mappable unit. This highest unit of the original member consists of gray to gray-white, thin-bedded to nodular (except thick-bedded at top), sandy (also toward top), poorly fossiliferous wackestone. Fossils present are mainly fusulinids and productid brachiopods, including gigantic specimens of *Echinoconchus*. In the Pleasant Hill syncline the Anadarche is poorly exposed. It was not measured, although the lithic unit was traced and typical Anadarche fusulinids obtained in small outcrops through the alluvial cover in NE¼ SE¼ SE¼ sec. 10, T. 5 S., R. 1 E. (fossil locality 52). In the Brock anticline the Anadarche Member consists of 2 feet or more of brown to yellow-brown, nodular, fossiliferous packstone and interbedded, yellow-tan, calcareous, limonitic shale, and 7 to 8 feet of thin- to medium-bedded, brown to gray, fossiliferous packstone. Bryozoans and fusulinids are found throughout the unit but are most abundant in the lower 2-foot shaly unit. The fusulinid *Triticites irregularis* is abundant in the Anadarche Member at fossil localities 51, 52, 53, and 54.

Unnamed unit. — Overlying the Anadarche is approximately 475 feet of shale with local zones of nodular limestone.

Daube Member. — The Daube Member (Tomlinson, 1929, p. 44-45) in SE¼ SE¼ sec. 16, T. 5 S., R. 2 E., consists of approximately 10 feet of highly calcareous shale with nodular calcite mudstones in stringers throughout the shale. This shaly unit overlies approximately 25 feet of red-brown, fine-grained, medium-bedded, slightly conglomeratic quartz sandstone. Overlying the shale unit is 2 feet of thick-bedded, brown, fretted, fossiliferous packstone. The differential weathering of the calcareous matrix of the rock and the brachiopod shells gives the Daube a characteristic weathered appearance. Fusulinids are present in the shale unit associated with the nodular limestone stringers, but the various genera of bryozoans are the most abundant fossils. Although the typical limestone of sec. 8, T. 5 S., R. 2 E. (fossil locality 59) is not highly developed at this locality, it is considered the best fossil-collecting locality for Daube fauna in the Overbrook anticline. *Triticites primarius* was found at fossil localities 58 and 59.

In the Brock anticline the Daube consists of about 11 feet of thin- to medium-bedded, brown to gray, fossiliferous, fretted packstone. *Triticites newelli* was found at fossil localities 55, 56, and 57 throughout the Daube Member.

Zuckermann Member. — Approximately 430 feet above the Daube Member in SW¼ sec. 15, T. 5 S., R. 2 E., is a ridge of calcareous quartz sandstone, with limestone conglomerate in the lower part, called Zuckermann by Tomlinson (1929, p. 46).

COMPARISON OF ARDMORE BASIN FUSULINIDS WITH THOSE OF SURROUNDING AREAS

Fusulinids are considered to be among the more abundant and to express the greatest morphological diversity of any common fossil group in the Pennsylvanian and Permian Systems. Thus, when present, they are a most valuable tool in time stratigraphy. Fusulinids can be used as yardsticks to practical units of time stratigraphy in the Ardmore basin, although any correlation which might be suggested in this paper is in terms of relative time, not in terms of rock, because the writer considers that, no matter how similar the fossils may be from two geographically separated outcrops, a correlation between them based upon their contained fauna does not demonstrate physical rock continuity.

Rocks of the "Atokan" Series are represented by only one named member in the Ardmore basin. The Bostwick Member contains *Fusulinella vacua* and *Fusulinella dakotensis,* which are more advanced than *Fusulinella prolifica* described from 200 feet above the base of the Atoka Formation in Coal County, Oklahoma. Upper Bostwick rocks are therefore considered to be younger "Atokan" than are rocks of the Atoka Formation containing *F. prolifica.* The oldest fusulinids found by the writer in the Ardmore basin occurred about 50 feet above the lowest conglomerate in the Bostwick Member in SW¼ SW¼ SW¼ sec. 32, T. 5 S., R. 2 E. (measured section 5, fossil locality 2) and they did not differ significantly from *F. dakotensis,* which was found abundantly in the upper 100 feet. It is probable, therefore, that the Bostwick Member does not constitute the entire "Atokan" Epoch in the Ardmore basin and that as yet undetermined amounts of shale above and below the Bostwick lithologies are "Atokan" in age.

The time-stratigraphic boundary separating the "Atokan" and the Desmoinesian Series, in the Ardmore basin, is probably contained within the approximately 600 feet of unnamed shale overlying the Bostwick Member. However, for cartographic convenience this boundary should be placed at the base of the lower Lester Member.

The Desmoinesian Series in the Ardmore basin includes rocks from the base of the Lester Member to the base of the Confederate Member, although both boundaries are probably a little high. The lower boundary is based upon the first occurrence of the genus *Fusulina* (although it could occur stratigraphically lower within the basin) and the upper boundary upon the presence of *Wedekindellina? ardmorensis* in mappable rocks (however the writer has collected *W.? ardmorensis* as much as 70 feet stratigraphically below the Confederate Member).

Fusulina insolita, F. mutabilis, F. pumila, and *F. plattensis* are all primitive forms of the genus *Fusulina* and indicate an early Desmoinesian (early Krebs) age for the Lester and Frensley Members. The Lester and Frensley Members are considered to find time equivalence in the Hartshorne-McAlester Formations of east-central Oklahoma, and in the Dickerson Formation of the Bend arch area of north-central Texas. *Wedekindellina* sp. A, associated with *Fusulina pumila* in the lower Frensley Member, is to the writer's knowledge the first representative of the genus to occur in the Ardmore basin.

Fusulina cf. *F. novamexicana* and *Wedekindellina* sp. B are found commonly in the Pumpkin Creek Member. Fusulinids of similar morphological advancement are found in the Spaniard Member of northeastern Oklahoma and in the Dennis Bridge-Meek Bend Members of the Bend arch area of north-central Texas.

Fusulina euryteines and *Wedekindellina* sp. C are found abundantly in the upper middle part of the Devils Kitchen Member. The Devils Kitchen is thought to find equivalence in the upper part of the Krebs Group of east-central Oklahoma.

The Arnold Member contains the youngest "true" *Wedekindellina* faunule in the Ardmore basin known to the writer. *Fusulina haworthi* and *Fusulina erugata* are also found in the Arnold. The Arnold Member is considered to be closely time equivalent to the Tiawah Member of northeastern Oklahoma and the Santo Member (or slightly older) of the Bend arch area of north-central Texas.

Fusulina aff. *F. whitakeri,* which is found in an unnamed limestone between the Rocky Point Member and the Camp Ground Member, is the first species of *Fusulina* in the Ardmore basin which is identifiable with species commonly found in the Marmaton Group of northeastern Oklahoma. The unnamed limestone is closely time equivalent to the Capps-Village Bend Members of north-central Texas.

Fusulina acme 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 considered to be upper Marmaton in age.

The Missourian Series is bounded at the base by the base of the Confederate Member and at the top by the unconformity with the overlying Vanoss Formation of Virgilian age. The lower boundary is probably a bit high; however, as stated previously, this boundary is arbitrarily picked for convenience. The upper boundary may also be high, as some geologists place the Zuckermann beds in the Virgilian Series. The writer chooses to consider the Zuckermann and overlying shales and sandstones to be Missourian because of the absence of both faunal and physical evidence that they should be placed elsewhere.

The Confederate Member contains *Wedekindellina? ardmorensis,* which is similar to the fusulinids reported from the Bethany Falls Member in eastern Kansas. The fusulinids of these two limestones are considered to be closely time equivalent.

The Crinerville Member contains *Triticites tomlinsoni* and is probably closely time equivalent to a part of the Palo Pinto interval of north-central Texas, although possibly older than the Belle City Member in south-central Oklahoma.

The Anadarche Member contains *Triticites irregularis.* These fusulinids are similar to those in the Brownwood Shale Member of north-central Texas, and the two members are considered approximately time equivalent.

The Daube Member contains *Triticites newelli* and *Triticites primarius,* and is considered to find approximate time equivalence in the Winchell-Ranger interval of north-central Texas.

PALEONTOLOGICAL DISCUSSION

Each individual fossil specimen collected is a sample representing a particular paleontological species. A paleontological (fossil) species is considered in this paper as a group (natural?) of individuals which possess certain morphological features, each varying within the "species population," which set them apart from other groups of individuals. It includes all those individuals of a once living biological species which exist now in the fossil state.

The ideal paleontological sample for taxonomic purposes is represented by a collection of randomly chosen specimens which represent the range of variation of morphological characters of the species. The specimens of the sample must also be unaffected by the selectivity applied by nature owing to chemical and physical conditions associated with transfer (erosion, transportation, and deposition) and diagenesis.

Morphological traits or characteristics are used in terms of features which tend to vary among fossils and about which a unique statement generally gives adequate description. Thus the width of the second volution of an individual fusulinid is defined in terms of units of measure; some characters are adequately defined by a statement of presence or absence, as axial filling in the Schwagerininae; other characters may be described by a number, as septal count, whereas other characters are continuously variable and are best described in terms of mathematical formulae. The proper selection of a character is as important as defining the character. Features which are constant within the sample should be excluded (e. g., wall type) when considering variation within a sample. Characters from all parts of the organism should be used rather than so-called "diagnostic features." Also, mathematical manipulations which are logical consequences of the mensuration process should be excluded because they add no new information (e. g., form ratio).

It has been pointed out (Burma, 1948, p. 758) that for fusulinids in general the characters measured and the method of measuring are, for the most part, adequate. The most utilitarian fusulinid measurements, in terms of rapidity and accuracy, are obtained by means of a good petrographic microscope used in conjunction with a micrometer ocular. The following features were measured and their data recorded in appendix B.

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 (a, text-fig. 5).

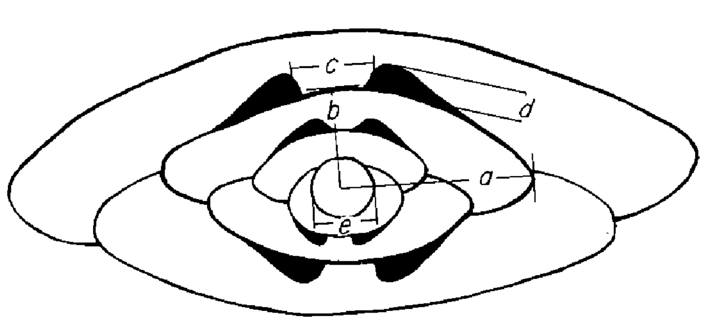
Radius vector — measured from the center of the proloculus to the tectum at the equator of each volution, perpendicular to the axis of coiling (b, text-fig. 5; a, text-fig. 6).

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

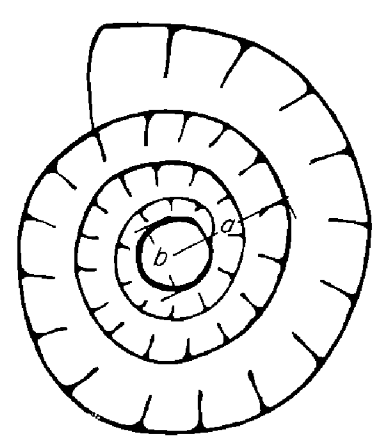
Epitheca — the upper and lower secondary veneer deposit added about the protheca. It is absent in the outer volutions of many species and in more advanced genera.

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

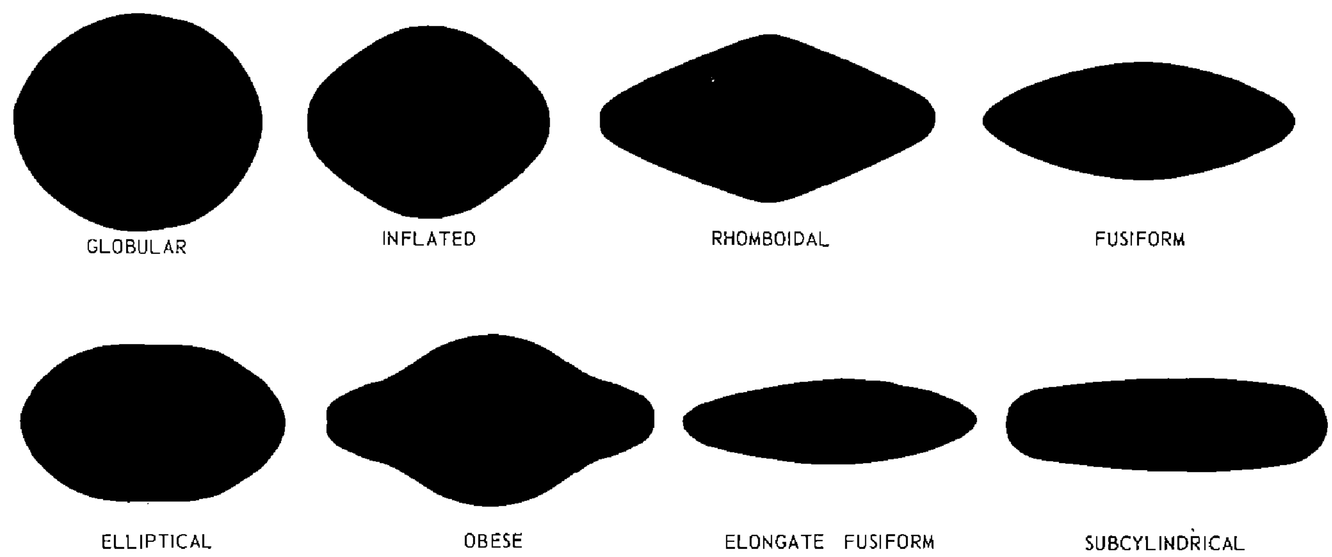
Proloculus — the measure of the outside diameter of the initial chamber. In most cases the maxi-



Text-figure 5. Axial section of a fusulinid, illustrating locations of some axial measurements.
a = half length c = tunnel width
b = radius vector d = chomata height
e = proloculus diameter



Text-figure 6. Sagittal section of a fusulinid, illustrating locations of some measurements.
a = radius vector b = proloculus diameter



Text-figure 7. General shapes of mature fusulinids.

mum and minimum outside diameters were recorded (e, text-fig. 5; b, text-fig. 6).

Wall—the thickness of the protheca and secondary deposits measured as near center of tunnel as practicable. In many cases the thickness of the protheca is the thickness of the wall if the wall is composed of the primary layers only.

Tunnel width—the linear distance between bisected near-tunnel slopes of adjacent chomata (c, text-fig. 5). Tunnel angle may be obtained from these data by plotting tunnel width against the corresponding radius vector.

Chomata height—height of chomata above the tectum (d, text-fig. 5). This measurement is properly questionable as chomata are secondary deposits and may be controlled by environmental factors as well as by genetic factors.

Certain morphological features of fusulinids have not been quantified. The terminology used herein to describe these traits is illustrated in text-figures 7-10. Alan Shaw, Pan American Petroleum Corporation, Research Division, has reminded the writer that, although shape of mature test and shape of polar extremities are not at present expressed in quantitative terms, it would not be difficult to do so as each is a figure of rotation.

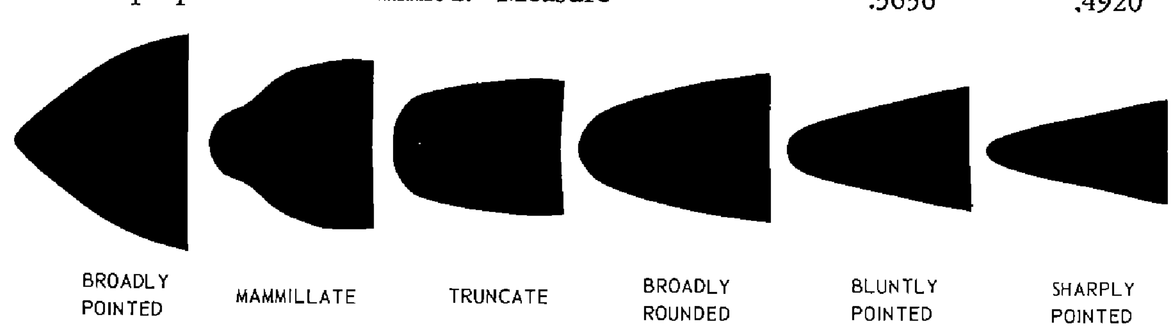
Approximately 2,000 thin sections of fusulinids from 62 geographic localities and 20 stratigraphic horizons were prepared and examined. Measurements were taken from both the sagittal and axial sections. The data recorded in appendix B have been summarized by the use of the mean ($\overline{X}$), standard deviation (s), and 99-percent-confidence intervals (UCL = upper confidence limit, and LCL = lower confidence limit).

The discussions of many fusulinids in the systematic section of this paper include discriminating formulae and index numbers. For example, below is the linear discriminant function and an "ordered" listing of randomly chosen specimen index values for the common character septal count from species population *Fusulinella dakotensis* and *Fusulinella vacua.*

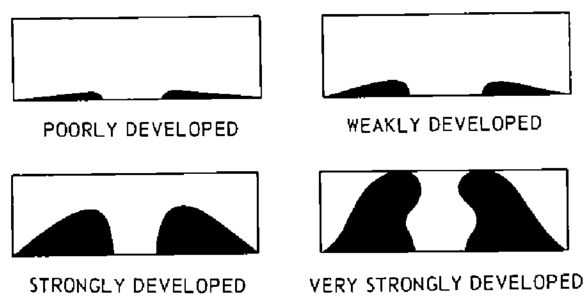
Septal Count

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

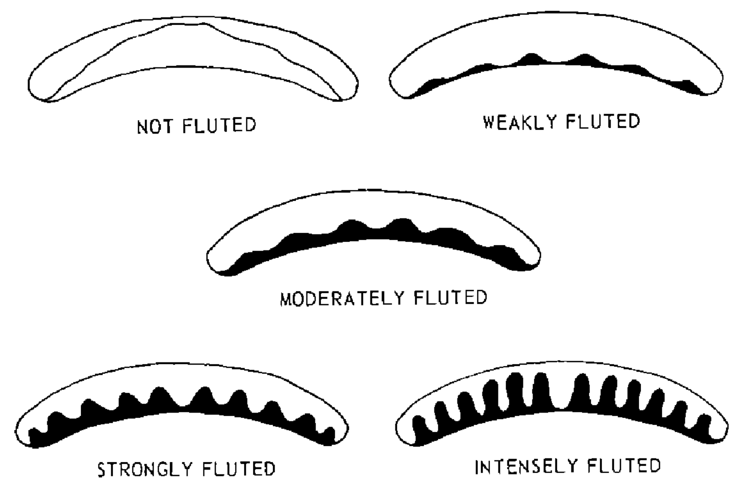
Fusulinella dakotensis	*Fusulinella vacua*
.5103	.6499
.4885	.6132
.4651	.6081
.4441	.5467
.4325	.5455
.3824	.5240
.3776	.5157
.3657	.5047
.3653	.4945
.3636	.4920



Text-figure 8. Shapes of polar extremities of fusulinids.



Text-figure 9. Degrees of development of the chomata.



Text-figure 10. Degrees of septal fluting.

If new collections are measured, as explained earlier, and study of the data precludes the "new specimens" being anything but either *F. dakotensis* or *F. vacua,* then their individual measurements, by volution (see appendix C), should be substituted into the linear discriminant function above and index values obtained. By comparing all the index values, the "new specimens" can then be assigned to that species population whose range of index values contains or overlaps to the greater degree the range of the "new specimens" index values. Index values should be computed on any "new sample" for all the significantly different characters of the two species it most closely resembles. That is, the specimens collected in the future and referred to *Fusulinella dakotensis* or *Fusulinella vacua* should have index values computed for septal count, radius vector, tunnel width, and half length. The index values for each character should overlap or fall within the limits of the index values of the species to which the "new specimens" are assigned.

SYSTEMATIC PALEONTOLOGY

Order FORAMINIFERA d'Orbigny, 1826
Family FUSULINIDAE Möller, 1878

Subfamily FUSULININAE Rhumbler, 1895

Genus *Fusulinella* Möller, 1877

Fusulinella dakotensis Thompson, 1936
Pl. I, figs. 1-4

Fusulinella dakotensis Thompson, 1936a, Jour. Paleontology, vol. 10, p. 99-100, pl. 13, figs. 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 sufficiently thick to be measured reliably in first volution. Mean thicknesses of second through seventh volutions are: 6.8/*22*, 9.1/*37*, 11.4/*37*, 13.7/*37*, 16.6/*37*, and 19.0/*37* microns.

Half length: Mean half 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 seventh volutions.

Radius vector: Mean radius-vector values of the first through seventh volutions are: .106/*37*, .160/*37*, .232/*37*, .326/*37*, .449/*37*, .605/*37*, and .788/*37* mm.

Wall: The protheca is thin with well-developed tectum and diaphanotheca.† Epitheca is 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: The tunnel outline is concave toward the poles. Mean widths of the first through 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 through 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: 127/*37* and 111/*37* microns.

Discussion. — *Fusulinella dakotensis* Thompson differs from other species of the genus described from Oklahoma. *Fusulinella prolifica* Thompson has a smaller proloculus and less intensely fluted septa, and, in general, is smaller. *Fusulinella juncea* Thompson is similar to *F. dakotensis* but differs principally in its tighter coiling. *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 the Bostwick Member (measured section 5, unit 6; fossil localities 1, 2).

Depository. — The University of Oklahoma paleontological collections: OPF-135 through OPF-138. Other 33 specimens in writer's personal collection.

Fusulinella vacua, new species
Pl. 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: Most specimens possessed 6 volutions, with a few having 7.

* In the fractionlike notations used herein to give the values for certain characteristics (such as thickness of the protheca, half length, etc.) the "numerator" is the mean value at the corresponding volution and the "denominator" (in italics) is the number of specimens upon which the mean value is based.

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

Protheca: The mean thicknesses of the tectum and diaphanotheca of the second through 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 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 seventh volutions are: .121/*39*, .189/*39*, .275/*39*, .396/*39*, .549/*39*, .723/*34*, and .922/*15* mm.

Chomata: Mean chomata heights of the first through 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: 67/*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 in *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/*24* and 123/*24* microns for the sagittal sections, and 156/*24* and 138/*24* microns for the axial sections.

Discussion. — *Fusulinella vacua*, new species, descended directly from *Fusulinella dakotensis* in the Ardmore basin. *F. vacua* has a more advanced stage of septal fluting than has *F. dakotensis* and is larger in the interior volutions. The specimen (OPF-133) illustrated on plate I, figure 6, is designated the holotype.*

Discriminating formulae and "ordered" listings of individual index values are given in the accompanying table.

Septal count (for example) is a morphological characteristic which differs significantly between *F. dakotensis* and *F. vacua.* The equation $R = -30.99X_1 \ldots + 16.60X_6$ is that equation which maximizes the difference between the two species while minimizing the difference within a species (see appendix C for presentation of the method in more complete form). The ordered index values listed for the species designated are index values from randomly chosen specimens of the species. These index values indicate (1) the amount of separation which exists between the two species in septal count, and (2) the range of the variation in septal count within a species. Index values from another sample, similar to both *F. dakotensis* and

* Holotype is used in terms of a nomenclatorial reference point, as the standard-bearer of the name. It signifies no more about the species than any other single individual in the sample.

DISCRIMINATING FORMULAE AND "ORDERED" LISTINGS OF INDEX VALUES FOR *Fusulinella dakotensis* AND *Fusulinella vacua*

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

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

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

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

SEPTAL COUNT		RADIUS VECTOR		TUNNEL WIDTH		HALF LENGTH	
dakotensis	*vacua*	*dakotensis*	*vacua*	*dakotensis*	*vacua*	*dakotensis*	*vacua*
.5103	.6499	—.6441	—.7605	.4886	.6499	—.2476	—.3101
.4885	.6132	—.6333	—.7480	.4651	.6132	—.2388	—.2694
.4651	.6081	—.6256	—.7442	.4441	.6081	—.2351	—.2607
.4441	.5467	—.6122	—.7368	.4325	.5468	—.1828	—.2513
.4325	.5455	—.5896	—.7345	.4274	.5455	—.1798	—.2097
.3824	.5240	—.5860	—.6792	.3824	.5298	—.1770	—.2023
.3776	.5157	—.5718	—.6708	.3776	.5240	—.1742	—.2002
.3657	.5047	—.5595	—.6608	.3664	.5157	—.1641	—.1798
.3653	.4945	—.5350	—.6238	.3657	.5049		
.3636	.4920	—.5274	—.5947	.3637	.4945		
				.2842	.4920		
				.1778	.4017		

F. vacua, when computed from the preceding discriminating formula for septal count should indicate to which species the new sample most probably belongs. If this process is repeated on the new sample for those characteristics which differ significantly between *F. dakotensis* and *F. vacua,* one will obtain a clear idea as to the over-all affinities of the new sample to the previously described species. The index values are simply an aid to the paleontologist in future speciation.

Although *F. dakotensis* and *F. vacua* are closely related, it has been demonstrated that an unbiased separation is possible. The index values for morphological characters show little overlap. Thus the process of classifying a new sample to its most probable paleontological population is facilitated.

The species is named from Latin vacua, meaning empty.

Occurrence. — *Fusulinella vacua* occurs abundantly in the shales separating the nodular limestone beds of the upper part of the Bostwick Member at fossil locality 2. Sparingly fossiliferous upper limestones occur along strike for several miles.

Depository. — The University of Oklahoma paleontological collections: OPF-131 through OPF-134. Other 35 specimens in writer's personal collection.

Genus *Fusulina* Fischer de Waldheim, 1829

Fusulina insolita Thompson, 1948
Pl. II, figs. 8-11

Fusulina? insolita Thompson, 1948, Kans., 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 and possibly another volution may be present on complete forms.

Protheca: The mean thicknesses of the second through 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 make the wall thick, and, although the thickness of the secondary deposit decreases in the outer volutions, the wall is still thick. Mean values of wall thickness of the first through 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 sixth volutions are: .147/*20*, .311/*20*, .562/*20*, .888/*20*, 1.31/*20*, and 1.68/*10* mm.

Radius vector: The mean values of the radius vector of the first through sixth volutions are: .110/*35*, .187/*35*, .302/*35*, .458/*35*, .659/*33*, and .794/*14* mm.

Chomata: Chomata are wider than high in the interior 2 to 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 fifth volutions are: 37/*20*, 57/*20*, 76/*20*, 103/*20*, and 105/*12* microns.

Tunnel width: Mean tunnel widths of the first through 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 over-all weak development. The mean septal counts of the first through 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.

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 evidence 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. insolita* are not so highly fluted, the proloculus is larger than that of *F. mutabilis,* and the tunnel of *F. insolita* is narrower. Index values that should allow placement of new samples to either *F. insolita* or *F. mutabilis* are given in the discussion of *F. mutabilis.*

Occurrence. — *Fusulina insolita* occurs sparingly in a sandy, thin- to medium-bedded, fossiliferous grainstone that crops out at fossil locality 5. The limestone is approximately 150 feet below the

* See footnotes, page 26.

"oölitic" Lester Member in the Overbrook anticline.

Depository.—The University of Oklahoma paleontological collections: OPF-139 through OPF-142. Other 31 specimens in writer's personal collection.

Fusulina mutabilis, new species
Pl. II, figs. 1-5

*Diagnosis**.—

Size: Mature specimens of 6½ 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 possess 6 volutions; however 7 are not uncommon and, if the preservation were better, as many as 8 might be present.

Protheca: The mean thicknesses of the second through sixth volutions are: 6.9/*40*, 9.1/*40*, 11.7/*40*, 13.8/*39*, and 15.1/*21* microns.

Wall: The wall is thick with well-developed epitheca. Mean thicknesses of the first through sixth volutions are: 17.3/*40*, 23.3/*40*, 29.4/*40*, 35.1/*40*, 38.3/*38*, and 39.7/*19* 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 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 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. 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 values of the outside diameter of the proloculus are 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 smaller tunnel width, smaller proloculus width, and higher degree of midplane septal fluting. The specimen (OPF-143) illustrated on plate II, figure 1, is the holotype. *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 in being longer.

Discriminating Formula and "Ordered" Listings of Index Values for *Fusulina insolita* and *Fusulina mutabilis*

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

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

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

Occurrence.—*Fusulina mutabilis,* new species, is common in the "oölitic" Lester Member at fossil locality 9. The Lester Member at this locality consists of approximately 8 to 9 feet of brown, thin- to medium-bedded, oölitic, sparry calcite-cemented limestone with numerous fusulinids and many other fossils (unit 6 of measured section 1). *Fusulina mutabilis* also occurs approximately 90 feet below the type Lester Member at fossil locality 7, in a deeply weathered, yellow-tan, thin- to medium-bedded, sparry calcite-cemented, sandy limestone (measured section 14).

Depository.—The University of Oklahoma paleontological collections: OPF-143 through OPF-147. Other 55 specimens in writer's personal collection.

* See footnotes, page 26.

Fusulina pumila Thompson, 1934
Pl. III, figs. 10-13

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

[?] *Fusulina pumila* Thompson, Dunbar and Henbest, 1942, Ill. State Geol. Survey, Bull. 67, p. 107-109, pl. 5, 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: Normally 6 to 7 volutions are present on these forms, but a volution or two is missing owing to abrasion or solution.

Protheca: The protheca is thin throughout the test. Mean thicknesses of the first through 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 seventh volutions are: .075/*28*, .168/*28*, .302/*28*, .507/*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 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, well-defined tunnel. The mean widths of the first through 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 midplane 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 diameters.

Discussion. — The forms which are assigned to *Fusulina pumila* Thompson from the Ardmore basin agree in all characters save septal count. The Ardmore basin forms have fewer septa per volution than have the Iowa forms.

Associated with *Fusulina pumila* is *Wedekindellina* sp. A, of which several are illustrated (pl. II, figs. 6, 7).

Occurrence. — *Fusulina pumila* is abundant in the lower part of the Frensley Limestone Member at fossil localities 12, 13, 14, and 15.

Depository. — The University of Oklahoma paleontological collections: OPF-150 through OPF-153. Other 37 specimens in writer's personal collection.

Fusulina plattensis Thompson, 1936
Pl. III, figs. 5-9

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

Fusulina sp. Thompson, 1936a, Jour. Paleontology, p. 111, pl. 14, figs. 23, 24.

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

*Diagnosis**. —

Size: 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.

Shape: The shell is fusiform in general outline with some specimens appearing rather elongate.

Number of volutions: Mature specimens contain 6 to 7 volutions.

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

Half length: 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.

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

Wall: The mean thicknesses of the spirotheca of the first through sixth volutions are: 12.7/*30*, 17.8/*30*, 22.3/*30*, 27.6/*29*, 30.2/*29*, and 30.5/*17* microns.

Chomata: The chomata are asymmetrical throughout the shell. In the inner volutions, asymmetry is due to tapering of the chomata toward the poles. In the outer two volutions, this asymmetry is due to overhang of the tunnel side of the

* See footnotes, page 26.

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.

Tunnel width: 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 fusulinids in the Ardmore basin which belong to the genus *Fusulina*. Topotype material from the Inola Limestone indicates *Fusulina leei* is similar to but differs from *F. plattensis* in more intensely fluted septa, in larger septal count per volution, and in greater length.

Occurring in association with *Fusulina plattensis* are a few 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 at fossil locality 13 and at NE¼ SE¼ NE¼ sec. 15, T. 6 S., R. 2 E. Fossil locality 13 is in unit 11 of measured section 1.

Depository. — The University of Oklahoma paleontological collections: OPF-154 through OPF-158. Other 37 specimens in writer's personal collection.

Fusulina cf. *F. novamexicana* Needham, 1937

Pl. III, figs. 1-4

Fusulina murrayensis Devonshire [nomen nudum], 1954, Oklahoma City Geol. Soc., 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 destroyed some volutions so that the forms studied normally have only 6 volutions.

Protheca: The protheca is thin for a form as large as those studied. The mean thicknesses of the first through 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 small half-length values. The mean lengths of the first through 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 differs little in thickness from midtunnel 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, asymmetrical in the inner volutions but 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 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 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 sixth volutions are: 10.9/*17*, 17.2/*17*, 21.0/*17*, 24.2/*17*, 27.3/*14*, and 32.5/*7*. The number ranges are 9 to 14, 15 to 20, 17 to 25, 21 to 31, 21 to 34, and 30 to 39 for corresponding 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 are fully discussed under *F. euryteines*. Numerous specimens of *Wedekindellina* sp. B (pl. V, figs. 9, 8) occur with *F.* cf. *F. novamexicana* at all localities sampled.

* See footnotes, page 26.

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

Occurrence. — *Fusulina* cf. *F. novamexicana* occurs at fossil localities 22, 23, 24, and 27 and north of Ardmore, as indicated in discussion of the Pumpkin Creek Member.

Depository. — The University of Oklahoma paleontological collections: OPF-159 through OPF-162. Other 44 specimens in writer's personal collection.

Fusulina euryteines Thompson, 1934

Pl. IV, figs. 1-5

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

Fusulina euryteines Thompson, 1934, 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 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 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 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 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 diameters.

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

Fusulina euryteines differs from *Fusulina haworthi* by having greater half-length and radius-

* See footnotes, page 26.

DISCRIMINATING FORMULAE AND "ORDERED" LISTINGS OF INDEX VALUES FOR *Fusulina* cf. *F. novamexicana* AND *Fusulina euryteines*

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

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

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

RADIUS VECTOR		TUNNEL WIDTH		HALF LENGTH	
nova-mexicana	*eury-teines*	*nova-mexicana*	*eury-teines*	*nova-mexicana*	*eury-teines*
—6.658	—7.988	—.6913	—.8779	—2.373	—2.998
—6.360	—7.760	—.6087	—.8498	—2.274	—2.844
—6.329	—7.741	—.5943	—.8419	—2.272	—2.843
—6.280	—7.280	—.5901	—.8266	—2.231	—2.819
—6.151	—7.258	—.5828	—.8036	—2.123	—2.799
—5.981	—7.205	—.5805	—.7897	—2.089	—2.761
—5.530	—6.471	—.5668	—.7581	—2.026	—2.745
		—.5595	—.7570	—2.009	—2.717
		—.5478	—.7465	—1.976	—2.666
		—.5375	—.7395	—1.912	—2.568
		—.5371	—.7344	—1.907	—2.539
		—.5252	—.7325	—1.866	—2.483
		—.4708	—.6814	—1.863	—2.342
		—.4611	—.6722	—1.716	—2.333

vector measurements at any given volution. *F. haworthi* also differs by having a significantly smaller proloculus and narrower fluting. Index values are given here for half length, radius vector, and tunnel width of randomly chosen specimens.

Fusulina euryteines was associated with abundant specimens of *Wedekindellina* sp. C (pl. IV, figs. 7, 6) at all outcrops.

Occurrence.—*Fusulina euryteines* occurs commonly in the middle part of the Devils Kitchen Member at fossil localities 29, 30, and 31, and in NW¼ NW¼ NW¼ sec. 4, T. 6 S., R. 2 E.

Depository.—The University of Oklahoma paleontological collections: OPF-165 through OPF-169. Other 31 specimens in writer's personal collection.

Fusulina erugata, new species

Pl. 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.

* See footnotes, page 26.

Protheca: The primary layers are thin. The mean thicknesses of the protheca of the second through 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 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 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 uppermost wall layer. If upper secondary deposits are present, they are extremely thin. The lower wall layer is a thick deposit of secondary material at midplane, but it thins poleward rapidly so that polar areas are normally 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 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

DISCRIMINATING FORMULAE AND "ORDERED" LISTINGS OF INDEX VALUES FOR *Fusulina euryteines* AND *Fusulina haworthi*

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

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

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

RADIUS VECTOR		TUNNEL WIDTH		HALF LENGTH	
euryteines	*haworthi*	*euryteines*	*haworthi*	*euryteines*	*haworthi*
—.6320	—.4831	—1.518	—.9866	—.8195	—.6284
—.6189	—.4817	—1.509	—.9716	—.7901	—.6142
—.5993	—.4716	—1.429	—.9466	—.7877	—.6097
—.5954	—.4630	—1.372	—.9363	—.7678	—.5512
—.5679	—.4490	—1.345	—.8902	—.7305	—.5509
—.5598	—.4443	—1.310	—.8781	—.7165	—.5079
—.5511	—.4264	—1.297	—.8694	—.7132	—.5075
—.5423	—.4200	—1.289	—.8514	—.6886	—.5038
—.5189	—.4027	—1.281	—.8495	—.6877	—.4909
—.5069	—.3731	—1.280	—.8439	—.6817	—.4852
—.4976	—.3544	—1.272	—.8234	—.6592	—.4831
—.4753	—.3419	—1.248	—.8052	—.6313	—.4831
		—1.229	—.7930		
		—1.204	—.7882		
		—1.199	—.7793		
		—1.143	—.6640		

first through 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 tight and high. The mean septal counts of the first through 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 to *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 are those of *F. plattensis*. The specimen (OPF-183) illustrated on plate VI, figure 9, is the holotype.

Fusulina erugata occurs throughout the Arnold Limestone. The species is named from Latin erugata, meaning clear of wrinkles, and refers to the poor septal fluting.

Occurrence. — *Fusulina erugata*, new species, occurs abundantly in the Arnold Member at fossil localities 34, 35, 36, and 37.

Depository. — The University of Oklahoma paleontological collections: OPF-180 through OPF-184. Other 41 specimens in writer's personal collection.

DISCRIMINATING FORMULA AND "ORDERED" LISTINGS OF INDEX VALUES FOR *Fusulina erugata* AND *Fusulina plattensis*

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

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

Fusulina haworthi (Beede), 1916, emended Dunbar and Henbest, 1942

Pl. 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, Nebr. Geol. Survey, ser. 2, Bull. 2, p. 62, pl. 2, figs. 6-11).

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

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

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

Fusulina haworthi (Beede), Alexander, 1954, Okla. Geol. Survey, Circ. 31, p. 30-32, pl. 2, figs. 11-12.

*Diagnosis**. —

Size: 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.

Shape: The shell is fusiform with bluntly pointed polar extremities.

Protheca: 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.

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

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

Wall: 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 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 irregular. The mean widths of the tunnel of the first through 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 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

* See footnotes, page 26.

values of the outside diameter of the proloculus are: 130/35 and 143/35 microns.

Discussion.—*Fusulina haworthi* is similar in some respects to *F. expedita* Alexander, but may be distinguished from the latter by its larger proloculus, longer test, and more intense septal fluting.

Fusulina haworthi is readily distinguished from *F. euryteines,* as is indicated in the discussion of the latter species. *Fusulina haworthi* may be distinguished from *F.* aff. *F. whitakeri* in the Ardmore basin by the greater half length, thicker protheca, and degree of fluting of the latter. Index values are given here for significantly different characters.

DISCRIMINATING FORMULAE AND "ORDERED" LISTINGS OF INDEX VALUES FOR *Fusulina haworthi* AND *Fusulina* aff. *F. whitakeri*

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

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

PROTHECA THICKNESS		HALF LENGTH	
haworthi	*whitakeri*	*haworthi*	*whitakeri*
.7794	.8887	—.6250	—.8140
.7605	.8874	—.6145	—.8054
.7443	.8511	—.5946	—.7931
.7302	.8509	—.5715	—.7759
.7281	.8124	—.5169	—.7299
.7171	.8113	—.5094	—.7289
.7145	.8061	—.5039	—.7078
.6885	.7936	—.5024	—.6851
.6793	.7737	—.4956	—.6837
.6662	.7638	—.4837	—.6246
.6655	.7579	—.4771	—.5783
.6368	.7455	—.4591	—.5780

Fusulina haworthi is associated with *Wedekindellina* sp. E (pl. V, figs. 6, 7) in the uppermost part of the Arnold "zone" (south of Ardmore) and may not be considered by some as having actually come from the Arnold Member. The occurrence of *Wedekindellina* in the Arnold "zone" marks the highest stratigraphic occurrence of the genus in the Ardmore basin to the writer's knowledge.

Occurrence.—*Fusulina haworthi* occurs abundantly in the Arnold "zone" (about 50 feet above the highest limestone) south of Ardmore in the same localities as listed for *Fusulina erugata* (fossil localities 34, 35, 36, 37).

Depository.—The University of Oklahoma paleontological collections: OPF-172 through OPF-176. Other 33 specimens in writer's personal collection.

Fusulina aff. *F. whitakeri* Stewart, 1958

Pl. VII, figs. 1-3, 5

Discussion.—Several rather badly weathered forms, found in unit 3 of measured section 8, are similar to *Fusulina acme* from the overlying Camp Ground Member except in tunnel width and proloculus diameter. These specimens are without doubt of Marmaton age. Index values are given here for the tunnel width.

DISCRIMINATING FORMULA AND "ORDERED" LISTINGS OF INDEX VALUES FOR *Fusulina* aff. *F. whitakeri* AND *Fusulina acme*

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

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

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

Depository.—The University of Oklahoma paleontological collections: OPF-191 through OPF-194. Other 36 specimens in writer's personal collection.

Fusulina acme Dunbar and Henbest, 1942

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

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

Fusulina acme Dunbar and Henbest, 1942, Ill. State Geol. Survey, Bull. 67, p. 122-123, pl. 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

* See footnotes, page 26.

rather badly weathered, and all volutions are not present. Specimens of 6½ to 7 volutions are 6 to 6.8 mm long and 1.5 to 2.1 mm wide.

Shape: Most specimens are fusiform 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 1 through 7.

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 1 through 6.

Chomata: Chomata are thickenings of the septa adjacent to the tunnel or actual deposits in the inner volutions, but they become rather obscure in outer volutions. Mean chomata heights of the first through 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 is straight to slightly irregular. Mean tunnel widths of the first through sixth volutions are: 65/*30*, 98/*30*, 157/*30*, 254/*30*, 400/*30*, and 614/*21* microns.

Septa: Septa are intensely fluted throughout the shell. The mean septal counts of the first through 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 minimum and maximum outside diameters 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*).

The index values given here differentiate *Fusulina acme* from *F. haworthi* for half length, radius vector, tunnel width, and protheca thickness.

Occurrence.—*Fusulina acme* Dunbar and Henbest occurs sparingly in the sandy, fossiliferous, crinoid-fusulinid packstone in the Camp Ground Member at fossil localities 40, 41, 61, and 62.

Depository.—The University of Oklahoma paleontological collections: OPF-195 through OPF-199. Other 31 specimens in writer's personal collection.

Genus *Wedekindellina* Dunbar and Henbest, 1933

Wedekindellina? *ardmorensis* Thompson, Verville, and Lokke, 1956

Pl. 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.

* See footnotes, page 26.

DISCRIMINATING FORMULAE AND "ORDERED" LISTINGS OF INDEX VALUES FOR *Fusulina acme* AND *Fusulina haworthi*

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

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

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

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

RADIUS VECTOR		TUNNEL WIDTH		HALF LENGTH		PROTHECA	
acme	*haworthi*	*acme*	*haworthi*	*acme*	*haworthi*	*acme*	*haworthi*
.0454	.0406	.5309	.3963	.7999	1.1640	—1.361	—1.760
.0454	.0390	.4948	.3824	.7686	1.0152	—1.351	—1.734
.0426	.0365	.4924	.3813	.7400	.9734	—1.350	—1.721
.0417	.0360	.4897	.3728	.7218	.9499	—1.310	—1.682
.0404	.0336	.4844	.3650	.7030	.8693	—1.303	—1.682
.0390	.0314	.4815	.3590	.6893	.8343	—1.302	—1.672
.0389	.0311	.4419	.3354	.6765	.8327	—1.246	—1.652
.0374	.0367	.4351	.3322	.6196	.8202	—1.246	—1.610
.0367	.0299	.4093	.3281	.6141	.7813	—1.232	—1.603
.0361	.0293	.3983	.2983	.6116	.7618	—1.172	—1.497
.0349	.0283						
.0333	.0280						

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 present within the primary layer cause reservation as to the assignment of this form to *Wedekindellina.* The primary layer is a primitive keriotheca. Secondary deposits in the form of tectoria are absent in many forms and appear as only a trace in others.

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

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

Wall: 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 thin section was cut parallel to a septum which falsely appeared as filling.

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

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

Septa: 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 counts as 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 at fossil locations 42, 43, and 44.

Depository. — The University of Oklahoma paleontological collections: OPF-179, OPF-185 through OPF-190. Other 53 specimens in writer's personal collection.

Subfamily SCHWAGERININAE Dunbar and Henbest, 1930

Genus *Triticites* Girty, 1904

Triticites tomlinsoni, new species

Pl. VIII, figs. 3-7; pl. IX, fig. 9; pl. 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 the keriothecal structure of the wall; however, the inner volutions do not show distinct keriothecal development. The mean thicknesses of the protheca of the first through 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 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 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 commonly not developed at all in the outer three volutions. When present, the chomata are small moundlike deposits of secondary material which are low and symmetrical. Mean chomata heights of the first through fifth volutions are: 36/*38*, 55/*38*, 80/*38*, 85/*33*, and 61/*14* microns.

* See footnotes, page 26.

Tunnel width: The tunnel is narrow and poorly developed except in the first three or four volutions. The mean tunnel widths of the first through 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 of *T. hobblensis* Thompson, Verville, and Bissell and of *T. moorei* Dunbar and Condra. The mean septal counts of the first through 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*. The specimen (OPF-204) illustrated on plate VIII, figure 7, is the holotype.

The specific name of the species is given in honor of the late Dr. C. W. Tomlinson.

Occurrence. — *Triticites tomlinsoni*, new species, occurs abundantly at fossil localities 46, 47, 48, 49, and 50. Fossil locality 46, on the Overbrook anticline, is designated as type locality of the species.

Depository. — The University of Oklahoma paleontological collections: OPF-200 through OPF-206. Other 65 specimens in writer's personal collection.

Triticites irregularis (Staff), 1912, emended Dunbar and Condra, 1927

Pl. 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, Nebr. Geol. Survey, Bull. 2, ser. 2, p. 108-111, 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 six volutions range in length from 4.5 to 6.5 mm and in width from 1.2 to 1.7 mm.

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

Protheca: The wall is composed of tectum and keriotheca with little secondary deposits. Mean thicknesses of the tectum and keriotheca of the first through 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 lengths of the first through 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 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 heights of the chomata of the first through fifth volutions are: 22.3/*31*, 35/*31*, 56/*31*, 72/*29*, and 70/*23* microns.

Tunnel width: The tunnel is broad and irregular in its development. The mean tunnel widths of the first through 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 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. Dunbar and Condra, 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. The forms in the Anadarche Limestone of the Overbrook anticline have a lesser degree of septal fluting 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).

Occurrence. — *Triticites irregularis* (Staff) occurs sparingly in the Anadarche Member at fossil localities 51, 52, 53, and 54.

Depository. — The University of Oklahoma paleontological collections: OPF-207 through OPF-213. Other 54 specimens in writer's personal collection.

* See footnotes, page 26.

Triticites primarius Merchant and Keroher, 1939

Pl. IX, fig. 8; pl. XI, figs. 1, 2, 4, 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 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 thickness of the tectum and keriotheca of the first through 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 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 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 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 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 absent or only weakly developed across midplane of the shell. Mean septal counts of the first through 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 maximum outside diameter of the proloculus 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 are given here for the significantly different characters.

Occurrence. — *Triticites primarius* occurs abundantly in the Daube Member in the Overbrook anticline at fossil localities 58 and 59.

Depository. — The University of Oklahoma paleontological collections: OPF-218 through OPF-222. Other 31 specimens in writer's personal collection.

Triticites newelli Burma, 1942

Pl. X, figs. 1-3; pl. XI, fig. 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

* See footnotes, page 26.

DISCRIMINATING FORMULAE AND "ORDERED" LISTINGS OF INDEX VALUES FOR *Triticites primarius* AND *Triticites newelli*

Tunnel Width: $R = -3.315X_1 - .9077X_2 - .1279X_3 + .6547X_4 + 1.332X_5$
Half Length: $R = -.2830X_1 + .2184X_2 - .2991X_3 + .2168X_4 + .2448X_5 + .6075X_6$
Protheca: $R = +23.47X_1 - 6.557X_2 - 4.967X_3 + 6.789X_4 + 5.519X_5 - 4.811X_6$
Septa: $R = +2.152X_1 + 13.48X_2 - 39.43X_3 + 57.05X_4 - 9.90X_5 - 166.59X_6$

TUNNEL WIDTH		HALF LENGTH		PROTHECA		SEPTA	
primarius	*newelli*	*primarius*	*newelli*	*primarius*	*newelli*	*primarius*	*newelli*
1.489	1.134	.3079	.2551	.3850	.2731	—3.179	—4.118
1.389	1.125	.2616	.2466	.3232	.2509	—3.140	—4.104
1.387	0.886	.2609	.2285	.3194	.2397	—3.087	—3.917
1.340	0.754	.2545	.2269	.3176	.2318	—3.034	—3.820
1.330	0.726	.2400	.1921	.3074	.1809	—2.508	—3.245
1.200	0.725			.2960	.1789		
				.2923	.1749		
				.2887	.1664		
				.2806	.1656		
				.2787	.1510		

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 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 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 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 narrower than that 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 extremities. Septal fluting extends up the sides toward the chomata in early volutions but decreases in intensity in outer volutions. The mean septal counts of the first through 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 is indicated in the discussion of *T. primarius.*

Occurrence. — *Triticites newelli* occurs abundantly in the Daube Member in the Brock anticline at fossil locality 55. It is less commonly found in the Daube Member at fossil localities 56 and 57.

Depository. — The University of Oklahoma paleontological collections: OPF-214 through OPF-217. Other 19 specimens in writer's personal collection.

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PENNSYLVANIAN FUSULINIDS

ARDMORE BASIN

PLATES I-XII

Species	Plate(s)	Species	Plate(s)
Fusulina acme	VII, VIII	*Fusulinella dakotensis*	I
Fusulina erugata	VI	*Fusulinella vacua*	I
Fusulina euryteines	IV	*Triticites irregularis*	IX
Fusulina haworthi	V	*Triticites newelli*	X, XI
Fusulina insolita	II	*Triticites primarius*	IX, XI
Fusulina mutabilis	II	*Triticites tomlinsoni*	VIII, IX, X
Fusulina cf. *F. novamexicana*	III	*Wedekindellina? ardmorensis*	VI
Fusulina plattensis	III	*Wedekindellina* sp. A	II
Fusulina pumila	III	*Wedekindellina* sp. B	V
Fusulina aff. *F. whitakeri*	VII	*Wedekindellina* sp. C	IV
Fusulina sp.	XII	*Wedekindellina* sp. E	V

Plate I

(all figures are unretouched photographs, x15)

		Page
1-4.	*Fusulinella dakotensis* Thompson, upper part of Bostwick Member, SW¼ SW¼ sec. 32, T. 5 S., R. 2 E., Carter County (fossil locality 2) 1. OPF-136 2. OPF-137 3. OPF-135 4. OPF-138	26
5-8.	*Fusulinella vacua*, new species, upper part of Bostwick Member, SW¼ SW¼ sec. 32, T. 5 S., R. 2 E., Carter County (fossil locality 2). 5. OPF-134 6. OPF-133 (holotype) 7. OPF-131 8. OPF-132	26

Plate I

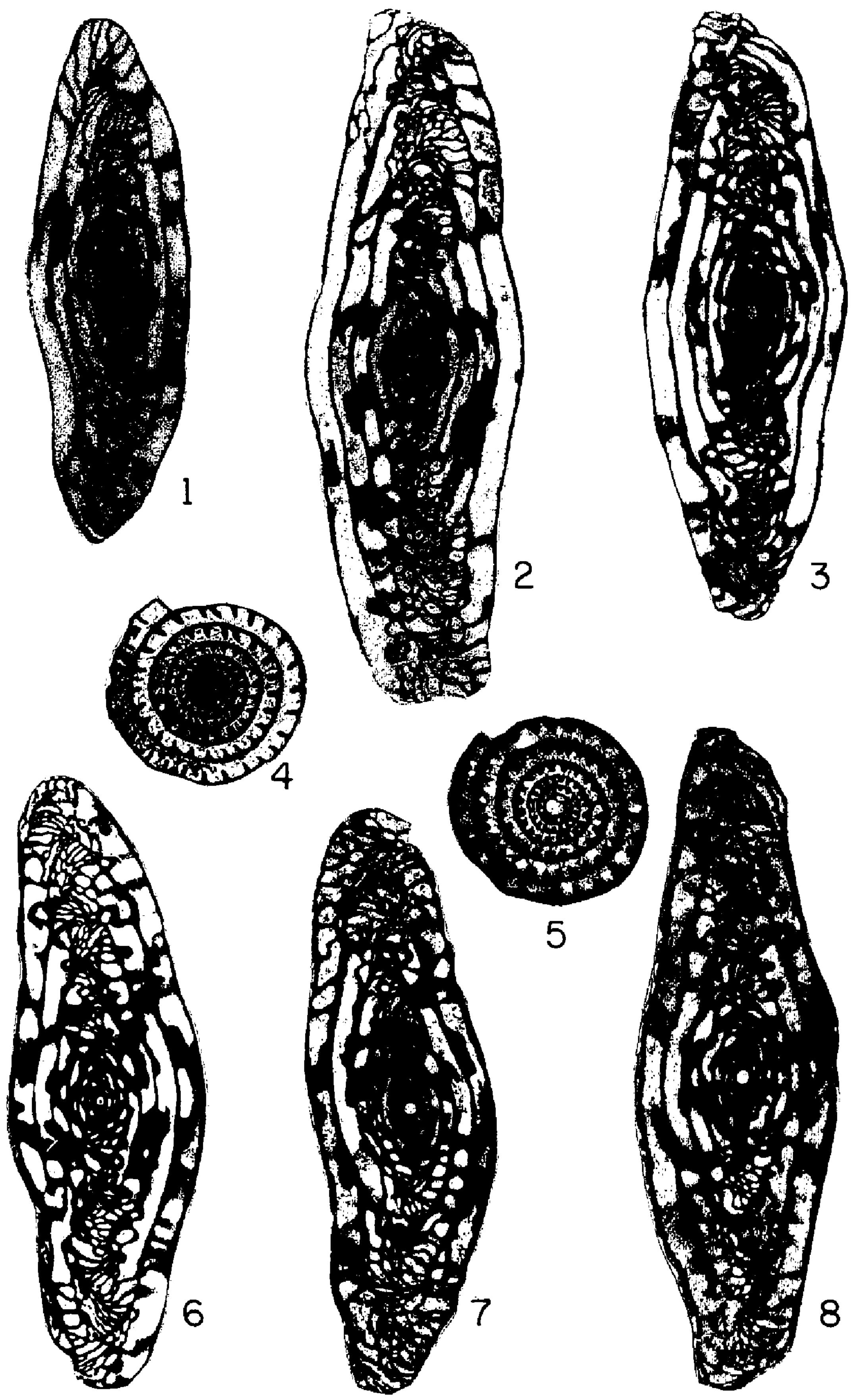

Plate II

(all figures are unretouched photographs, x15)

		Page
1-5.	*Fusulina mutabilis,* new species.	29
	1,4. 90 feet below Lester Member, NE¼ NE¼ NE¼ sec. 13, T. 4 S., R. 1 E., Carter County (fossil locality 7).	
	1. OPF-143 (holotype)	
	4. OPF-144	
	2,3,5. Oölitic Lester Member, NW¼ NE¼ NE¼ sec. 22, T. 6 S., R. 2 E., Love County (fossil locality 9).	
	2. OPF-145	
	3. OPF-146	
	5. OPF-147	
6-7.	*Wedekindellina* sp. A, lower part of Frensley Member, NE¼ NE¼ NE¼ NE¼ sec. 22, T. 6 S., R. 2 E., Carter County (fossil locality 12).	30
	6. OPF-148	
	7. OPF-149	
8-11.	*Fusulina insolita* Thompson, 150 feet below the oölitic Lester Member, NE cor. NW¼ NE¼ sec. 22, T. 6 S., R. 2 E., Love County (fossil locality 6).	28
	8. OPF-139	
	9. OPF-140	
	10. OPF-142	
	11. OPF-141	

Plate II

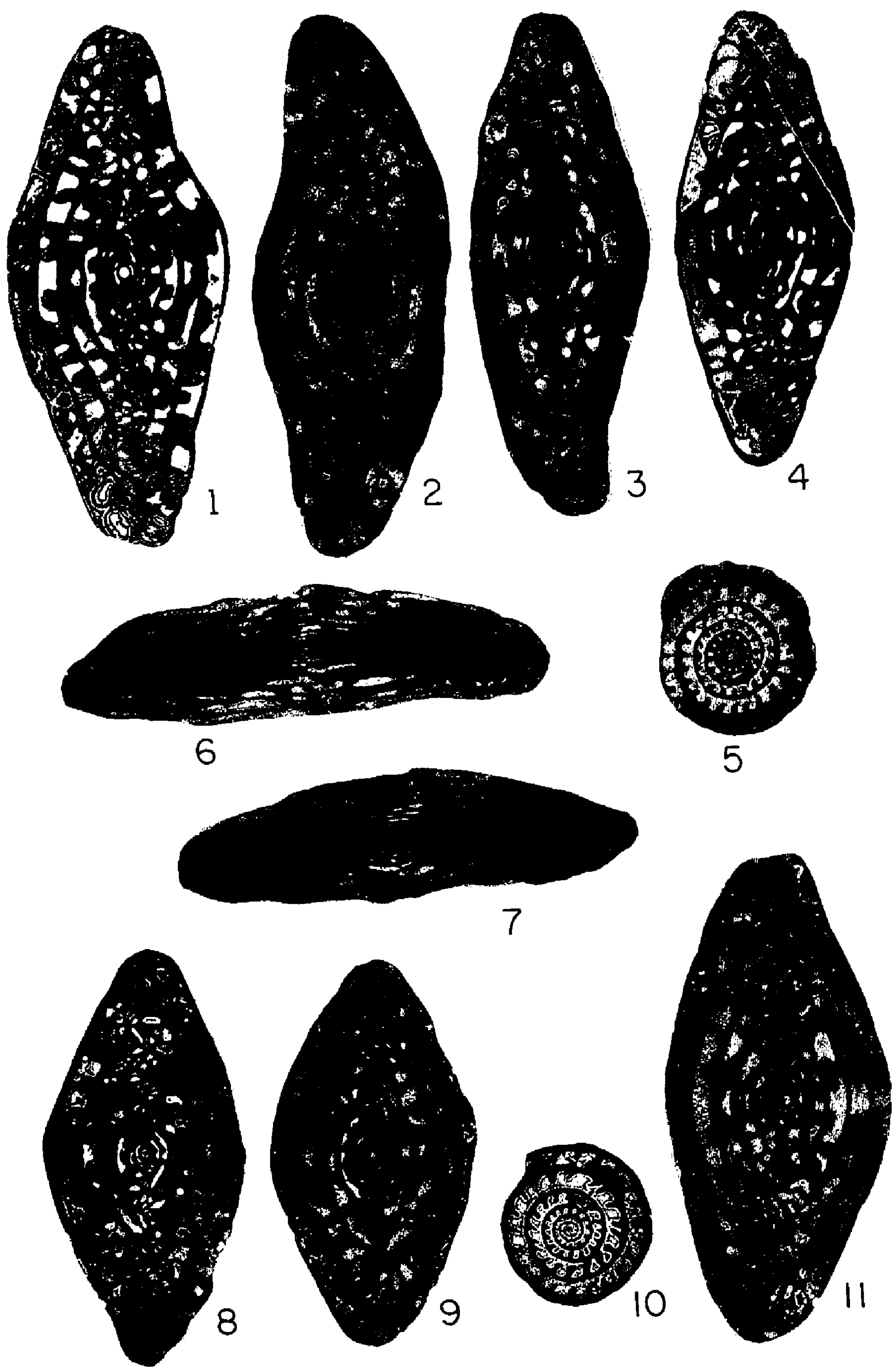

Plate III

(all figures are unretouched photographs, x15)

		Page
1-4.	*Fusulina* cf. *F. novamexicana* Needham, Pumpkin Creek Member, NW¼ NE¼ NW¼ sec. 23, T. 6 S., R. 2 E., Love County (fossil locality 22). 1. OPF-161 2. OPF-159 3. OPF-160 4. OPF-162	31
5-9.	*Fusulina plattensis* Thompson, upper part of Frensley Member, SW¼ SE¼ SE¼ sec. 15, T. 6 S., R. 2 E., Love County (fossil locality 16). 5. OPF-154 6. OPF-157 7. OPF-155 8. OPF-156 9. OPF-158	30
10-13.	*Fusulina pumila* Thompson, lower part of Frensley Member, NE¼ NE¼ NE¼ sec. 22, T. 6 S., R. 2 E., Love County (fossil locality 12). 10. OPF-153 11. OPF-152 12. OPF-150 13. OPF-151	30

Plate III

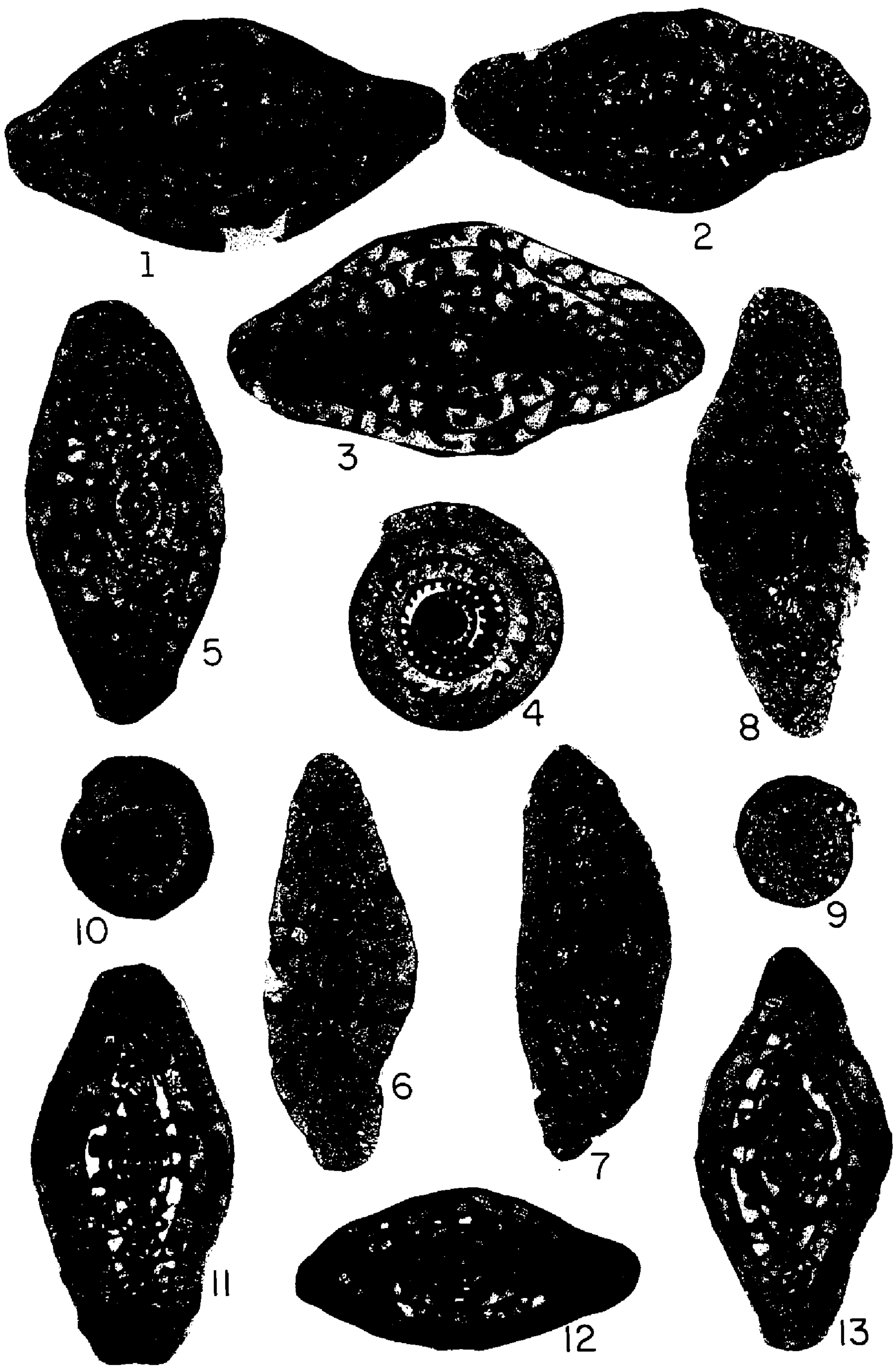

Plate IV

(all figures are unretouched photographs, x15)

		Page
1-5.	*Fusulina euryteines* Thompson, Devils Kitchen Member (middle shale-limestone unit), NE¼ NE¼ SW¼ sec. 4, T. 6 S., R. 2 E., Love County (fossil locality 29). 1. OPF-169 2. OPF-167 3. OPF-166 4. OPF-168 5. OPF-165	32
6-7.	*Wedekindellina* sp. C, Devils Kitchen Member (middle shale-limestone unit), NE¼ NE¼ SW¼ sec. 4, T. 6 S., R. 2 E., Love County (fossil locality 29). 6. OPF-171 7. OPF-170	33

Plate IV

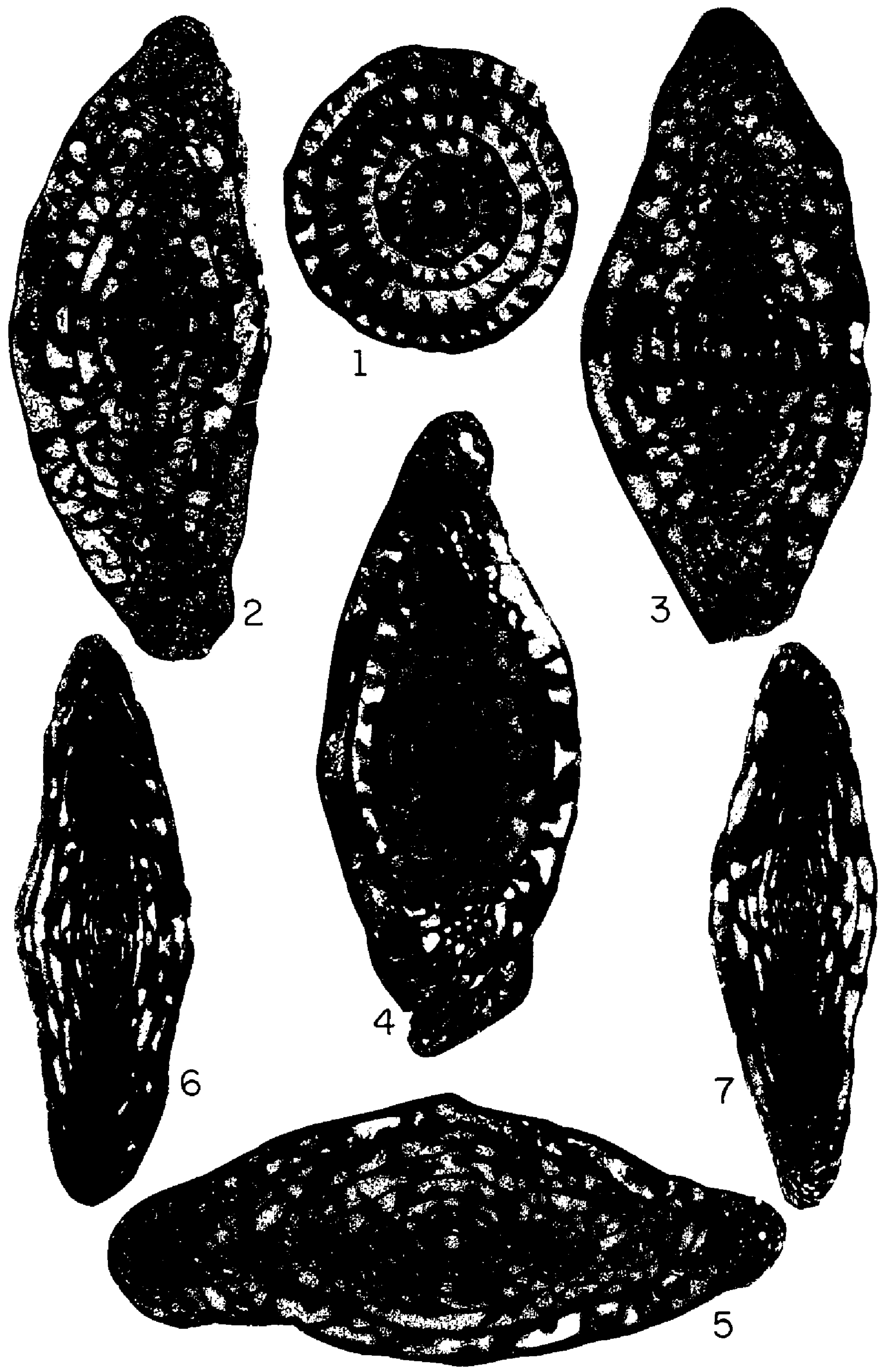

Plate V

(all figures are unretouched photographs, x15)

		Page
1-5.	*Fusulina haworthi* (Beede), upper part of Arnold zone, NE¼ SE¼ SW¼ sec. 33, T. 5 S., R. 2 E., Carter County (fossil locality 35). 1. OPF-176 2. OPF-172 3. OPF-173 4. OPF-175 5. OPF-174	34
6-7.	*Wedekindellina* sp. E, upper part of Arnold zone, NE¼ SE¼ SW¼ sec. 33, T. 5 S., R. 2 E., Carter County (fossil locality 35). 6. OPF-178 7. OPF-177	35
8-9.	*Wedekindellina* sp. B, Pumpkin Creek Member, NE¼ NW¼ sec. 15, T. 6 S., R. 2 E., Love County (fossil locality 24). 8. OPF-164 9. OPF-163	31

Plate V

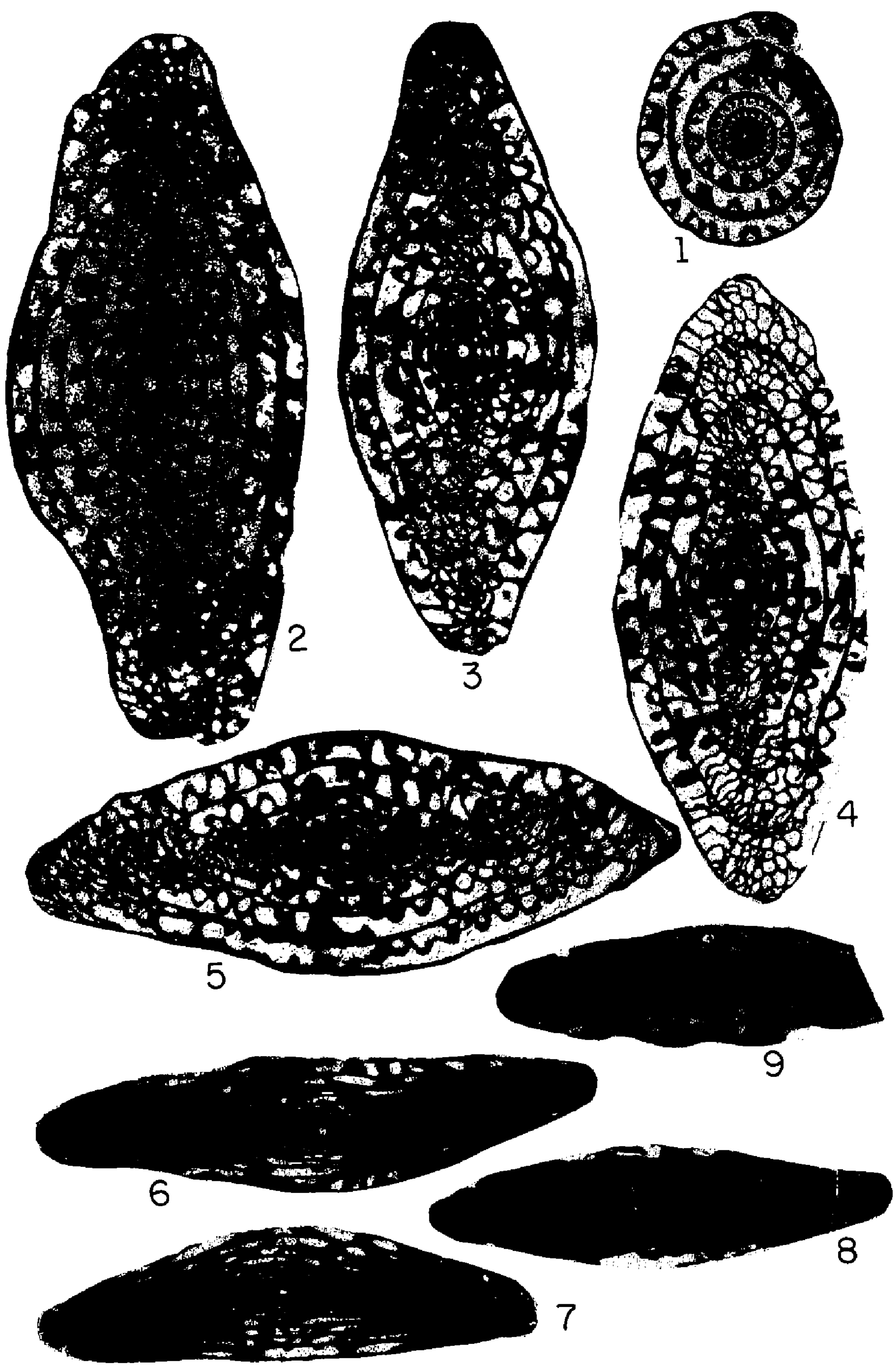

Plate VI

(all figures are unretouched photographs, x15)

		Page
1-7.	*Wedekindellina? ardmorensis* Thompson, Verville, and Lokke. 1-3, 5-7. Confederate Member, NW¼ NE¼ NW¼ sec. 17, T. 5 S., R. 2 E., Carter County (fossil locality 42). 1. OPF-179 2. OPF-189 3. OPF-188 5. OPF-187 6. OPF-186 7. OPF-185 4. Confederate Member, E½ SE¼ SW¼ sec. 14, T. 5 S., R. 1 E., Carter County (fossil locality 45). 4. OPF-190	36
8-12.	***Fusulina erugata***, new species, lower part of Arnold Member, NE¼ NW¼ NE¼ sec. 4, T. 6 S., R. 2 E., Love County (fossil locality 34). 8. OPF-182 9. OPF-183 (holotype) 10. OPF-180 11. OPF-184 12. OPF-181	33

Plate VI

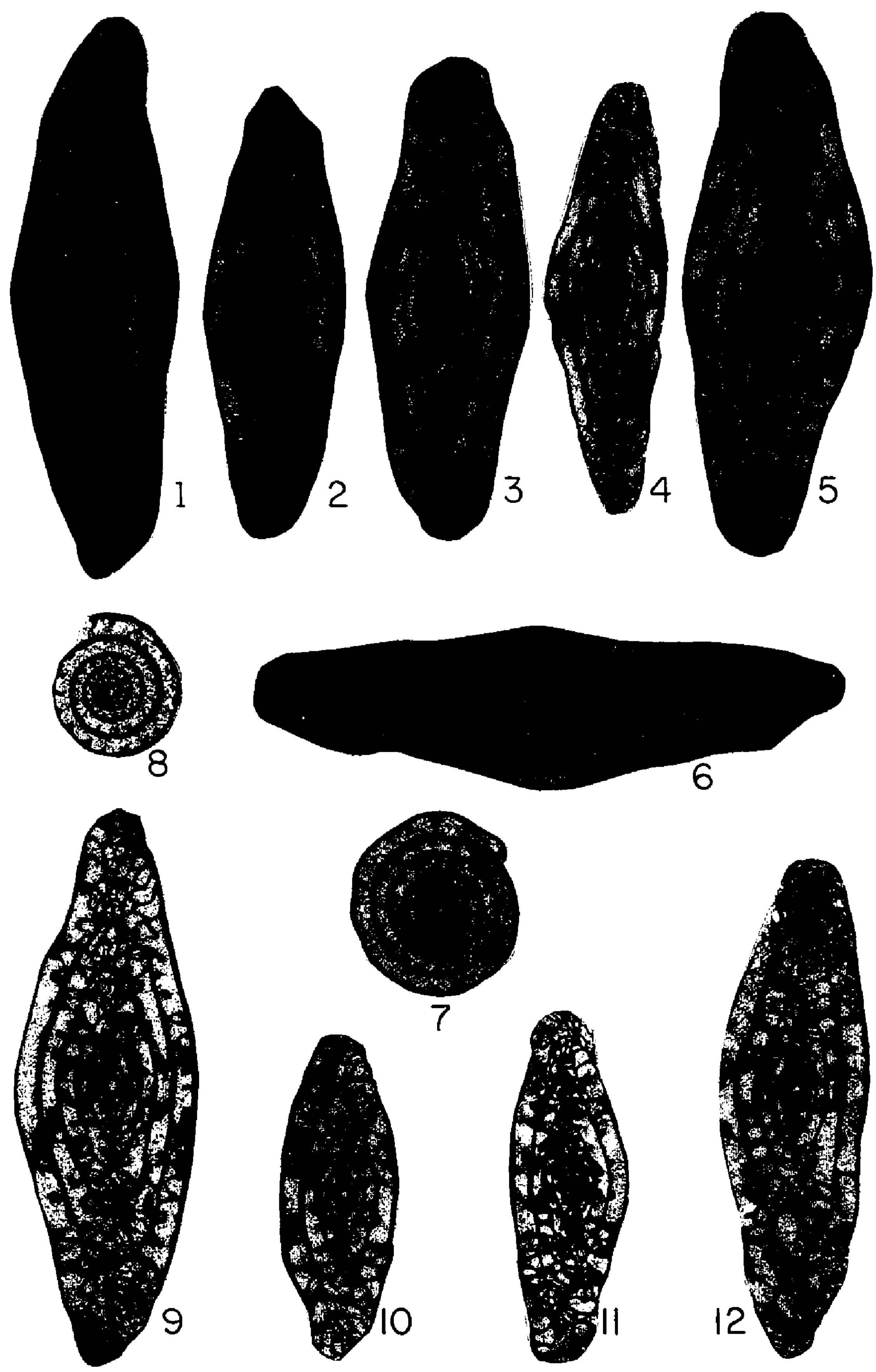

Plate VII

(all figures are unretouched photographs, x15)

		Page
1-3, 5.	*Fusulina* aff. *F. whitakeri* Stewart, unnamed limestone between Rocky Point Conglomerate and "type" Camp Ground Member, SW¼ NE¼ SE¼ sec. 20, T. 5 S., R. 2 E., Carter County (fossil locality 38). 1. OPF-191 2. OPF-192 3. OPF-193 5. OPF-194	35
4, 6-7.	*Fusulina acme* Dunbar and Henbest, limestone in lower part of Camp Ground Member, center of west line NW¼ SW¼ sec. 21, T. 5 S., R. 2 E., Carter County (fossil locality 40). 4. OPF-195 6. OPF-196 7. OPF-197	35

Plate VII

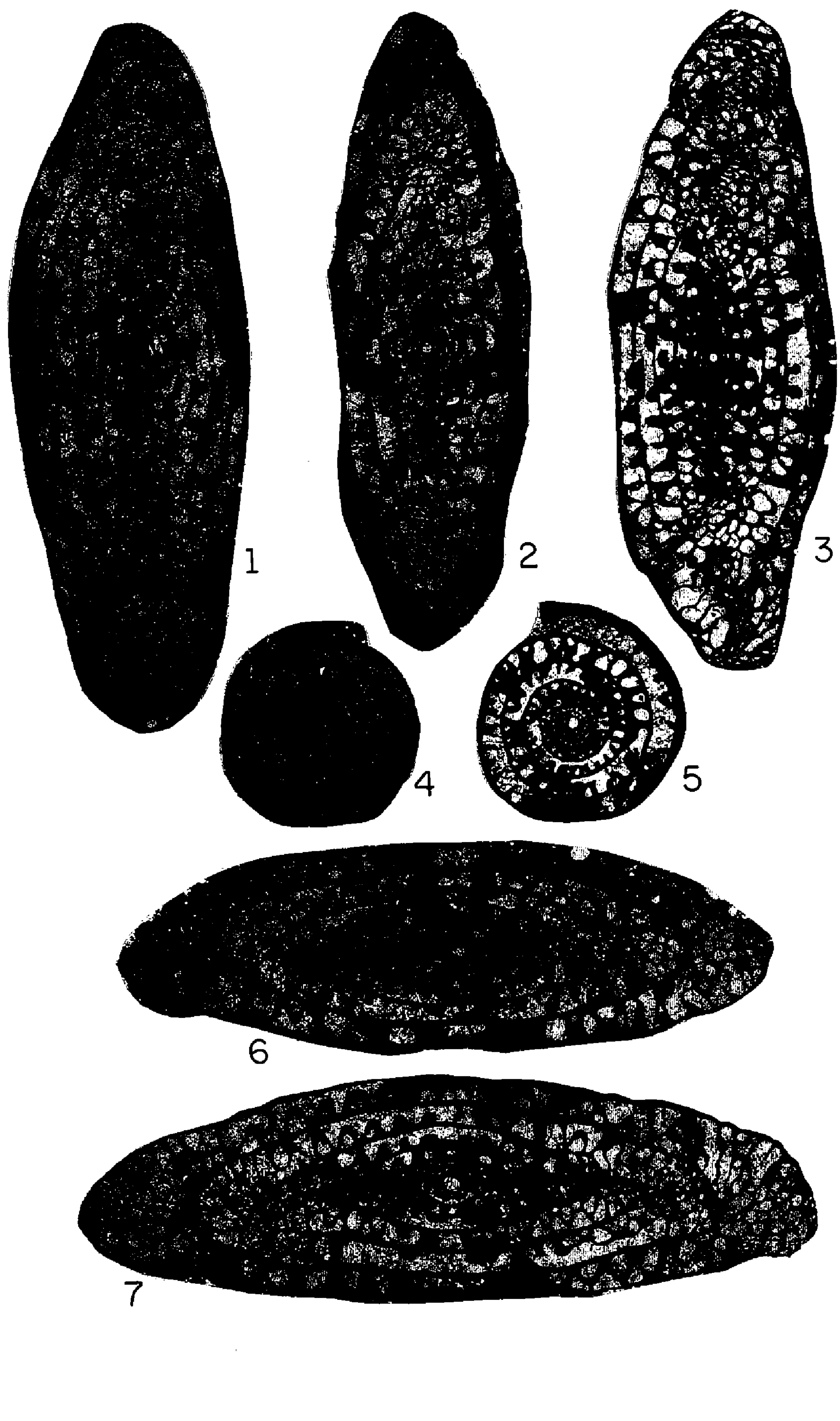

Plate VIII

(all figures are unretouched photographs, x15)

		Page
1,2.	*Fusulina acme* Dunbar and Henbest, limestone in lower part of Camp Ground Member, center of west line NW¼ SW¼ sec. 21, T. 5 S., R. 2 E., Carter County (fossil locality 40). 1. OPF-198 2. OPF-199	35
3-7.	*Triticites tomlinsoni,* new species. 3-4, 6-7. Crinerville Member, NW¼ NE¼ SW¼ sec. 6, T. 5 S., R. 2 E., Carter County (fossil locality 46). 3. OPF-200 4. OPF-202 6. OPF-203 7. OPF-204 (holotype) 5. Crinerville Member, SE¼ NW¼ SW¼ sec. 14, T. 5 S., R. 1 E., Carter County (fossil locality 47). 5. OPF-201	37

Plate VIII

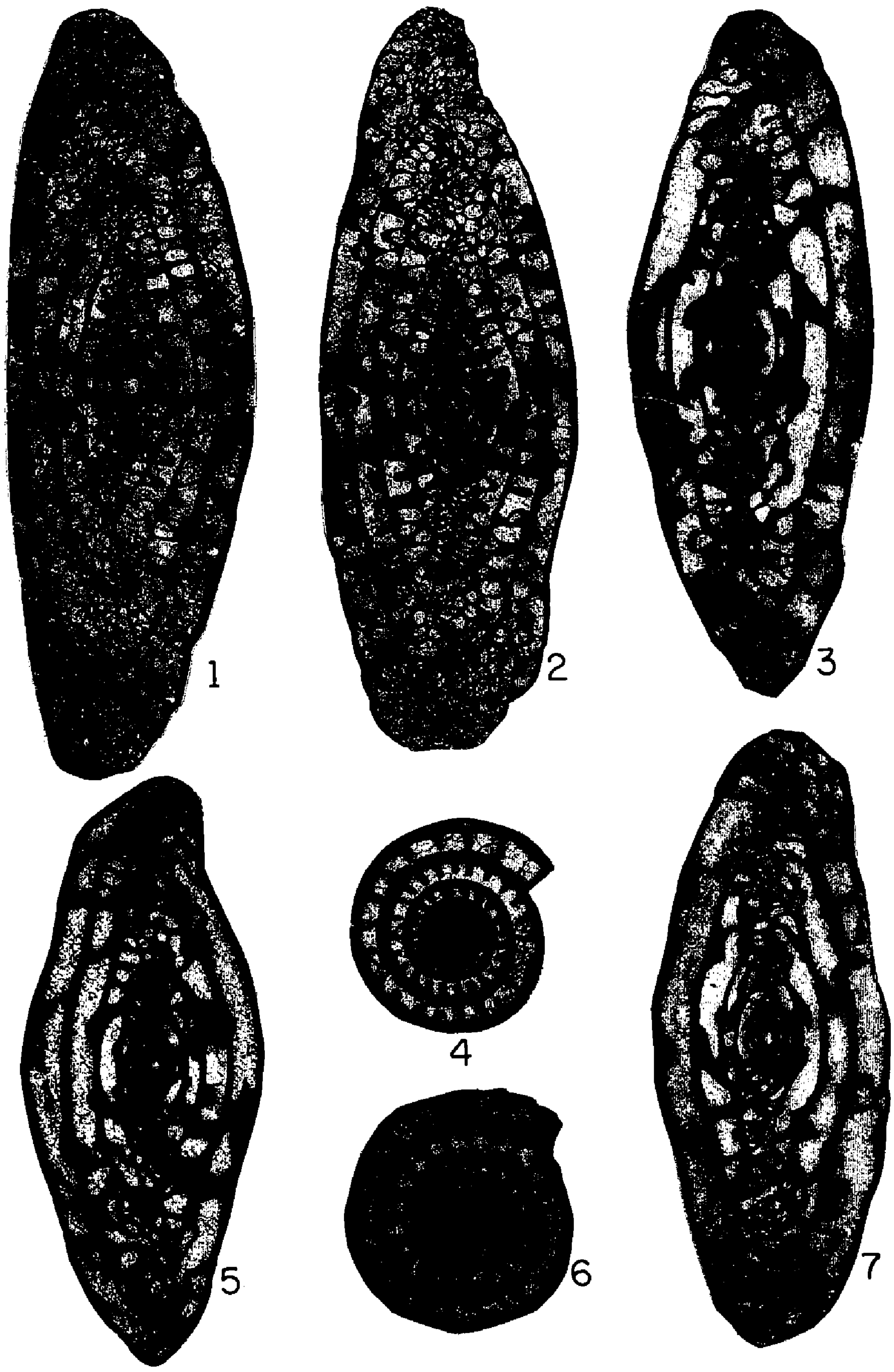

Plate IX

(all figures are unretouched photographs, x15)

		Page
1-7.	*Triticites irregularis* (Staff) emend. Dunbar and Condra. 1, 6. Anadarche Member, SE¼ SW¼ SE¼ sec. 17, T. 5 S., R. 1 E., Carter County (fossil locality 53). 1. OPF-207 6. OPF-212 2-5, 7. Anadarche Member, NW¼ SW¼ SE¼ sec. 8, T. 5 S., R. 2 E., Carter County (fossil locality 51). 2. OPF-208 3. OPF-209 4. OPF-210 5. OPF-211 7. OPF-213	38
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Plate IX

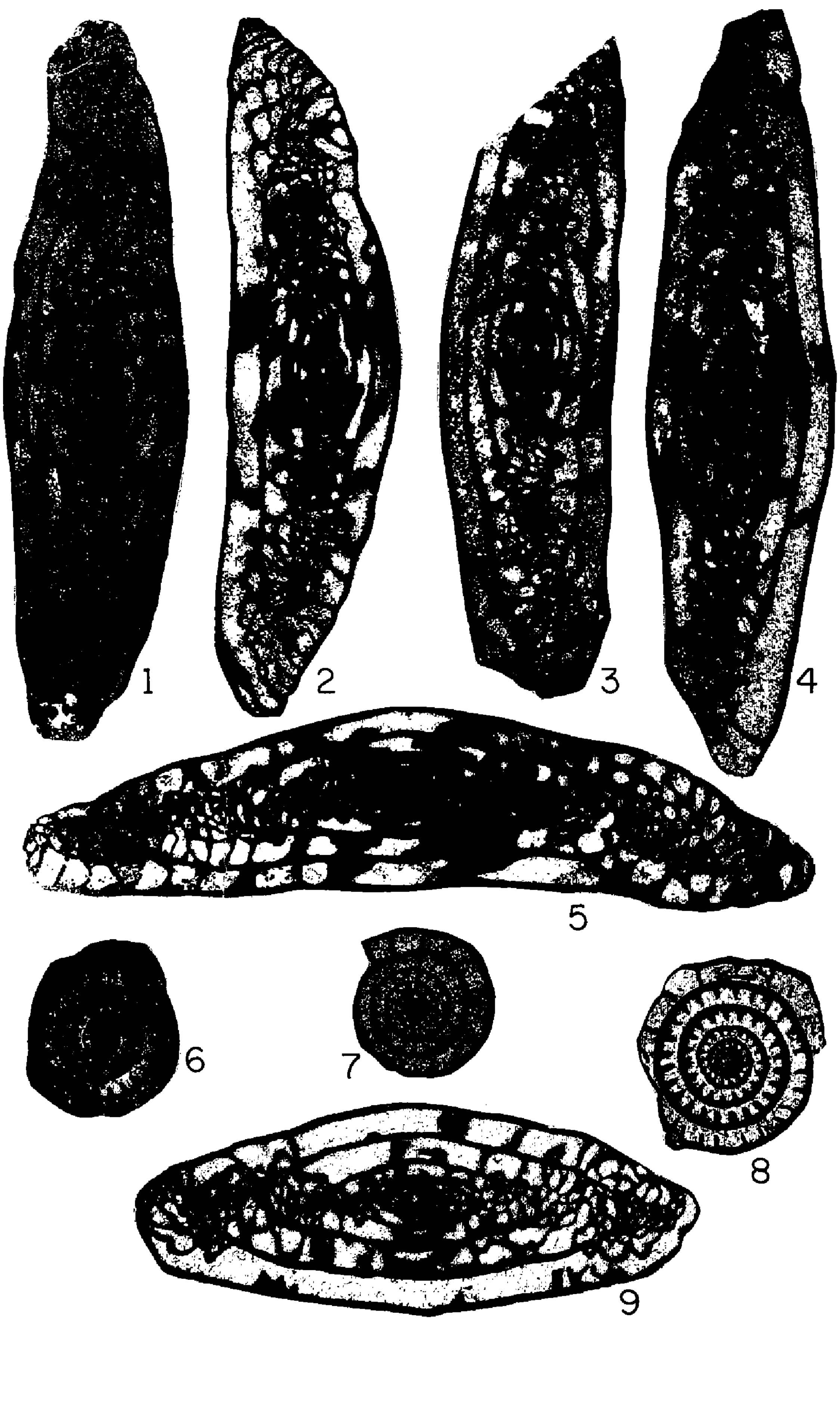
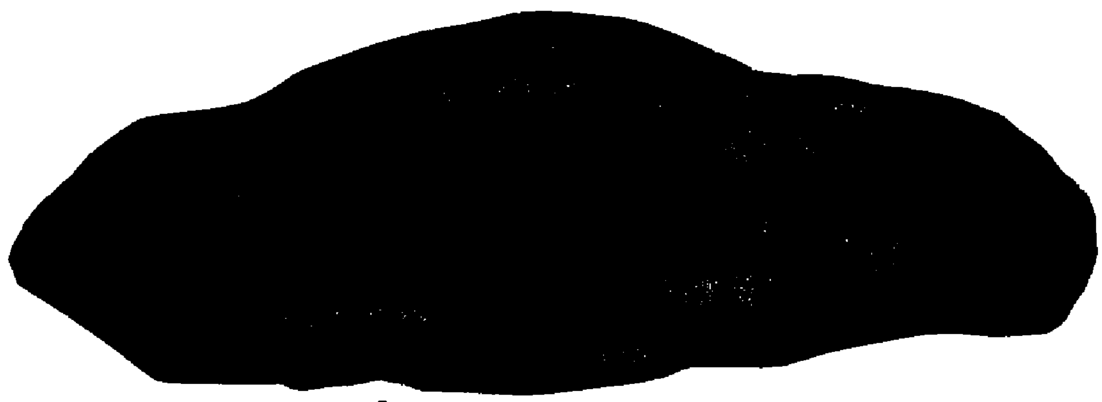


Plate X

(all figures are unretouched photographs, x15)

		Page
1-3.	*Triticites newelli* Burma, Daube Member, C NW¼ SE¼ NE¼ sec. 19, T. 5 S., R. 1 E., Carter County (fossil locality 55). 1. OPF-214 2. OPF-215 3. OPF-216	39
4.	*Triticites tomlinsoni,* new species, Crinerville Member, NW¼ NE¼ SW¼ sec. 6, T. 5 S., R. 2 E., Carter County (fossil locality 46). 4. OPF-206	37

Plate X



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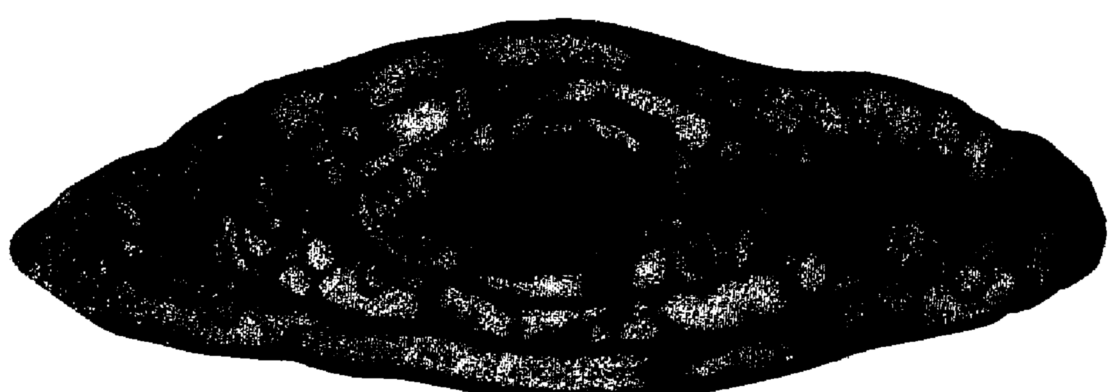

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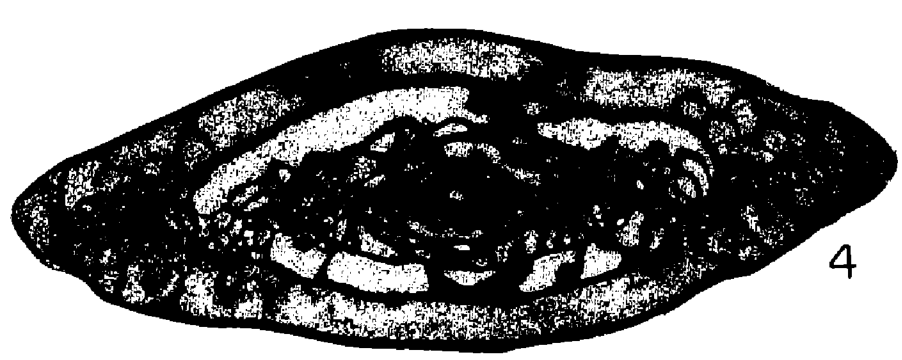

4

Plate XI

(all figures are unretouched photographs, x15)

		Page
1, 2, 4, 5.	*Triticites primarius* Merchant and Keroher, Daube Member, SW¼ SE¼ SE¼ sec. 16, T. 5 S., R. 2 E., Carter County (fossil locality 58). 1. OPF-219 2. OPF-220 4. OPF-221 5. OPF-222	39
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Plate XI

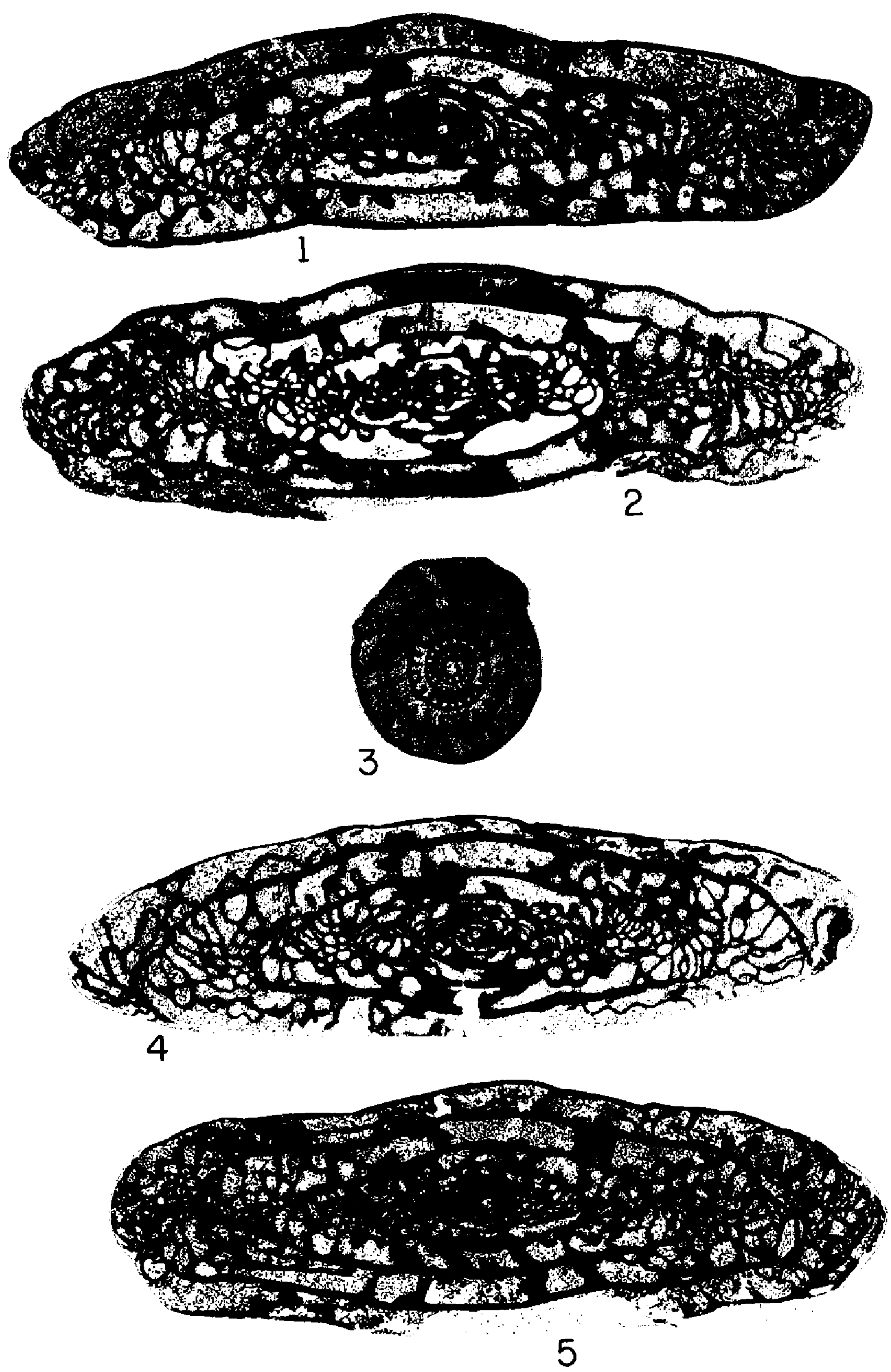


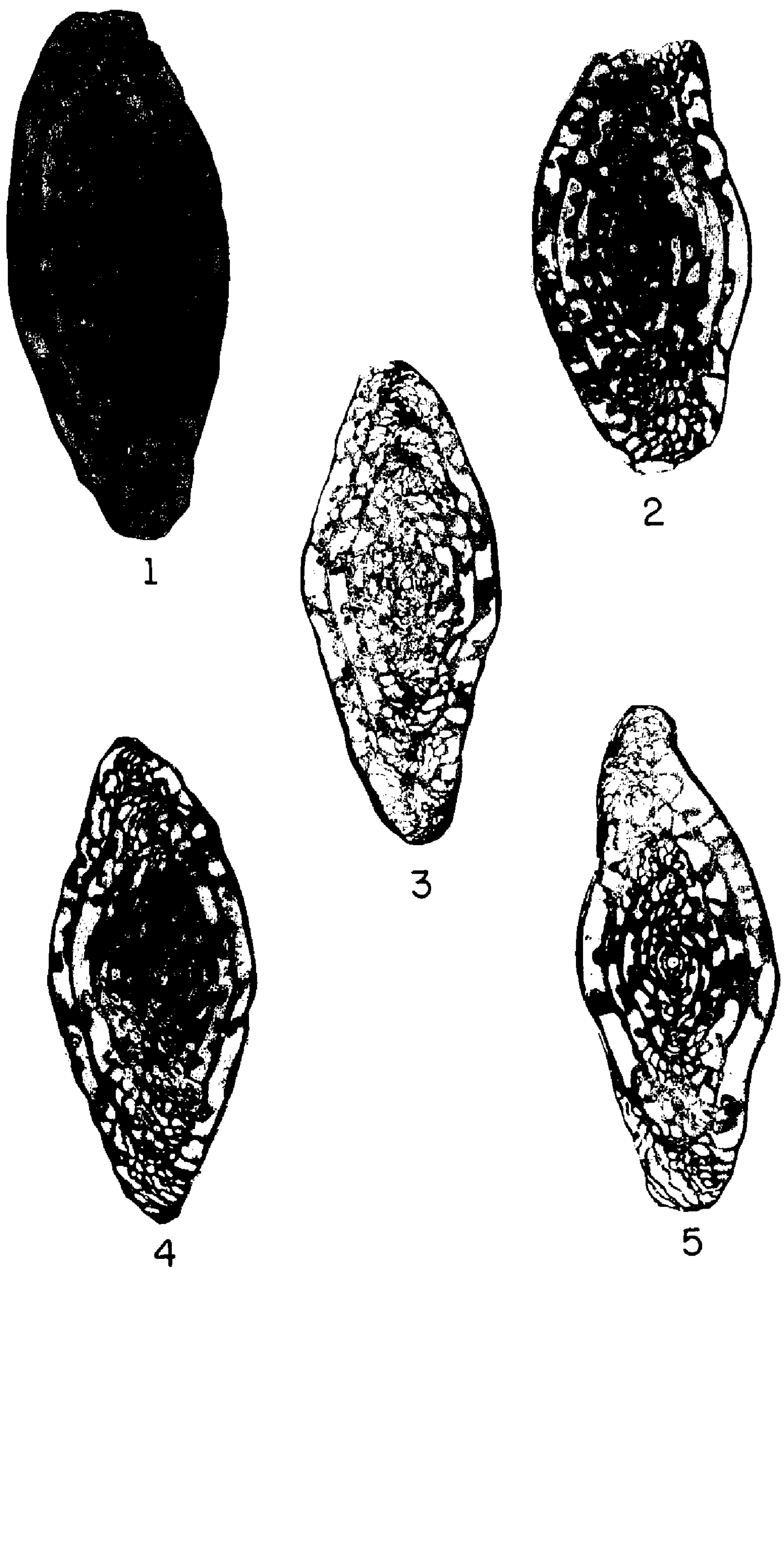
Plate XII

(all figures are unretouched photographs, x15)

		Page
1-5.	*Fusulina* sp., from deeply weathered lime mudstone at base of limestone conglomerate adjacent to the Criner Hills in sec. 36, T. 5 S., R. 1 E., Carter County (fossil locality 60).	75

1. OPF-223
2. OPF-224
3. OPF-225
4. OPF-226
5. OPF-227

Plate XII

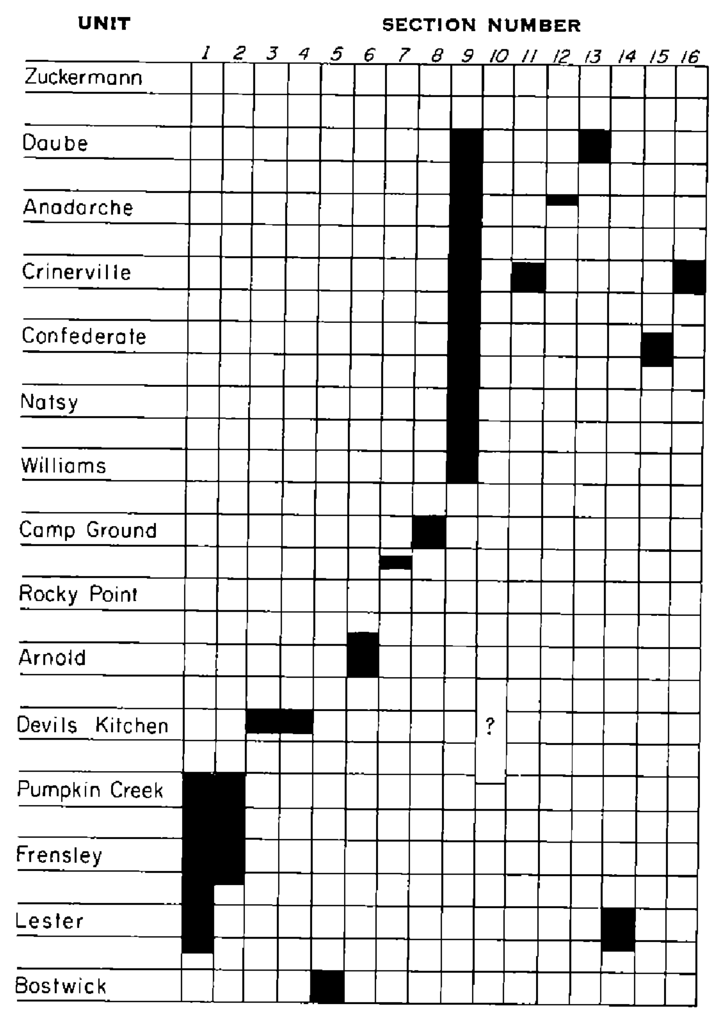


APPENDIX A

Measured Sections

The measured sections described herein include the stratigraphic units as shown on the diagram to the right. As the ranges indicated are only approximate and no scale is intended, the diagram is presented as a quick reference to the descriptions, not as a source of precise stratigraphic information. The locations are given below.

The format of the descriptions is in the following sequence: lithologic name, color (fresh and weathered), bedding (in terms of Ingram, 1954), cement (Folk, 1959), sorting (including particulate constituents), grain size, and other noteworthy features.



Locations of Measured Sections

Section Number	Section Location	T-S	R-E	County	Page
1	NE¼ NE¼ 22, SE¼ SE¼ 15; NW¼ 23	6	2	Love	69
2	N½ NW¼ 15	6	2	Love	70
3	S½ SE¼ NW¼, NE¼ NE¼ SW¼, W½ NW¼ SE¼ 4	6	2	Love	71
4	S½ SE¼ SE¼ SE¼ 32	5	2	Carter	71
5	SW¼ SW¼ SW¼ 32	5	2	Carter	71
	N line NW¼ NW¼ 5	6	2	Love	
6	NE¼ NW¼ NE¼ 4	6	2	Love	72
7	C W line NE¼ SE¼, NE¼ NW¼ SE¼ 20	5	2	Carter	72
8	C W line NW¼ SW¼ 21	5	2	Carter	73
9	17; NW¼ NE¼ SW¼ 6; SW¼ SE¼ SE¼ 16	5	2	Carter	73
10	W½ SE¼ NW¼ 36	5	1	Carter	74
11	SE¼ SE¼ SW¼ 28	5	1	Carter	75
12	SE¼ SW¼ SE¼ 17	5	1	Carter	75
13	C NW¼ SE¼ NE¼ 19	5	1	Carter	75
14	NE¼ NE¼ NE¼ 13	4	1	Carter	75
15	C E½ SE¼ SW¼ 14	5	1	Carter	76
16	SE¼ NW¼ SW¼ 14	5	1	Carter	76

Measured Section 1

NE¼ NE¼ sec. 22; SE¼ SE¼ sec. 15; NW¼ sec. 23; T. 6 S., R. 2 E., Love County

Measured section 1 is 0.5 mile south of Lake Murray Park on State Highway 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 29 to the immediate southwest and the numbers above 29 offset another 250 to 275 yards southeast along strike and to the northeast. The strike ranges from N. 50° W. to N. 63° W.; the dip ranges from 30° to 60° NE., with the more gentle dips toward the top of the section.

UNIT	DESCRIPTION	THICKNESS (FEET)
	Pumpkin Creek Member:	
44	Limestone, yellow-gray; weathering, gray with dark-yellow blotches; bedding, medium to thick; sparry calcite-cemented; fossiliferous, rare specimens of *Wedekindellina* sp. B. Skeletal framework is fragmental fossil debris; lower contact sharp.	10
43	Limestone, brown to yellow-brown; weathering, gray-brown; bedding, thin; sparry calcite-cemented, medium-crystalline. Upper 2 feet contains as much as 10 percent quartz sand grains.	10
42	Limestone, yellow-brown; weathering, gray-brown; bedding, fine to medium, irregular; cement, fine- to medium-crystalline sparry calcite; fragmental fossil material poorly sorted. Contains clay intraclasts; middle 10 feet shaly.	21
41	Limestone, brown; weathering, gray-brown; bedding, medium; cement, fine- to medium-crystalline sparry calcite; fossiliferous; much of particulate material silica replaced. *Fusulina* cf. *F. novamexicana* is common, *Wedekindellina* sp. B is rare.	5
	Unnamed unit:	
40	Covered.	103
39	Limestone, yellow-brown; weathering, dark gray-brown; bedding, thick to very thick; cement, fine-crystalline, micrite; poorly fossiliferous; an occasional specimen of *Fusulina* cf. *F. novamexicana* was seen. Contains quartz sand grains of between 2 and 3 ϕ.	11
38	Covered.	38
37	Limestone, red-brown; weathering, yellow-brown; bedding, medium to thick; cement, coarse to very-coarse sparry calcite; fragmental material poorly sorted; argillaceous. Contains clay intraclasts. Rare specimens of *Fusulina* cf. *F. novamexicana* are found.	4
36	Limestone, red-brown; weathering, yellow-brown; bedding, medium; cement, fine-crystalline calcite containing clay; moderate sorting of fragmental material.	2
35	Sandstone, red-brown; weathering, yellow-brown; bedding, thin to medium; cement, calcite with some clay, indurated to friable; fine-grained (2 to 3 ϕ) but ranging to 0 ϕ on some of the chert flakes. Clay intraclasts are common.	2
34	Covered.	50
33	Limestone, yellow-brown; weathering, dirty yellow-tan; bedding, medium; cement, coarse-crystalline grading upward to medium-crystalline sparry calcite; sandy (2 to 3 ϕ); fossiliferous.	8-12
32	Covered; intermittent exposures of shale, yellow-brown; weathering, tan; laminations, thin; silty. Few thin sandstone beds, yellow to yellow-tan, poorly cemented, fine-grained (3 to 4 ϕ).	200
31	Covered.	120
30	Sandstone, light tan-brown; weathering, brown; bedding, medium; cement, ferruginous calcite; fine-grained (2 to 3 ϕ); sorting, moderate. Unit changes facies in NW¼ sec. 22 into a sandy limestone.	3.5
29	Covered; observable areas are shale, yellow-brown, silty; with thin-bedded, fine-grained sandstone beds.	75
	Frensley Member:	
28	Limestone, brown; weathering, yellow-brown; bedding, thin to very thin; cement, medium- to coarse-crystalline sparry calcite to uncemented. Approximately 1.5 feet above base is 6- to 8-inch, uncemented, fragmental bioclastic zone; abundantly fossiliferous. *Fusulina plattensis* is common; *Wedekindellina* sp. A is rare.	4
27	Covered; probably shale.	50
26	Siltstone, yellow-purple to tan, thin-bedded; with thin-parted, tan, calcareous shale.	9
25	Limestone, brown; weathering, gray-brown; bedding, medium; cement, coarse-crystalline sparry calcite. Upper 4 inches becoming unconsolidated bioclastic hash. Abundant *Desmoinesia* and *Neospirifer.*	1
24	Covered.	45
23	Limestone, brown; weathering, gray-brown; bedding, medium; cement, micro-spar or micrite, fine-crystalline; fossiliferous. Skeletal constituents broken brachiopod fragments. Upper and lower contacts sharp.	1
22	Covered.	17
21	Limestone, yellow-tan; weathering, tan; bedding, thin to medium; medium-crystalline; nodular.	1
20	Shale, yellow-tan to gray-tan; weathering, yellow-tan; thinly laminated, soft, calcareous, and sandy.	8
19	Limestone, light-brown; weathering, gray-brown; bedding, medium; cement, medium-crystalline, limonitic sparry calcite. Unit becomes nodular and marly toward the southeast and abounds with *Fusulina pumila* and *Wedekindellina* sp. A.	2-4
	Unnamed unit:	
18	Shale, calcareous, tan to yellow-tan, thinly laminated, sandy; with limestone, yellow-tan, weathering tan; nodular, irregular bedding; cement, medium-crystalline sparry calcite. Rare specimens of *Fusulina pumila* and *Wedekindellina* sp. A.	18
17	Covered.	123
16	Limestone, yellow-brown; weathering, brown; bedding, medium; cement, coarse-crystalline limonitic sparry calcite; particulate material principally brachiopods; sandy (2 to 3 ϕ). Zone crops out along State Highway Scenic 77 as an unconsolidated, fragmented, brachiopod hash.	2
15	Covered.	70
14	Sandstone, white to yellow-white; weathering, gray-white; bedding, thin to thick; poorly cemented; fine-grained (2 to 3 ϕ), mod-	

UNIT	DESCRIPTION	THICKNESS (FEET)
	erately well-sorted, subangular grains. Thickness ranges along strike from 2 to 6 feet.	2-6
13	Covered.	53
	Lester Member (Lester Member restricted, only beds 11 and 12):	
12	Limestone, brown; weathering, yellow-brown; bedding, thin; oölitic; cement, coarse-crystalline sparry calcite; fossiliferous. Fusulinid species *Fusulina mutabilis* is common.	1
11	Limestone, brown; weathering, brown-yellow; bedding, thin; cement, coarse-crystalline sparry calcite; fossiliferous. *Fusulina mutabilis* is rare.	7-8
10	Shale, limonitic, silty; calcareous toward top; yellow-tan; thinly laminated.	118
9	Limestone, brown; weathering, yellow-brown; bedding, medium to thick; cement, coarse-crystalline sparry calcite; clay intraclasts. In upper 1 foot 90% of all fossils and many clay intraclasts are covered by thick layers of *Osagia*? algae. Some clay clasts up to 4 x 1 inches.	2
	Unnamed unit:	
8	Shale, yellow-tan, thinly laminated, limonitic, silty; with sandstone, thin-bedded siliceous-cemented, fine-grained, in thin beds.	40
7	Limestone, brown; weathering, yellow-brown; bedding, thin to thick; cement, limonitic, fine- to coarse-crystalline sparry calcite; microcross-bedding in lower 6 inches; fossiliferous. Fusulinid species *Fusulina insolita* rare and erratic in its distribution along strike.	1.5-3
6	Covered; probably shale because a strike valley is developed on this interval.	247
5	Sandstone, tan; weathering, yellow-tan; bedding, thin to thick; cement, limonitic calcite; very fine grained (3 to 4 ϕ), moderately well sorted. Upper and lower contacts sharp.	6-8
4	Shale, sandy (3 to 4 ϕ), yellow-tan; contains limonitic nodules; upper 6 inches flaggy, fine-grained sandstone in very thin beds.	25.5
3	Sandstone, light-brown; weathering, yellow-tan; bedding medium to thick; cement, limonitic calcite; grain size between 2 and 3 ϕ; well sorted.	2-3
2	Shale, yellow-tan, very thinly laminated, sandy, and limonitic.	13
1	Limestone, purple-brown; weathering, reddish-tan; bedding, medium to thick; fine-crystalline. Probably as much as 25% fine quartz sand grains (3 to 4 ϕ) present.	1.5

Measured Section 2

N½ NW¼ sec. 15, T. 6 S., R. 2 E., Love County

Section 2 is northwest of turn-off to Tucker Tower on State Highway Scenic 77, a distance of approximately 400 yards. The location is the quarry immediately to the north. The strike ranges from N. 28° W. to N. 30° W.; the dip ranges from 50° to 60° NE.

UNIT	DESCRIPTION	THICKNESS (FEET)
	Pumpkin Creek Member:	
17	Limestone, yellow-tan; weathering, yellow-gray; bedding, medium to thick; sparry calcite-cemented; fossiliferous, *Wedekindellina* sp. B and rare specimens of *Fusulina* cf. *F. novamexicana;* occasional chert pebble (—2 to —6 ϕ).	8
16	Shale, yellow-tan; sandy in lower part, becoming calcareous in upper part; quartz grains (2 to 3 ϕ). Contains limestone nodules in upper 6 inches.	6
15	Limestone, light yellow-tan; weathering, yellow-white; bedding, medium to thick; cement, medium to fine; could be incompletely recrystallized micrite. Unit changes to sandstone, yellow-tan; weathering, tan-white; bedding, thick; calcareous-cemented; grain size, fine to medium (1 to 3 ϕ); with beds of very thinly laminated gray to gray-green, sandy shale.	6
14	Shale, yellow-brown, fossiliferous; upper 2 feet sandy (3 to 4 ϕ); bedding obscured by sand content.	4
13	Limestone, yellow-brown; bedding, thick; cement, not cemented, loose, fragmented fossil shell, friable; some clay material in matrix. Sorting of the fragmented fossil material poor. Mud mounds (mudstone or micrite) containing large amplexizaphrentid rugose corals, fenestrate bryozoans, and the colonial rugose coral *Michelinia* occur in this horizon along strike. The fusulinid *Fusulina* cf. *F. novamexicana* is rare.	4
12	Limestone, brown-gray; weathering, dark gray-tan; bedding, generally thick; cement, coarse-crystalline sparry calcite, with limonite staining; chert pebbles (concentrated in lower part of bed) 0.5 to 1.0 inches. Lower bedding plane a mass of crushed *Hustedia* and *Composita* shells. *Fusulina* cf. *F. novamexicana* rare.	2-3
11	Shale, purple to yellow-tan, calcareous, fossiliferous.	6
10	Limestone, gray to brown; weathering, gray-tan; bedding, thin to medium; cement, sparry calcite; fossiliferous.	2.5
	Unnamed unit:	
9	Shale (?), badly covered, yellow-tan, sandy, thinly laminated, fossiliferous. A few specimens of large inflated fusulinids (*Fusulina* cf. *F. novamexicana* ?) are present.	124
8	Limestone, brown to tan; weathering, brown; bedding, medium to thick; sparry calcite-cemented; sandy (1 to 2 ϕ). Rare fusulinids of genus *Fusulina.*	6
7	Covered; approximately	500
	Frensley Member:	
6	Limestone, brown; weathering, yellow-tan; bedding, thick; cement, sparry calcite; unfossiliferous.	1.5
5	Covered.	34
4	Limestone, gray-splotched; weathering, gray-white; bedding, thin to medium, irregular; cement, micrite; fossiliferous, conspicuous *Composita* and *Desmoinesia* brachiopods.	10
3	Limestone, gray; weathering, gray-white; cement, fine-crystalline sparry calcite; sandy.	1
2	Covered.	11
1	Limestone, gray; weathering, gray-tan; bedding, medium; cement, micrite; abundantly fossiliferous. Lower contact (and shale below the limestone) contains *Fusulina pumila* and *Wedekindellina* sp. A.	1

Measured Section 3

S½ SE¼ NW¼, NE¼ NE¼ SW¼, W½ NW¼ SE¼ sec. 4, T. 6 S., R. 2 E., Love County

Section 3 is 0.52 mile southeast on State Highway 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 approximately 0.25 mile. Strike is N. 40° W.; dip is 60° NE.

UNIT	DESCRIPTION	THICKNESS (FEET)
	Upper Devils Kitchen Member:	
8	Sandstone, yellow-tan; weathering, tan; bedding, thick; cement, silica; grain size, medium (1 to 2 ϕ); occasional chert pebbles. Within 200 feet southeast along strike, this unit becomes a chert pebble conglomerate (chert pebbles up to 4 inches) and remains such until it disappears beneath the Cretaceous overlap in sec. 24, T. 6 S., R. 2 E.	41
7	Sandstone, yellow-brown; weathering, red-brown; bedding, thin to very thin; cement, hematitic-silica; grain size, medium (1 to 2 ϕ); few if any chert pebbles.	76
	Middle Devils Kitchen Member:	
6	Limestone, yellow-gray; weathering, gray-white; bedding, thin to medium, irregular; cement, micrite. Upper 2 feet becoming thick-bedded. Shale partings within this unit yield many specimens of *Fusulina euryteines* and *Wedekindellina* sp. C.	10
5	Shale, gray-white, calcareous; abundantly fossiliferous, *Mesolobus, Fusulina euryteines, Wedekindellina* sp. C, and many productid brachiopods.	4
4	Limestone, yellow-white; weathering, gray-white; bedding, thin and nodular; cement, micrite; unfossiliferous.	0.8
3	Shale, yellow-tan, calcareous, soft. Abundant fossils, *Fusulina euryteines* and *Wedekindellina* sp. C.	5.5
2	Limestone, gray-white; weathering, yellow-white; bedding, thin and nodular; cement, micrite; unfossiliferous.	0.8
1	Shale, yellow-tan to yellow-red; weathering, gray to red-brown; calcareous in upper half and sandy in lower part. Rare fusulinids in upper 50 feet.	225

Measured Section 4

S½ SE¼ SE¼ SE¼ sec. 32, T. 5 S., R. 2 E., Carter County

Section 4 is 2 miles east on State Highway Scenic 77 from its junction with U. S. Highway 77, 7 miles south of Ardmore. Begin clocking mileage at U. S. Highway 77 and U. S. Highway 70 junction at west edge of Ardmore. Strike of beds is N. 35° W., dip is 55° NE.

UNIT	DESCRIPTION	THICKNESS (FEET)
	Upper Devils Kitchen Member:	
8	Sandstone, yellow-brown; weathering, yellow-tan; bedding, thick to very thick, irregular; well sorted; poorly cemented, silica and clay, often friable; grain size, medium (1 to 2 ϕ); white and yellow chert pieces up to 0.25 to 0.5 inches.	58
7	Sandstone, red-brown; weathering, reddish; bedding, thin to very thin; cement, hematitic-clay; grain size, medium (1 to 2 ϕ); friable.	53
	Middle Devils Kitchen Member:	
6	Limestone, gray; weathering, gray-white; bedding, thin, nodular, irregular; cement, micrite. *Fusulina euryteines* and *Wedekindellina* sp. C abundant in shale partings between limestones.	15
5	Shale, gray-tan, calcareous, thinly laminated, fossiliferous. *Fusulina euryteines* and *Wedekindellina* sp. C are common.	2
4	Limestone, gray; weathering, gray-white; bedding, thin, regular; poorly fossiliferous.	0.3
3	Shale, yellow-tan; weathering, gray-tan; high clay content; thinly laminated. *Fusulina euryteines* and *Wedekindellina* sp. C present.	4
2	Limestone, gray-tan; weathering, gray-white; bedding, thin, irregular; unfossiliferous.	1
1	Shale, yellow-tan; calcareous in upper half and sandy in lower part; thinly laminated; poorly fossiliferous; lower contact concealed. Rare fusulinids of genus *Fusulina* in upper 60 feet.	120+

Measured Section 5

SW¼ SW¼ SW¼ sec. 32, T. 5 S., R. 2 E., Carter County

N line NW¼ NW¼ sec. 5, T. 6 S., R. 2 E., Love County

Section 5 is 1.1 miles east of U. S. Highway 77 and State Highway Scenic 77 junction, 7 miles south of Ardmore. Begin clocking mileage from U. S. Highway 77 and U. S. Highway 70 junction at west edge of Ardmore. Strike of beds is N. 15° W.; dip is 74° NE.

UNIT	DESCRIPTION	THICKNESS (FEET)
	Bostwick Member:	
17	Limestone, blue-black to dark-gray; weathering, gray-white; bedding, thin, irregular; poorly fossiliferous. Shale between limestone beds is gray; weathering, gray-white; calcareous; abundantly fossiliferous. Productid brachiopods, rugose corals, bryozoans, *Climacammina*, and *Fusulinella vacua* are common fossils.	16
16	Shale, yellow-tan; weathering, chalky-tan; calcareous; fossiliferous. Many small limonitic sandstone concretions. *Fusulinella vacua* rare.	2
15	Limestone, brown; weathering, yellow-tan; bedding, medium; cement, fine spar or	

UNIT	DESCRIPTION	THICKNESS (FEET)
	possibly partially recrystallized micrite; poorly fossiliferous.	8
14	Shale, yellow-brown, thinly laminated, calcareous. Four feet below top is a 2-foot, thin-bedded, dark-gray, fine-crystalline limestone. Shale unit is sparingly fossiliferous.	40
13	Limestone, light yellow-tan; weathering, light-gray; bedding, thin to very thin or indistinct; marly; calcareous clay is principal binding agent; highly fossiliferous; lophophyllidid and caninid rugose corals, syringoporid corals, bryozoans, and *Fusulinella dakotensis*.	4.7
12	Shale, blue-tan, platy, thinly laminated, calcareous, fossiliferous. Rare specimens of *Fusulinella dakotensis* are present.	25
11	Limestone, gray; weathering, gray-tan; bedding, medium, regular; sandy; fossiliferous. Limestone in three beds with brownish-gray, calcareous, fossiliferous shale about 4.5 feet thick separating limestone beds.	16
10	Shale, gray-brown; weathering, gray-tan; calcareous. Concretionary limestone nodules are in upper 16 feet, limonitic concretions in lower part. Shale is very thinly laminated.	10
9	Limestone, tan, uncemented, friable, marly; poorly sorted fossil hash; fossils principally brachiopods.	0.6
8	Conglomerate, limestone and chert pebble; pebbles of limestone as old as Early Ordovician; matrix, quartz sandstone and calcite. Some pebbles up to 2 inches in diameter, average about 0.5 inch.	0.8
7	Shale, dark gray-tan, blocky, calcareous, poorly fossiliferous.	17
6	Sandstone, conglomeratic, yellow-tan; grain size, medium; bedding, medium; cement, calcite; poorly sorted. Shale partings, dark gray-tan, sandy, limonitic, separate some of sandstone beds. Conglomerate generally confined to lower part of sandstone beds.	16
5	Conglomerate, limestone and chert pebble; limestone predominates; pebbles up to 3.5 inches in diameter; bedding, thick; cement, sandstone and calcite, graded.	3.5
4	Shale, gray-tan, calcareous, limonitic, thinly laminated. On south side of road lower 10 feet is a massive limestone-chert conglomerate. Rare specimens of *Fusulinella dakotensis*.	58
3	Siltstone-mudstone, black to gray-black; weathering, gray; bedding, thin, regular; highly calcareous.	21
2	Shale, gray-tan to light-gray; high clay content; calcareous; lower part becoming limonitic; silty in upper 20 feet. Rare specimens of *Fusulinella* sp.	70
1	Conglomerate; limestone and chert pebble; limestone pebbles predominate; average diameter about 0.5 inch; limestone pebbles as old as Late Ordovician; matrix, sandstone, limonite, and calcite. About 3.5 feet of conglomeratic shale separates the two beds of conglomerate.	11

Measured Section 6

NE¼ NW¼ NE¼ sec. 4, T. 6 S., R. 2 E., Love County

Section 6 may be reached by traveling east 75 yards on paved road leading to Lake Murray Lodge from its junction with State Highway Scenic 77. Turn south (right) on narrow paved road leading among cabins, keep left, continue 0.14 mile east. Turn south (right) onto narrow, poorly kept dirt road and continue for about 175 yards. Section 6 is on the immediate left and right.

UNIT	DESCRIPTION	THICKNESS (FEET)
	Unnamed unit:	
7	Sandstone, yellow-white; weathering, gray-white; bedding, medium; cement, calcite, friable; grain size, fine (2 to 3 ϕ), subangular, fair sorting.	4
	"Arnold Zone":	
6	Shale, yellow-white to tan, calcareous; thinly laminated, generally covered. Approximately 30 feet above the base is a nodular, micritic, gray-white limestone zone which contains abundant specimens of *Fusulina haworthi, Wedekindellina* sp. E, productid brachiopods, and bryozoans. All fossils are found in the highly calcareous shale associated with the limestone nodules but not in the limestone nodules themselves.	38
	Arnold Member (restricted):	
5	Limestone, gray; weathering, gray-white; bedding, medium, fairly regular; cement, micrite. Upper 2 feet is fragmental and highly crinoidal (encrinite), with a sparry calcite cement.	12
4	Covered; probably shale.	25
3	Limestone, yellow-gray; weathering, gray-white; bedding, thin to medium, at many places irregular and nodular; matrix, incompletely recrystallized micrite in places; fossiliferous; productid brachiopods common; rare specimens of *Fusulina erugata.*	18
2	Shale, yellow-gray, thinly laminated, calcareous. In middle of shale are several very thin to nodular, yellow-gray, sandy limestones with common specimens of *Fusulina erugata.*	12
1	Limestone, yellow-gray; weathering, gray-white; bedding, thin, nodular, irregular; matrix, sparry calcite and some micrite; fossiliferous; abundant *Fusulina erugata.*	1.5

Measured Section 7

C W line NE¼ SE¼, NE¼ NW¼ SE¼ sec. 20, T. 5 S., R. 2 E., Carter County

Section 7 may be reached by following State Highway 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 is exposed to the northeast with only unit 7 exposed in the clearing; other units are in the dense growth of trees. Strike of beds is N. 36° W.; dip is 60° NE.

UNIT	DESCRIPTION	THICKNESS (FEET)
	Unnamed limestones between Rocky Point Member and Camp Ground Member:	
7	Limestone, reddish-brown; weathering, reddish-tan; bedding, thin, irregular; cement, micrite. Clay intraclasts present; soft due to extreme weathering. Abundant specimens of *Fusulina* aff. *F. whitakeri.*	0.5
6	Shale, gray, sandy (3 to 4 ϕ), unfossiliferous, thinly laminated.	3
5	Limestone, reddish-brown; weathering, reddish; bedding, thin; cement, micrite; sandy (2 to 4 ϕ). Contains clay intraclasts.	0.5
4	Covered; probably shale.	34
3	Limestone, yellow-brown; weathering, reddish-brown; bedding, thin to medium, at places irregular; cement, micrite. Contains gray clay intraclasts. Rock is badly weathered and soft; unfossiliferous.	1
2	Covered.	76
1	Limestone, reddish-brown; weathering, reddish-brown; bedding, thin, regular; cement, sparry calcite. Contains green and gray clay intraclasts; poorly fossiliferous.	2

Measured Section 8

C W line NW¼ SW¼ sec. 21, T. 5 S., R. 2 E., Carter County

Section 8 may be reached by traveling 3.1 miles north on State Highway 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 southeast 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. Strike of beds is N. 34° W.; dip is 40° NE.

UNIT	DESCRIPTION	THICKNESS (FEET)
	Camp Ground Member:	
10	Sandstone, yellow-tan; weathering, tan-white; bedding, medium to thick; cement, calcite and silica, friable at places; grain size, medium (1 to 2 ϕ).	7
9	Mostly covered but road bed and glades show yellow-red to yellow-tan, sandy shale with thinly bedded sandstone beds.	115
8	Sandstone, yellow-brown; weathering, yellow-tan; bedding, medium; cement, silica and limonite, friable; grain size, fine (2 to 3 ϕ). Rare specimens of *Fusulina acme.*	4
7	Covered.	10
6	Shale, yellow-tan, sandy; with very thin-bedded sandstone stringers.	10
5	Sandstone, yellow-tan; weathering, yellow-brown; bedding, medium to thick, regular; grain size, medium (1 to 2 ϕ); grains, subangular and fairly well-sorted.	15
4	Shale: thinly laminated, yellow-tan, soft; becoming sandy at base; calcareous.	5
3	Limestone, yellow-brown; weathering, reddish-tan; deeply weathered; bedding, thin; cement, when fresh surface can be found apparently sparry calcite, but normally a soft fine-grained weathering product; sandy. On the unweathered surfaces are rare specimens of *Fusulina acme.*	1
2	Shale, yellow-brown, thinly laminated, very sandy (2 to 3 ϕ). Contains in lower 1 foot, a chonetid, crinoid, fusulinid marly zone. *Fusulina acme* is abundant but most specimens are so iron stained that they are not usable.	3
1	Limestone, brown-gray; weathering, red-brown; bedding, thin; fresh rock apparently sparry calcite cemented; deeply weathered; sandy. Rare specimens of *Fusulina acme.*	2

Measured Section 9

Sec. 17; NW¼ NE¼ SW¼ sec. 6; SW¼ SE¼ SE¼ sec. 16; T. 5 S., R. 2 E., Carter County

Units 1 through 11 are in sec. 17, T. 5 S., R. 2 E. Units 1-5 may be reached by traveling 3.25 miles on State Highway Scenic 77 from the southeast edge of Ardmore (township line between T. 4 S. and T. 5 S.). This should position one on units 1 and 2 with units 3-5 exposed to the northeast along the road for approximately 275 yards. Units 7-11 and units 14 and 15 may be reached by traveling 2.65 miles south of Ardmore on State Highway Scenic 77 and walking northwest about 700 yards to abandoned house. Units 7-11 are about 210 yards to the southwest of the abandoned homesite in a deep ravine, and units 14 and 15 are to the north-northeast approximately 180 yards where a gully cuts through the soil cover of the pasture and exposes the limestone. Unit 13 (NW¼ NE¼ SW¼ sec. 6, T. 5 S., R. 2 E.) may be reached by traveling to the northwest corner of Rose Hill cemetery at the south end of C Street SE (Douglas Blvd.) at the southern edge of Ardmore. Unit 13 is exposed north along railroad track approximately 300 yards. Units 17-19 may be reached by traveling approximately 2.1 miles south on State Highway Scenic 77 from the southeast edge of Ardmore. Turn to southeast (left) and continue on asphalt road for 1.45 miles. Just before cresting hill, take narrow road south (right) over conglomerate ridge and continue south and southwest for 0.5 mile. Units

17-19 are in SW¼ SE¼ SE¼ sec. 16, T. 5 S., R. 2 E. The strike of the beds of the composite section (section 9) ranges from N. 33° W. to N. 40° W.; dip ranges from 30° to 60° NE.

UNIT	DESCRIPTION	THICKNESS (FEET)
	Daube Member:	
19	Limestone, brown; weathering, dull-brown; bedding, medium; cement, fine-crystalline, micrite; fossiliferous; fretted with brown brachiopod shells standing in relief above weathered matrix. Rock termed a brachiopod packstone. Specimens of the fusulinid *Triticites primarius* are present but rare.	2
18	Shale, calcareous, yellow-brown; fossiliferous, abundant productid brachiopods, fusulinids, and bryozoans. Many thin, nodular limestone lenses throughout. This unit becomes an interbedded thin, nodular limestone-shale northwest along strike. *Triticites primarius* abundant.	8
	Unnamed Unit:	
17	Sandstone, quartz, red to chocolate-brown, conglomeratic; with chert pebbles; bedding, thin, irregular; grain size, fine; ferruginous. Lower contact of sandstone covered.	25
16	Covered; probably shale with thin sandstone beds.	477
	Anadarche Member:	
15	Limestone, blue-gray to gray; weathering, gray-white; bedding, medium, rather regular; cement, fine-crystalline, micrite; fossiliferous; large productid brachiopods, paleotextulariids, and rare specimens of the fusulinid *Triticites irregularis*. Rock classed as a wackestone.	12
	Unnamed Unit:	
14	Covered; probably shale with thin sandstone beds.	680
	Crinerville Member:	
13	Limestone, yellow-brown to yellow-tan; weathering, yellow-gray; bedding, thin to medium; cement, fine-crystalline, micrite; appears to have some sparry recrystallization; fossiliferous; *Triticites tomlinsoni* abundant. To southeast in sec. 18, this unit develops 30 to 40 feet of sandstone at the base and the limestone becomes a limestone conglomerate.	21
	Unnamed Unit:	
12	Covered; probably shale with thin sandstone beds.	446
11	Shale, carbonaceous, gray, soft. X-ray indicates clay is illite-chlorite. Coal (possibly a petroleum residue) in veins up to 0.5 inch thick. Selenite crystals abundant.	4.5
10	Covered; probably shale.	6
	Confederate Member:	
9	Limestone, gray-white; weathering, light gray; bedding, medium; sparry calcite-cemented, very coarse-crystalline. In places conglomeratic; pebbles composed of limestone.	2-4
8	Covered; probably shale.	14
7	Limestone, yellow-brown; weathering, brown or tan; bedding, thin to medium; cement, fine-crystalline, micrite. Rock could be classed as a fusulinid wackestone or fusulinid packstone depending upon abundance of fossils. *Wedekindellina ? ardmorensis* common. Base poorly exposed.	15
	Unnamed Unit:	
6	Covered; probably shale with thin sandstone beds.	450
	Natsy Member:	
5	Limestone, yellow-brown; weathering, tan to brown; bedding, medium; cement, fine sparry calcite or micrite; fossiliferous, mostly brachiopods. Interbeds of gray-brown, calcareous shale.	17
4	Sandstone, quartz, yellow-tan to "off-white;" weathering, gray-tan; bedding, thick, indurated; grain size, fine (2 to 3 ϕ).	32
	Unnamed Unit:	
3	Covered; is shale, gray-white; with limonitic concretions and limonitic sandstone beds where exposed.	360
	Williams Member:	
2	Sandstone, quartz, yellow-brown; weathering, yellow tan; bedding, thin to medium; grain size, fine; sorting, poor; limonitic.	25
1	Limestone, yellow-tan; bedding, medium; matrix cement, micrite; sandy; fossiliferous. *Myalina* most abundant fossil.	2

Measured Section 10

W½ SE¼ NW¼ sec. 36, T. 5 S., R. 1 E., Carter County

Section 10 may be reached by traveling south 6.7 miles from junction of U. S. Highway 70 and U. S. Highway 77 at west edge of Ardmore. Turn west (right) and continue 0.8 mile. Then north at entrance of McAlester 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. The strike of the beds is N. 10° W.; the dip is 55° SW.

UNIT	DESCRIPTION	THICKNESS (FEET)
	Unnamed Unit (in literature known variously as "psuedo-Bostwick," "Bostwick," or "Deese conglomerate"):	
13	Conglomerate; zone composed of 3 or 4 thick-bedded units each 2 to 4 feet thick; pebbles and cobbles composed of limestone and chert; matrix of sandstone with calcareous cement; grain size ranging from sand size to small cobbles. Beds separated by covered intervals of 1 foot to 2 feet.	12
12	Covered; probably shale and sandstone interval.	24
11	Conglomerate; limestone and chert pebbles grading into yellow-white, (weathering, gray-white) quartz sandstone; fine-grained (1 to 2 ϕ); friable; cement, calcite.	5
10	Covered; probably shale and sandstone interval.	20
9	Sandstone, quartz, yellow-brown; weathering, reddish-brown; bedding, thick; cement, calcite, friable; grain size, fine (2 to 3 ϕ); sorting, moderate; grains, subangular.	8

UNIT	DESCRIPTION	THICKNESS (FEET)
8	Covered; probably shale and sandstone interval.	17
7	Conglomerate; limestone and chert pebbles; grading into yellow-white (weathering, gray-white) quartz sandstone; bedding, medium to thick; cement, calcite.	5
6	Covered; probably shale and sandstone interval.	20
5	Sandstone, yellow-brown; weathering, reddish brown; bedding, thick; cement, calcite, friable; grain size, fine (2 to 3 ϕ); sorting, moderate; grains, subangular.	8
4	Covered; probably shale and sandstone interval.	17
3	Conglomerate; chert and limestone pebbles, some up to 2.5 inches; bedding, thick; cement, calcite and quartz sandstone matrix; chert is principally Woodford type. Upper few inches yellow-brown, quartz sandstone.	2
2	Covered; probably shale.	35
1	Limestone, yellow-brown; weathering, yellow-tan; highly limonitic; bedding, thick, regular; cement, fine-crystalline, micrite; fossiliferous. Many large rugose corals of the amplexizaphrentid type. A species of *Fusulina* (*Fusulina* sp.) that is at least as morphologically advanced as Pumpkin Creek forms is present.	4.5

Measured Section 11

SE¼ SE¼ SW¼ sec. 28, T. 5 S., R. 1 E., Carter County

Section 11 may be reached by traveling 4.0 miles south on U. S. Highway 77 from its junction with U. S. Highway 70 at west edge of Ardmore, turn west (right) and continue 2.0 miles, turn south (left) and continue 2.3 miles, turn west (right) and continue approximately 1.4 miles; road makes sharp turn north (right). Section is in creek bottom east of house about 40 yards north of sharp bend in road. The strike of the beds is N. 32° W.; the dip is 17° SW.

UNIT	DESCRIPTION	THICKNESS (FEET)
Unnamed Unit:		
5	Sandstone, quartz, gray-tan; weathering to gray-tan; bedding, medium to thick; cement, calcite; fine-grained (2 to 3 ϕ); sorting, moderate. Top is poorly exposed owing to soil cover.	8+
4	Shale, yellow-tan to gray-tan, sandy, thinly laminated.	2
3	Sandstone, quartz, gray-tan; weathering, gray; bedding, medium to thick; fine-grained (2 to 3 ϕ).	3
2	Shale, dark-gray to gray-tan, sandy, soft, thinly laminated.	1
Crinerville Member:		
1	Limestone, gray-tan to brown; weathering, gray-brown; bedding, thin, irregular; cement, fine-crystalline, micrite; sandy; fossiliferous. Limestone is ripple marked on many bedding surfaces. Abundant specimens of *Triticites tomlinsoni.*	5

Measured Section 12

SE¼ SW¼ SE¼ sec. 17, T. 5 S., R. 1 E., Carter County

Section 12 may be reached by traveling west on U. S. Highway 70 for 5.0 miles from its junction with U. S. Highway 77 at west edge of Ardmore. Turn south (left) onto dirt road and continue 4.0 miles, turn east (left) 0.7 mile and stop. Section is small limestone ledge cropping out in pasture to the north. The strike of the beds is N. 40° W.; the dip is 13° NE.

UNIT	DESCRIPTION	THICKNESS (FEET)
Anadarche Member:		
2	Limestone, brown to gray; weathering, rusty gray-brown; bedding, thin to medium; cement, fine-crystalline, micrite; fossiliferous. *Triticites irregularis* common to abundant. Upper contact covered.	7+
1	Shale-limestone; zone of nodular, tan-brown (weathering, yellow-brown) micrite limestone with thin partings of calcareous, fossiliferous shale. Shale has abundant bryozoan faunule. *Triticites irregularis* common.	2.5

Measured Section 13

C NW¼ SE¼ NE¼ sec. 19, T. 5 S., R. 1 E., Carter County

Section 13 may be reached by driving west 5.0 miles on U. S. Highway 70 from its junction with U. S. Highway 77 at west edge of Ardmore. Turn south (left) and continue for 4.25 miles. Last 0.25 mile is over an abandoned section-line road. Units crop out approximately 300 yards west of road. The strike of the bed is N. 6° W.; the dip is 14° SW.

UNIT	DESCRIPTION	THICKNESS (FEET)
Daube Member:		
1	Limestone, gray-brown to tan; weathering, gray-white to tan; bedding, thin to medium, irregular; cement, fine-crystalline, micrite. Weathering surface fretted with brown etched brachiopods standing out in relief. Very fossiliferous, abundant specimens of *Triticites newelli.* Interbeds of calcareous shale. Limestone is most commonly a brachiopod and/or fusulinid packstone.	11

Measured Section 14

NE¼ NE¼ NE¼ sec. 13, T. 4 S., R. 1 E., Carter County

Section 14 may be reached by driving north 2.9 miles on U. S. Highway 77 from its junction with U. S. Highway 70 at west edge of Ardmore. The strike of the beds is N. 70° W.; the dip is 60° SW.

UNIT	DESCRIPTION	THICKNESS (FEET)
Lester Member (type):		
3	Limestone, gray-tan to yellow-tan; weathering, gray-white; bedding, thin to medium; sparry calcite-cemented; oölitic. Abundant bryozoans; other fossils common. Two specimens of primitive *Fusulina* that were similar to *Fusulina mutabilis* of unit 1 below were found during thin sectioning.	17
Unnamed Unit (probably both unit 1 and unit 2 below should be considered a part of the Lester Member):		
2	Covered; however that exposed is limonitic red-tan to gray-tan, calcareous shale with occasional thin beds of highly limonitic limestone and sandstone.	90
1	Limestone, red-gray to red-brown; weathering, rusty red-brown; bedding, thin; sparry calcite cemented; coarse-crystalline; sandy. Occasional oöliths are present. Rock is a fusulinid grainstone at many places. The fusulinid *Fusulina mutabilis* is common to abundant.	2

Measured Section 15

C E½ SE¼ SW¼ sec. 14, T. 5 S., R. 1 E., Carter County

Section 15 may be reached by traveling 3.0 miles south on U. S. Highway 77 from its junction with U. S. Highway 70 at west edge of Ardmore. 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. Units are exposed approximately 440 yards southeast of house on east side of farm pond. The strike of the beds is N. 16° W.; the dip is 78° NE. (overturned).

UNIT	DESCRIPTION	THICKNESS (FEET)
Confederate Member:		
4	Conglomeratic sandstone, brown; weathering, brown-tan; bedding, thick; irregularly cross-bedded; cement, calcite; sorting, poor. Pebbles are composed of clay, older Pennsylvanian sandstone, and limestone. Sand-grain size, fine to medium (1 to 3 ϕ).	5
3	Shale, gray-tan; weathering, yellow-tan; calcareous; with several very thin-bedded limestone lenses.	5
2	Limestone, brown to gray-brown; weathering, light-brown; bedding, medium to thick; sparry calcite-cemented; fossiliferous.	6
1	Sandstone, gray-white weathering, slightly more gray in color; bedding, thin to medium, regular; cement, calcite; grain size, very fine (3 to 4 ϕ); moderately well sorted.	8
Unnamed Unit:		
0	Exposures below the sandstone at the base of the Confederate are mostly grass covered and poorly exposed. However, approximately 60 to 70 feet below unit 1 common to abundant specimens of *Wedekindellina? ardmorensis* are present.	70+

Measured Section 16

SE¼ NW¼ SW¼ sec. 14, T. 5 S., R. 1 E., Carter County

Same directions as for section 15. Section 16 is approximately 200 yards north-northeast of farm house on poorly exposed ridge. The strike of the beds is N. 76° E.; the dip is 13° NW.

UNIT	DESCRIPTION	THICKNESS (FEET)
Crinerville Member:		
1	Limestone, gray-white to tan-brown; weathering, gray to gray-brown; bedding, thin to medium, regular; sparry calcite cemented with some micrite cement toward top; fossiliferous. Some beds contain quartz sand. Abundant specimens of *Triticites tomlinsoni* throughout exposure. Base not well exposed.	20

APPENDIX B

Tabulation of Mensural Data

All continuous variables such as radius vector, half length, tunnel width, spirotheca thickness, chomata height, and proloculus diameter are given in millimeters. Statistical notations are as follows: $\overline{X}$ is the mean, s is the sample standard deviation, UCL and LCL are the upper and lower confidence limits, respectively, at the 99 percent level.

Index to Mensural Data

FUSULINA INSOLITA Thompson

Lester Member, Locality 6

Radius Vector

1	.091	.150	.252	.424	.636	.843
2	.148	.270	.430	.650	.860	.000
3	.165	.257	.390	.551	.740	.000
4	.107	.199	.319	.473	.000	.000
5	.119	.202	.314	.474	.000	.000
6	.094	.158	.263	.394	.578	.760
7	.130	.207	.326	.484	.694	.000
8	.086	.138	.197	.293	.408	.588
9	.127	.244	.377	.572	.808	.000
10	.119	.210	.351	.547	.746	.000
11	.105	.174	.288	.432	.638	.000
12	.119	.202	.393	.519	.720	.000
13	.100	.168	.248	.345	.512	.701
14	.111	.189	.301	.458	.648	.000
15	.120	.188	.286	.432	.637	.844
16	.103	.182	.280	.435	.614	.832
17	.118	.200	.320	.518	.773	.000
18	.112	.118	.297	.454	.640	.830
19	.089	.151	.264	.396	.600	.840
20	.090	.147	.250	.400	.600	.858
21	.078	.140	.246	.400	.608	.836
22	.135	.240	.406	.622	.851	.000
23	.126	.210	.355	.535	.801	.000
24	.089	.151	.264	.396	.600	.800
25	.118	.202	.330	.495	.720	.000
26	.092	.153	.249	.400	.614	.811
27	.100	.175	.265	.382	.556	.000
28	.104	.174	.240	.355	.522	.690
29	.100	.170	.288	.446	.676	.000
30	.088	.171	.317	.482	.696	.827
31	.094	.168	.280	.442	.665	.852
32	.116	.180	.312	.488	.714	.000
33	.130	.210	.320	.475	.672	.000
34	.100	.170	.269	.413	.581	.000
35	.114	.187	.286	.444	.618	.000
$\bar{x}$	.110	.186	.302	.458	.659	.794
s	.019	.032	.053	.076	.098	.077
UCL	.118	.201	.326	.493	.705	.856
LCL	.101	.172	.278	.423	.612	.733

Tectum & Diaphanotheca

.004	.007	.010	.012	.016	.016
.004	.007	.010	.017	.000	.000
.006	.007	.010	.013	.017	.000
.005	.007	.010	.012	.016	.000
.005	.007	.009	.011	.015	.000
.004	.006	.008	.011	.012	.019
.004	.007	.009	.012	.016	.000
.004	.007	.008	.010	.014	.016
.004	.009	.010	.012	.017	.000
.004	.006	.010	.013	.014	.000
.004	.007	.009	.013	.015	.000
.000	.007	.009	.012	.015	.000
.004	.007	.010	.011	.012	.015
.005	.007	.008	.013	.015	.000
.004	.007	.008	.010	.013	.016
.005	.007	.009	.011	.015	.019
.005	.007	.010	.014	.015	.000
.000	.007	.009	.011	.014	.018
.005	.009	.009	.012	.013	.000
.004	.007	.008	.010	.013	.016
.004	.006	.009	.010	.013	.015
.005	.008	.011	.012	.014	.000
.005	.007	.009	.013	.014	.000
.004	.007	.010	.013	.017	.000
.005	.007	.010	.013	.014	.000
.005	.007	.010	.012	.013	.000
.005	.007	.010	.012	.015	.000
.005	.000	.008	.011	.013	.000
.005	.008	.009	.013	.018	.000
.005	.007	.009	.012	.016	.018
.004	.007	.009	.012	.014	.000
.005	.007	.010	.015	.017	.000
.006	.008	.010	.013	.017	.000
.005	.007	.009	.012	.013	.000
.005	.007	.010	.013	.014	.000
.005	.007	.009	.012	.015	.017
.001	.001	.001	.001	.002	.002
.005	.007	.010	.013	.015	.018
.004	.007	.009	.012	.014	.015

Spirotheca Thickness

1	.010	.022	.030	.045	.044	.000
2	.013	.026	.030	.045	.000	.000
3	.015	.022	.037	.037	.040	.000
4	.015	.022	.037	.037	.048	.000
5	.020	.022	.029	.027	.032	.000
6	.014	.013	.021	.027	.030	.037
7	.015	.023	.028	.037	.037	.000
8	.012	.019	.020	.028	.031	.043
9	.019	.027	.031	.041	.042	.000
10	.017	.030	.037	.041	.041	.000
11	.013	.015	.024	.041	.043	.000
12	.000	.022	.037	.048	.039	.000
13	.013	.016	.022	.028	.032	.050
14	.015	.019	.028	.038	.037	.041
15	.017	.020	.027	.040	.037	.000

Septal Count

	10	11	12	15	21	26
	8	13	13	18	23	00
	10	16	20	19	25	00
	10	13	15	19	00	00
	9	14	19	19	00	00
	8	12	14	15	16	23
	8	14	16	18	20	00
	7	14	15	19	19	23
	10	14	15	20	24	00
	12	15	16	19	21	00
	8	12	12	16	20	00
	9	14	15	20	23	00
	8	11	17	18	21	24
	9	12	17	24	25	00
	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

	Spirotheca Thickness (Cont'd)						Tunnel Width				
16	.015	.023	.034	.035	.037	.040	.066	.112	.172	.370	.000
17	.018	.025	.036	.034	.055	.000	.070	.134	.167	.268	.000
18	.000	.021	.024	.035	.035	.037	.065	.104	.145	.240	.430
19	.017	.025	.037	.037	.037	.000	.056	.108	.149	.198	.280
20	.012	.022	.026	.034	.037	.044	.048	.080	.140	.220	.320
21	.011	.018	.021	.030	.044	.037	.056	.093	.172	.267	.336
22	.019	.029	.040	.032	.052	.000	.068	.104	.208	.320	.000
23	.012	.019	.028	.040	.034	.000	.062	.080	.160	.180	.000
24	.016	.024	.030	.037	.044	.000	.060	.098	.160	.264	.360
25	.013	.022	.029	.039	.037	.000	.050	.094	.140	.240	.000
26	.015	.021	.032	.055	.060	.000	.051	.102	.120	.216	.292
27	.020	.021	.031	.037	.044	.000	.046	.070	.116	.160	.280
28	.017	.022	.027	.044	.037	.000	.056	.096	.062	.222	.320
29	.016	.028	.035	.037	.052	.000	.066	.094	.195	.290	.000
30	.015	.021	.037	.041	.041	.054	.048	.094	.184	.266	.320
31	.014	.025	.035	.044	.040	.000	.070	.104	.160	.258	.424
32	.015	.028	.037	.042	.050	.000	.058	.118	.200	.260	.436
33	.017	.022	.028	.037	.037	.000	.064	.094	.112	.182	.320
34	.012	.019	.028	.034	.037	.000	.062	.110	.138	.264	.410
35	.016	.026	.034	.035	.037	.000	.062	.100	.144	.230	.000
$\bar{x}$	.015	.022	.030	.037	.041	.043	.059	.099	.152	.246	.348
s	.003	.004	.005	.006	.007	.006	.008	.014	.034	.049	.058
UCL	.016	.024	.033	.040	.044	.050	.064	.109	.174	.278	.399
LCL	.014	.020	.028	.035	.037	.035	.054	.090	.130	.214	.297

	Proloculus Diameter			Proloculus Diameter			Proloculus Diameter	
	Min.	Max.		Min.	Max.		Min.	Max.
1	.072	.079	14	.101	.119	27	.098	.107
2	.133	.153	15	.112	.131	28	.100	.120
3	.182	.190	16	.100	.100	29	.114	.114
4	.097	.112	17	.142	.160	30	.108	.108
5	.117	.122	18	.102	.123	31	.106	.134
6	.091	.115	19	.111	.118	32	.086	.104
7	.123	.140	20	.116	.128	33	.122	.127
8	.078	.097	21	.096	.100	34	.106	.118
9	.112	.125	22	.154	.156	35	.096	.100
10	.123	.131	23	.148	.156	$\bar{x}$	.112	.124
11	.096	.117	24	.112	.120	s	.022	.022
12	.109	.121	25	.144	.160	UCL	.122	.134
13	.091	.106	26	.110	.120	LCL	.101	.114

	Half Length						Chomata Height				
16	.138	.290	.548	.876	1.340	1.680	.040	.052	.080	.092	.000
17	.161	.293	.573	.940	1.600	.000	.043	.066	.093	.118	.000
18	.142	.277	.464	.808	1.220	1.780	.037	.056	.074	.096	.096
19	.119	.286	.502	.857	1.220	1.790	.034	.064	.080	.104	.096
20	.129	.254	.798	1.100	1.320	1.900	.028	.048	.056	.088	.096
21	.122	.274	.506	.795	1.220	1.690	.024	.056	.070	.067	.072
22	.184	.400	.773	1.160	1.680	.000	.044	.072	.088	.104	.000
23	.180	.371	.570	.982	1.430	.000	.038	.064	.080	.120	.000
24	.145	.303	.509	.753	1.030	1.490	.036	.064	.080	.108	.120
25	.135	.290	.525	.900	1.370	.000	.035	.048	.080	.104	.000
26	.122	.274	.506	.811	1.230	1.600	.038	.058	.072	.118	.136
27	.128	.283	.470	.696	1.020	1.650	.044	.048	.064	.116	.096
28	.171	.348	.522	.779	1.100	1.580	.044	.040	.078	.098	.112
29	.184	.347	.541	.866	1.310	.000	.035	.062	.080	.124	.000
30	.129	.291	.569	.933	1.250	.000	.035	.052	.074	.112	.116
31	.138	.322	.621	.853	1.370	.000	.029	.057	.072	.096	.110
32	.122	.296	.564	.966	1.350	.000	.030	.062	.072	.102	.000
33	.193	.367	.580	.940	1.350	.000	.048	.069	.088	.112	.000
34	.129	.302	.506	.921	1.370	1.810	.038	.048	.064	.088	.096

	Half Length (Cont'd)						Chomata Height (Cont'd)				
35	.164	.348	.586	.827	1.320	.000	.042	.048	.080	.092	.116
x̄	.147	.311	.562	.888	1.305	1.697	.037	.057	.076	.103	.105
s	.024	.039	.087	.112	.161	.124	.006	.009	.009	.014	.017
UCL	.163	.337	.618	.961	1.411	1.831	.041	.062	.082	.112	.121
LCL	.131	.285	.505	.815	1.200	1.563	.033	.051	.070	.094	.090

FUSULINA cf. F. NOVAMEXICANA Needham — Pumpkin Creek Member, Locality 22, 23

	Radius Vector						Tectum & Diaphanotheca					
1	.129	.203	.315	.473	.676	.000	.006	.008	.009	.011	.016	.000
2	.196	.286	.393	.547	.750	.976	.007	.008	.010	.012	.015	.016
3	.148	.209	.396	.448	.621	.844	.005	.008	.010	.010	.013	.017
4	.161	.264	.422	.628	.000	.000	.006	.008	.009	.011	.000	.000
5	.200	.296	.425	.621	.824	.000	.006	.009	.011	.011	.012	.017
6	.145	.235	.341	.506	.721	.966	.006	.007	.009	.012	.014	.000
7	.110	.180	.287	.425	.611	.000	.007	.009	.010	.011	.013	.000
8	.123	.257	.386	.564	.000	.000	.006	.008	.010	.011	.000	.000
9	.180	.268	.393	.528	.725	.914	.006	.008	.011	.012	.015	.017
10	.158	.254	.374	.570	.799	1.030	.006	.009	.010	.011	.013	.015
11	.200	.303	.457	.663	.000	.000	.006	.009	.011	.011	.000	.000
12	.142	.219	.345	.512	.744	.000	.005	.007	.010	.011	.013	.000
13	.138	.222	.345	.493	.699	.940	.006	.008	.009	.010	.012	.016
14	.145	.219	.338	.493	.686	.966	.006	.009	.010	.012	.013	.014
15	.161	.242	.357	.483	.679	.000	.006	.009	.010	.013	.015	.000
16	.219	.306	.451	.618	.873	.000	.006	.009	.011	.012	.016	.000
48	.190	.296	.448	.644	.917	.000	.006	.009	.011	.012	.015	.000
17	.126	.219	.312	.460	.638	.866	.006	.007	.009	.012	.014	.016
18	.128	.193	.302	.448	.644	.866	.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	.009	.011	.013	.014
31	.129	.225	.322	.483	.692	.000	.007	.009	.011	.013	.017	.016
32	.113	.177	.309	.486	.699	.000	.006	.009	.011	.013	.016	.000
33	.132	.219	.322	.489	.673	.927	.007	.010	.013	.015	.015	.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	.924	.007	.008	.010	.011	.014	.015
40	.161	.245	.357	.515	.699	.887	.007	.010	.011	.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
x̄	.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	.977	.007	.009	.011	.013	.015	.017
LCL	.137	.221	.337	.497	.688	.894	.006	.008	.010	.012	.014	.015

	Half Length					
17	.219	.393	.605	.828	1.180	1.580
18	.158	.319	.541	.766	1.010	1.430
19	.248	.441	.686	.966	1.550	1.980
20	.219	.434	.795	1.320	.000	.000
21	.235	.374	.605	.896	1.150	1.690
22	.151	.290	.586	.924	1.260	1.780
23	.206	.367	.602	1.010	1.520	2.090
24	.248	.418	.644	1.040	1.430	.000
25	.155	.287	.473	.750	1.260	.000
26	.177	.386	.654	.998	1.370	.000
27	.241	.438	.641	.940	1.260	1.690
28	.219	.386	.596	.850	1.210	.000
29	.167	.251	.421	.650	.966	1.560
30	.184	.309	.554	.940	1.280	1.830
31	.209	.361	.538	.898	1.420	1.910
32	.145	.299	.573	.966	1.550	.000
33	.187	.345	.573	.886	1.210	1.590
34	.203	.364	.538	.892	1.280	1.930
35	.193	.351	.531	.757	1.130	1.590
36	.225	.380	.596	.889	1.250	1.900
37	.193	.348	.544	.733	1.090	1.670
38	.193	.367	.544	.802	1.130	1.650
39	.203	.345	.535	.753	1.110	1.640
40	.238	.393	.631	.895	1.230	1.680
41	.218	.396	.676	.979	1.550	.000
42	.184	.364	.605	.808	1.250	.000
43	.167	.296	.544	.950	1.450	.000
44	.174	.345	.528	.782	1.170	.000
45	.167	.322	.518	.805	1.160	1.660
46	.219	.419	.670	1.040	1.530	.000
47	.193	.361	.596	.834	1.200	1.710
x̄	.198	.360	.585	.889	1.272	1.728
s	.029	.047	.071	.123	.163	.164
UCL	.212	.383	.620	.950	1.353	1.829
LCL	.184	.336	.551	.828	1.191	1.627

	Tunnel Width					
17	.060	.080	.105	.148	.194	.374
18	.053	.067	.092	.164	.215	.348
19	.060	.080	.112	.178	.310	.000
20	.069	.104	.200	.272	.000	.000
21	.052	.072	.152	.172	.344	.000
22	.052	.064	.112	.212	.336	.000
23	.062	.097	.180	.220	.444	.000
24	.058	.096	.136	.174	.280	.000
25	.060	.080	.131	.211	.000	.000
26	.062	.106	.160	.201	.270	.000
27	.064	.080	.111	.160	.252	.000
28	.069	.102	.140	.254	.360	.000
29	.050	.066	.128	.252	.290	.400
30	.062	.080	.142	.160	.320	.440
31	.056	.115	.160	.240	.300	.000
32	.059	.096	.160	.268	.000	.000
33	.058	.080	.128	.194	.266	.000
34	.052	.080	.096	.160	.284	.348
35	.056	.080	.115	.187	.198	.300
36	.072	.118	.160	.170	.320	.000
37	.061	.080	.105	.172	.320	.000
38	.054	.100	.110	.198	.266	.000
39	.060	.080	.108	.170	.264	.000
40	.062	.080	.136	.240	.280	.000
41	.068	.098	.148	.216	.000	.000
42	.061	.098	.160	.220	.348	.000
43	.058	.096	.240	.320	.000	.000
44	.072	.080	.142	.223	.000	.000
45	.072	.114	.141	.188	.276	.000
46	.063	.099	.160	.254	.000	.000
47	.066	.089	.139	.240	.299	.000
x̄	.061	.089	.139	.207	.293	.368
s	.006	.015	.032	.041	.054	.048
UCL	.064	.096	.155	.228	.325	.455
LCL	.057	.082	.123	.187	.261	.281

	Proloculus Diameter				
	Min.	Max.		Min.	Max.
1	.133	.147	26	.169	.171
2	.213	.229	27	.141	.166
3	.131	.154	28	.154	.177
4	.155	.172	29	.151	.154
5	.187	.205	30	.155	.182
6	.126	.134	31	.168	.182
7	.091	.105	32	.138	.145
8	.148	.156	33	.154	.164
9	.141	.170	34	.160	.171
10	.160	.180	35	.138	.160
11	.187	.208	36	.166	.170
12	.132	.139	37	.151	.168
13	.124	.135	38	.178	.178
14	.130	.153	39	.170	.179
15	.155	.190	40	.146	.146
16	.197	.209	41	.172	.178
48	.195	.208	42	.145	.160
17	.149	.169	43	.162	.167
18	.114	.122	44	.150	.152
19	.146	.168	45	.149	.160
20	.155	.164	46	.166	.174
21	.196	.198	47	.162	.173
22	.142	.150	x̄	.154	.168
23	.172	.206	s	.023	.024
24	.143	.160	UCL	.163	.177
25	.132	.146	LCL	.145	.158

	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	28	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
x̄	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

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	.097	.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

Chomata Height (Cont'd)

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	.165
LCL	.047	.067	.088	.101	.110	.060

FUSULINA EURYTEINES Thompson

Devils Kitchen Member, Locality 29, 30

Radius Vector

1	.145	.242	.393	.602	.847	1.110
2	.155	.251	.393	.583	.805	1.000
3	.180	.299	.415	.576	.818	1.110
4	.171	.270	.444	.692	.950	.000
5	.203	.325	.473	.673	.873	1.120
6	.155	.264	.409	.605	.831	.000
7	.200	.335	.509	.683	.914	1.180
8	.219	.303	.457	.644	.847	.000
9	.174	.280	.467	.673	.940	1.190
10	.171	.277	.454	.663	.000	.000
11	.158	.270	.451	.615	.902	.000
12	.177	.267	.405	.586	.805	.000
13	.171	.306	.480	.702	.966	1.230
14	.171	.254	.393	.560	.773	.000
15	.196	.325	.511	.728	.943	.000
16	.171	.325	.483	.689	.921	.000
17	.222	.345	.464	.625	.815	1.020
18	.177	.283	.428	.612	.815	1.060
19	.148	.248	.406	.605	.805	1.050
20	.177	.264	.390	.567	.808	1.050
21	.151	.270	.431	.644	.921	.000
22	.135	.232	.377	.551	.801	1.050
23	.138	.245	.386	.554	.766	1.050
24	.177	.274	.425	.596	.799	.000
25	.126	.209	.354	.493	.656	.895
26	.183	.283	.399	.554	.757	.966
27	.151	.280	.454	.647	.876	1.130
28	.157	.283	.464	.689	.908	.000
29	.164	.270	.406	.573	.799	1.100
30	.187	.293	.441	.676	.892	.000
31	.180	.293	.444	.663	.901	.000
32	.142	.242	.403	.589	.849	1.110
33	.171	.270	.419	.628	.886	.000
34	.167	.278	.396	.570	.801	1.080
35	.129	.242	.396	.634	.876	1.130
36	.132	.222	.345	.535	.740	.976
$\bar{x}$	.168	.276	.427	.619	.846	1.077
s	.023	.031	.040	.055	.069	.079
UCL	.178	.290	.445	.644	.877	1.124
LCL	.157	.261	.409	.594	.814	1.029

Tectum & Diaphanotheca

.006	.008	.009	.012	.010	.015
.006	.007	.010	.012	.013	.016
.007	.010	.010	.011	.015	.016
.006	.009	.009	.013	.017	.000
.007	.009	.009	.012	.013	.015
.006	.008	.010	.012	.016	.000
.006	.007	.009	.012	.013	.016
.006	.008	.010	.013	.014	.018
.006	.008	.009	.011	.013	.015
.006	.009	.012	.012	.000	.000
.006	.008	.010	.012	.013	.000
.006	.009	.011	.012	.013	.000
.007	.010	.010	.012	.016	.017
.006	.008	.010	.012	.015	.000
.007	.008	.010	.011	.013	.000
.006	.009	.011	.013	.017	.000
.006	.008	.010	.012	.015	.017
.006	.008	.010	.012	.015	.015
.006	.008	.011	.013	.013	.013
.007	.009	.012	.014	.013	.018
.006	.009	.010	.012	.013	.000
.006	.009	.012	.013	.014	.014
.006	.008	.010	.011	.014	.017
.006	.009	.012	.014	.015	.000
.006	.008	.010	.012	.014	.014
.006	.008	.012	.013	.013	.017
.007	.009	.011	.013	.015	.017
.007	.009	.010	.013	.016	.000
.007	.009	.011	.013	.015	.016
.007	.009	.011	.014	.014	.017
.008	.009	.012	.013	.015	.000
.008	.009	.012	.012	.016	.018
.006	.009	.011	.012	.016	.019
.007	.009	.012	.013	.015	.019
.006	.009	.010	.013	.016	.020
.007	.009	.013	.013	.014	.016
.006	.009	.011	.012	.014	.016
.001	.001	.001	.001	.001	.002
.007	.009	.011	.013	.015	.017
.006	.008	.010	.012	.014	.015

Half Length

17	.283	.477	.747	1.080	1.670	2.350
18	.277	.483	.815	1.180	1.680	2.300
19	.264	.444	.631	.972	1.540	2.310
20	.248	.434	.702	.982	1.410	2.100
21	.261	.534	.885	1.260	1.840	.000
22	.232	.474	.718	1.070	1.560	2.090
23	.238	.470	.815	1.110	1.720	2.350
24	.264	.547	.834	1.290	1.700	.000
25	.235	.448	.696	1.070	1.680	2.390
26	.290	.518	.776	1.130	1.540	2.330
27	.274	.441	.750	1.380	1.770	2.620
28	.254	.502	.840	1.290	1.930	.000
29	.277	.506	.741	1.110	1.550	2.160
30	.270	.541	.895	1.410	2.030	.000
31	.290	.580	.873	1.220	1.790	.000
32	.248	.464	.802	1.270	1.800	2.290
33	.277	.502	.831	1.310	1.930	.000
34	.248	.406	.592	.886	1.310	1.950
35	.180	.348	.712	1.160	1.730	2.330
36	.232	.393	.596	.824	1.320	1.930
x̄	.257	.476	.763	1.150	1.675	2.250
s	.026	.057	.090	.158	.195	.185
UCL	.273	.510	.818	1.247	1.795	2.388
LCL	.241	.441	.707	1.053	1.555	2.112

Tunnel Width

17	.080	.148	.208	.285	.480
18	.080	.108	.160	.234	.358
19	.076	.109	.166	.278	.426
20	.092	.119	.240	.297	.406
21	.080	.148	.186	.260	.000
22	.070	.104	.188	.240	.352
23	.076	.112	.192	.280	.376
24	.080	.130	.189	.288	.000
25	.061	.094	.180	.254	.380
26	.091	.160	.208	.330	.400
27	.091	.114	.160	.320	.424
28	.120	.171	.266	.480	.000
29	.080	.128	.188	.256	.418
30	.084	.116	.176	.416	.000
31	.086	.112	.176	.240	.360
32	.068	.112	.190	.309	.416
33	.072	.128	.196	.280	.388
34	.062	.112	.188	.240	.448
35	.080	.112	.153	.288	.420
36	.080	.108	.150	.196	.320
x̄	.080	.122	.188	.289	.398
s	.013	.020	.028	.064	.040
UCL	.088	.135	.205	.328	.426
LCL	.073	.110	.171	.249	.370

Proloculus Diameter

	Min.	Max.		Min.	Max.
1	.160	.169	21	.113	.142
2	.122	.149	22	.134	.146
3	.172	.199	23	.172	.174
4	.169	.187	24	.153	.196
5	.167	.200	25	.164	.166
6	.153	.156	26	.170	.196
7	.214	.219	27	.184	.204
8	.195	.221	28	.160	.174
9	.161	.174	29	.195	.200
10	.169	.174	30	.192	.208
11	.140	.156	31	.204	.220
12	.154	.166	32	.171	.180
13	.179	.210	33	.204	.218
14	.184	.199	34	.207	.230
15	.183	.201	35	.185	.210
16	.149	.181	36	.160	.160
17	.178	.227	x̄	.168	.186
18	.136	.170	s	.024	.025
19	.131	.160	UCL	.179	.197
20	.154	.154	LCL	.157	.175

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	.060	.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

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

Septal Count (Cont'd)

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	00
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

FUSULINELLA DAKOTENSIS Thompson

Bostwick Member, Locality 1, 2

	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	.459	.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
32	.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	.051	.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

Tunnel Width (Cont'd)

32	.058	.096	.126	.264	.372	.528
33	.048	.076	.128	.146	.272	.640
34	.052	.086	.096	.138	.240	.440
35	.054	.120	.120	.190	.320	.512
36	.066	.066	.114	.197	.292	.640
37	.052	.104	.176	.258	.320	.000
x̄	.057	.087	.129	.207	.363	.632
s	.006	.013	.022	.042	.088	.161
UCL	.061	.095	.142	.233	.417	.745
LCL	.054	.079	.115	.182	.309	.519

Chomata Height (Cont'd)

32	.030	.030	.044	.062	.069	.060
33	.028	.032	.048	.048	.072	.080
34	.029	.044	.044	.052	.076	.070
35	.024	.032	.040	.044	.052	.059
36	.032	.040	.040	.054	.062	.056
37	.026	.038	.041	.033	.056	.000
x̄	.029	.036	.046	.059	.063	.069
s	.004	.006	.007	.012	.012	.016
UCL	.031	.039	.051	.066	.070	.080
LCL	.026	.032	.042	.051	.051	.058

Spirotheca Thickness

1	.010	.013	.019	.023	.025	.021	.028
2	.011	.016	.017	.023	.023	.024	.020
3	.013	.013	.016	.021	.028	.026	.031
4	.010	.013	.014	.019	.025	.027	.029
5	.013	.016	.018	.025	.026	.032	.028
6	.011	.015	.018	.018	.022	.030	.025
7	.012	.015	.018	.025	.024	.028	.017
8	.011	.015	.019	.025	.025	.028	.026
9	.014	.018	.024	.028	.025	.028	.024
10	.011	.014	.017	.021	.028	.035	.037
11	.012	.016	.015	.018	.022	.025	.025
12	.012	.017	.022	.023	.023	.025	.027
13	.012	.016	.019	.024	.028	.032	.030
14	.011	.017	.020	.022	.022	.026	.026
15	.013	.012	.015	.019	.024	.023	.035
16	.014	.019	.019	.026	.032	.024	.021
17	.014	.017	.024	.028	.035	.024	.020
18	.013	.016	.015	.025	.032	.026	.032
19	.012	.013	.019	.025	.032	.029	.026
20	.014	.016	.022	.020	.021	.025	.028
21	.014	.014	.022	.022	.028	.028	.028
22	.013	.015	.023	.030	.022	.031	.031
23	.014	.015	.016	.025	.026	.032	.030
24	.016	.015	.027	.030	.023	.029	.021
25	.013	.016	.021	.024	.031	.031	.019
26	.011	.016	.017	.025	.029	.029	.015
27	.014	.018	.022	.029	.026	.033	.022
28	.013	.016	.020	.030	.037	.030	.026
29	.012	.014	.019	.023	.037	.032	.024
30	.018	.020	.024	.021	.030	.034	.020
31	.012	.015	.026	.021	.027	.028	.017
32	.012	.015	.022	.025	.025	.030	.032
33	.011	.016	.019	.030	.032	.039	.022
34	.012	.014	.017	.022	.029	.032	.034
35	.012	.012	.017	.022	.026	.028	.026
36	.011	.015	.022	.028	.026	.034	.036
37	.012	.014	.018	.029	.029	.032	.000
x̄	.013	.015	.020	.024	.027	.029	.026
s	.002	.002	.003	.004	.004	.004	.006
UCL	.013	.016	.021	.026	.029	.031	.029
LCL	.012	.015	.018	.023	.025	.027	.024

Septal Count

	12	16	18	21	25	27	30
	13	18	19	22	22	28	29
	11	15	19	21	23	23	25
	10	15	16	17	19	16	22
	11	15	17	19	22	24	27
	12	18	20	21	23	24	24
	11	18	20	23	23	25	28
	11	16	19	21	25	27	31
	9	18	19	22	26	24	24
	10	15	17	19	21	23	21
	10	18	17	20	22	24	27
	11	16	19	20	22	29	30
	11	18	22	26	24	28	30
	9	17	19	19	21	23	26
	10	17	18	20	23	25	29
x̄	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

Half Length

	.164	.320	.518	.924	1.330	1.870	2.600
	.177	.354	.564	1.020	1.530	2.200	2.860
	.109	.216	.377	.711	1.070	1.710	2.330
	.180	.363	.580	.863	1.610	2.130	2.660
	.135	.274	.457	.692	1.000	1.480	1.850
	.142	.278	.431	.589	.898	1.480	2.040
	.161	.290	.460	.692	1.050	1.530	2.130
	.126	.251	.437	.776	1.160	1.640	2.210
	.155	.293	.499	.840	1.220	1.780	2.330
	.173	.293	.531	.815	1.290	2.000	2.730
	.177	.334	.567	.933	1.350	1.950	.000
	.161	.322	.515	.750	1.170	1.930	2.580
	.142	.320	.554	.857	1.380	2.070	2.720
	.145	.258	.425	.644	1.040	1.500	2.080
	.145	.309	.467	.821	1.390	1.970	2.900
	.138	.284	.467	.750	1.150	1.570	2.240
	.145	.277	.434	.693	1.170	1.770	2.570
	.135	.283	.428	.734	1.040	1.720	2.450
	.129	.277	.441	.689	1.070	1.560	2.240
	.129	.267	.438	.715	1.100	1.660	2.230
	.164	.306	.538	.779	1.180	1.870	2.300
	.170	.328	.518	.853	1.370	1.990	.000
x̄	.150	.295	.484	.779	1.208	1.790	2.403
s	.019	.035	.057	.104	.179	.222	.289
UCL	.162	.317	.519	.843	1.318	1.927	2.592
LCL	.138	.274	.449	.715	1.097	1.653	2.213

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

FUSULINELLA VACUA, new species

Bostwick Member, Locality 1, 2

	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	.872	.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
x̄	.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

	Tunnel Width						Chomata Height					
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

1	.013	.018	.022	.030	.028	.033
2	.019	.022	.022	.025	.027	.029
3	.014	.017	.023	.023	.033	.029
4	.014	.019	.026	.031	.033	.033
5	.014	.019	.023	.031	.034	.037
6	.013	.018	.024	.037	.028	.037
7	.018	.024	.027	.030	.032	.033
8	.020	.018	.022	.031	.031	.034
9	.013	.015	.019	.024	.025	.031
10	.013	.017	.024	.025	.028	.028
11	.016	.024	.031	.032	.032	.000
12	.016	.020	.030	.032	.037	.034
13	.016	.021	.026	.026	.031	.032
14	.014	.014	.022	.031	.028	.030
15	.017	.022	.027	.031	.031	.000
16	.017	.018	.022	.037	.043	.000
17	.017	.023	.024	.023	.044	.033
18	.017	.021	.023	.025	.039	.039
19	.017	.020	.028	.025	.044	.052
20	.015	.021	.021	.024	.030	.037
21	.014	.019	.027	.032	.030	.025
22	.019	.021	.032	.032	.027	.032
23	.022	.025	.028	.031	.032	.037
24	.019	.020	.026	.030	.033	.032
25	.014	.019	.028	.031	.037	.037

Septal Count

	10	15	18	23	27	25	29
	10	17	21	24	27	29	27
	12	16	18	24	27	29	30
	10	17	20	23	28	32	00
	10	14	21	21	21	25	00
	12	17	20	24	25	29	28
	10	17	21	22	31	00	00
	11	18	21	25	24	31	00
	11	17	20	24	27	27	29
	11	17	18	20	24	27	27
	11	17	23	23	25	00	00
	11	18	22	23	24	28	24
	9	17	21	20	23	26	26
	12	18	21	23	31	31	00
	9	17	19	21	00	00	00
$\bar{x}$	11	17	20	23	26	28	28
s	001	001	001	002	003	002	002
UCL	11	18	21	24	28	30	30
LCL	10	16	19	21	24	26	25

Half Length

.206	.380	.621	.972	1.390	.000	.000
.193	.396	.663	1.070	1.480	2.070	.000
.161	.320	.573	.859	1.410	1.930	.000
.148	.303	.502	.811	1.160	1.660	2.180
.203	.335	.557	.847	1.190	1.550	2.130
.187	.370	.621	1.090	1.710	2.380	.000
.228	.463	.718	1.090	1.530	2.230	2.830
.219	.370	.686	1.130	1.730	2.500	.000
.209	.367	.628	1.070	1.530	2.280	.000
.229	.444	.667	1.180	1.920	2.620	.000

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

FUSULINA MUTABILIS, new species

90' below "Type" Lester Member, Locality 7

	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

Radius Vector (Cont'd)

22	.090	.152	.218	.336	.494	.650
23	.094	.162	.245	.386	.546	.000
24	.096	.164	.240	.347	.490	.656
25	.096	.173	.232	.338	.544	.750
26	.090	.156	.248	.396	.566	.748
27	.074	.128	.209	.309	.485	.692
28	.080	.132	.202	.322	.472	.656
29	.090	.015	.243	.380	.531	.693
30	.078	.132	.211	.355	.524	.688
x̄	.092	.152	.230	.353	.518	.687
s	.010	.016	.020	.034	.041	.034
UCL	.097	.160	.240	.370	.538	.707
LCL	.087	.144	.220	.336	.497	.667

Tectum & Diaphanotheca (Cont'd)

22	.005	.007	.009	.012	.014	.017
23	.006	.007	.009	.011	.015	.000
24	.006	.008	.009	.012	.013	.015
25	.005	.007	.011	.013	.015	.016
26	.006	.007	.009	.011	.014	.016
27	.005	.008	.010	.010	.011	.014
28	.006	.007	.009	.010	.013	.016
29	.005	.007	.009	.013	.013	.015
30	.005	.007	.011	.013	.013	.014
x̄	.005	.007	.009	.011	.013	.015
s	.001	.001	.001	.001	.001	.001
UCL	.005	.007	.010	.012	.014	.016
LCL	.004	.006	.008	.011	.012	.014

Tunnel Width

11	.046	.080	.106	.123	.196	.366
12	.060	.089	.141	.220	.372	.560
13	.052	.080	.136	.206	.320	.000
14	.046	.070	.096	.184	.258	.480
15	.048	.066	.106	.213	.400	.000
16	.046	.080	.126	.211	.302	.000
17	.064	.080	.112	.208	.288	.400
18	.060	.064	.128	.146	.240	.000
19	.062	.096	.108	.240	.320	.000
20	.051	.080	.112	.248	.344	.000
21	.060	.086	.143	.216	.320	.000
22	.052	.070	.116	.160	.320	.000
23	.048	.092	.168	.360	.000	.000
24	.055	.094	.120	.200	.240	.000
25	.058	.080	.096	.173	.278	.640
26	.049	.080	.133	.222	.320	.000
27	.051	.073	.120	.176	.250	.000
28	.046	.064	.097	.180	.256	.352
29	.052	.096	.136	.251	.320	.000
30	.056	.064	.112	.144	.296	.384
x̄	.053	.079	.121	.202	.297	.455
s	.006	.011	.018	.052	.050	.110
UCL	.057	.086	.132	.234	.328	.575
LCL	.049	.073	.109	.170	.266	.334

Chomata Height

11	.046	.054	.088	.098	.088	.000
12	.034	.039	.062	.086	.090	.077
13	.030	.038	.072	.080	.064	.000
14	.030	.053	.066	.108	.080	.000
15	.030	.046	.072	.100	.100	.000
16	.038	.042	.067	.065	.074	.000
17	.030	.035	.052	.096	.096	.104
18	.032	.036	.056	.068	.080	.000
19	.026	.042	.064	.088	.080	.000
20	.034	.052	.080	.104	.000	.000
21	.034	.038	.072	.092	.070	.000
22	.041	.040	.061	.090	.094	.088
23	.030	.058	.065	.080	.000	.000
24	.034	.049	.066	.085	.093	.000
25	.038	.038	.064	.080	.108	.092
26	.034	.054	.066	.120	.120	.000
27	.030	.040	.062	.078	.120	.000
28	.027	.044	.068	.086	.096	.080
29	.030	.048	.066	.080	.072	.000
30	.033	.044	.068	.080	.086	.088
x̄	.033	.045	.067	.088	.089	.088
s	.005	.007	.008	.013	.016	.010
UCL	.036	.049	.072	.096	.100	.100
LCL	.030	.040	.062	.080	.079	.077

Spirotheca Thickness

1	.012	.016	.023	.031	.031	.000
2	.013	.021	.029	.030	.029	.037
3	.020	.026	.029	.034	.037	.037
4	.020	.022	.030	.044	.042	.042
5	.018	.025	.032	.037	.035	.000
6	.018	.023	.031	.037	.037	.000
7	.020	.025	.030	.034	.000	.000
8	.016	.023	.028	.044	.042	.037
9	.024	.022	.031	.038	.044	.000

Septal Count

	9	14	15	19	26	27
	9	13	14	17	20	24
	8	11	14	17	19	26
	8	12	14	15	17	22
	9	13	17	19	23	00
	9	12	14	15	20	00
	9	12	15	16	21	00
	9	11	17	16	21	24
x̄	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

11	.019	.021	.032	.032	.037	.028
12	.020	.022	.027	.037	.044	.041
13	.017	.024	.025	.026	.034	.000
14	.018	.022	.027	.034	.044	.044

Half Length

.122	.280	.470	.712	.985	1.590
.158	.303	.518	.824	1.290	1.890
.138	.332	.538	.831	1.310	.000
.145	.267	.477	.753	1.160	1.650

	Spirotheca Thickness (Cont'd)						Half Length (Cont'd)					
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
x̄	.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			Proloculus Diameter			Proloculus Diameter	
	Min.	Max.		Min.	Max.		Min.	Max.
1	.088	.098	13	.080	.098	24	.106	.106
2	.063	.075	14	.098	.110	25	.120	.122
3	.076	.087	15	.088	.103	26	.094	.097
4	.083	.094	16	.080	.096	27	.086	.086
5	.100	.102	17	.106	.110	28	.069	.080
6	.085	.098	18	.080	.090	29	.108	.116
7	.087	.098	19	.108	.117	30	.080	.096
8	.066	.082	20	.090	.100	x̄	.092	.102
9	.096	.119	21	.102	.114	s	.015	.013
11	.106	.120	22	.078	.090	UCL	.099	.108
12	.116	.116	23	.118	.126	LCL	.084	.095

FUSULINA MUTABILIS, new species "oolitic" Lester Member, Locality 9, 10

	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	.014	.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

Radius Vector (Cont'd)

29	.108	.168	.264	.390	.555	.766
30	.088	.146	.226	.350	.516	.702
31	.113	.172	.246	.364	.533	.708
32	.080	.124	.207	.350	.475	.622
33	.085	.140	.214	.326	.490	.000
34	.114	.169	.240	.362	.530	.695
35	.101	.160	.240	.358	.510	.728
$\bar{x}$	.097	.157	.246	.374	.533	.704
s	.011	.017	.026	.042	.051	.038
UCL	.103	.165	.259	.396	.559	.730
LCL	.092	.148	.232	.353	.506	.679

Tectum & Diaphanotheca (Cont'd)

.005	.007	.012	.012	.017	.000
.005	.007	.010	.012	.013	.019
.005	.007	.010	.015	.015	.000
.004	.007	.009	.012	.014	.017
.006	.008	.009	.013	.014	.000
.005	.007	.009	.013	.012	.018
.005	.007	.011	.012	.014	.017
.005	.007	.009	.012	.015	.017
.001	.001	.001	.001	.002	.002
.005	.007	.010	.013	.016	.018
.004	.006	.009	.012	.014	.016

Tunnel Width

16	.042	.066	.146	.160	.262
17	.045	.080	.104	.149	.280
19	.080	.100	.204	.400	.640
20	.069	.104	.172	.304	.456
21	.060	.072	.112	.184	.320
22	.048	.070	.100	.160	.266
24	.060	.085	.160	.236	.400
25	.052	.068	.165	.240	.400
28	.058	.080	.168	.308	.000
29	.054	.092	.160	.216	.320
30	.061	.092	.138	.188	.320
31	.055	.080	.124	.160	.320
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

Chomata Height

.024	.045	.074	.096	.000
.038	.048	.062	.080	.088
.030	.048	.096	.088	.116
.034	.049	.076	.084	.108
.029	.048	.062	.088	.074
.030	.048	.052	.100	.100
.030	.051	.068	.104	.104
.028	.052	.061	.070	.080
.038	.046	.080	.096	.077
.036	.054	.064	.100	.108
.032	.060	.067	.088	.096
.030	.052	.063	.088	.088
.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

Spirotheca Thickness

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
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

Septal Count

	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

Half Length

.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

	Spirotheca Thickness (Cont'd)					
22	.015	.022	.019	.026	.041	.044
24	.017	.020	.026	.030	.037	.000
25	.018	.023	.027	.041	.045	.045
28	.018	.024	.026	.037	.035	.000
29	.019	.022	.034	.034	.037	.000
30	.019	.023	.034	.037	.037	.050
31	.019	.022	.032	.039	.037	.000
32	.014	.021	.025	.032	.036	.045
33	.018	.025	.028	.037	.045	.000
34	.016	.021	.031	.035	.042	.046
35	.018	.024	.033	.034	.037	.040
x̄	.017	.021	.028	.035	.038	.039
s	.002	.003	.005	.006	.005	.008
UCL	.018	.023	.031	.038	.040	.045
LCL	.016	.019	.026	.032	.035	.033

	Half Length (Cont'd)					
22	.151	.290	.483	.741	1.160	1.720
24	.122	.225	.428	.766	1.210	.000
25	.120	.280	.522	.782	1.200	1.770
28	.180	.383	.677	.956	1.610	.000
29	.161	.300	.589	.892	1.290	.000
30	.132	.280	.486	.750	1.240	.000
31	.161	.312	.493	.809	1.400	.000
32	.106	.235	.431	.821	1.210	1.810
33	.119	.300	.435	.676	1.110	.000
34	.148	.296	.464	.805	1.250	1.900
35	.138	.274	.460	.786	1.560	2.090
x̄	.136	.287	.495	.820	1.304	1.777
s	.021	.041	.067	.101	.185	.179
UCL	.150	.315	.541	.890	1.432	2.437
LCL	.121	.258	.449	.750	1.175	1.603

	Proloculus Diameter			Proloculus Diameter			Proloculus Diameter	
	Min.	Max.		Min.	Max.		Min.	Max.
1	.101	.117	13	.091	.101	29	.100	.109
2	.085	.100	14	.070	.086	30	.101	.114
3	.089	.105	16	.094	.106	31	.106	.120
4	.082	.092	17	.080	.098	32	.101	.107
6	.089	.097	19	.096	.112	33	.100	.106
7	.104	.116	20	.106	.106	34	.096	.100
8	.091	.124	21	.102	.102	35	.108	.117
9	.086	.095	22	.118	.126	x̄	.095	.107
10	.078	.087	24	.088	.111	s	.011	.011
11	.094	.105	25	.080	.094	UCL	.101	.113
12	.111	.122	28	.110	.128	LCL	.089	.101

FUSULINA PUMILA Thompson — lower Frensley Member, Locality 12, 13

	Radius Vector						Tectum & Diaphanotheca					
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

	Radius Vector (Cont'd)						Tectum & Diaphanotheca (Cont'd)					
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
$\bar{x}$	.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	.173	.256	.268	.022	.034	.051	.074	.096	.096
33	.029	.056	.071	.110	.160	.200	.016	.036	.054	.080	.112	.080
34	.032	.054	.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						Septal Count					
1	.009	.012	.014	.017	.024	.028	8	13	16	20	20	25
2	.012	.019	.019	.034	.034	.030	11	17	21	23	26	27
3	.010	.019	.027	.032	.037	.032	8	12	12	14	17	22
4	.009	.012	.018	.020	.023	.029	9	16	16	20	22	28
5	.013	.016	.022	.028	.029	.033	9	15	20	18	23	32
6	.015	.020	.027	.027	.027	.038	9	13	15	20	24	29

Spirotheca Thickness (Cont'd)

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	.031
13	.010	.014	.018	.026	.031	.031

Septal Count (Cont'd)

	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
s	01	02	03	03	03	03
UCL	10	16	19	22	25	29
LCL	8	12	14	17	20	23

Spirotheca Thickness (Cont'd)

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
30	.011	.021	.020	.031	.038	.029
31	.011	.012	.018	.022	.023	.018
32	.014	.014	.023	.026	.037	.041
33	.009	.016	.024	.025	.036	.038
34	.010	.011	.013	.022	.026	.031
35	.012	.020	.021	.027	.031	.034
36	.009	.014	.022	.025	.032	.039
37	.010	.012	.013	.018	.030	.027
38	.013	.020	.021	.025	.036	.041
39	.011	.015	.023	.032	.032	.034
40	.012	.014	.018	.023	.032	.032
41	.010	.011	.022	.024	.029	.034
$\bar{x}$	.011	.015	.020	.027	.030	.032
s	.002	.003	.004	.005	.004	.006
UCL	.012	.017	.022	.029	.032	.035
LCL	.010	.014	.019	.024	.029	.029

Half Length

.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
.084	.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	1.590
.058	.122	.238	.419	.663	.949	1.470
.077	.177	.315	.557	.857	1.290	1.860
.071	.154	.290	.451	.683	1.010	1.470
.087	.167	.322	.586	.882	1.420	.000
.064	.138	.270	.419	.747	1.160	1.620
.064	.138	.261	.435	.712	.978	1.530
.071	.173	.320	.551	.801	1.150	1.700
.068	.154	.306	.499	.828	1.580	.000
.061	.151	.290	.467	.757	1.170	.000
.090	.171	.274	.455	.712	1.060	.000
.074	.187	.325	.602	.949	1.320	.000
.070	.158	.264	.412	.634	1.070	.000
.081	.155	.290	.483	.750	1.100	.000
.075	.168	.302	.507	.807	1.221	1.587
.010	.024	.035	.082	.110	.204	.181
.081	.180	.320	.549	.863	1.328	1.741
.070	.156	.283	.465	.750	1.113	1.434

	Proloculus Diameter			Proloculus Diameter			Proloculus Diameter	
	Min.	Max.		Min.	Max.		Min.	Max.
1	.056	.062	16	.066	.066	31	.072	.072
2	.072	.082	17	.064	.070	32	.082	.088
3	.052	.056	18	.064	.080	33	.064	.064
4	.066	.076	19	.048	.064	34	.062	.067
5	.069	.080	20	.086	.088	35	.064	.066
6	.071	.080	21	.068	.072	36	.052	.054
7	.078	.099	22	.075	.096	37	.046	.050
8	.057	.067	23	.062	.074	38	.066	.067
9	.070	.074	24	.056	.078	39	.072	.072
10	.054	.065	25	.064	.080	40	.062	.073
11	.054	.056	26	.062	.062	41	.061	.070
12	.058	.075	27	.069	.074	$\bar{x}$	.063	.071
13	.065	.068	28	.064	.068	s	.009	.011
14	.070	.082	29	.048	.055	UCL	.067	.076
15	.058	.062	30	.052	.062	LCL	.060	.067

FUSULINA PLATTENSIS Thompson — upper Frensley Member, Locality 16

	Radius Vector						Tectum & Diaphanotheca					
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	.011	.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	.045	.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						Septal Count					
1	.011	.013	.024	.029	.029	.037	9	13	16	19	19	23
2	.009	.016	.025	.031	.032	.000	10	16	18	21	28	00
3	.006	.012	.018	.026	.026	.000	7	14	16	17	20	25
4	.012	.014	.022	.000	.022	.000	10	13	19	00	27	00
5	.010	.015	.012	.019	.019	.025	8	13	17	20	24	25
6	.009	.014	.026	.037	.043	.037	10	14	17	18	21	00
7	.014	.016	.021	.022	.024	.000	9	18	21	21	25	00
8	.009	.017	.022	.021	.027	.000	8	12	14	17	23	00
9	.009	.016	.022	.030	.034	.000	8	15	16	19	20	00
10	.010	.015	.020	.017	.020	.000	8	14	15	19	20	25
x̄							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

							Half Length					
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
x̄	.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			Proloculus Diameter			Proloculus Diameter	
	Min.	Max.		Min.	Max.		Min.	Max.
1	.058	.072	13	.114	.116	24	.078	.080
2	.090	.103	14	.080	.080	25	.096	.106
3	.053	.061	15	.074	.080	26	.089	.098
4	.078	.089	16	.074	.085	27	.085	.088
5	.065	.075	17	.080	.100	28	.091	.103
6	.075	.097	18	.080	.096	29	.106	.110
7	.082	.097	19	.078	.078	30	.073	.074
8	.067	.080	20	.064	.076	31	.065	.067
9	.052	.062	21	.082	.082	x̄	.078	.087
10	.065	.080	22	.098	.098	s	.014	.014
12	.066	.080	23	.089	.098	UCL	.085	.095
						LCL	.071	.080

FUSULINA ERUGATA, new species — Arnold Member, Locality 34, 35

	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	.432
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

	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

	Radius Vector (Cont'd)						Tectum & Diaphanotheca (Cont'd)					
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						Proloculus Diameter Min.	Max.
1	9	11	15	19	26	00	.085	.105
2	10	14	15	16	19	16	.077	.087
3	8	12	16	16	18	00	.096	.115
4	10	14	15	19	23	23	.098	.116
5	9	13	15	17	24	00	.079	.091
6	9	13	17	18	18	00	.101	.111
7	10	15	19	20	20	00	.088	.098
8	9	13	13	15	19	00	.093	.113
9	8	13	16	21	24	29	.083	.095
10	8	12	15	17	21	00	.065	.086
11	10	13	14	17	16	23	.085	.098
12	9	12	16	19	18	00	.079	.096
13	9	15	15	16	20	00	.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

	Chomata Height (Cont'd)					Proloculus Diameter (Cont'd) Min.	Max.
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
x̄	.022	.038	.060	.080	.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, Locality 34, 35

	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

	Radius Vector (Cont'd)					
29	.142	.200	.296	.409	.592	.824
30	.113	.177	.280	.441	.618	.844
31	.119	.187	.277	.419	.602	.824
32	.119	.193	.287	.406	.570	.750
33	.129	.200	.296	.405	.609	.799
34	.087	.155	.242	.361	.515	.721
35	.122	.193	.306	.441	.631	.834
36	.129	.209	.303	.425	.596	.821
37	.145	.222	.320	.493	.696	.911
38	.103	.164	.289	.399	.576	.821
$\bar{x}$	.118	.184	.280	.411	.588	.802
s	.016	.024	.032	.047	.065	.081
UCL	.125	.195	.294	.431	.617	.838
LCL	.111	.174	.265	.390	.560	.766

	Tectum & Diaphanotheca (Cont'd)					
29	.007	.009	.012	.013	.016	.019
30	.008	.008	.010	.011	.012	.014
31	.006	.008	.009	.010	.011	.014
32	.007	.007	.012	.016	.015	.018
33	.007	.009	.011	.014	.014	.018
34	.006	.009	.010	.011	.014	.015
35	.007	.009	.011	.013	.016	.000
36	.006	.009	.011	.012	.014	.018
37	.007	.009	.012	.013	.016	.016
38	.006	.009	.011	.013	.014	.017
$\bar{x}$	.006	.009	.011	.013	.014	.017
s	.001	.001	.001	.001	.002	.002
UCL	.007	.009	.011	.013	.015	.018
LCL	.006	.008	.010	.012	.014	.016

	Tunnel Width					
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
22	.046	.085	.118	.160	.222	.246
23	.057	.083	.087	.172	.256	.480
24	.056	.080	.120	.240	.280	.440
25	.060	.080	.112	.155	.275	.356
26	.065	.080	.112	.200	.240	.280
27	.058	.070	.109	.160	.240	.000
28	.040	.070	.100	.164	.192	.274
29	.062	.080	.130	.175	.293	.368
30	.060	.098	.124	.254	.000	.600
31	.064	.080	.134	.202	.303	.440
32	.048	.080	.118	.190	.240	.352
33	.062	.090	.134	.256	.320	.600
34	.048	.080	.098	.144	.320	.334
35	.053	.084	.116	.164	.270	.338
36	.053	.090	.126	.190	.340	.452
37	.045	.089	.120	.230	.280	.416
38	.062	.076	.116	.220	.354	.480
$\bar{x}$	.054	.081	.118	.187	.279	.402
s	.008	.007	.012	.033	.043	.090
UCL	.058	.085	.124	.205	.303	.452
LCL	.050	.077	.111	.169	.255	.352

	Half Length						
14	.181	.338	.467	.692	1.070	1.460	2.000
15	.183	.309	.473	.759	1.130	1.630	2.170
16	.145	.283	.454	.696	1.040	1.540	2.400
17	.190	.312	.564	.998	1.440	2.020	2.790
18	.206	.338	.579	.886	1.310	1.980	2.760
19	.164	.316	.605	.837	1.150	1.770	.000
20	.132	.229	.435	.673	1.110	1.620	2.370
21	.190	.325	.470	.821	1.260	1.820	2.450
22	.158	.300	.496	.789	1.150	1.590	2.180
23	.158	.312	.515	.734	1.150	1.660	2.190
24	.161	.296	.467	.686	1.150	1.550	2.080
25	.174	.306	.540	.831	1.290	2.090	.000
26	.231	.405	.621	.979	1.440	1.930	2.580
27	.187	.287	.457	.776	1.160	1.630	.000
28	.177	.296	.470	.753	1.140	1.610	2.000
29	.183	.367	.570	.847	1.340	1.830	.000
30	.190	.354	.570	.914	1.490	2.150	.000
31	.174	.312	.493	.766	1.250	1.830	.000
32	.164	.338	.528	.805	1.160	1.590	2.120
33	.184	.341	.567	.940	1.370	1.990	.000
34	.132	.293	.506	.757	1.050	1.400	2.070
35	.161	.303	.531	.917	1.290	1.700	2.670
36	.177	.364	.592	.924	1.290	1.790	2.530
37	.155	.300	.531	.866	1.270	1.850	2.450
38	.142	.290	.547	.802	1.350	1.980	2.670
$\bar{x}$	.172	.317	.522	.818	1.234	1.760	2.360
s	.023	.035	.052	.092	.126	.203	.267
UCL	.184	.336	.551	.869	1.303	1.872	2.533
LCL	.160	.298	.493	.767	1.165	1.649	2.187

	Septal Count					
1	11	17	22	24	27	29
2	12	18	21	26	30	29
3	12	19	24	27	29	30
4	13	17	19	24	28	32
5	10	16	23	26	30	36
6	11	16	17	19	23	27
7	10	18	18	23	23	28
8	9	17	19	25	28	26
9	11	16	21	25	31	32
10	11	15	18	22	25	27
11	11	18	20	24	29	33
12	12	18	22	22	26	31
13	11	18	21	26	26	31

	Proloculus Diameter	
	Min.	Max.
1	.112	.120
2	.149	.187
3	.155	.178
4	.120	.140
5	.112	.116
6	.110	.116
7	.112	.134
8	.098	.102
9	.119	.137
10	.104	.112
11	.134	.149
12	.108	.118
13	.124	.145

	Septal Count (Cont'd)					
x̄	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						Proloculus Diameter (Cont'd) Min.	Max.
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
x̄	.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

Limestone between Rocky Point Member and Camp Ground Member, Locality 38, 39

	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

	Half Length (Cont'd)							Tunnel Width (Cont'd)					
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	.782	.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						Proloculus Diameter Min.	Proloculus Diameter Max.
1	11	18	22	24	30	29	.123	.131
2	9	18	23	25	29	34	.119	.140
3	10	20	22	25	28	30	.126	.155
4	14	20	26	29	33	00	.149	.193
5	10	16	18	25	29	31	.106	.117
6a	10	22	22	28	29	30	.165	.173
6b	10	17	22	23	25	00	.112	.125
7	11	18	21	21	30	32	.100	.123
8	9	17	21	25	00	34	.098	.112
9	13	21	19	22	30	00	.120	.135
10	9	17	21	24	27	00	.135	.142
11	12	18	23	23	26	31	.151	.166
12	11	20	20	25	30	31	.153	.156
13	11	18	21	25	30	33	.134	.147
14	12	14	17	21	27	00	.121	.146
15	10	18	18	24	29	32	.120	.129
x̄	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		

	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
x̄	.040	.058	.086	.106	.114	.116	.133	.148
s	.010	.011	.016	.018	.024	.024	.018	.018
UCL	.046	.064	.096	.116	.128	.134	.140	.156
LCL	.034	.051	.077	.095	.100	.098	.125	.140

FUSULINA ACME Dunbar and Henbest

Camp Ground Member, Locality 40, 41

	Half Length							Tunnel Width					
17	.231	.457	.844	1.340	2.170	3.130	.000	.070	.106	.206	.400	.680	1.040
18	.231	.435	.689	1.180	1.780	2.490	3.250	.068	.094	.134	.240	.340	.604
19	.200	.357	.644	1.230	1.770	2.610	3.360	.053	.088	.134	.240	.344	.800
20	.231	.470	.876	1.350	2.140	3.220	.000	.068	.124	.186	.360	.620	.000
21	.167	.348	.644	1.010	1.510	2.230	2.980	.062	.091	.110	.218	.336	.540

	Half Length (Cont'd)							Tunnel Width (Cont'd)					
22	.251	.486	.723	1.060	1.880	2.560	3.220	.067	.116	.160	.234	.361	.736
23	.170	.367	.560	.867	1.520	2.240	.000	.058	.100	.130	.196	.268	.520
24	.258	.470	.879	1.260	2.090	2.780	.000	.062	.086	.165	.270	.000	.000
25	.216	.428	.708	1.090	1.590	2.390	3.140	.064	.094	.110	.240	.328	.500
26	.219	.399	.676	.998	1.880	2.050	.000	.060	.086	.160	.230	.352	.450
27	.235	.431	.805	1.350	1.930	2.530	.000	.080	.144	.192	.384	.680	.000
28	.190	.345	.605	1.020	1.590	2.250	3.020	.064	.096	.136	.170	.275	.560
29	.187	.345	.644	1.020	1.550	2.260	.000	.062	.092	.144	.204	.374	.560
30	.161	.325	.551	.943	1.420	1.970	2.640	.058	.080	.136	.148	.250	.424
31	.193	.361	.609	1.150	1.760	2.500	3.170	.056	.068	.148	.218	.400	.720
32	.203	.444	.773	1.060	1.570	2.150	3.040	.070	.092	.147	.246	.388	.620
33	.206	.412	.773	1.210	1.810	2.470	3.320	.068	.096	.160	.216	.400	.560
34	.296	.547	.934	1.410	2.090	2.990	.000	.066	.103	.183	.270	.440	.000
35	.241	.413	.644	1.050	1.680	2.390	.000	.060	.102	.171	.262	.444	.000
36	.248	.419	.741	1.160	1.610	2.300	3.320	.064	.088	.142	.278	.440	.742
37	.213	.348	.734	1.030	1.550	2.230	2.900	.070	.080	.107	.178	.320	.574
38	.203	.415	.683	1.050	1.450	1.840	.000	.067	.090	.176	.302	.380	.800
39	.209	.409	.705	1.050	1.630	2.230	3.030	.070	.104	.131	.220	.320	.454
40	.248	.547	1.060	1.610	2.100	.000	.000	.070	.132	.228	.380	.000	.000
41	.248	.438	.702	1.160	1.780	2.380	3.150	.056	.090	.160	.222	.274	.480
42	.264	.460	.847	1.440	2.080	.000	.000	.070	.132	.186	.280	.000	.000
43	.229	.412	.718	1.280	1.890	2.760	3.400	.068	.080	.188	.280	.480	.600
44	.219	.423	.750	1.100	1.580	2.220	.000	.064	.080	.120	.188	.360	.600
45	.232	.370	.628	1.050	1.660	2.280	3.040	.060	.088	.154	.236	.400	.000
46	.232	.399	.824	1.220	1.960	2.840	.000	.080	.114	.193	.300	.520	.000
$\bar{x}$	.221	.416	.732	1.159	1.767	2.439	3.124	.065	.098	.157	.254	.399	.614
s	.030	.056	.114	.165	.224	.332	.196	.006	.018	.030	.062	.114	.148
UCL	.236	.444	.789	1.241	1.879	2.611	3.259	.068	.107	.171	.287	.459	.702
LCL	.206	.388	.675	1.076	1.655	2.267	2.988	.062	.089	.142	.221	.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	.012	.013	.020	.022	.024
25	.138	.222	.322	.473	.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	.950	.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

	Radius Vector (Cont'd)					
42	.154	.267	.415	.586	.828	.000
43	.132	.200	.316	.477	.712	.937
44	.132	.200	.290	.419	.576	.773
45	.135	.219	.322	.487	.683	.911
46	.180	.258	.367	.528	.715	.918
$\bar{x}$	.143	.218	.323	.469	.656	.865
s	.030	.041	.052	.067	.082	.087
UCL	.156	.237	.347	.500	.693	.906
LCL	.129	.200	.300	.439	.619	.825

	Tectum & Diaphanotheca (Cont'd)					
42	.008	.012	.014	.019	.021	.000
43	.009	.010	.014	.017	.018	.022
44	.010	.010	.011	.016	.016	.020
45	.008	.012	.014	.016	.020	.022
46	.010	.013	.016	.016	.022	.028
$\bar{x}$	.009	.011	.014	.016	.020	.024
s	.001	.001	.001	.002	.002	.002
UCL	.009	.012	.014	.017	.021	.025
LCL	.008	.011	.013	.016	.019	.023

	Septal Count					
1	12	20	25	22	30	37
2	16	20	22	27	28	30
3	13	19	22	26	27	34
4	12	18	23	26	30	36
5	9	16	18	23	28	28
6	9	17	22	21	28	27
$\bar{x}$	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

	Chomata Height					
17	.044	.054	.080	.099	.116	.109
18	.035	.068	.124	.118	.140	.121
19	.034	.061	.076	.120	.146	.100
20	.048	.080	.117	.100	.000	.000
21	.029	.051	.070	.073	.080	.067
22	.044	.054	.088	.088	.128	.072
23	.039	.069	.071	.071	.128	.130
24	.038	.062	.094	.120	.128	.000
25	.038	.051	.088	.064	.072	.128
26	.146	.072	.113	.140	.160	.126
27	.038	.066	.108	.090	.064	.000
28	.038	.064	.090	.120	.116	.134
29	.027	.048	.078	.102	.080	.066
30	.030	.052	.060	.096	.096	.120
31	.028	.042	.056	.072	.072	.112
32	.026	.044	.080	.088	.062	.124
33	.045	.054	.066	.088	.120	.000
34	.048	.067	.080	.120	.140	.000
35	.040	.050	.076	.106	.112	.000
36	.041	.070	.092	.112	.121	.104
37	.024	.045	.072	.090	.115	.160
38	.030	.050	.098	.094	.090	.000
39	.040	.052	.062	.096	.100	.100
40	.048	.052	.068	.066	.000	.000
41	.045	.067	.100	.094	.112	.109
42	.054	.056	.120	.160	.000	.000
43	.045	.060	.080	.112	.123	.132
44	.040	.058	.091	.098	.102	.128
45	.042	.056	.060	.120	.120	.000
46	.030	.037	.054	.068	.100	.110
$\bar{x}$	.038	.057	.084	.100	.109	.113
s	.008	.010	.019	.023	.026	.024
UCL	.042	.062	.094	.111	.123	.128
LCL	.035	.052	.074	.088	.095	.097

	Proloculus Diameter	
	Min.	Max.
1	.193	.203
2	.209	.216
3	.210	.231
4	.169	.193
5	.121	.128
6	.145	.161
17	.170	.201
18	.194	.199
19	.104	.154
20	.160	.170
21	.140	.147
22	.178	.198
23	.136	.165
24	.147	.182
25	.185	.190
26	.182	.200
27	.240	.240
28	.140	.141
29	.121	.134
30	.120	.130
31	.132	.140
32	.144	.148
33	.160	.160
34	.148	.164
35	.152	.171
36	.134	.144
37	.151	.151
38	.166	.170
39	.154	.160
40	.198	.206
41	.236	.240
42	.210	.228
43	.160	.176
44	.160	.173
45	.192	.204
46	.148	.209
$\bar{x}$	.164	.179
s	.033	.032
UCL	.179	.193
LCL	.149	.164

WEDEKINDELLINA? ARDMORENSIS
Thompson, Verville, and Lokke

Confederate Member, Locality 42, 43

	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	.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

	Radius Vector (Cont'd)							Tectum & Diaphanotheca (Cont'd)						
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	.000
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							Proloculus Diameter
1	8	12	16	16	18	20	18	.069
2	9	12	16	14	15	18	20	.076
3	8	13	14	17	19	20	24	.066
4	8	12	14	15	19	21	22	.059
5	10	13	15	16	15	18	18	.087
6	9	14	15	16	18	20	00	.072
7	8	13	16	16	20	22	19	.083
8	8	13	16	19	21	21	20	.080
9	8	14	16	16	18	20	20	.094
10	8	13	15	17	20	21	20	.081
11	8	12	13	13	19	21	20	.067
12	7	13	16	16	18	19	18	.087
13	9	14	16	16	17	18	18	.088
14	8	14	15	16	20	20	00	.082
15	8	12	16	17	20	20	20	.082
16	9	12	15	17	17	21	20	.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

	Chomata Height (Cont'd)						Proloculus Diameter (Cont'd)
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, Locality 45

	Radius Vector						Tectum & Keriotheca					
1	.077	.121	.174	.246	.345	.454	.007	.009	.010	.012	.015	.017
2	.078	.124	.199	.287	.400	.000	.007	.009	.011	.014	.020	.022
3	.096	.157	.240	.350	.000	.000	.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							Proloculus Diameter Min.	Proloculus Diameter Max.
1	9	13	16	19	21	23	29	.072	.079
2	9	15	16	18	20	26	00	.075	.086
4	8	11	14	15	18	20	26	.098	.100
5	9	13	16	18	19	23	00	.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
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, Locality 46, 48

	Half Length						Tunnel Width				
19	.189	.379	.631	1.180	2.120	.000	.051	.100	.205	.596	.000
20	.160	.389	.772	1.410	2.040	.000	.083	.144	.272	.599	.000
21	.199	.399	.876	1.400	2.330	3.650	.072	.112	.275	.494	.972
22	.206	.389	.732	1.190	2.270	2.850	.067	.104	.255	.529	.000
24	.206	.491	.883	1.440	2.260	.000	.082	.173	.390	.000	.000
25	.196	.389	.680	1.230	2.030	.000	.059	.143	.298	.658	.000
26	.199	.386	.755	1.410	2.420	.000	.056	.125	.281	.544	.000
27	.154	.307	.638	1.080	1.960	2.550	.060	.132	.275	.429	.860
28	.206	.383	.811	1.570	2.500	3.340	.069	.143	.319	.780	.000
29	.150	.294	.464	.925	1.690	2.490	.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

	Half Length (Cont'd)						Tunnel Width (Cont'd)				
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
x̄	.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						Proloculus Diameter
1	11	15	15	18	28	25	.154
2	10	14	17	21	21	24	.143
3	9	13	16	22	23	22	.109
4	9	13	14	18	19	22	.128
5	10	15	15	18	23	25	.151
6	9	13	18	23	26	26	.132
7	10	16	18	20	23	20	.148
8	11	17	19	18	22	23	.178
9	8	15	18	18	19	22	.141
10	10	15	18	20	20	20	.136
11	10	14	17	20	19	19	.163
12	9	13	14	17	17	20	.119
13	9	13	15	17	22	22	.116
14	11	14	16	19	19	00	.125
15	9	15	17	20	22	00	.154
16	10	14	17	18	20	22	.130
17	10	13	15	20	21	22	.099
18	9	15	17	19	21	23	.098
23	9	15	17	20	23	21	.120
x̄	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

	Chomata Height (Cont'd)					Proloculus Diameter (Cont'd)
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	.02.	.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	.043	.059	.051
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

	Radius Vector (Cont'd)						Tectum & Keriotheca (Cont'd)					
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, Locality 47

	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	.018	.032	.054	.053
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						Proloculus Diameter
1	8	15	15	16	17	00	.131
2	8	15	15	17	19	00	.134
3	7	13	14	14	18	16	.117
4	7	12	12	13	18	22	.096
5	8	11	15	15	17	18	.141
6	8	11	13	15	18	19	.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					
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, Locality 51

	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	3.640	.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

	Half Length (Cont'd)						Tunnel Width (Cont'd)				
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
$\bar{x}$	.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						Proloculus Diameter
1	10	14	17	22	20	19	.098
2	11	11	16	22	21	00	.102
3	9	12	20	19	20	00	.120
4	9	12	16	18	19	19	.085
5	10	14	19	21	23	23	.121
6	12	16	18	19	23	21	.118
7	8	13	12	15	20	20	.066
8	8	13	15	17	18	16	.093
9	8	13	16	20	22	23	.080
10	7	13	18	17	20	00	.085
11	10	14	17	19	22	21	.100
12	9	12	14	20	22	20	.075
13	8	13	15	18	18	00	.080
14	8	12	15	18	21	22	.067
15	10	17	17	20	23	21	.081
16	10	15	17	19	24	00	.082
$\bar{x}$	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, Locality 53, 54

	Tectum & Keriotheca						Radius Vector					
1	.007	.009	.013	.026	.024	.000	.086	.139	.212	.334	.480	.672
2	.009	.011	.014	.023	.037	.037	.086	.142	.203	.329	.493	.674
3	.008	.010	.013	.019	.031	.040	.102	.154	.226	.334	.488	.692
4	.009	.011	.014	.022	.035	.046	.099	.162	.257	.374	.570	.000
5	.007	.011	.017	.024	.034	.000	.086	.144	.235	.374	.556	.000
6	.009	.011	.014	.018	.028	.000	.074	.118	.186	.272	.418	.000
7	.007	.010	.018	.028	.037	.000	.090	.160	.263	.409	.581	.000
8	.006	.008	.019	.025	.033	.037	.076	.115	.194	.298	.459	.667
9	.010	.015	.018	.024	.037	.041	.092	.160	.250	.377	.560	.784
10	.010	.012	.020	.026	.033	.042	.113	.160	.238	.367	.533	.728
11	.011	.014	.019	.023	.031	.037	.094	.138	.212	.305	.449	.608
12	.008	.016	.021	.026	.037	.000	.100	.156	.232	.337	.506	.000
13	.011	.017	.020	.023	.026	.037	.080	.125	.188	.274	.441	.640
14	.007	.011	.029	.023	.035	.043	.075	.110	.186	.286	.461	.658
$\bar{x}$	.009	.012	.017	.024	.033	.040	.089	.142	.220	.334	.499	.680
s	.002	.003	.003	.003	.004	.003	.011	.018	.027	.043	.053	.051
UCL	.010	.014	.019	.026	.036	.043	.098	.155	.240	.365	.549	.729
LCL	.007	.010	.015	.022	.030	.037	.081	.128	.200	.302	.461	.632

	Chomata Height						Tunnel Width					
8	.016	.037	.041	.062	.102	.067	.032	.055	.100	.180	.400	.720
9	.016	.030	.054	.066	.074	.000	.045	.080	.135	.282	.499	.576
10	.022	.034	.044	.054	.063	.075	.036	.064	.128	.292	.600	.000
11	.023	.036	.060	.060	.067	.000	.052	.080	.102	.192	.560	.000
12	.019	.033	.047	.049	.000	.000	.048	.104	.260	.520	.000	.000
13	.019	.024	.037	.062	.086	.086	.027	.059	.104	.196	.360	.640
14	.026	.033	.050	.074	.082	.000	.028	.066	.101	.220	.440	.000
$\bar{x}$	.020	.032	.048	.061	.079	.076	.038	.073	.133	.269	.476	.645
s	.004	.004	.008	.008	.014	.010	.010	.017	.058	.119	.092	.071
UCL	.024	.037	.056	.070	.096	.094	.049	.091	.196	.399	.588	.782
LCL	.016	.028	.039	.052	.062	.058	.027	.054	.070	.138	.365	.509

	Septal Count						Proloculus Diameter
1	9	14	19	21	23	25	.091
2	9	15	19	21	24	25	.101
3	10	16	17	22	24	27	.114
4	10	15	17	22	25	28	.101
5	9	13	17	21	24	00	.089
6	10	13	15	20	20	25	.085
7	10	14	16	18	24	23	.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						Proloculus Diameter
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, Locality 58

	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	3.060	.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	.013	.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	.046	.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

	Septal Count						Proloculus Diameter	
							Min.	Max.
1	11	21	23	22	25	00	.148	.178
2	10	16	18	22	24	27	.116	.128
3	9	17	20	21	24	22	.111	.119
4	10	13	17	23	26	27	.116	.116
5	9	19	20	26	26	29	.128	.150
6	9	13	15	17	23	25	.080	.094
7	8	15	21	19	25	26	.080	.102
8	7	14	16	20	23	27	.090	.100
x̄	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		

	Half Length							Proloculus Diameter	
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
x̄	.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

APPENDIX C

BIOMETRICS

Table 1 contains the data from the measurement of specimens of *Fusulina* cf. *Fusulina novamexicana* and *Fusulina euryteines.* Due to replacement by a foreign substance, masking by secondary deposits, indistinctness, solution, or simply because the animal died before reaching the larger growth stage, any unit of data for a character may be missing. If for any reason a unit of data is missing, it is expressed by .000 in the appropriate row and column in table 1. This same procedure was used in expressing missing data in the mensuration tables in appendix B.

The first manipulation performed on the above mensuration data was to determine if this particular morphological feature (radius vector) was significantly different between the two similar species. This was accomplished by applying a multivariate test (Hotelling, 1931, p. 360-378) to the data array (table 1) and testing the hypotheses specifying the values of the "species population" means of the various units comprising the morphological characteristic, radius vector. The general subject of multivariate theory and application is well covered by Hotelling (1931, p. 360-378), Hodges (1955, p. 27-34), Miller and Kahn (1962, p. 248-257), and Burma (1949, p. 95-103). Application of the multivariate technique will not be presented in this paper as the method is easily programmed for the computer. However, certain assumptions, made during the process of species discrimination, must be presented: (1) paleontological samples consist of individuals possessing several identifying characteristics whose measurements are normally distributed; that is, the individuals are taken from a multivariate, normal, paleontological species population; (2) correlation among pairs of measurements are stable within a paleontological species population (e. g., the correlation coefficient between variable X_1 and X_2, at a particular growth stage, will be closely similar within a range of expected variation for all individuals of the species population); (3) the variance (a measure of the spread of *n* observations of a single variable about the mean) and the covariance (the relationship between two variables) of several samples will not differ significantly if the samples are from the same species population; (4) samples from different geo-

TABLE 1. — MEASUREMENTS OF RADIUS VECTORS ON SPECIMENS OF *Fusulina* cf. *F. novamexicana* AND *Fusulina euryteines*

Fusulina cf. *F. novamexicana* (*a*)						*Fusulina euryteines* (*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	.257	.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

TABLE 2. — COMPUTATION OF S_{ij}, WHEN $i = 1$ AND $j = 1$

$(X_{aik} - \bar{X}_{ai})$	$(X_{ajk} - \bar{X}_{aj})$		$(X_{bik} - \bar{X}_{bi})$	$(X_{bjk} - \bar{X}_{bj})$	
(.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			
$N_a = 17$	Total (T_a) =	.015482	$N_b = 16$	Total (T_b) =	.005867

$$S_{11} = T_a + T_b$$

$$S_{11} = .015482 + .005867 = .0213$$

TABLE 3. — COMPUTATION OF S_{ij}, WHEN $i = 5$ AND $j = 6$

$(X_{aik} - \bar{X}_{ai})$	$(X_{ajk} - \bar{X}_{aj})$		$(X_{bik} - \bar{X}_{bi})$	$(X_{bjk} - \bar{X}_{bj})$	
(.676 — .738)	(.000 — .948)	.000000*	(.847 — .876)	(1.11 — 1.13)	.000580
(.750 — .738)	(.976 — .948)	.000336	(.805 — .876)	(1.00 — 1.13)	.009230
(.621 — .738)	(.844 — .948)	.012168	(.818 — .876)	(1.11 — 1.13)	.001160
(.000 — .738)	(.000 — .948)	.000000*	(.950 — .876)	(.000 — 1.13)	.000000*
(.824 — .738)	(.000 — .948)	.000000*	(.873 — .876)	(1.12 — 1.13)	.000030
(.721 — .738)	(.966 — .948)	—.000306	(.831 — .876)	(.000 — 1.13)	.000000*
(.611 — .738)	(.000 — .948)	.000000*	(.914 — .876)	(1.18 — 1.13)	.001900
(.000 — .738)	(.000 — .948)	.000000*	(.847 — .876)	(.000 — 1.13)	.000000*
(.725 — .738)	(.914 — .948)	.000442	(.940 — .876)	(1.19 — 1.13)	.003840
(.799 — .738)	(1.03 — .948)	.005002	(.000 — .876)	(.000 — 1.13)	.000000*
(.000 — .738)	(.000 — .948)	.000000*	(.902 — .876)	(.000 — 1.13)	.000000*
(.744 — .738)	(.000 — .948)	.000000*	(.805 — .876)	(.000 — 1.13)	.000000*
(.699 — .738)	(.940 — .948)	.000312	(.966 — .876)	(1.23 — 1.13)	.009000
(.686 — .738)	(.966 — .948)	—.000936	(.773 — .876)	(.000 — 1.13)	.000000*
(.679 — .738)	(.000 — .948)	.000000*	(.943 — .876)	(.000 — 1.13)	.000000*
(.873 — .738)	(.000 — .948)	.000000*	(.921 — .876)	(.000 — 1.13)	.000000*
(.917 — .738)	(.000 — .948)	.000000*			
$N_a = 7$	Total (T_a) =	.017018	$N_b = 7$	Total (T_b) =	.025740

$$S_{56} = T_a + T_b$$

$$S_{56} = .017018 + .025740 = .0427$$

* Any mathematical manipulation involving the "no data" value .000 is inadmissible.

data are missing (see columns 5 and 12, table 1). When measurements are missing, that pair of observations is omitted.

The values for d_i, the difference between sample means, are computed from the relationship previously given. Table 4 presents the computations for d_i for values of $i = 1, 2, \ldots 6$. After all appropriate values of S_{ij} and d_i have been computed, these values are then arranged in the form shown in table 5.

The solution to the set of six ($p = 6$) simultaneous linear equations of table 5 is given in table 6. The values of h_i (for $i = 1, 2, \ldots 6$) in table 6 are those coefficients of the equation (linear discriminant function)

$$R_{rk} = h_1 X_{r1k} + h_2 X_{r2k} + \ldots + h_6 X_{r6k}$$

TABLE 4. — COMPUTATION OF d_i FOR $i = 1, 2, \ldots 6$

(Values of X_{bi} and X_{ai} are from table 1)

d_i =	X_{bi} — X_{ai} =	d_i
d_1 =	.176 — .161 =	—.015
d_2 =	.287 — .251 =	—.036
d_3 =	.446 — .376 =	—.070
d_4 =	.642 — .542 =	—.100
d_5 =	.876 — .738 =	—.138
d_6 =	1.134 — .948 =	—.186

TABLE 5. — MATRIX OF VALUES OF S_{ij} AND d_i

$$
\begin{aligned}
.0213b_1 + .0239b_2 + .0289b_3 + .0331b_4 + .0311b_5 + .0046b_6 &= -.015\\
.0239b_1 + .0373b_2 + .0467b_3 + .0569b_4 + .0541b_5 + .0131b_6 &= -.036\\
.0289b_1 + .0467b_2 + .0673b_3 + .0863b_4 + .0834b_5 + .0210b_6 &= -.070\\
.0331b_1 + .0569b_2 + .0863b_3 + .1249b_4 + .1186b_5 + .0309b_6 &= -.100\\
.0311b_1 + .0541b_2 + .0834b_3 + .1186b_4 + .1575b_5 + .0426b_6 &= -.138\\
.0046b_1 + .0131b_2 + .0210b_3 + .0309b_4 + .0426b_5 + .0540b_6 &= -.186
\end{aligned}
$$

which maximize the separation between species *A* and *B* (for the character radius vector only) and minimize the dispersion within species *A* and *B*.

TABLE 6. — VALUES OF b_i FROM THE SOLUTION OF THE MATRIX IN TABLE 5

$b_1 = -0.7641$	$b_4 = +0.4922$
$b_2 = +2.4503$	$b_5 = +0.1408$
$b_3 = -2.1114$	$b_6 = -3.5536$

Substituting the values of b_i (table 6) and X_{rik} (table 1, specimen measurements) into the linear discriminant function, one obtains the index value R_{rk} for all specimens of species *A* and *B* which possess six volutions (measurements). Table 7 illustrates the computation of the index value R_{rk} (for the second specimen from species *A*, table 1).

TABLE 7. — COMPUTATION OF THE INDEX VALUE R_{a2}

(Specimen 2, sample *a*, table 1)

$$
\begin{aligned}
R_{a2} = {} & (-.7641)\ (.196) + (+2.4503)\ (.286) + \\
& (-2.1114)\ (.393) + (+0.4922)\ (.547) + \\
& (+0.1408)\ (.750) + (-3.5536)\ (.976)
\end{aligned}
$$

$$R_{a2} = -3.372$$

The specimen index values of all specimens from table 1, with six volutions, and all specimens from the comparative sample *c* (unknown species), with six volutions, are listed in table 8.

The index values of table 8 can be utilized for interpretative purposes as follows:

(1) Individual index values are placed in an "ordered" listing, as table 8, through which the degree of separation achieved by the linear discriminant function is readily noted. When one observes the individual index values of species *A* and species *B* of table 8 it is immediately noted that very little overlapping of the index values occurs, thus a very good separation exists between the species in expansion (radius vector measure-

TABLE 8. — "ORDERED" INDEX VALUES OF TWO SPECIES OF *Fusulina* AND AN UNKNOWN SPECIES

(All specimens possessing six volutions)

Fusulina cf. *F. novamexicana*	Unknown species (sample *c*)	*Fusulina euryteines*
—3.555	—3.2799	—4.284
—3.381	—3.2776	—4.198
—3.372	—2.8423	—4.135
—3.337		—3.883
—3.289		—3.877
—3.197		—3.827
—2.959		—3.486

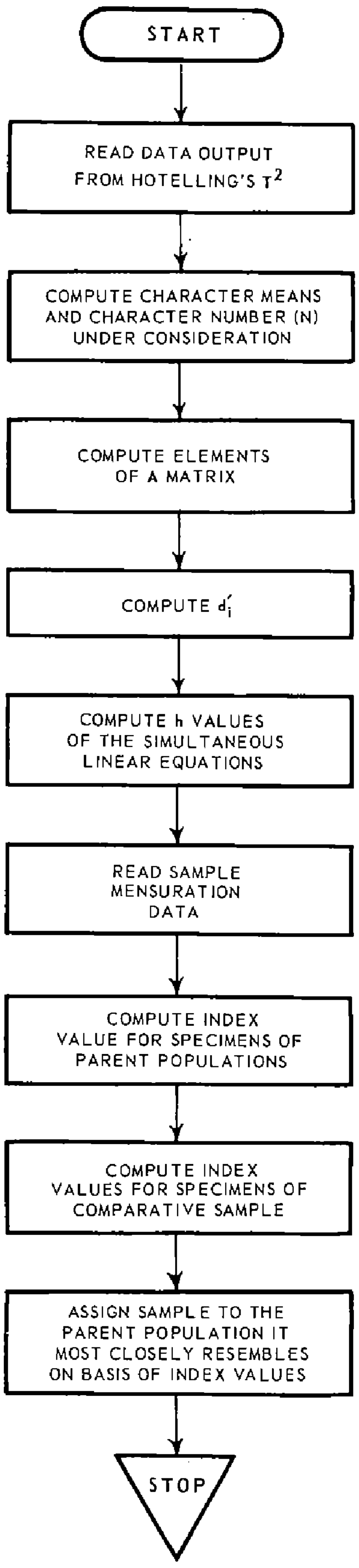
ment) of the shell. Other characteristics may or may not differ, we do not know at this point as we have considered only one character, the radius vector. The index values of the unknown species (sample *c*) is seen to overlap the lower range limit of *Fusulina* cf. *F. novamexicana* (sample *a* of table 1). The best estimate of the information at hand concludes that the probability is greatest that the few specimens comprising sample *c* were taken from the species population called *Fusulina* cf. *F. novamexicana* (sample *a*, table 1).

(2) In this method, individual index values are summed and their mean value computed for the different groups (samples *a*, *b*, and *c*). The values obtained are the values $\bar{R}_a$, $\bar{R}_b$, and $\bar{R}_c$ discussed previously. The averages of the index values of the samples discussed are as follows:

Sample *a* $\bar{R}_a = -3.298$

Sample *b* $\bar{R}_b = -3.955$

Sample *c* $\bar{R}_c = -3.133$



Text-figure 11. Flow sheet for computation of linear discriminant index values.

It can be seen that the index average of sample *c* more closely approximates the index average of sample *a* than the average of sample *b*. Upon this basis it is logical to assume that sample *c* and sample *a* were obtained from the same species population. This method of interpretation was not used in this paper because it yields no visual concept of index variation and overlap, and because the degree of relationship between the unknown and its nearest neighbor was considered obscured.

It is important to note that in neither of the above cases is it stated that the assignment of the individuals of the unknown sample *c* to species population *Fusulina* cf. *F. novamexicana* is absolute, or for that matter, ever correct. It is simply stated that according to the presently available information, the probability is greater that sample *c* was collected from species population *Fusulina* cf. *F. novamexicana* than from *Fusulina euryteines*.

Text-figure 11 is a flow diagram which outlines the steps in the computation of the linear discriminant function. The flow diagram is based upon the program written for the computer.

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(**Boldface number** indicates main reference; number in parentheses (2) is text-figure number)