# FUSULINID SPECIES ASSOCIATED WITH THE PENNSYLVANIAN - PERMIAN CONTACT OF THE MANHATTAN, KANSAS AREA

by

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# INTRODUCTION

## Purpose of the Investigation

The purpose of this investigation is to describe and discuss the fusulinid fauna of formations in the vicinity of Manhattan, Kansas that are stratigraphically near the Pennsylvanian - Permian boundary. Such a study should more thoroughly define the variation of the previously described species, and perhaps reveal the existence of new species, both of which would make inter-regional correlations more accurate. An attempt will be made to observe the evolutionary progress of these fusulinids, and determine any differences that may distinguish Pennsylvanian forms from those of the Permian strata.

## Area Covered and the Stratigraphy of This Investigation

The area covered in this study includes the northern half of Lyon County, the western part of Wabaunsee County, and the east central portion of Riley County. All three counties lie in the northeastern quarter of the State of Kansas. Figure 1 indicates the position of these counties in the state and shows the sample collecting localities.

The rocks which crop out in Lyon, Wabaunsee, and Riley Counties are predominantly of the Wolfcampian series, Permian system. All three counties have smaller areas where rocks of the Virgilian series, Pennsylvanian system crop out. The Wolfcampian series is composed of the Admire, Council Grove, and Chase groups. Rocks of the Admire group, which is the lowermost unit of the Wolfcampian

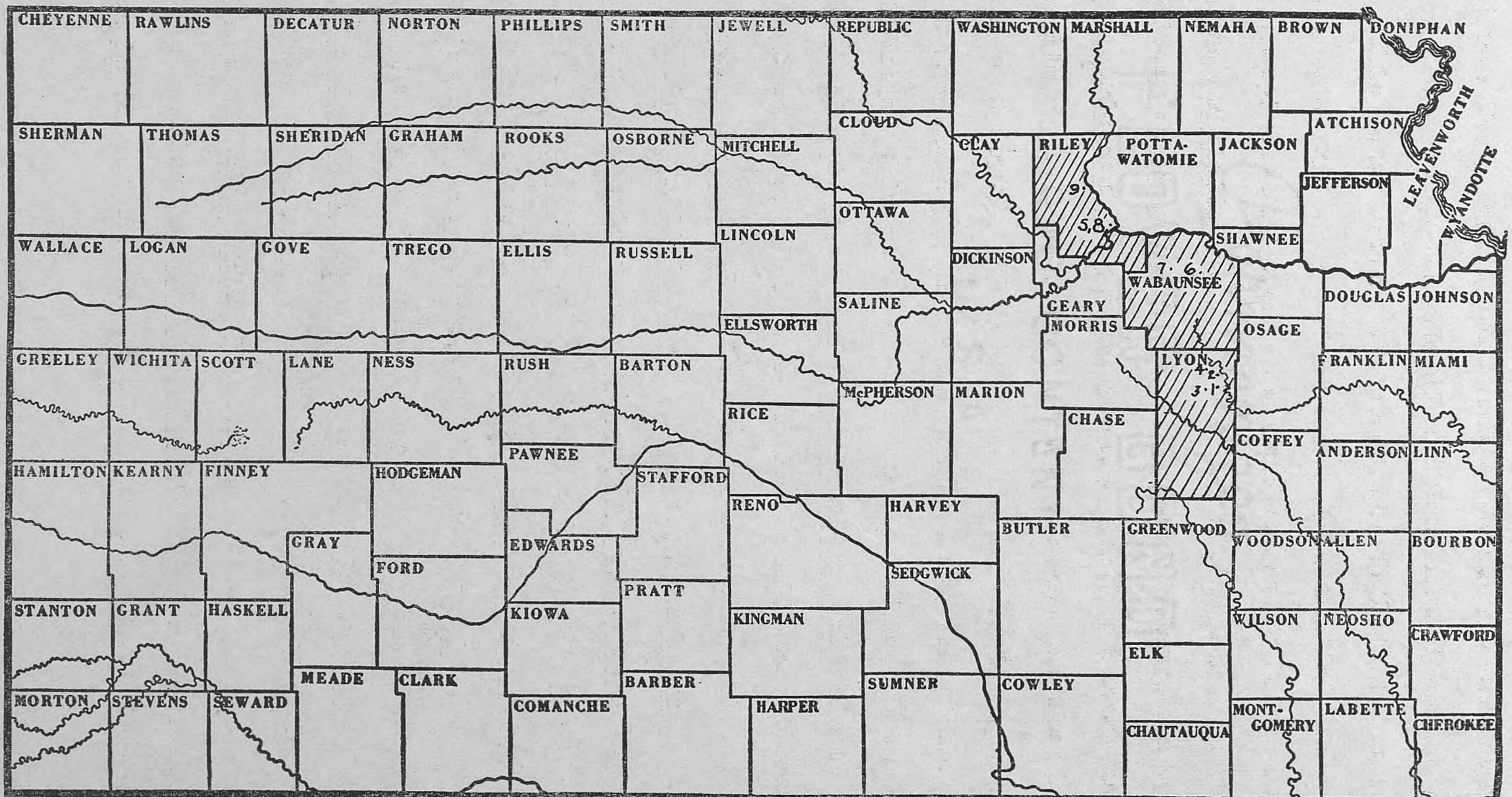



Figure 1. Map showing area covered by this investigation and sample location.

series, are sparcely fossiliferous, and consist primarily of shale and sandstone. Several thin limestone formations are also present.

The Council Grove group, second oldest group of the Wolfcampian series, is composed of limestones and vari-colored shales. Most of the limestones and shales are highly fossiliferous, although several formations are entirely barren of fossils.

The Chase group, youngest of the Wolfcampian series, is composed of thick beds of cherty limestone separated by vari-colored shales. The rocks of this group are fossiliferous, but to a lesser extent than those of the Council Grove group.

The Pennsylvanian strata of these three counties are of the Wabaunsee group, Virgilian series. The rocks of this group consist of thick shale formations, which are often sandy or silty, interbedded with thin limestone formations. Most formations are fossiliferous, although several zones contain no fossils.

In general the rocks which crop out in Riley County belong to the Wolfcampian series of the Permian system, but in the northwestern corner there are exposures of Cretaceous age, and in the southeastern part of the county the upper units of the Pennsylvanian system are exposed.

The Admire, Council Grove, and Chase groups of the Permian Wolfcampian series crop out in the western half of Lyon County. The eastern half of this county has many excellent exposures of rocks of the Wabaunsee group, which belongs to the Virgilian series of Pennsylvanian age.

Rocks of the Chase group, Wolfcampian series, are exposed in the western half of Wabaunsee County. East of this sequence, rocks of the Council Grove and Admire groups, Wolfcampian series, crop out in irregular north-south trending bands. The Wabaunsee group of the Virgilian series, Pennsylvanian system, is exposed along the eastern border of this county. Figure 2 shows a generalized stratigraphic section of the rocks of the three counties considered in this investigation.

The stratigraphic units studied in this investigation extend from the Grandhaven limestone to the Cottonwood limestone. Within this zone the fusulinid bearing formations, arranged from oldest to youngest, are the Grandhaven, Jim Creek, and Brownville limestones of Pennsylvanian age, and the Five Point limestone, Americus limestone, Hughes Creek shale, Glenrock limestone, Neva limestone, and the Cottonwood limestone of Permian age. All formations were sampled except the Americus limestone which locally does not contain an abundant fusulinid population. Figure 1 shows the location of sample collections.

## Previous Work

Little study has been given the fusulinids of Kansas that occur within the stratigraphic zone examined in this report. Meek and Hayden (1858) first studied a collection of fusulinids from "Juniata on the Blue River and Manhattan, Kansas", and described the species Fusulina cylindrica var. ventricosus. Moller (1879) examined a different collection of these specimens from Blue Mount, Manhattan, Kansas, and realized that the species

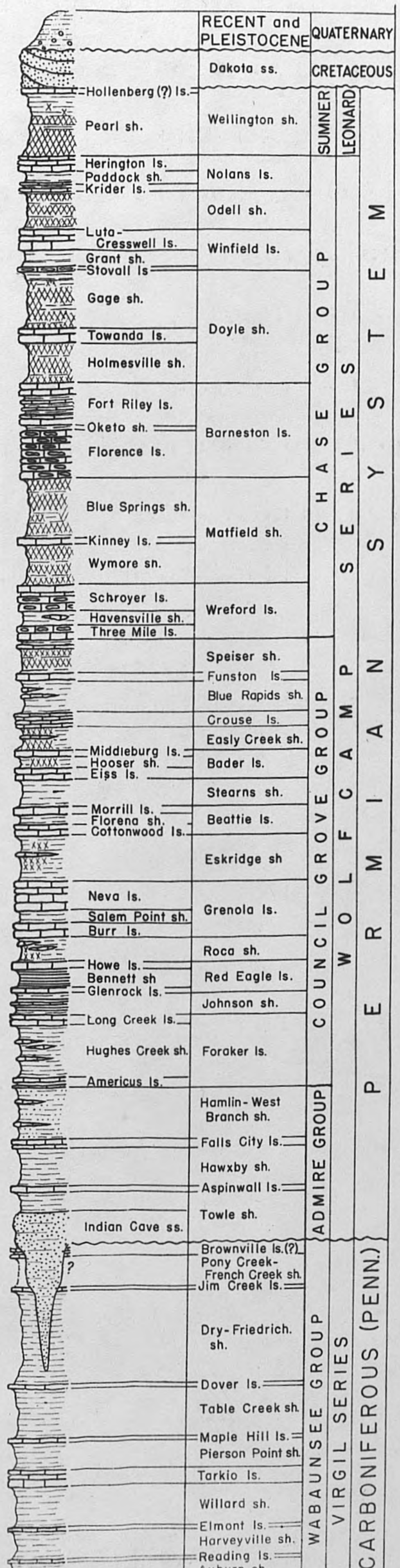



Figure 2. Generalized columnar section of the formations of Lyon, Wabaunsee, and Riley Counties, Kansas. (After Jewett, 1941).

described by Meek and Hayden (1858) were unlike *Fusulina cylindrica*, and therefore referred them to *Fusulina ventricosus* Meek and Hayden. He also noticed that some of these forms were more elongate than others. These he called *Fusulina ventricosus* var. *meeki*. Girty (1904) established *Triticites* for forms like *Fusulina ventricosus*, because he realized that the wall structure of these forms differed from other members of genus *Fusulina*.

Thompson (1954) made the only comprehensive study of Kansas Wolfcampian fusulinids. In this report he described new species from the Five Point limestone (*Triticites pointensis*, *Triticites confertus*, and *Dunbarinella fivensis*), Americus limestone (*Dunbarinella americana*, and *Dunbarinella coextenta*), Hughes Creek shale (*Dunbarinella hughensis*), Glenrock limestone (*Dunbarinella glensis*, *Triticites rockensis*, and *Schwagerina campa*), and Cottonwood limestone (*Schwagerina jewetti*).

## Field Methods

A lithologic description was made of the formations from which fusulinids were collected for the preparation of this report. These descriptions appear in the Appendix.

Each collection consisted of at least 60 specimens. Fusulinids gathered from the Jim Creek, Brownville, Five Point, and Glenrock limestones were chipped from the rock in the field, while those of the Cottonwood and Grandhaven limestones weathered free of their matrix and were picked from the formations at their field exposures. Specimens from the Neva limestone were collected from an included shale parting near the base of this formation.

The Hughes Creek shale, because it was thick and of variable lithology, was sampled in both limestone and shale horizons. The limestone sampled was argillaceous, and permitted the fusulinids to be picked from it at its field exposure.

Fusulinids chipped from outcropping rocks were probably biased toward the larger sizes, for smaller members of the population blended well with their limestone groundmass and were probably overlooked. Samples taken from shale were less biased. Approximately five pounds of unweathered shale was collected from the field outcrop and taken to the laboratory, where a ten to 15 gram portion was disaggregated and picked clean of all fusulinids.

## Laboratory Procedure

Approximately 250 thin-sections were prepared for this report. Ten sagittal and axial sections were initially made from each fusulinid collection, and supplementary thin-sections were prepared where additional information was thought necessary.

Preliminary to sectioning an attempt was made to clean the outside of each shell, so that any diagnostic external characteristics could be noted. It was impossible to follow this procedure for fusulines entrapped in limestone, but those enclosed in shale were easily cleaned by boiling in a sodium hydroxide solution for several hours. If any matrix material remained after the initial boiling, the sample was again treated.

The sectioning technique used was that described by Dunbar and Henbest (1942). The specimen was first ground nearly one-half the thickness of the shell by use of either 300 grit abrasive and glass lap, or by use of a mechanical lap. It was then cemented, ground side to the slide, by Lakeside 70, a balsa derivitive. Grinding was then continued until the proloculum was penetrated. The specimen was then thoroughly cleaned of grinding compound with a water rinse, and ground with a 600 grit abrasive until the center of the proloculus was reached. Only through experience was it possible to determine when this point had been reached.

The ground specimen was then turned on its opposite side, and again cemented so that the ground surface was exposed and parallel to the glass slide. Grinding was then continued in the same manner used to prepare the reverse side of the specimen. When the section was thin enough so that transmitted light clearly defined the proloculus and the innermost chomata, grinding was considered complete.

The section was again cleaned of grinding compound and affixed with a coverglass. A label was attached and the specimen was stored for study with microscope.

## Specimen Orientation

The axial section is cut parallel to the axis of coiling, and ideally includes the axis. This ideal is seldom realized, for grinding technique is not refined enough to permit perfect centering of the axis within the confines of the ground section. The axis instead is commonly inclined, or lies parallel to but outside the ground section.

It is usually possible to determine the orientation of the axis while grinding, and make corrections that will yield a serviceable specimen. Dunbar and Henbest (1942) have considered this problem, and a summary of their conclusions follows:

If the outline of volutions assumes the shape of an ovoid spiral as cutting progresses (Figure 3a), the section is at a considerable angle with the axis. If a specimen is prepared with this orientation, it is called a tranverse section, and is of little value in any fusulinid study. There is no corrective measure that will yield a workable specimen once grinding has progressed at this orientation.

A specimen which assumes the volution contour depicted in Figure 3b misses the ideal by only several degrees of axial inclination. It may easily be corrected by grinding more material from the blunter side of the asymmetrical volution. This in effect reduces the degree of inclination. A specimen completed with several degrees of inclination is undesirable for the purpose of measurement, because all recorded values will be smaller than their true value.

If the axis of coiling lies outside the plane of the finished thin section, but is parallel to it, the fusulinid section will assume the volution configuration depicted in Figure 3c. This is a common orientation and is recognized by the fuzzy outline of the proloculus. Numerical values will be slightly smaller than true, but may be used for qualitative studies.

The ideal specimen is realized when the umbilici at both ends of the shell are cut. The concentric elliptical volution

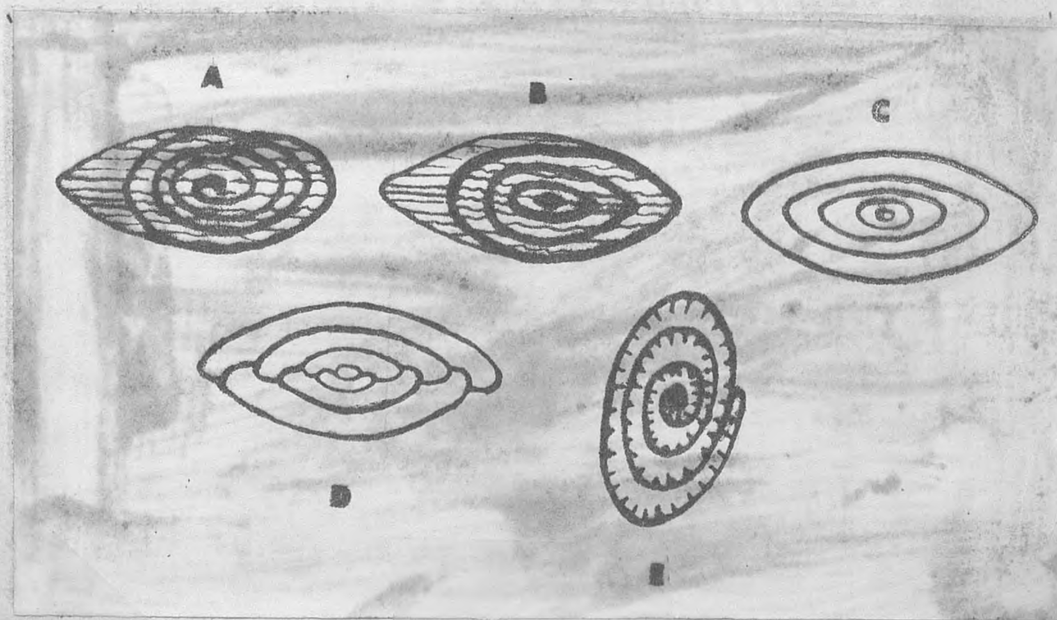



Figure 3. Diagram to illustrate orientation of thin-sections. A, extreme oblique orientation, continued grinding will result in transverse section; B, oblique orientation, cut too deep at right end; C, perfectly oriented axial section that does not cut exact center of proloculus; D, perfectly oriented axial section that cuts the center of the proloculus; E, oblique sagittal section. (Redrawn from Dunbar and Henbest, 1942.)

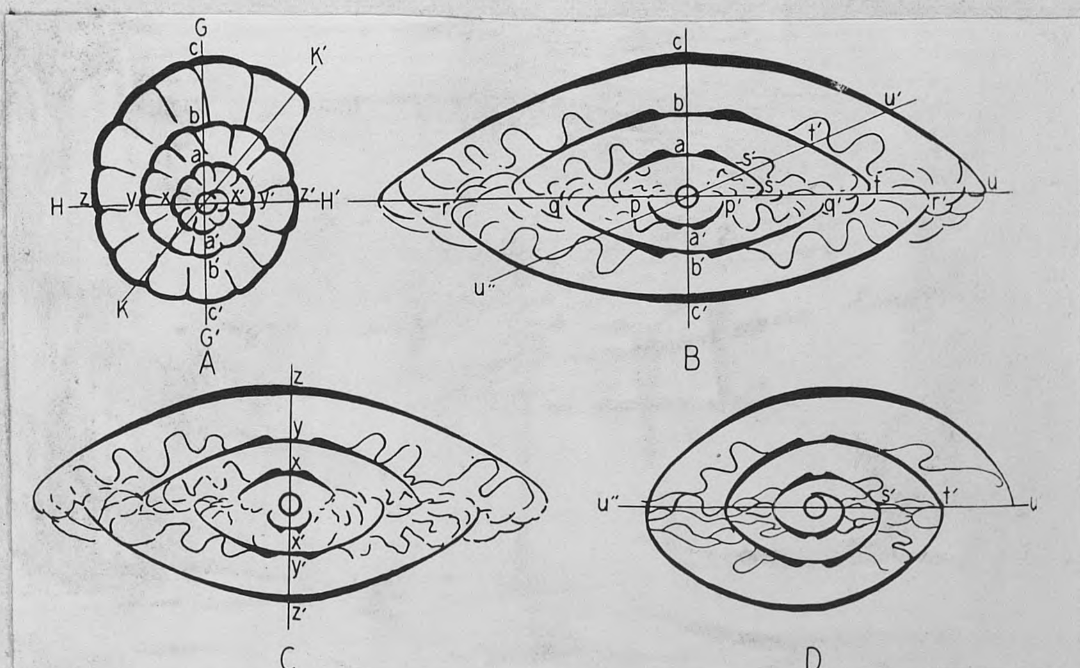



Figure 4. Diagrams to illustrate correct shell measurement. These are four ideal sections of a single shell. A, sagittal section; B, perfectly oriented axial section lying in direction of G-G' in figure A; C, axial section lying along line H-H' of figure A; D, oblique section lying along line U'-U'' of figure B and at right angles to that section. (After Dunbar and Henbest, 1942.)

outlines (Figure 3c) then break into a series of offset and opposed hemiellipses (Figure 3d). This orientation gives the most accurate measurements. It should be noted that axial measurements are never entirely reliable, because their orientation in relation to the beginning of the first volution is never known. The following discussion of this problem is quoted from Dunbar and Henbest (1942):

> The difficulties may be explained by means of Figure 4a, which represents the sagittal section. It is easy to see where each volution begins and ends, but since the initial point of coiling cannot be seen from the outside of the shell the orientation of the axial section with respect to the ends of the several volutions is purely fortuitous.
>
> Figure 4b represents an axial section in the position G-G' of the sagittal section, falling exactly in the ideal plane so the upper half of the section coincides exactly with the ends of the several volutions. But even here a choice must be made as to which side of the section to measure. The assumed relation to the sagittal section makes it clear that measurements on the lower half of this section (i.e., p-p', q-q', and r-r') really could indicate the length at 1/2, 1 1/2, and 2 1/2 volutions, respectively.
>
> But in practice the orientation of the axial section with respect to the ends of the volution has to be inferred. In Figure 4c, the orientation is represented as lying at 90 degrees to the desired plane (i.e., along the line H-H' of Figure 4a). In this section the shell appears smaller than in the former, for it only shows 2 3/4 whorls of the shell. In it the hemiellipses on the upper half give the dimensions of 3/4, 1 3/4, and 2 3/4 volutions while those of the lower half correspond to 1/4, 1 1/4, and 2 1/4 volutions. It is therefore impossible to measure the full dimensions of any volution from this section. But obviously if we choose the side which gives the largest figures the results are most nearly correct.
>
> The section may lie in some intermediate position, as k-k' of Figure 4a. In this instance, the smaller half would show the shell at 1/8, 1 1/8, and 2 1/8 volutions, and the larger half would represent 5/8, 1 5/8 and 2 5/8 volutions. In this case we approach closest to the true dimensions if we ignore the first tiny section of a volution and call the next one the first volution. If the

expansion and elongation of the shell is relatively rapid, the experienced student can safely infer from the size and shape of the first tiny whorl whether it lies within the first quarter volution; but if the elongation is slow and gradual there is more uncertainty. In the latter case, however, an error of judgement is less serious than in rapidly elongated shells.

To summarize, the rule for deciding which side of an axial section to measure is as follows: If the smallest whorl section is inferred not to lie within the initial 1/4 volution, measure the side opposite to it, i.e., the side which will give the larger dimensions for the corresponding whorls; but if the first tiny whorl section lies within the initial 1/4 volution, measure the side in which it occurs, but ignore this apical section and call the next whorl section number one.

The sagittal (or equatorial) section is cut perpendicular to the axis of coiling and intersects the proloculus. There is no method of accurately determining the perpendicularity of the axis once grinding begins, but if care is taken to maintain the volution outline in a perfect spiral, the resultant thin-section will be satisfactory. Sections which appear to have a distorted spiral (Figure 3e) are not orientated perpendicular to the axis.

## Measurement

A petrographic microscope was used to determine measured values. Linear measurements were made with an ocular micrometer, which had an estimated accuracy of plus or minus two microns. Angular measurements were computed by use of the microscope stage. Accuracy was no greater than plus or minus 0.5 degrees for this operation.

If measurements are to have universal significance, they must be accomplished so that any worker may duplicate another's findings. To assure this, the author used a method proposed by

Dunbar and Henbest (1942), and most commonly used by all students of fusulinids. The following discussion is a summary of the methods suggested by Dunbar and Henbest (1942):

Radius Vector. Either the diameter or radius vector for each volution is commonly recorded in fusulinid studies. The diameter is the straight line distance, through the proloculus, between the farthest extremities of a volution. The radius vector is measured from the center of the proloculus to the outside extremity of a volution. Because of equipment limitations, i.e., most specimens are too large to be included in the low power field of the microscope, the radius vector was used exclusively in this study.

The radius vector is measured in both sagittal and axial section. In the former it can be determined more precisely, since the beginning of each volution is usually easy to locate. The correct orientation is indicated in Figure 5 by line OR.

In axial section the radius vector may be measured on either side of the axis. No general rule is available that will show which of these alternatives can be expected to give the most accurate measure. Only through experience and consideration of axial orientation, previously discussed, is it possible to determine which option will be most satisfactory.

Half-length. Either the length or half-length is calculated for each volution in the axial section. The former is the length of a volution measured parallel to the axis through the proloculus. The half-length is measured from the center of the proloculus to the outside of a volution parallel to the axis. The half-length

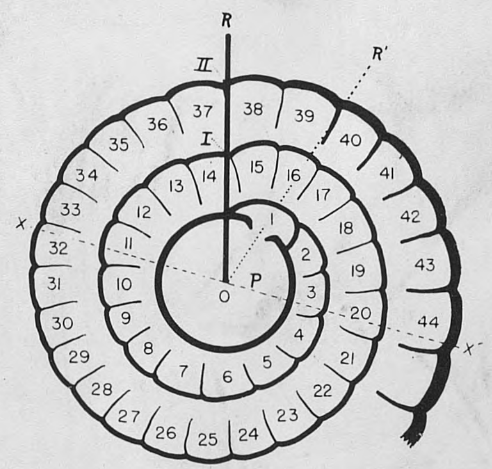



Figure 5. Sagittal section to illustrate the correct measurement of radius vector and septal count. P, proloculus; O, center of proloculus; OR, line marking ends of volutions; OR', incorrect position for measuring radius vector. (After Dunbar and Henbest, 1942.)

was measured in this study for the same reason the radius vector was used, i.e., equipment limitations.

When computing the length or half-length of a volution it is necessary to determine whether the measured value is the true one, because axial orientation is so unpredictable. The problem is thoroughly discussed above under the heading Axial Orientation.

Form Ratio. The form ratio is the ratio between the width and the length of a shell. It is determined for each volution by dividing the half-length by the radius vector.

Thickness of Spirotheca. This is determined in both axial and sagittal section. In axial section it is measured for each volution midway between the chomata. The side of the shell used for measurement of the radius vector should also be used for this measurement.

In sagittal section thickness of the spirotheca should be measured at the end of the volution. Thus in Figure 5 the wall thickness would be measured where the spirotheca is cut by line OR. The thickness should be determined midway between the two septa. When measuring wall thickness, the epitheca should be excluded, because this is actually a portion of the succeeding volution.

Proloculus. The proloculus is usually circular, but is sometimes oval in outline. It is measured in both axial and sagittal section. The diameter (outside) is measured parallel to the axis in axial section, while in sagittal section it is measured parallel to the imaginary line connecting the beginning of each new volution (along line OR in Figure 5).

Tunnel Angle. The tunnel angle may be measured in axial section only, and is recorded for each volution. It is the central angle with its apex at the center of the proloculus. The sides of the angle are determined by the thickest portion of the chomata, i.e., at the ridge formed by the chomata.

Septal Count. A count of the septa is made from the sagittal section for each volution. The start of a new volution is depicted by the line OR in Figure 5.

## SYSTEMATIC PALEONTOLOGY

This section of systematic paleontology includes major and minor taxonomic divisions; syononomy; description of test characteristics; test measurements; a discussion that considera distinctive characteristics; similarities to other species; and the stratigraphic and geographical occurrence of each species. The taxonomic classification is that of Thompson (1954).

Phylum PROTOZOA

CLASS SARCODINA

Order FORAMINIFERA

Family FUSULINIDAE Moller, 1878

Subfamily SCHWAGERININAE Dunbar and Henbest, 1930

Genus *Dunbarinella* Thompson, 1942

*Dunbarinella creekensis* Matthews, n. sp.

Material Studied. Abundant specimens were collected from one outcrop of the Jim Creek limestone. From this collection 28 thin-sections were prepared.

Description. The test of Dunbarinella creekensis was small, slightly inflated, and fusiform with sharply pointed poles. The lateral slopes were slightly concave or convex, and the axis of coiling was straight. Large specimens with seven volutions were 5.8 mm. to 7.5 mm. long, and 1.8 mm. to 2.1 mm. wide. Several specimens contained eight volutions, but because their state of preservation was poor, no exact measurements were possible. However, length and width estimates of these forms did not differ significantly from the range of variation for those of seven volutions. The inner three or four volutions increased uniformly, but in the remainder of the shell the poles were rapidly extended, until in the seventh volution a form ratio greater than 3.1, but less than 3.7, was attained. The proloculus was minute and averaged .098 mm. for five specimens.

The spirotheca was thin, but coarsely alveolar for a shell of this size. Fluting was narrow in the polar extremities, where adjacent septa touched to form closed chamberlets, and persisted with this intensity to the poleward side of the chomata where they assumed a nearly straight path across the tunnel. The keriotheca extended down both sides of moderately spaced septa for short distances. The average number of septa in the seventh volution was 27 for six specimens. Septal pores were common in the polar extremities of the outer volutions, but were rare in the central portion of the shell. Axial filling was light or absent in the inner two or three volutions, but became heavy in the remainder of the shell.

The tunnel was regular and narrow, subtending an arc of about 30 degrees in the sixth volution, but one specimen anomalously attained a value of 41 degrees for this whorl. The chomata extended half or greater than half the chamber height at all stages of development. In the inner three or four volutions the chomata were highly asymmetrical, but became massive and nearly symmetrical in the remainder of the shell. Table 1 contains the measurements made of these specimens, while Plate I, Figure 1 shows a typical form.

Discussion. This form is similar to *Triticites acutus* Dunbar and Condra. However *Dunbarinella creekensis* has a slightly greater tunnel angle, smaller proloculus, and more highly fluted septa than *Triticites acutus*. For the purpose of this report they are given independent status, but the author realizes that these two forms may be cospecific.

*Dunbarinella creekensis* may be distinguished from *Dunbarinella fivensis* Thompson by its larger size, fewer volutions, and greater form ratio in the outer volutions. They differ from *Dunbarinella americana* Thompson by their larger form ratio and heavier axial filling. *Dunbarinella creekensis* is similar to *Dunbarinella lyonensis*, but is 3 to 4 mm. smaller, more highly inflated, and has a relatively thicker spirotheca.

Occurrence. *Dunbarinella creekensis* was found in abundance in the Jim Creek limestone. This sample was collected from that formation at the center of S.W. 1/4, Sec. 13, T. 16 S., R. 12 E., Lyon County, Kansas. The lithologic description of the Jim Creek limestone appears in the Appendix, Sample Number 2.

Table 1. Measurements of Dunbarinella creekensis Matthews, n. sp.

| Spec. | Prol. | Half length V1 | V2 | V3 | V4 | V5 | V6 | V7 | Radius vector V1 | V2 | V3 | V4 | V5 | V6 | V7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| JC 3 | .088 | .16 | .32 | .63 | .96 | 1.50 | 2.34 | 3.77 | .10 | .16 | .25 | .40 | .56 | .79 | 1.03 |
| JC 4 | .125 | - | - | - | - | - | - | - | .11 | .18 | .27 | .40 | .58 | .79 | 1.02 |
| JC 5 | - | .13 | .34 | - | 1.30 | 1.82 | 2.42 | - | .10 | .17 | .30 | .48 | .69 | .95 | - |
| JC 8 | - | - | - | - | - | - | - | - | .07 | .11 | .17 | .25 | .41 | .60 | .84 |
| JC 13 | .105 | .24 | .28 | .58 | .90 | 1.34 | 1.93 | 3.24 | .10 | .15 | .22 | .34 | .49 | .68 | .93 |
| JC 14 | .085 | - | - | - | - | - | - | - | .07 | .13 | .23 | .34 | .51 | .70 | - |
| JC 15 | - | .20 | .35 | .63 | 1.08 | 1.74 | 2.38 | - | .12 | .18 | .29 | .42 | .61 | .85 | - |
| JC 21 | - | .13 | .33 | .58 | .82 | 1.20 | 2.24 | - | .10 | .16 | .25 | .39 | .55 | .78 | - |
| JC 27 | - | .13 | .30 | .53 | .82 | 1.36 | 2.18 | 3.14 | .08 | .14 | .23 | .37 | .55 | .80 | 1.01 |

| Spec. | Form ratio V1 | V2 | V3 | V4 | V5 | V6 | V7 | Tunnel angle V1 | V2 | V3 | V4 | V5 | V6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| JC 3 | 1.6 | 2.0 | 2.5 | 2.4 | 2.7 | 3.0 | 3.7 | 24 | 20 | 25 | 30 | 42 | 34 |
| JC 5 | 1.3 | 2.0 | - | 2.7 | 2.6 | 2.6 | - | 14 | 18 | 22 | 29 | 15 | - |
| JC 13 | 1.6 | 1.9 | 2.6 | 2.7 | 2.7 | 2.8 | 3.6 | 19 | 18 | 26 | 31 | 31 | 41 |
| JC 15 | 1.7 | 2.0 | 2.2 | 2.6 | 2.9 | 2.8 | - | 19 | 20 | 22 | 26 | 31 | - |
| JC 21 | 1.3 | 2.0 | 2.3 | 2.1 | 2.2 | 2.9 | - | 14 | 17 | 23 | 33 | 30 | - |
| JC 27 | 1.6 | 2.1 | 2.3 | 2.2 | 2.5 | 2.7 | 3.1 | 20 | 19 | 24 | 26 | 32 | 29 |

| Spec. | Thickness of spirotheca V1 | V2 | V3 | V4 | V5 | V6 | V7 | Septal count V1 | V2 | V3 | V4 | V5 | V6 | V7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| JC 3 | - | .012 | .020 | .028 | .048 | .078 | - | - | - | - | - | - | - | - |
| JC 4 | - | - | - | .026 | .029 | .051 | .070 | 11 | 15 | 18 | 20 | 22 | 25 | 28 |
| JC 8 | - | - | - | - | .023 | .039 | .061 | 7 | 12 | 16 | 19 | 19 | 21 | 24 |
| JC 13 | - | - | - | - | .034 | .060 | .074 | - | - | - | - | - | - | - |
| JC 14 | - | - | .018 | .025 | .045 | .060 | - | 10 | 13 | 15 | 18 | 20 | 24 | - |
| JC 15 | - | - | .024 | .032 | .062 | .096 | - | - | - | - | - | - | - | - |
| JC 21 | - | .008 | .016 | .025 | .035 | .064 | - | - | - | - | - | - | - | - |
| JC 27 | - | - | .009 | .027 | .041 | .073 | .078 | - | - | - | - | - | - | - |

Dunbarinella lyonensis Matthews, n. sp.

Material Studied. Abundant well preserved specimens were collected from one outcrop of the Brownville limestone. From this collection 32 thin-sections were prepared.

Description. The tests of Dunbarinella lyonensis were highly elongate and fusiform. The lateral slopes had a crooked and irregular outline. Large specimens of eight to nine volutions attained a length of 8.1 mm. to 10.5 mm., and a corresponding width of 2.4 mm. to 2.7 mm. The first volution was commonly oval, but in the remainder of the shell polar extremities became progressively sharper. The form ratio was commonly several tenths less than 2.0 in the first volution, and thereafter increased irregularly to the last volution where a value greater than 3.0, but less than 4.5 was usual. The axis of coiling was essentially straight, but some irregularity was common in the outer volutions where the shell often became obliquely extended. The proloculus was minute and averaged .111 mm. for five specimens.

The spirotheca was thin and finely alveolar. The keriotheca extended down both sides of the septa for short distances, producing a sharp increase in thickness of the spirotheca near the septa. The septa were closely spaced. Fluting was narrow in the end regions of the shell, and was intense enough so that adjacent septa touched to form closed chambers. Toward the center of the shell fluting became broader until directly over the tunnel these septal flexures were all but absent, and appeared only as slight curvatures on otherwise straight septa. Small septal pores were present in the polar extremities of the outer volutions in several species. Axial filling was heavy in the outer volutions, but absent in the inner three or four.

The tunnel was slit-like, narrow, and irregular, rarely subtending an arc greater than 35 degrees in the penultimate volution. The chomata reached half to greater than one-half the chamber height. Chomata of the inner two to four volutions had steep tunnel sides and long slightly inclined polar slopes, forming high asymmetrical wedges. In the remainder of the shell they were nearly symmetrical. Table 2 contains measurements made of these specimens, while Plate I, Figure 2 shows a typical form.

Discussion. *Dunbarinella lyonensis* probably represented a transitional stage between *Triticites* and *Dunbarinella*. It most closely resembled the latter by nature of its small proloculus, highly fluted septa, dense axial filling, elongate fusiform shell, straight axis of coiling, and pointed poles, but had chomata which were more typical of *Triticites*, for the chomata were persistent throughout all stages of growth. This was the only exception to Thompson's description of *Dunbarinella*, and these specimens were therefore assigned this classification. *Dunbarinella lyonensis* was an unusually large form of this genus; a fact that should make it a valuable tool in correlation studies.

Occurrence. *Dunbarinella lyonensis* occurs in abundance in the Brownville limestone, and was collected from that formation at N.W. 1/4, N.W. 1/4, Sec. 33, T. 16 S., R. 12 E., Lyon County, Kansas. A lithologic description appears in the Appendix, Sample Number 3.

Table 2. Measurements of *Dunbarinella lyonensis* Matthews, n. sp.

| | Half length | | | | | | | | | Radius vector | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spec. | $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ | $V_9$ | $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ | $V_9$ |
| B 2 | - | - | - | - | - | - | - | - | - | .10 | .16 | .25 | .39 | .53 | .74 | .98 | 1.13 | 1.47 |
| B 4 | - | - | - | - | - | - | - | - | - | .09 | .16 | .26 | .35 | .49 | .68 | .93 | - | - |
| B 5 | .16 | .38 | .56 | .86 | 1.48 | 2.27 | - | - | - | .09 | .16 | .24 | .37 | .51 | .76 | - | - | - |
| B 16 | - | - | - | - | - | - | - | - | - | .09 | .15 | .19 | .30 | .45 | .62 | .83 | - | - |
| B 18 | - | - | - | - | - | - | - | - | - | .11 | .17 | .25 | .36 | .52 | .70 | - | 1.15 | - |
| B 21 | .13 | .19 | .49 | 1.02 | 1.51 | 2.56 | 3.77 | - | - | .09 | .15 | .21 | .34 | .47 | .64 | .84 | - | - |
| B 27 | .16 | .26 | .39 | .65 | 1.19 | 1.86 | 2.55 | 3.34 | 4.60 | .08 | .13 | .20 | .30 | .41 | .61 | .78 | 1.00 | 1.27 |
| B 29 | .18 | .35 | .57 | .90 | 1.50 | 2.27 | 3.28 | 4.25 | - | .10 | .16 | .23 | .35 | .48 | .64 | .86 | 1.19 | - |
| B 35 | .23 | .47 | .66 | 1.02 | 1.65 | 2.85 | 3.65 | 4.18 | - | .11 | .19 | .28 | .38 | .55 | .74 | .98 | 1.24 | - |
| B 37 | .27 | .40 | .59 | .98 | 1.92 | 2.76 | 4.18 | 5.23 | - | .16 | .23 | .35 | .46 | .63 | .84 | 1.07 | 1.35 | - |
| B 39 | .09 | .25 | .42 | .70 | 1.05 | 1.51 | 2.25 | 3.07 | - | .07 | .13 | .19 | .27 | .40 | .59 | .80 | 1.05 | - |
| B 41 | .21 | .41 | .58 | .83 | 1.17 | 2.01 | 2.49 | 4.04 | - | .12 | .18 | .26 | .38 | .52 | .74 | .93 | 1.20 | - |

| | Tunnel angle | | | | | | | | Form ratio | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spec. | $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ | $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ | $V_9$ |
| B 5 | 15 | 16 | 22 | 20 | 27 | 29 | - | - | 1.7 | 2.4 | 2.3 | 2.3 | 2.9 | 3.0 | - | - | - |
| B 21 | 13 | 20 | 22 | 26 | 35 | 57 | - | - | 1.5 | 1.3 | 2.3 | 3.0 | 3.2 | 4.0 | 4.5 | - | - |
| B 27 | - | 14 | 20 | 20 | 21 | 25 | 27 | 29 | 1.9 | 2.0 | 1.9 | 2.2 | 2.9 | 3.1 | 3.3 | 3.3 | 3.6 |
| B 29 | 14 | 24 | 24 | 28 | 31 | 32 | 35 | - | 1.8 | 2.2 | 2.4 | 2.6 | 3.1 | 3.5 | 3.8 | 3.6 | - |
| B 35 | 15 | 16 | 22 | 25 | 30 | 34 | 32 | - | 2.1 | 2.5 | 2.4 | 2.7 | 3.0 | 3.9 | 3.7 | 3.4 | - |
| B 37 | 12 | 18 | 20 | 20 | 28 | 26 | 39 | - | 1.7 | 1.7 | 1.7 | 2.3 | 3.0 | 3.3 | 3.9 | 3.8 | - |
| B 39 | 15 | 19 | 20 | 23 | 25 | 28 | 28 | - | 1.3 | 2.0 | 2.2 | 2.6 | 2.6 | 2.6 | 2.8 | 2.9 | - |
| B 41 | 14 | 16 | 20 | - | 29 | 36 | 20 | - | 1.8 | 2.3 | 2.3 | 2.2 | 2.2 | 2.7 | 2.7 | 3.4 | - |

| | Thickness of spirotheca | | | | | | | | | | Septal count | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spec. | Prol. | $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ | $V_9$ | $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ |
| B 2 | .107 | - | - | .014 | .024 | .035 | .050 | .062 | .078 | .072 | 10 | 18 | 19 | 24 | 26 | 28 | 29 | 35 |
| B 4 | - | - | - | - | .018 | .025 | .041 | - | - | - | 10 | 18 | - | 26 | 30 | 33 | - | - |
| B 5 | - | - | - | - | .027 | .028 | .039 | .050 | - | - | - | - | - | - | - | - | - | - |
| B 16 | - | - | - | .012 | .016 | .023 | .032 | .043 | .054 | .069 | 11 | 20 | - | 22 | 30 | - | - | - |
| B 18 | .104 | - | - | - | - | - | .041 | .062 | .069 | - | 12 | 18 | 21 | 24 | 23 | 27 | 30 | 32 |
| B 21 | - | - | - | - | .023 | .034 | .045 | .061 | - | - | - | - | - | - | - | - | - | - |
| B 27 | .094 | - | - | .018 | .022 | .025 | .019 | .047 | .065 | .069 | - | - | - | - | - | - | - | - |
| B 29 | - | - | - | .009 | .019 | .031 | .067 | .078 | .078 | - | - | - | - | - | - | - | - | - |
| B 35 | - | - | .009 | .020 | .032 | .046 | .068 | .083 | .087 | - | - | - | - | - | - | - | - | - |
| B 37 | .149 | - | - | .020 | .029 | - | .072 | .072 | .072 | - | - | - | - | - | - | - | - | - |
| B 39 | - | - | - | .017 | .021 | .025 | .045 | .053 | - | - | - | - | - | - | - | - | - | - |
| B 41 | - | - | - | - | - | .020 | .047 | .052 | .072 | - | - | - | - | - | - | - | - | - |

<u>Dunbarinella</u> <u>obesa</u> Beede (Thompson, M. L., Protozoa: American Wolfcampian fusulinids. Univ. Kans. Paleontological Contr. Article 5: 50-51. 1954.)

<u>Material</u> <u>Studied</u>. Abundant specimens were collected from the Neva limestone at one outcrop. From this collection 26 specimens were selected and prepared in thin-section.

<u>Description</u>. The largest shell of <u>Dunbarinella</u> <u>obesa</u> Beede was 6.2 mm. long and 3.1 mm. wide in the eighth volution. The lateral slopes were convex, but some forms exhibited concavity in the outer volutions. The form ratio increased uniformly until the third or fourth volution was reached. Thereafter the ratio remained constant or sometimes decreased slightly for the next one or two volutions, but then increased slightly throughout the remainder of the shell. In no instance was the form ratio greater than 2.5 for any volution. The most common value for the ultimate volution varied from 2.0 to 2.3. The proloculus was minute, and varied from .178 to .125 mm. with the majority of the specimens near .100 mm.

The spirotheca was always thin and finely alveolar. It thinned gradually as the polar extremities were approached, but the alveola retained their identity in all but the very end-points of each volution. The extension of tectum down the septa appeared as a fine dark line, and was commonly covered by an epithecal layer of shell material. The number of septa per volution increased regularly from the first to ultimate volution.

Fluting was extreme in the polar regions, but less intense in the central portion of the shell. The base of the septa were less intensely fluted than their outer portions, but never appeared perfectly straight. The tunnel was narrow and maintained a steady, but slightly irregular growth throughout all portions of the shell. In the inner five or six volutions the chomata extended better than half the height of the chambers. Thereafter they were more subdued, but never less than half the chamber height. The chomata were massive, and appeared nearly symmetrical, except for a small wedge that often overhung the tunnel. This overhang, especially within the inner five or six volutions, sometimes resulted in a tunnel that appeared as a slit or small circular opening in the septa. Axial filling was generally light. Table 3 should be consulted for measurements of these specimens. Plate I, Figure 3 contains an illustration of a typical member of this species.

Discussion. The mature shells of the author's collection were about 1.5 mm. smaller in length than those described by Thompson (1954). This difference may be attributed to environmental factors, or biased sampling technique by the author or Thompson. Whatever the cause this is a minor difference, and the two forms are considered cospecific.

Occurrence. *Dunbarinella obesa* was abundant in the Neva limestone. This collection was from Blue Mount north of Manhattan, Kansas, in Sec. 7, T. 10 S., R. 8 E., Riley County. The lithology of the Neva limestone at the collecting locality is described in the Appendix, Sample Number 8.

Table 5. Measurements of Dunbarinella obesa (Beede).

| Spec. | Half length | | | | | | | | | Radius vector | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ | $V_9$ | $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ | $V_9$ |
| N 1 | .16 | .30 | .53 | .85 | 1.27 | 1.74 | 2.52 | - | - | .12 | .17 | .27 | .41 | .57 | .76 | 1.02 | - | - |
| N 2 | - | - | - | - | - | - | - | - | - | .07 | .12 | .19 | .31 | .45 | .67 | - | - | - |
| N 4 | - | - | - | - | - | - | - | - | - | .11 | .19 | .31 | .42 | .62 | .88 | 1.16 | - | - |
| N 5 | - | .22 | .39 | .56 | .84 | 1.23 | 1.86 | 2.44 | 3.10 | .08 | .12 | .20 | .31 | .45 | .63 | .89 | 1.17 | 1.56 |
| N 6 | - | - | - | - | - | - | - | - | - | .10 | .17 | .26 | .38 | .58 | .81 | 1.05 | - | - |
| N 7 | .19 | .30 | .56 | .89 | 1.28 | 1.80 | - | - | - | .09 | .14 | .22 | .37 | .56 | .81 | 1.06 | - | - |
| N 8 | - | - | - | - | - | - | - | - | - | .11 | .18 | .28 | .41 | .58 | - | - | - | - |
| N 11 | .24 | .43 | .58 | .85 | 1.25 | 1.88 | 2.62 | 3.19 | - | .14 | .21 | .32 | .45 | .65 | .90 | 1.16 | - | - |
| N 12 | - | - | - | - | - | - | - | - | - | .14 | .21 | .32 | .49 | .68 | .93 | - | - | - |
| N 13 | .06 | .13 | .27 | .47 | .77 | 1.28 | 1.86 | - | - | .06 | .13 | .17 | .29 | .44 | .64 | .87 | - | - |
| N 14 | - | - | - | - | - | - | - | - | - | .10 | .15 | .23 | .33 | .48 | .71 | .98 | - | - |
| N 15 | - | .27 | .44 | .67 | .99 | 1.46 | 2.07 | 2.87 | - | .09 | .14 | .22 | .34 | .46 | .67 | .92 | 1.21 | - |
| N 16 | - | - | - | - | - | - | - | - | - | .10 | .15 | .25 | .36 | .43 | .70 | .94 | - | - |
| N 17 | .21 | .33 | .54 | .79 | 1.27 | - | - | - | - | .12 | .19 | .29 | .46 | .66 | - | - | - | - |
| N 18 | - | - | - | - | - | - | - | - | - | .11 | .16 | .27 | .38 | .54 | .77 | 1.06 | 1.34 | - |
| N 19 | .20 | .39 | .54 | .79 | 1.17 | 1.79 | 2.48 | - | - | .15 | .24 | .36 | .52 | .72 | .96 | 1.22 | - | - |
| N 21 | .11 | .22 | .39 | .67 | .84 | 1.27 | 1.86 | 2.24 | - | .08 | .12 | .21 | .33 | .47 | .67 | .92 | 1.19 | - |
| N 23 | .12 | .23 | .36 | .74 | 1.09 | 1.49 | 2.25 | - | - | .09 | .14 | .24 | .37 | .56 | .82 | 1.13 | - | - |
| N 27 | .25 | .46 | .88 | 1.23 | 1.65 | 2.35 | - | - | - | .14 | .23 | .35 | .51 | .70 | .95 | 1.23 | - | - |

| Spec. | Tunnel angle | | | | | | | | Form ratio | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ | $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ | $V_9$ |
| N 1 | 10 | 16 | 18 | 18 | 21 | 28 | - | - | 1.3 | 1.7 | 2.0 | 2.1 | 2.2 | 2.3 | 2.5 | - | - |
| N 5 | 20 | 15 | 16 | 18 | 19 | 25 | 30 | 38 | - | 1.8 | 2.0 | 1.8 | 1.9 | 2.0 | 2.1 | 2.1 | 2.0 |
| N 7 | - | 20 | 19 | 25 | 30 | 34 | - | - | 2.0 | 2.1 | 2.5 | 2.4 | 2.3 | 2.2 | - | - | - |
| N 11 | 14 | 20 | 23 | 27 | 40 | 32 | 35 | - | 1.7 | 2.0 | 1.9 | 1.9 | 1.9 | 2.1 | 2.3 | - | - |
| N 13 | 13 | 9 | 20 | 18 | 20 | 21 | - | - | 0.9 | 1.3 | 1.6 | 1.7 | 1.8 | 2.0 | 2.2 | - | - |
| N 15 | - | 16 | 16 | 22 | 26 | 34 | 31 | - | - | 1.9 | 2.0 | 2.0 | 2.2 | 2.2 | 2.3 | 2.4 | - |
| N 17 | 14 | 14 | 21 | 22 | 23 | - | - | - | 1.7 | 1.7 | 1.8 | 1.7 | 1.9 | - | - | - | - |
| N 19 | - | 16 | 21 | 23 | 21 | 21 | - | - | 1.3 | 1.6 | 1.5 | 1.6 | 1.6 | 1.9 | 2.0 | - | - |
| N 21 | 21 | 18 | 17 | 22 | 19 | 19 | 20 | 24 | 1.5 | 1.8 | 1.9 | 2.1 | 1.8 | 1.9 | 2.0 | 1.9 | - |
| N 23 | 18 | 19 | 20 | 19 | 23 | 36 | - | - | 1.3 | 1.6 | 1.5 | 2.0 | 1.9 | 1.8 | 2.0 | - | - |
| N 27 | 26 | 20 | 17 | 22 | 23 | 23 | - | - | 1.7 | 2.0 | 2.5 | 2.4 | 2.4 | 1.9 | - | - | - |

| Spec. | Septal Count | | | | | | | | | Thickness of spirotheca | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Prol. | $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ | $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ |
| N 1 | .107 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| N 2 | .078 | 9 | 14 | 16 | 21 | 25 | 23 | 28 | - | - | - | .016 | .020 | .073 | .054 | - | - |
| N 4 | .101 | 12 | 17 | 22 | 23 | 27 | 30 | 29 | - | .017 | .018 | .024 | .035 | .035 | .047 | .073 | - |
| N 5 | - | - | - | - | - | - | - | - | - | - | - | .013 | .019 | .041 | .059 | - | - |
| N 6 | .113 | 8 | 16 | 19 | 23 | 21 | 24 | 30 | - | - | - | .022 | .027 | .034 | .041 | .053 | - |
| N 7 | .096 | - | - | - | - | - | - | - | - | - | - | .011 | .023 | .034 | .055 | - | - |
| N 8 | .109 | 11 | 18 | 20 | 23 | 28 | - | - | - | - | - | - | - | - | - | - | - |
| N 11 | - | - | - | - | - | - | - | - | - | - | - | .009 | - | .045 | .060 | .073 | - |
| N 12 | - | 11 | 17 | 24 | 23 | 25 | - | - | - | - | .012 | .017 | .024 | .041 | .051 | - | - |
| N 13 | - | - | - | - | - | - | - | - | - | - | - | - | .020 | - | - | .041 | - |
| N 14 | .101 | 10 | 17 | 19 | 20 | 23 | 27 | - | - | - | - | .015 | .024 | .030 | .039 | .060 | - |
| N 15 | .078 | - | - | - | - | - | - | - | - | - | - | .018 | .023 | - | .045 | - | - |
| N 16 | .100 | 12 | 13 | 17 | 20 | 22 | 25 | 23 | 29 | .016 | .009 | .029 | .034 | .034 | .034 | .054 | - |
| N 17 | - | - | - | - | - | - | - | - | - | - | - | - | .025 | - | - | - | - |
| N 18 | .125 | 9 | 16 | 23 | 22 | 27 | 28 | - | - | - | - | - | - | - | - | - | - |
| N 19 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | .041 | - | - |
| N 21 | .094 | - | - | - | - | - | - | - | - | - | - | .015 | .016 | - | .041 | .052 | .062 |
| N 23 | .096 | - | - | - | - | - | - | - | - | - | - | - | .025 | .041 | - | - | - |
| N 27 | .125 | - | - | - | - | - | - | - | - | .008 | .014 | .020 | .028 | .045 | .053 | .052 | - |

Genus Schwagerina Moller, 1877

Schwagerina jewetti Thompson (Thompson, M. L., Protozoa: American Wolfcampian fusulinids. Univ. Kans. Paleontological Contr. Article 5: 61-62. 1954.)

Material Studied. Abundant material was collected from the Cottonwood limestone. The specimens of the collection were calcite-filled and poorly preserved. In several instances replacement was so extensive that internal structure was destroyed, and the thin-sections were useless. Twenty specimens were prepared in thin-section from this collection.

Description. The tests of Schwagerina jewetti Thompson were elongate with bluntly pointed poles that became extended in the outer volutions, and possessed lateral slopes that were broadly convex. These forms consisted of six or seven volutions, which had a length that varied from 5.6 to 6.0 mm. with a corresponding width that varied from 2.0 to 2.3 mm. The proloculus was small, averaging .118 mm. for four specimens. The elongation of these shells was reflected in their form ratio, which commonly reached a value between 2.7 and 3.2 in the ultimate volution. Chamber height was smallest at the center of the shell, but increased gradually as the polar ends were approached. The spirotheca was thin and finely alveolar.

The tunnel was narrow and slit-like with a path that was irregular or straight. The tunnel angle of the first whorl was commonly near 20 degrees, and gradually increased in each successive volution until a value greater than 30, but less than 40 degrees was obtained for the ultimate volution. The chomata were symmetrical and half the height of the chamber, except in the penultimate volution where they were subdued or missing.

The septa were highly fluted in all parts of the shell. The first volution of three sagittal sections contained 11 septa, while the ultimate volution varied in number from 29 to 33. Axial filling was dense. Plate I, Figure 4 shows one specimen that was typical of this group. Measurements of these species are contained in Table 4.

Discussion. The specimens of Thompson's collection contained six to eight and one-half volutions, and were 4.9 to 8.0 mm. long and 1.6 to 2.6 mm. wide. None of the specimens of the author's sample attained the maximum size reached by Thompson's collection, but all were within Thompson's stated range of variation; a factor that may be attributed to sampling technique, but may also indicate an immature population. No evidence can be cited that would support either supposition. These forms agreed with Thompson's description of Schwagerina jewetti in all other respects.

Occurrence. This species is found in abundance in the Cottonwood limestone. The collecting locality of specimens for this study was the N.W. 1/4, N.W. 1/4, Sec. 4, T. 9 S., R. 7 E., Riley County, Kansas. A lithologic description of the Cottonwood limestone at the collecting locality appears in the Appendix, Sample Number 9.

Genus Triticites Girty, 1904

Triticites confertus Thompson var. inflatus Matthews, n. var.
(Thompson, M. L., Protozoa: American Wolfcampian fusulinids, Univ. Kans. Paleontological Contr. Article 5: 38-39. 1954.)

Table 4. Measurements of *Schwagerina jewetti* Thompson.

| | | Half length | | | | | | | Radius vector | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spec. | Prol. | $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ |
| C 1 | .116 | - | .40 | .68 | .99 | 1.77 | 2.42 | - | .11 | .17 | .27 | .38 | .57 | .76 | - |
| C 4 | - | - | - | - | - | - | - | - | .09 | .19 | .28 | .43 | .65 | .96 | - |
| C 5 | - | .13 | .30 | .56 | .88 | 1.41 | 2.13 | 3.03 | .09 | .16 | .26 | .40 | .60 | .84 | 1.13 |
| C 7 | - | - | .32 | .57 | .86 | 1.36 | 2.09 | 2.82 | .11 | .16 | .24 | .35 | .52 | .75 | 1.00 |
| C 8 | .130 | - | - | - | - | - | - | - | .12 | .19 | .30 | .46 | .67 | - | - |
| C 9 | .108 | .16 | .31 | .78 | 1.20 | 1.97 | - | - | .10 | .16 | .26 | .43 | .64 | - | - |
| C 10 | .118 | - | - | - | - | - | - | - | .14 | .21 | .34 | .56 | .82 | 1.11 | - |

| | Form ratio | | | | | | | Tunnel angle | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spec. | $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ |
| C 1 | - | 1.2 | 2.5 | 2.6 | 3.1 | 3.2 | - | 16 | 16 | 25 | 30 | - | - |
| C 5 | 1.5 | 1.9 | 2.2 | 2.2 | 2.4 | 2.5 | 2.7 | 20 | 36 | 30 | 32 | 37 | - |
| C 7 | - | 2.0 | 2.4 | 2.5 | 2.6 | 2.7 | 2.8 | - | 24 | 28 | - | - | - |
| C 9 | 1.6 | 2.0 | 3.0 | 2.8 | 3.1 | - | - | 20 | 25 | 32 | 31 | - | - |

Thickness of spirotheca

| Spec. | $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ |
|---|---|---|---|---|---|---|---|
| C 1 | - | - | - | .035 | .059 | - | - |
| C 4 | - | - | - | - | .058 | .078 | - |
| C 5 | - | - | - | - | .062 | - | .074 |
| C 7 | - | - | - | - | .056 | .072 | - |
| C 8 | - | - | - | .037 | .057 | - | - |
| C 9 | - | - | .019 | .031 | - | - | - |
| C 10 | - | .019 | .033 | .049 | .062 | - | - |

Material Studied. Ten thin-sections were prepared for this study from material collected from the Five Point limestone. The tests were well preserved although calcite-filled.

Description. Triticites confertus var. inflatus was small and fusiform and consisted of seven to nine volutions at maturity. The length was generally between 3.0 and 4.0 mm. with a corresponding width near 2.0 mm., although one exceptional specimen of nine volutions measured 4.8 mm. in length and 3.4 mm. in width. The central region was inflated, and lateral slopes were either straight or concave. The axis of coiling was straight, and the poles were sharply pointed. The form ratio commonly increased steadily throughout the first two or three volutions, but thereafter remained constant or gradually decreased in the remainder of the shell. Only rarely was a value greater than 2.0 registered for any of the volutions. The proloculus was small, and varied from .091 to 176 mm. for seven specimens with an average of .121 mm.

The spirotheca was moderately thick and coarsely alveolar. Septa were moderately spaced, and nearly straight in the central portion of the shell, but became broadly fluted in the polar extremities.

The tunnel was narrow and regular in its development. The tunnel angle of the first volution was commonly near 20 degrees, and increased only slightly until a value approximating 30 degrees was attained in the ultimate volution. The chomata were distinctly asymmetrical in the first several volutions, but became nearly symmetrical in the outer ones. Chomata were massive and high, and usually reached at least three-fourths the height of the chamber at all stages of growth. Plate I, Figure 5 is an illustration of one of the species of this group. Quantitative data is listed in Table 5.

Discussion. Since these forms were easily identified with those of Thompson's description, but exhibited certain differences, they were thought to comprise a variation of Triticites confertus, and were therefore designated as such by the author.

Triticites confertus var. inflatus was 1.0 to 2.0 mm. shorter than Triticites confertus; had a 10 to 20 degree narrower tunnel in the outer three or four volutions; and was highly inflated in the center of its shell. Thompson's specimens frequently had a form ratio equal or greater than 2.0 for the sixth to final volutions, while the specimens of the author's collection were most commonly less than 2.0 in these volutions. This fact was well illustrated by specimen FP 21 which maintained a form ratio of 1.4 or 1.5 for the fifth to ninth volution. The characteristic that most sharply distinguished Triticites confertus from Triticites confertus var. inflatus was the latter's more inflated central area.

Occurrence. These specimens were collected from the Five Point limestone at a road cut on the county road that borders the south side of Sec. 34, T. 15 S., R. 12 E., Lyon County, Kansas. The lithology of the Five Point limestone at the collecting locality is noted in the Appendix, Sample Number 4.

Table 5. Measurements of <u>Triticites</u> <u>confertus</u> Thompson var. <u>inflatus</u> Matthews.

| | Half length | | | | | | | | | Radius vector | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spec. | $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ | $V_9$ | $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ | $V_9$ |
| FP 3 | .22 | .41 | - | .83 | 1.19 | 1.60 | - | - | - | .12 | .22 | .31 | .46 | .64 | .84 | - | - | - |
| FP 4 | - | - | - | - | - | - | - | - | - | .12 | .19 | .35 | .54 | .74 | 1.09 | - | - | - |
| FP 5 | .18 | .30 | .48 | .75 | 1.17 | 1.58 | 2.00 | - | - | .11 | .18 | .31 | .50 | .76 | 1.02 | - | - | - |
| FP 10 | - | - | - | - | - | - | - | - | - | .14 | .25 | .29 | .59 | .83 | 1.10 | - | - | - |
| FP 16 | - | - | - | - | - | - | - | - | - | .09 | .15 | .24 | .36 | .50 | .74 | .94 | - | - |
| FP 18 | - | - | - | - | - | - | - | - | - | .08 | .14 | .23 | .34 | .46 | .65 | .87 | - | - |
| FP 21 | .14 | .30 | .47 | .67 | .86 | 1.16 | 1.60 | 2.06 | 2.42 | .11 | .19 | .29 | .41 | .58 | .82 | 1.09 | 1.39 | 1.69 |
| FP 23 | .16 | .30 | .53 | .67 | 1.07 | 1.37 | - | - | - | .09 | .16 | .27 | .45 | .67 | .94 | - | - | - |
| FP 25 | .18 | .37 | .71 | .97 | 1.22 | 1.87 | - | - | - | .12 | .20 | .31 | .47 | .65 | .92 | - | - | - |
| FP 29 | .11 | .23 | .42 | .67 | .97 | 1.32 | 1.79 | - | - | .08 | .15 | .24 | .35 | .53 | .74 | 1.03 | - | - |

| | Form ratio | | | | | | | | | Tunnel angle | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spec. | $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ | $V_9$ | $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ |
| FP 3 | 1.8 | 1.9 | - | 1.8 | 1.9 | 1.9 | - | - | - | 20 | 25 | 26 | 25 | 30 | - | - | - |
| FP 5 | 1.7 | 1.7 | 1.6 | 1.5 | 1.5 | 1.5 | - | - | - | 22 | 20 | 27 | 16 | 26 | 33 | - | - |
| FP 21 | 1.3 | 1.5 | 1.6 | 1.6 | 1.5 | 1.4 | 1.5 | 1.5 | 1.4 | 20 | 13 | 16 | 18 | 17 | 17 | 24 | 31 |
| FP 23 | 1.4 | 1.9 | 1.9 | 1.5 | 1.6 | 1.4 | - | - | - | 20 | 19 | 16 | 26 | 27 | - | - | - |
| FP 25 | 1.5 | 1.9 | 2.3 | 2.1 | 1.9 | 2.0 | - | - | - | 18 | 19 | 23 | 28 | 26 | - | - | - |
| FP 29 | 1.3 | 1.6 | 1.8 | 1.9 | 1.8 | 1.8 | 1.8 | - | - | 20 | 19 | 21 | 17 | 26 | 26 | - | - |

| | Septal count | | | | | | | | Thickness of spirotheca | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spec. | Prol. | $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ |
| FP 3 | .169 | - | - | - | - | - | - | - | .016 | - | - | .034 | - | - | - | - |
| FP 4 | .122 | 8 | 17 | 21 | 27 | 28 | 30 | - | - | - | - | .038 | .066 | .082 | .091 | - |
| FP 5 | - | - | - | - | - | - | - | - | - | .027 | .037 | .053 | .065 | .100 | .170 | - |
| FP 10 | .176 | 10 | 17 | 21 | 23 | 27 | 28 | 29 | - | - | .039 | .061 | .072 | .098 | .105 | - |
| FP 16 | .102 | 9 | 13 | 18 | 19 | 23 | 20 | 23 | - | - | - | .027 | .034 | .070 | - | - |
| FP 18 | .091 | 9 | 14 | 16 | 17 | 21 | 25 | 28 | - | - | - | - | .037 | .045 | .051 | - |
| FP 21 | .106 | - | - | - | - | - | - | - | - | .021 | .027 | .037 | .051 | .078 | .075 | .098 |
| FP 23 | .101 | - | - | - | - | - | - | - | .006 | .010 | .016 | .030 | .055 | .078 | - | - |
| FP 25 | - | - | - | - | - | - | - | - | .014 | .021 | .028 | .019 | .036 | - | - | - |

Triticites havenensis Matthews, n. sp.

Material Studied. Specimens were collected from one outcrop of the Grandhaven limestone. From this collection, whose members were excellently preserved although calcite-filled, 31 thin-sections were prepared.

Description. The shell of Triticites havenensis was moderately large and fusiform, with bluntly pointed polar ends and inflated center. The lateral slopes were convex in the inner five or six volutions, but noticeably concave in the remainder of the shell. Large specimens with eight volutions were about 8.5 mm. in length and 3.4 mm. wide, giving a form ratio of 2.7 or 2.8 for the ultimate volution. Shell shape remained the same for the first five or six volutions, but thereafter the polar ends became progressively more extended. The proloculus was small with an outside diameter that varied from .089 to .192 mm. The average value for 13 specimens was .130 mm.

The spirotheca was finely alveolar, but thick. Septa were thin, moderately spaced, and possessed a structureless pycnotheca. The first volution usually contained eight to 11 septa, while the last varied from 27 to 30. Septal pores were numerous in the polar extremities of the shell, but scarce in the central portions. Fluting was narrow in the polar ends, but the septa became broadly warped to straight near the tunnel.

The tunnel's path was usually straight, although several specimens were extremely irregular. The tunnel angle increased uniformly for the first four or five volutions, but thereafter became rapidly expanded. The second volution most often gave a value greater than 20 degrees, while the seventh was commonly greater than 60 degrees. The chomata had steep tunnel sides, and lowly inclined poleward slopes in the first or second volutions, but became narrow and more symmetrical in outer whorls, where they often exhibited tunnel overhang. Chomata extended one-half to slightly less than one-half the height of the chamber in all but the ultimate volution, where they were usually subdued. Measurements of specimens appear in Table 6. Plate I, Figure 6 shows one of the typical specimens of this group.

Discussion. Triticites havenensis was similar to Triticites ventricosus of the Hughes Creek shale, but may be distinguished from the latter by its greater tunnel angle, and larger form ratio for most volutions. This Pennsylvanian form was also similar to Triticites uddeni, but may be distinguished from it by its higher degree of inflation, thicker spirotheca, concave lateral slopes in the outer volutions, and more fusiform shape.

Occurrence. The sample studied was collected from the Grandhaven limestone where it cropped out in the S.W. 1/2, S.W. 1/4, Sec. 25, T. 16 S., R. 12 E., Lyon County, Kansas. In the Appendix, Sample Number 1, the lithology of this formation is described.

Triticites meeki Moller (Thompson, M. L., Protozoa: American Wolfcampian fusulinids. Univ. Kans. Paleontological Contr. Article 5: 39-40. 1954.)

Material Studied. From two samples of the Hughes Creek shale approximately 20 thin-sections were prepared for this study. All tests were well preserved and calcite-filled.

Table 6. Measurements of *Triticites havenensis* Matthews.

| Spec. | Half length $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ | Radius vector $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| G 3 | .23 | .50 | .96 | 1.37 | 1.98 | 3.21 | - | - | .14 | .25 | .40 | .61 | .87 | 1.20 | 1.59 | - |
| G 4 | - | - | - | - | - | - | - | - | .11 | .19 | .32 | .50 | .72 | .96 | - | - |
| G 5 | .38 | .58 | .81 | 1.25 | 1.98 | 3.07 | - | - | .19 | .21 | .42 | .61 | .85 | 1.13 | - | - |
| G 8 | - | - | - | - | - | - | - | - | .14 | .24 | .40 | .60 | .83 | 1.15 | - | - |
| G 10 | - | - | - | - | - | - | - | - | .13 | .21 | .34 | .50 | .70 | 1.01 | 1.29 | 1.59 |
| G 11 | .21 | .38 | .56 | .93 | 1.55 | 2.41 | 3.45 | - | .12 | .20 | .34 | .51 | .74 | 1.09 | 1.44 | - |
| G 12 | - | - | - | - | - | - | - | - | .14 | .25 | .41 | .62 | .91 | 1.23 | 1.61 | - |
| G 14 | - | - | - | - | - | - | - | - | .11 | .18 | .30 | .47 | .65 | .91 | - | - |
| G 16 | - | - | - | - | - | - | - | - | .09 | .16 | .23 | .46 | .72 | .98 | 1.38 | - |
| G 18 | - | - | - | - | - | - | - | - | .10 | .17 | .26 | .39 | .58 | .81 | - | - |
| G 20 | - | - | - | - | - | - | - | - | .12 | .21 | .33 | .47 | .65 | .88 | - | - |
| G 21 | .27 | .54 | .71 | 1.08 | 1.85 | 2.67 | - | - | .16 | .25 | .39 | .58 | .85 | 1.16 | 1.56 | - |
| G 25 | .18 | .31 | .50 | .90 | 1.45 | 1.99 | 3.08 | - | .11 | .18 | .30 | .44 | .64 | .86 | 1.18 | - |
| G 29 | .21 | .37 | .70 | 1.22 | 1.87 | 2.69 | 3.76 | - | .14 | .23 | .35 | .54 | .76 | 1.09 | 1.36 | 1.69 |
| G 33 | .19 | .32 | .62 | .98 | 1.45 | 2.05 | 3.04 | 4.30 | .15 | .22 | .37 | .56 | .79 | 1.05 | 1.35 | 1.69 |
| G 35 | .17 | .44 | .65 | 1.03 | 1.63 | 2.38 | 3.23 | 4.30 | .14 | .23 | .36 | .51 | .67 | .96 | 1.24 | 1.64 |

| Spec. | Form ratio $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ | Tunnel angle $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| G 3 | 1.6 | 2.0 | 2.4 | 2.2 | 2.2 | 2.6 | - | - | 24 | 45 | 23 | 33 | 34 | - | - |
| G 5 | 2.0 | 2.0 | 1.9 | 2.0 | 2.3 | 2.7 | - | - | 26 | 16 | 27 | 40 | 38 | - | - |
| G 11 | 1.8 | 1.9 | 1.7 | 1.8 | 2.1 | 2.3 | 2.4 | - | 24 | 21 | 34 | 39 | 50 | 48 | - |
| G 21 | 1.7 | 2.1 | 1.8 | 1.9 | 2.0 | 2.3 | - | - | 27 | 31 | 24 | 32 | 34 | 35 | - |
| G 25 | 1.7 | 1.7 | 1.7 | 2.1 | 2.3 | 2.3 | 2.6 | - | 19 | 25 | 32 | 49 | 59 | 60 | - |
| G 29 | 1.5 | 1.7 | 2.0 | 2.3 | 2.4 | 2.5 | 2.7 | - | 21 | 23 | 30 | 27 | 37 | 41 | 64 |
| G 33 | 1.3 | 1.4 | 1.7 | 1.8 | 1.8 | 2.2 | 2.4 | - | 14 | 21 | 24 | 27 | 35 | 40 | 53 |
| G 35 | 1.3 | 1.9 | 1.8 | 2.0 | 2.3 | 2.4 | 2.5 | 2.8 | 20 | 24 | 26 | 35 | 50 | 37 | 63 |

| Spec. | Septal count Prol. | $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ | Thickness of spirotheca $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| G 3 | .151 | - | - | - | - | - | - | - | - | - | .046 | .048 | .069 | .088 | .101 | - | - |
| G 4 | .108 | 8 | 15 | 17 | 22 | 24 | 22 | - | - | - | - | - | .030 | .062 | - | - | - |
| G 5 | .192 | - | - | - | - | - | - | - | - | - | .024 | .034 | .055 | .078 | .090 | - | - |
| G 8 | .140 | 10 | 17 | 20 | 21 | 23 | 28 | - | - | - | - | - | .067 | .087 | .117 | - | - |
| G 10 | .126 | 9 | 15 | 17 | 22 | 23 | 25 | 27 | 40 | - | .035 | .039 | .051 | .072 | .079 | - | - |
| G 11 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| G 12 | .120 | 11 | 16 | 18 | 25 | 29 | - | - | - | - | - | .029 | .057 | .074 | .095 | - | - |
| G 14 | .091 | 9 | 14 | 16 | 18 | 23 | 24 | - | - | - | - | .034 | .042 | .061 | .084 | - | - |
| G 16 | .087 | 8 | 13 | 18 | 21 | 22 | 29 | 30 | - | - | .020 | .023 | .049 | .079 | .080 | - | - |
| G 18 | - | 10 | 15 | 16 | 20 | 19 | 21 | - | - | - | - | - | .033 | .055 | - | - | - |
| G 20 | .123 | 8 | 16 | 19 | 23 | 25 | - | - | - | - | - | - | .035 | .046 | - | - | - |
| G 21 | .178 | - | - | - | - | - | - | - | - | - | .021 | .038 | .078 | .086 | .123 | .147 | - |
| G 25 | .125 | - | - | - | - | - | - | - | - | - | .027 | .023 | .059 | .066 | .098 | .096 | - |
| G 29 | - | - | - | - | - | - | - | - | - | - | .020 | .037 | .056 | .071 | .100 | .118 | .143 |
| G 33 | .106 | - | - | - | - | - | - | - | - | - | - | .039 | .078 | .082 | .107 | .134 | .139 |
| G 35 | .147 | - | - | - | - | - | - | - | - | - | .023 | .035 | .058 | .087 | .084 | .092 | .126 |

<u>Description</u>. The shells of <u>Triticites meeki</u> were elongate to nearly fusiform in shape. They attained a maximum length and width in the eighth volution of 10.0 and 3.7 mm. respectively, and a minimum length and width in the seventh volution of 7.9 and 3.4 mm. respectively. The lateral slopes were broadly convex, but showed slight concavity in the outer volutions. The poles were bluntly pointed, and sometimes became noticeably extended in the outer volutions. Chamber height remained nearly uniform for the entire length of the shell, a phenomenon particularly noticeable in the outer volutions. The form ratio increased steadily in successive volutions until a value which varied from 2.5 to 3.1 was obtained in the ultimate volution of mature specimens. The proloculus was moderate in size and oval or irregular in outline with a diameter that averaged .247 mm. for five specimens.

The spirotheca was thick and coarsely alveolar, and maintained nearly the same width for the entire length of the shell. Near the poles it tapered in thickness rapidly, until in the polar ends, it appeared thin and structureless. The keriotheca often extended down the septa and caused the spirotheca to sporadically thicken. Fluting was narrow in the polar extremities, and adjacent septa often touched. Toward the center of the shell fluting became broader, but was never perfectly straight. There were either 10 or 11 septa in the first volution of the three shells studied in sagittal section, and from 29 to 35 in the ultimate volution. Septal pores were large and abundant in the polar ends and in the central portion of the shell in outer volutions.

The tunnel was usually regular and became wide in the outer volutions, where it attained a value greater than 50 degrees, and sometimes exceeded 60 degrees. The chomata were asymmetrical and massive in the inner five or six volutions, and extended half the chamber height. Thereafter they became lower, less massive, and were often absent in the penultimate volution. Table 7 contains quantitative data for these specimens. Plate I, Figure 7 shows an axial section of a typical member of this group.

Discussion. The shells of this collection varied little from those described by Thompson. The only difference, which was not a consistent one, was the smaller form ratio of the specimens of the author's collection. *Triticites meeki* was found in association with *Triticites ventricosus* and *Triticites ventricosus* var. *inflatus*. It may be distinguished from these two by its more elongate shape, less inflated central area, and greater tunnel angle.

Occurrence. Abundant well preserved specimens were collected from the Hughes Creek shale at two different locations. The first collection was taken from this formation at Blue Mount Hill north of Manhattan in Sec. 7, T. 10 S., R. 8 E., Riley County, Kansas; the second from a road cut in U. S. Highway 40, in the S.W. 1/4, S.W. 1/4, S.W. 1/4, Sec. 27, T. 11 S., R. 12 E., Wabaunsee County, Kansas. Lithologic descriptions of these formations appear in the Appendix, Samples Numbers 5 and 6.

*Triticites* cf. *T. pointensis* Thompson (Thompson, M. L., Protozoa: American Wolfcampian fusulinids, Univ. Kans. Paleontological Contr. Article 5: 37-39. 1954.)

Table 7. Measurements of *Triticites meeki* Moller.

| Spec. | Prol. | Half length V1 | V2 | V3 | V4 | V5 | V6 | V7 | V8 | Radius vector V1 | V2 | V3 | V4 | V5 | V6 | V7 | V8 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H 28 | .194 | - | - | - | - | - | - | - | - | .19 | .32 | .49 | .69 | .96 | 1.26 | 1.58 | 1.86 |
| H 30 | - | - | - | - | - | - | - | - | - | .21 | .35 | .53 | .75 | 1.03 | 1.37 | 1.83 | - |
| H 32 | - | - | - | - | - | - | - | - | - | .17 | .28 | .45 | .67 | .89 | 1.17 | 1.39 | - |
| H 47 | - | .37 | .59 | .91 | 1.47 | 2.03 | 2.65 | 3.35 | 4.24 | .20 | .31 | .49 | .67 | .91 | 1.13 | 1.39 | 1.68 |
| H 51 | .259 | .30 | .51 | .86 | 1.33 | 2.23 | 3.03 | 3.96 | - | .20 | .31 | .47 | .64 | .91 | 1.24 | 1.49 | - |
| H 53 | .305 | .56 | .87 | 1.35 | 1.95 | 2.69 | 3.61 | 4.84 | - | .32 | .48 | .66 | .86 | 1.09 | 1.34 | 1.58 | - |
| H 57 | .222 | .31 | .56 | 1.00 | 1.71 | 2.28 | 3.14 | 3.86 | 5.01 | .21 | .32 | .53 | .77 | .98 | 1.26 | 1.54 | 1.88 |
| H 61 | - | .29 | .54 | 1.01 | 1.55 | 2.24 | 3.10 | 3.97 | - | .17 | .31 | .53 | .76 | 1.05 | 1.43 | 1.73 | - |
| H 69 | - | .58 | .82 | 1.22 | 1.95 | 2.59 | 3.67 | 4.82 | - | .28 | .44 | .62 | .85 | 1.09 | 1.42 | 1.82 | - |
| H 71 | - | .31 | .56 | .84 | 1.17 | 1.67 | 2.58 | 3.24 | 4.18 | .20 | .32 | .48 | .67 | .87 | 1.14 | 1.42 | - |
| H 73 | - | .30 | .62 | .90 | 1.31 | 1.92 | 2.54 | 3.77 | 4.63 | .17 | .30 | .48 | .72 | .94 | 1.24 | 1.53 | 1.87 |
| H 75 | - | .36 | .65 | .96 | 1.42 | 2.04 | 2.67 | 3.42 | 4.18 | .18 | .32 | .48 | .65 | .90 | 1.13 | 1.40 | 1.61 |

| Spec. | Thickness of spirotheca V1 | V2 | V3 | V4 | V5 | V6 | V7 | V8 | Septal count V1 | V2 | V3 | V4 | V5 | V6 | V7 | V8 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H 28 | - | - | - | .071 | .072 | .098 | .107 | - | 11 | 21 | 21 | 25 | 27 | 30 | 31 | 35 |
| H 30 | - | - | - | .069 | .087 | .116 | .105 | - | 10 | 17 | 18 | 22 | 25 | 25 | 28 | 31 |
| H 32 | - | - | - | .078 | .097 | .119 | - | - | 11 | 17 | 19 | 21 | 27 | 28 | 29 | - |
| H 47 | .023 | .047 | .059 | .063 | .102 | .094 | .102 | .103 | - | - | - | - | - | - | - | - |
| H 51 | - | .028 | .046 | .075 | .097 | .106 | - | - | - | - | - | - | - | - | - | - |
| H 53 | .031 | .048 | .078 | .090 | .130 | .108 | - | - | - | - | - | - | - | - | - | - |
| H 57 | .020 | .027 | .042 | .072 | .092 | .111 | .126 | .133 | - | - | - | - | - | - | - | - |
| H 61 | - | .029 | .054 | .088 | .100 | .130 | .108 | - | - | - | - | - | - | - | - | - |
| H 69 | .025 | .039 | .072 | .105 | .109 | .125 | .129 | - | - | - | - | - | - | - | - | - |
| H 71 | .016 | .034 | .057 | .073 | .073 | .110 | - | - | - | - | - | - | - | - | - | - |
| H 73 | .018 | .029 | .039 | .078 | .085 | .110 | .105 | .129 | - | - | - | - | - | - | - | - |
| H 75 | .020 | - | .051 | - | .078 | .090 | .090 | - | - | - | - | - | - | - | - | - |

| Spec. | Form ratio V1 | V2 | V3 | V4 | V5 | V6 | V7 | V8 | Tunnel angle V1 | V2 | V3 | V4 | V5 | V6 | V7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H 47 | 1.9 | 1.9 | 1.9 | 2.2 | 2.2 | 2.4 | 2.4 | 2.5 | 18 | 25 | 28 | 35 | 37 | 32 | - |
| H 51 | 1.6 | 1.7 | 1.9 | 2.1 | 2.5 | 2.5 | 2.7 | - | 21 | 20 | 28 | 33 | 54 | 30 | - |
| H 53 | 1.7 | 1.8 | 2.0 | 2.3 | 2.5 | 2.7 | 3.1 | - | 22 | 26 | 35 | 53 | 66 | - | - |
| H 57 | 1.5 | 1.7 | 1.9 | 2.2 | 2.3 | 2.5 | 2.5 | 2.7 | 14 | 23 | 24 | 31 | 32 | 46 | 53 |
| H 61 | 1.7 | 1.7 | 1.9 | 2.0 | 2.1 | 2.2 | 2.4 | - | - | 25 | 32 | 43 | 40 | 49 | - |
| H 69 | 2.1 | 1.9 | 2.0 | 2.3 | 2.4 | 2.6 | 2.7 | - | 34 | 27 | 33 | 34 | 38 | 50 | - |
| H 71 | 1.6 | 1.8 | 1.7 | 1.7 | 1.9 | 2.3 | 2.3 | 2.5 | 18 | 22 | 25 | 25 | 26 | 30 | - |
| H 73 | 1.8 | 2.1 | 1.9 | 1.8 | 2.1 | 2.1 | 2.5 | 2.5 | 20 | 25 | 22 | 32 | 39 | 51 | - |
| H 75 | 2.0 | 2.0 | 2.0 | 2.2 | 2.3 | 2.4 | 2.3 | 2.6 | 22 | 23 | 28 | 38 | 49 | - | - |

Material Studied. Only two specimens of this form were available for study from the Five Point limestone. Both were arbitrarily prepared in axial section.

Description. Triticites cf. T. pointensis consisted of seven volutions. They were small and fusiform with sharply pointed poles. The largest of the two attained a length of 4.1 mm. and a width of 1.9 mm. The lateral slopes were convex, and the axis of coiling straight. The form ratio was generally small throughout the entire shell, but showed an increase in the outer volutions. The proloculus was small, and measured .073 and .078 mm. in the two specimens of this collection. The spirotheca was thin and finely alveolar. Since no sagittal section was available, it was impossible to make any statement regarding the number or spacing of the septa. The tunnel was narrow, and never attained 30 degrees for any volution except in the third volution of specimen FP 37, where an anomalous value of 40 degrees was recorded. The chomata extended half the height of the chambers and were highly asymmetrical in the outer whorls. The tunnel side of the chomata often overhung the tunnel and sometimes caused the tunnel to appear as a small circular opening in the septa. Table 8 contains measurements for this group. Plate I, Figure 9 illustrates a typical specimen of these species.

Discussion. These forms are probably cospecific with Triticites pointensis Thompson, for the chomata configuration, shell shape, proloculus size, wall thickness, and tunnel angle are similar, but since the number of septa is unknown, and these forms have slightly larger tests, their designation is uncertain.

Table 8. Measurements of Triticites cf. pointensis Thompson.

| Spec. | Prol. | Half length $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | Radius vector $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FP 19 | .073 | .16 | .30 | .45 | .73 | 1.14 | 1.42 | 2.03 | .10 | .16 | .25 | .37 | .56 | .76 | .94 |
| FP 37 | .078 | .15 | .33 | .57 | .87 | 1.42 | 1.85 | - | .10 | .17 | .28 | .43 | .64 | .93 | - |

| Spec. | Form ratio $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | Septal count $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FP 19 | 1.6 | 1.9 | 1.8 | 2.0 | 2.0 | 1.9 | 2.2 | 20 | 18 | 20 | 25 | 26 | 26 |
| FP 37 | 1.5 | 2.0 | 2.1 | 2.0 | 2.2 | 2.0 | - | 20 | 24 | 40 | - | 28 | - |

| Spec. | Thickness of spirotheca $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ |
|---|---|---|---|---|---|---|---|
| FP 19 | - | .009 | .011 | .021 | .038 | .067 | .064 |
| FP 37 | .009 | .014 | .018 | .036 | .043 | - | - |

They are therefore questionably referred to Triticites pointensis.

Occurrence. These forms were found associated with Triticites confertus var. inflatus in the Five Point limestone S.W. 1/4, S.W. 1/4, S.W. 1/4, Sec. 34, T. 15 S., R. 12 E., Lyon County, Kansas. The Appendix, Sample Number 4, should be consulted for the lithologic description of the Five Point limestone made at the collecting location.

Triticites rockensis Thompson var. paxicoensis Matthews, n. var.
(Thompson, M. L., Univ. Kans. Paleontological Contr. Protozoa: American Wolfcampian fusulinids. Article 5: 44. 1954.)

Material Studied. Numerous specimens were collected from one outcrop of the Glenrock limestone, and ten axial and six sagittal sections were prepared from this collection. These specimens had been weathered, and as a result the penultimate and ultimate volutions were commonly missing. All specimens were calcite-filled and partially replaced, which made spirotheca thickness measurements difficult.

Description. Triticites rockensis var. paxicoensis was small, inflated, and fusiform with convex lateral slopes. The axis of coiling was straight. Since the outer volutions were usually missing, the number of volutions of mature individuals must remain uncertain. The remaining damaged and unmeasureable portions of the outer shell indicated a mature test that contained at least seven and one-half volutions. This was one volution less than Thompson's originally described specimens. Five specimens of five volutions averaged 6.0 mm. in length, and 3.4 mm. in width. The form ratio commonly varied from 1.3 to 1.9 for the first volution, and thereafter increased uniformly to between 1.9 and 2.1 in the fifth volution.

The proloculus was relatively large in comparison with the small shell size. It ranged from .156 to .232 mm. for six specimens, with an average value of .190 mm. The chamber height was either constant throughout the length of the shell or increased slightly at the polar extremities.

The spirotheca was thin throughout. The alveola were coarse, and could be easily recognized in the fourth or fifth volution, but only with difficulty in the inner volutions. Epithecal deposits commonly extended down the septa, and usually coated the top of the underlying chamber between chomata. The septa were thin and composed of thin pycnotheca. They were slightly fluted to plane in the central portion of the shell, but more highly fluted near the poles. There were usually ten or less septa in the first volution, and the number increased regularly until 22 or 23 septa were present in the fifth volution.

The tunnel was usually straight, but sometimes showed some slight irregularity. The first volution was usually wide and often attained a value near 40 degrees. Thereafter the increase was irregular but steady until a 50 degree width was approached in the fifth volution. The chomata were distinct and asymmetrical. They usually extended half the height of the chamber in the inner three or four volutions, but thereafter became progressively less bold, and grew lower and wider until they vanished in the penultimate volution. Table 9 contains measurements for this group. Plate I, Figure 9 illustrates a typical specimen of this species.

Table 9. Measurements of <u>Triticites</u> <u>rockensis</u> (Thompson) var. <u>Paxicoensis</u> Matthews.

| | | Half-length | | | | | | Radius vector | | | | | | Tunnel angle | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spec. | Prol. | $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ |
| Gl 1 | .209 | .36 | .62 | .97 | 1.43 | - | - | .20 | .33 | .50 | .73 | - | - | 32 | 22 | 36 | 54 | - | - |
| Gl 3 | .211 | .28 | .56 | .95 | 1.42 | - | - | .19 | .31 | .52 | .78 | - | - | 21 | 25 | 30 | - | - | - |
| Gl 5 | .156 | .18 | .41 | .77 | 1.13 | - | - | .13 | .21 | .33 | .56 | - | - | 40 | 42 | 47 | 48 | - | - |
| Gl 7 | .232 | .37 | .68 | .90 | 1.49 | - | - | .29 | .42 | .56 | .79 | 1.02 | - | 13 | 20 | - | 31 | - | - |
| Gl 11 | - | .26 | .39 | .69 | 1.05 | 1.53 | - | .16 | .26 | .39 | .55 | .74 | - | 32 | 32 | 37 | - | - | - |
| Gl 13 | - | .14 | .25 | .46 | .73 | 1.17 | 1.55 | .09 | .16 | .25 | .39 | .56 | - | - | 34 | 37 | 47 | 46 | 44 |
| Gl 14 | - | - | - | - | - | - | - | .17 | .20 | .31 | .46 | .63 | - | - | - | - | - | - | - |
| Gl 15 | - | .19 | .38 | .63 | 1.02 | 1.57 | - | .10 | .20 | .34 | .55 | .84 | 1.17 | 33 | 32 | 35 | 40 | - | - |
| Gl 16 | .174 | - | - | - | - | - | - | .15 | .24 | .38 | .56 | .75 | - | - | - | - | - | - | - |
| Gl 17 | .172 | .34 | .52 | .83 | 1.28 | 1.87 | - | .20 | .33 | .51 | .73 | 1.00 | - | 30 | 25 | 20 | 38 | - | - |
| Gl 19 | .162 | .22 | .47 | .82 | 1.33 | 1.91 | - | .13 | .23 | .40 | .65 | .93 | - | - | 35 | 30 | 33 | - | - |

| | Form ratio | | | | | | Spirotheca thickness | | | | | | Septal count | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spec. | $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ |
| Gl 1 | 1.8 | 1.9 | 2.0 | 2.0 | - | - | .016 | .033 | .065 | .064 | - | - | - | - | - | - | - | - |
| Gl 3 | 1.5 | 1.8 | 1.8 | 1.8 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Gl 5 | 1.4 | 2.0 | 2.3 | 2.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Gl 7 | 1.3 | 1.6 | 1.6 | 1.9 | - | - | - | .041 | - | - | - | - | - | - | - | - | - | - |
| Gl 11 | 1.6 | 1.5 | 1.8 | 1.9 | 2.1 | - | - | - | - | - | .073 | - | - | - | - | - | - | - |
| Gl 13 | 1.5 | 1.6 | 1.8 | 1.9 | 2.1 | 2.0 | - | - | - | - | - | - | - | - | - | - | - | - |
| Gl 14 | - | - | - | - | - | - | - | - | - | .047 | .076 | - | 8 | 17 | 19 | - | 22 | - |
| Gl 15 | 1.9 | 1.9 | 1.9 | 1.9 | 1.9 | - | - | - | - | .045 | .076 | .082 | - | - | - | - | - | - |
| Gl 16 | - | - | - | - | - | - | - | .041 | - | .063 | .076 | .085 | 10 | 19 | 17 | 19 | 23 | 25 |
| Gl 17 | 1.7 | 1.6 | 1.6 | 1.8 | 1.9 | - | - | .027 | .040 | .072 | - | - | - | - | - | - | - | - |
| Gl 19 | 1.6 | 2.0 | 2.0 | 2.0 | 2.1 | - | .023 | .021 | .034 | - | .076 | - | - | - | - | - | - | - |

Discussion. Thompson's specimens had a proloculus that varied from .091 to .186 mm., averaging .128 mm. in 11 specimens; and a tunnel angle that averaged 23, 29, 27, 32, 38, 40, and 43 degrees for the first to eight volution for six specimens. In addition the chomata were distinct and highly asymmetrical through most of the shell, and about half as high as the chambers in all parts of the shell except the last volution.

The specimens of the author's collection had large proloculus averaging .190 mm. for six specimens; wider tunnel angles throughout all parts of the shell, 30 degrees in the first volution to nearly 50 degrees in the fifth; and less bold chomata than Thompson's species. In all other aspects these two forms were similar, and so these specimens were regarded as a variation of Triticites rockensis Thompson.

Occurrence. Triticites rockensis var. paxicoensis occurs in abundance in the upper portion of the Glenrock limestone. The specimens used in this study were collected two and one-half miles east of Paxico, Kansas from a road cut on the north side of abandoned State Highway 10. The Appendix, Sample Number 7 contains the lithologic description of this formation.

Triticites ventricosus Meek and Hayden (Thompson, M. L., Protozoa: American Wolfcampian fusulinids. Univ. Kans. Paleontological Contr. Article 5: 40-42. 1954.)

Material Studied. This study was based on ten thin-sections prepared from two collections of fusulinids picked from the Hughes Creek shale. All specimens were well preserved and calcite-filled.

Description. The ten species of this classification showed considerable variation, and were divided into three groups. Group A was comprised of three specimens, which were fusiform and inflated. The shells were of eight to nine volutions and attained a length and width that varied from 7.7 to 9.7 mm. and 3.3 to 3.7 mm. respectively. Lateral slopes were convex, but showed slight concavity adjacent the polar extremities. The first one or two volutions were circular or oval shaped, but thereafter the ends became sharply pointed. This trend climaxed in the fourth to sixth volution, and remaining volutions once again became bluntly pointed. The shell developed uniformly throughout its growth, and had a form ratio of 2.1, plus or minus one tenth, in the ultimate volution. The proloculus was circular in one specimen, and had a measured outside diameter of .234 mm., while the second specimen was oval shaped and measured .278 mm. at its longest dimension. The third test also had a circular proloculus, but because the specimen was improperly centered, could not be measured.

The spirotheca was thick and coarsely alveolar. In axial section the spirotheca had an irregular outline due to sporadic epithecal deposits, and the extension of the keriotheca down the septa. The number of septa per volution is unknown, because these forms cannot be distinguished in sagittal section from those of group B and C. Fluting was narrow in the polar extremities, but adjacent septa rarely touched. Septa became straight to broadly fluted in the central portion of the shell. Large septal pores were numerous in the polar extremities, and the central portion of outer volutions. The tunnel was regular and narrow for all but the penultimate volution where an angle greater than 40 degrees was common. The chomata usually extended better than one-half the height of the chamber in the inner five or six volutions, but became more subdued in the remainder of the shell. Table 10 contains all measurements pertaining to these species. Plate II, Figure 1 shows a typical specimen of this group.

Group B consisted of two specimens. They were similar to the shells of group A in most respects, but differed by their more sharply pointed poles, less inflated central area, and more regular spirotheca thickness. The quantitative data regarding these species is contained in Table 10. An illustration of one of these forms appears in Plate II, Figure 2.

Group C was composed of three specimens. These forms were less inflated; had more bluntly rounded poles; possessed a more regular spirotheca, both in outline and thickness; and had a tunnel that was considerably wider than the specimens of group A. Table 10 contains the measurements that pertain to these specimens. Plate II, Figure 3 contains an illustration of one of these specimens.

Discussion. None of the three groups exactly fit the description of Triticites ventricosus. Most all have a smaller form ratio in the earlier volutions, and none attained the maximum size of the holotype specimen. Groups A and B have approximately the same degree of inflation as the holotype, but group C is decidedly more elongate. Groups A and B have the narrow tunnel

Table 10. Measurements of *Triticites ventricosus* Meek and Hayden

### Group A

| Spec. | Half length $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ | $V_9$ | Radius vector $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ | $V_9$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H 63 | .38 | .58 | .88 | 1.49 | 2.00 | 2.71 | 3.31 | 4.25 | - | .19 | .31 | .48 | .71 | .97 | 1.31 | 1.67 | - | - |
| H 67 | .35 | .72 | 1.06 | 1.41 | 1.80 | 2.24 | 3.16 | 3.86 | 4.82 | .28 | .40 | .56 | .67 | 1.02 | 1.29 | 1.63 | 1.94 | 2.22 |
| *H 81 | .26 | .56 | .91 | 1.27 | 1.55 | 1.92 | 2.90 | 3.89 | - | .20 | .32 | .51 | .67 | .95 | 1.19 | 1.54 | 1.88 | - |

| Spec. | Form ratio $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ | $V_9$ | Tunnel angle $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H 63 | 2.0 | 1.9 | 1.8 | 2.1 | 2.1 | 2.1 | 2.0 | - | - | 16 | 16 | 21 | 27 | 29 | 32 | - | - |
| H 67 | 1.2 | 1.8 | 1.9 | 1.8 | 1.8 | 1.7 | 1.9 | 2.0 | 2.2 | 12 | 14 | 18 | 21 | 22 | 27 | 31 | - |
| *H 81 | 1.3 | 1.8 | 1.8 | 1.9 | 1.6 | 1.6 | 1.9 | 2.1 | - | 19 | 21 | 23 | 20 | 27 | 41 | 42 | - |

Thickness of spirotheca

| Spec. | Prol. | $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ |
|---|---|---|---|---|---|---|---|---|---|
| H 63 | - | .027 | - | - | - | - | .121 | - | - |
| H 67 | .278 | .014 | .033 | .042 | .069 | .088 | .115 | .156 | .125 |
| *H 81 | .264 | - | - | - | - | .083 | - | .108 | - |

### Group B

| Spec. | Half length Prol. | $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ | Radius vector $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H 65 | .174 | .28 | .47 | .70 | 1.15 | 1.73 | 2.20 | 3.16 | 4.19 | .19 | .30 | .44 | .65 | .92 | 1.19 | 1.59 | 1.94 |
| *H 79 | .234 | .31 | .57 | .82 | 1.20 | 1.94 | 2.68 | 3.62 | - | .16 | .30 | .48 | .73 | 1.01 | 1.32 | 1.58 | - |

| Spec. | Form ratio $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ | Tunnel angle $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H 65 | 1.5 | 1.6 | 1.6 | 1.8 | 1.9 | 1.8 | 2.0 | 2.2 | 16 | 20 | 16 | 20 | 25 | 35 | 34 | - |
| *H 79 | 1.7 | 1.9 | 1.7 | 1.7 | 1.9 | 2.0 | 2.3 | - | 14 | 22 | 28 | 27 | 34 | 34 | - | - |

Thickness of spirotheca

| Spec. | $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ |
|---|---|---|---|---|---|---|---|---|
| H 65 | - | - | .048 | .069 | .069 | .078 | .112 | .134 |
| *H 79 | - | .023 | .061 | .084 | .087 | .103 | - | - |

### Group C

| Spec. | Half length $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ | $V_9$ | Radius vector $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ | $V_9$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *H 31 | .21 | .38 | .61 | .89 | 1.30 | 1.96 | 2.57 | 3.40 | 4.13 | .16 | .26 | .41 | .58 | .79 | 1.06 | 1.31 | 1.61 | 1.95 |
| *H 35 | .27 | .51 | 1.05 | 1.36 | 1.81 | 2.19 | 3.37 | 4.14 | - | .18 | .31 | .49 | .71 | .97 | 1.19 | 1.47 | 1.80 | - |
| *H 59 | .26 | .51 | .81 | 1.00 | 1.81 | 2.57 | 3.47 | 4.16 | - | .19 | .31 | .52 | .73 | 1.01 | 1.39 | 1.71 | 2.09 | - |

| Spec. | Form ratio $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ | $V_9$ | Tunnel angle $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *H 31 | 1.3 | 1.4 | 1.5 | 1.6 | 1.6 | 1.8 | 2.0 | 2.1 | 2.1 | 22 | 21 | 32 | 34 | 39 | 41 | 50 | - |
| *H 35 | 1.5 | 1.7 | 2.1 | 1.9 | 1.9 | 1.9 | 2.3 | 2.3 | - | 24 | 26 | 26 | 25 | 38 | 35 | 51 | - |
| *H 59 | 1.4 | 1.6 | 1.6 | 1.4 | 1.8 | 1.9 | 2.0 | 2.1 | - | 15 | 20 | 20 | 40 | 40 | 54 | - | - |

Thickness of spirotheca

| Spec. | Prol. | $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ |
|---|---|---|---|---|---|---|---|---|---|
| *H 31 | .189 | .016 | - | - | .049 | .080 | .107 | .107 | .109 |
| *H 35 | - | - | .027 | - | - | .100 | - | .109 | - |
| *H 59 | - | - | - | .061 | .078 | .111 | .151 | - | - |

Note: An asterisk (*) denotes the specimens collected from Blue Mount Hill, Manhattan, Kansas; all others are specimens taken from Highway cut on U. S. 40, Wabaunsee County.

of the holotype, but group C was much wider. Groups A and B probably represent insignificant variation from the holotype, and are probably cospecific with it, but group C may represent a true variation. Because only three specimens comprised the latter group, the author felt there was not sufficient evidence to support a further subdivision of Triticites ventricosus and considers them cospecific.

Occurrence. Abundant well preserved specimens were collected from the Hughes Creek shale at two different locations. The first collection was taken from this formation at Blue Mount north of Manhattan, Sec. 7, T. 10 S., R. 8 E., Riley County, Kansas; the second from a road cut in U. S. Highway 40, S.W. 1/4, S.W. 1/4, S.W. 1/4, Sec. 27, T. 11 S., R. 12 E., Wabaunsee County, Kansas. The Appendix, Sample Numbers 5 and 6 contain lithologic descriptions made at the collecting localities.

Triticites ventricosus var. inflatus Galloway and Ryniker (Ellis, B. F. and A. R. messina, Calalogue of foraminifera. Am. Mus. Nat. Hist. N. Y. Volume 27. 1940.)

Material Studied. Six specimens were prepared in thin-section from two collections of fusulinids that were picked from the Hughes Creek shale. All specimens were calcite-filled, but in an excellent state of preservation.

Description. These shells were highly inflated and fusiform. They contained eight to nine volutions, and had a length and width that varied from 8.7 to 7.1 mm. and 4.9 to 3.9 mm. respectively. The lateral slopes were usually convex, but sometimes showed slight concavity where the shell was extended along its axis of coiling, a situation common in the last two or three volutions. The end points of these shells were most usually blunt, but several forms had pointed poles. These fusulinids developed uniformly, a fact reflected in their form ratio. The first volution was never more than four tenths smaller than the last, where a value of 1.8 or 1.7 was common for the five specimens studied in axial section. The proloculus was of moderate size, averaging .216 mm. for five specimens.

The spirotheca was thick and coarsely alveolar. It attained greatest thickness between chomata, and tapered gradually toward the poles, where it became thin and structureless. The ultimate volution contained 34 moderately spaced septa, which were thin and contained a thin pyknotheca. Fluting was narrow in the polar region and usually extended the entire height of the chamber, but in the central portion of the shell it was reduced to broad undulations. Septal pores were abundant in the polar ends and central portion of the outer volutions.

The tunnel angle was narrow and straight, and subtended an arc of 30 degrees in the penultimate volution, although one anomalously subtended an angle of 41 degrees in this volution. The chomata extended slightly better than half the chamber height in the inner five or six volutions, and were massive and asymmetrical with steep tunnel sides. They became faint and lower in the remainder of the shell. Table 11 contains the measurements of these specimens. Plate II, Figure 4 shows one member of this group.

<u>Discussion</u>. <u>Triticites</u> <u>ventricosus</u> var. <u>inflatus</u> is found associated with <u>Triticites</u> <u>ventricosus</u> and <u>Triticites</u> <u>meeki</u>. It

Table 11. Measurements of <u>Triticites</u> <u>ventricosus</u> var. <u>inflatus</u> Galloway and Ryniker.

| Spec. | Half length $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ | $V_9$ | Radius vector $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ | $V_9$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H 24 | - | - | - | - | - | - | - | - | - | .25 | .36 | .54 | .77 | 1.05 | 1.33 | 1.75 | 2.16 | - |
| H 29 | .45 | .72 | 1.05 | 1.45 | 1.94 | 2.90 | 3.56 | 4.35 | - | .30 | .48 | .70 | .96 | 1.22 | 1.59 | 1.96 | 2.45 | - |
| *H 39 | .43 | .74 | 1.15 | 1.51 | 2.10 | 2.76 | 3.42 | 4.32 | - | .27 | .43 | .67 | .94 | 1.31 | 1.65 | 2.02 | 2.38 | - |
| *H 41 | .26 | .56 | .75 | 1.13 | 1.62 | 2.15 | 3.28 | - | - | .19 | .31 | .46 | .71 | 1.01 | 1.30 | 1.77 | 2.09 | - |
| *H 43 | .19 | .37 | .64 | 1.00 | 1.35 | 1.75 | 2.06 | 2.62 | 3.53 | .12 | .18 | .31 | .48 | .68 | .95 | 1.34 | 1.60 | 1.97 |
| *H 45 | .46 | .66 | 1.00 | 1.32 | 1.51 | 1.96 | 2.63 | 3.56 | - | .30 | .44 | .62 | .82 | 1.05 | 1.36 | 1.69 | 2.06 | - |

| Spec. | Thickness of spirotheca Prol. | $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ | Tunnel angle $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H 24 | - | .019 | .026 | .045 | .052 | .071 | .071 | .097 | .116 | - | - | - | - | - | - | - | - |
| H 29 | .242 | - | .033 | .061 | .081 | .092 | .124 | .127 | - | 18 | 19 | 18 | 16 | 20 | 24 | 31 | 40 |
| *H 39 | .246 | - | - | .052 | .068 | .086 | .079 | .109 | - | 17 | 19 | 23 | 18 | 25 | 33 | 27 | - |
| *H 41 | .203 | - | - | .039 | .055 | .078 | .109 | .145 | - | 17 | 19 | 17 | 23 | 20 | 18 | 31 | - |
| *H 43 | .131 | - | - | - | - | .064 | .074 | .109 | .092 | 18 | 15 | 20 | 20 | 19 | 20 | 23 | 31 |
| *H 45 | .259 | - | - | - | - | - | - | - | - | 16 | 16 | 18 | 18 | 23 | 24 | 28 | - |

| Spec. | Form ratio $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ | $V_9$ | Septal count $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ | $V_9$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H 24 | - | - | - | - | - | - | - | - | - | 12 | 24 | 25 | 31 | 28 | 32 | 31 | 33 | 34 |
| H 29 | 1.5 | 1.5 | 1.5 | 1.5 | 1.6 | 1.8 | 1.8 | 1.8 | - | - | - | - | - | - | - | - | - | - |
| *H 39 | 1.6 | 1.7 | 1.8 | 1.6 | 1.6 | 1.7 | 1.7 | 1.8 | - | - | - | - | - | - | - | - | - | - |
| *H 41 | 1.4 | 1.8 | 1.6 | 1.6 | 1.6 | 1.7 | 1.8 | - | - | - | - | - | - | - | - | - | - | - |
| *H 43 | 1.7 | 2.0 | 2.1 | 2.1 | 2.0 | 1.8 | 1.5 | 1.6 | 1.8 | - | - | - | - | - | - | - | - | - |
| *H 45 | 1.5 | 1.5 | 1.6 | 1.6 | 1.4 | 1.4 | 1.6 | 1.7 | - | - | - | - | - | - | - | - | - | - |

Note: An asterisk (*) denotes the specimens collected from the Highway cut on U.S. 40, Wabaunsee County; all others are from Blue Mount Hill, Manhattan, Riley County, Kansas.

may be distinguished from both these forms by its more highly inflated center and lower form ratio in all volutions.

Occurrence. Abundant well preserved specimens were collected from the Hughes Creek shale at two different locations. The first collection was taken from this formation at Blue Mount north of Manhattan, Sec. 7, T. 10 S., R. 8 E., Riley County, Kansas; the second from a road cut in U. S. Highway 40, S.W. 1/4, S.W. 1/4, S.W. 1/4, Sec. 27, T. 11 S., R. 12 E., Wabaunsee County, Kansas. The Appendix, Samples Numbers 5 and 6 contain the lithologic descriptions of the Hughes Creek shale.

EXPLANATION OF PLATE I

(All specimens 8x.)

Fig. 1. Dunbarinella creekensis Matthews, n. sp., axial section.

Fig. 2. Dunbarinella lyonensis Matthews, n. sp., axial section.

Fig. 3. Dunbarinella obesa Beede, axial section.

Fig. 4. Schwagerina jewetti Thompson, axial section.

Fig. 5. Triticites confertus Thompson var. inflatus Matthews, n. var., axial section.

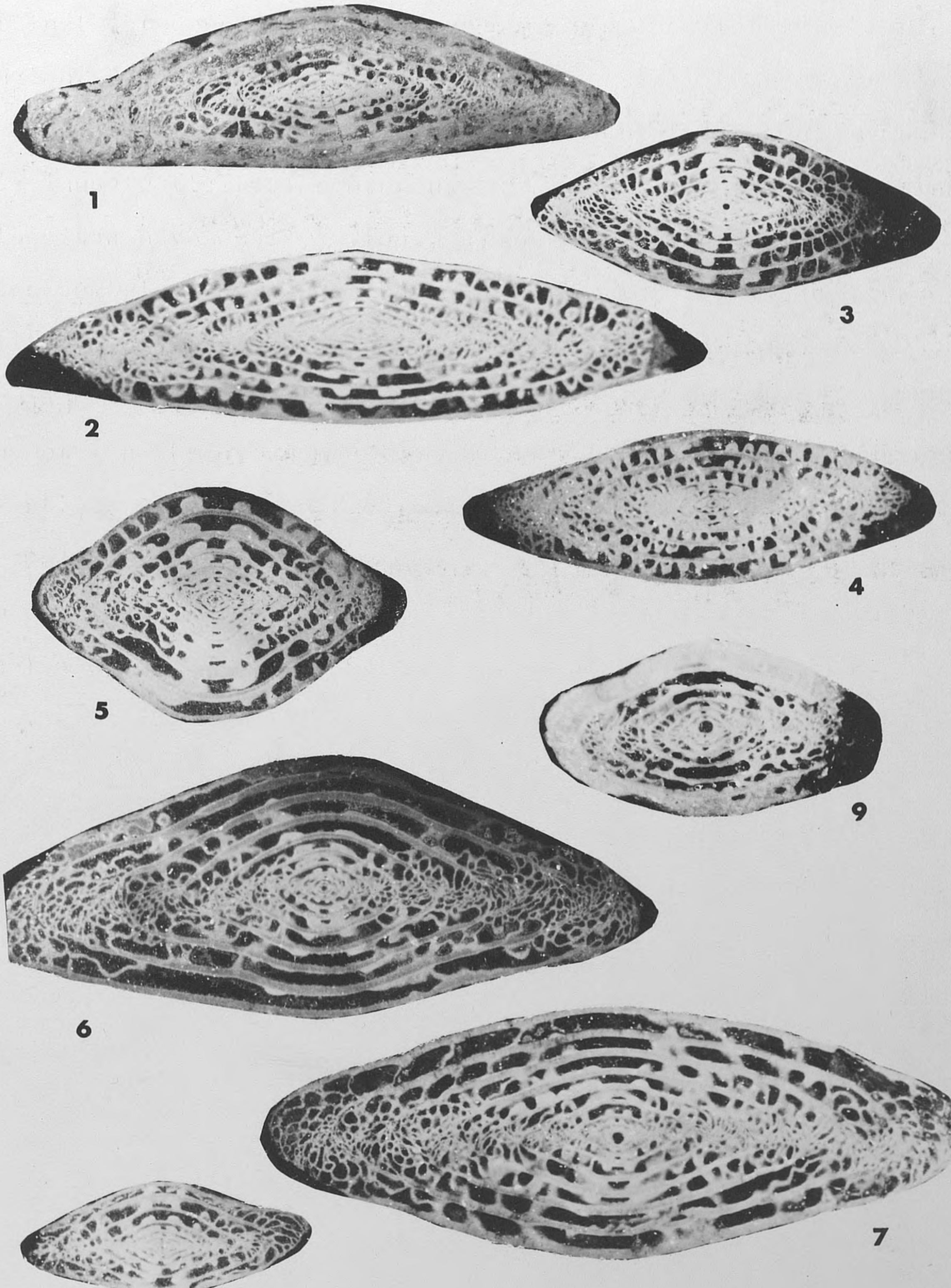
Fig. 6. Triticites havenensis Matthews, n. sp., axial section.

Fig. 7. Triticites meeki Moller, axial section.

Fig. 8. Triticites cf. T. pointensis Thompson, axial section.

Fig. 9. Triticites rockensis Thompson var. paxicoensis Matthews, n. var., axial section.

PLATE I



EXPLANATION OF PLATE II

(All specimens 8x.)

Fig. 1. *Triticites ventricosus* Meek and Hayden, Group A, axial section.

Fig. 2. *Triticites ventricosus* Meek and Hayden, Group B, axial section.

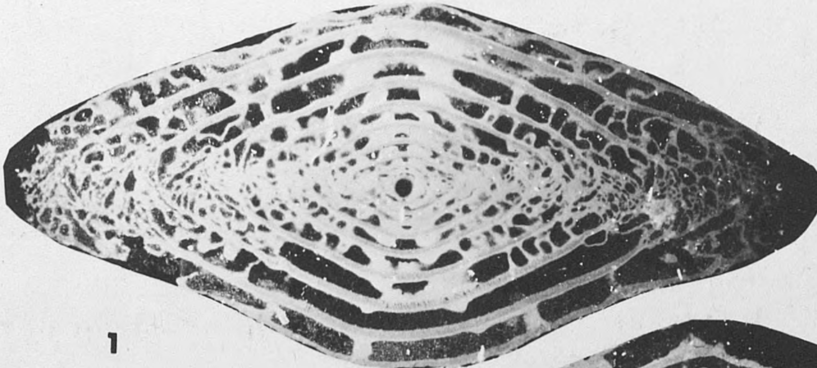
Fig. 3. *Triticites ventricosus* Meek and Hayden, Group C, axial section.

Fig. 4. *Triticites ventricosus* var. *inflatus* Galloway and Ryniker, axial section.

Fig. 5. *Dunbarinella tumida* Skinner, axial section.

Fig. 6. *Dunbarinella* ?, axial section, Jim Creek limestone.

PLATE II



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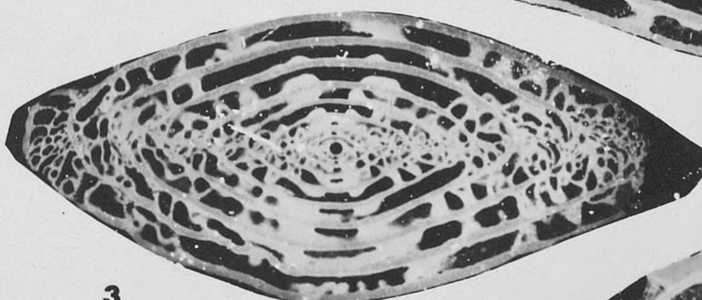

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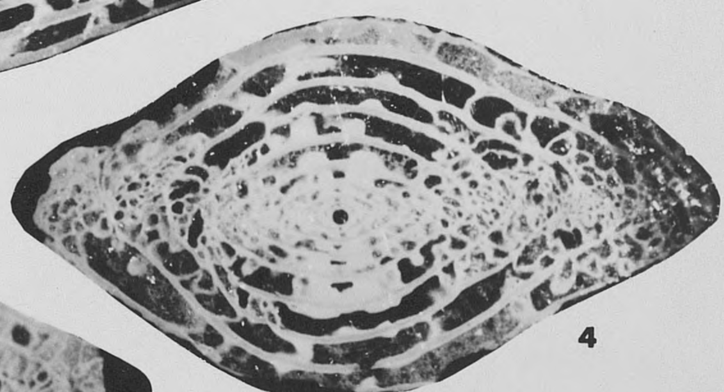

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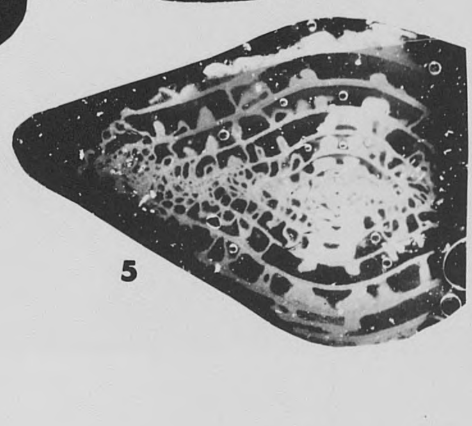

5

## SUMMARY AND CONCLUSIONS

The eight formations sampled contained the fusulinid fauna catalogued below, and were arranged from oldest to youngest.

Jim Creek limestone. Two different species were recognized from this formation. The first, Dunbarinella creekensis, n. sp., occurred in abundance, and was described for the first time. Only one specimen of the other, a form of Dunbarinella ?, was present in this sample of over seventy fusulinids. Therefore no description was attempted, but this form was illustrated and appears on Plate II, Figure 6.

Grandhaven limestone. The large shelled, Triticites havenensis, n. sp. was described for the first time from the Grandhaven limestone, where this species occurred in flood proportions.

Brownville limestone. From this, the upper most formation of the Pennsylvanian sequence, Dunbarinella lyonensis, n. sp., were described for the first time.

Five Point limestone. This was the oldest formation of the Permian sequence that contained fusulinids. Thompson (1954) sampled this formation in three Kansas locations, and found it to contain specimens of Triticites pointensis Thompson, Triticites confertus Thompson, and Dunbarinella fivensis Thompson. The author sampled this formation in one outcrop, and found it to contain the small tests of Triticites cf. T. pointensis Thompson and Triticites confertus Thompson var. inflatus Matthews, n. var.

*Hughes Creek shale*. Specimens of *Triticites meeki* Moller, *Schwagerina longissimoidea* Beede, *Dunbarinella hughesensis* Thompson, and *Triticites ventricosus* Meek and Hayden were reported by Thompson (1954) to occur in this formation. The author found this member of the Foraker limestone to contain specimens of *Triticites meeki*, *Triticites ventricosus*, and *Triticites ventricosus* var. *inflatus* Galloway and Ryniker.

*Glenrock limestone*. Thompson (1954) found specimens of *Dunbarinella glenensis* Thompson, *Triticites rockensis* Thompson, and *Schwagerina campa* Thompson in the Glenrock limestone. The author sampled this formation, but found only *Triticites rockensis* Thompson var. *paxicoensis* Matthews, n. var.

*Neva limestone*. The fusulinids *Dunbarinella tumida* Skinner, *Dunbarinella koschmanni* Skinner, *Dunbarinella obesa* Beede, *Schwagerina longissimoidea* Beede, and *Paraschwagerina kansasensis* Beede and Kniker were described by Thompson (1954) from his samples of this formation. The author's collection yielded but two species, these being numerous shells of *Dunbarinella obesa* Beede, and a single specimen of *Dunbarinella tumida* Skinner.

*Cottonwood limestone*. Thompson (1954) found this member of the Beattie limestone to contain specimens of *Schwagerina emaciata* Beede, *Schwagerina jewetti* Thompson, and *Schubertella kingi* Dunbar and Skinner. The sample examined by the author contained only poorly preserved specimens of *Schwagerina jewetti* Thompson.

In this report three different species of *Dunbarinella* were described: *Dunbarinella obesa* Beede of Permian age, *Dunbarinella lyonensis*, n. sp., and *Dunbarinella creekensis*, n. sp., both from

Pennsylvanian strata. Dunbarinella obesa was an advanced form of this genus, and may easily be mistaken for a member of the genus Triticites Girty because of its light axial filling, high degree of inflation, large size and thick spirotheca. It was not typical of other members of this genus, and was one of the oldest species of Dunbarinella found in Wolfcampian strata (Thompson, 1954).

Dunbarinella lyonensis, n. sp., and Dunbarinella creekensis, n. sp. were similar in many respects, but were differentiated by the latter's smaller size, more inflated equator, and relatively thicker spirotheca. It is possible that these two are cospecific, but because they may be easily separated, are given independent status. Dunbarinella lyonensis, n. sp. may prove important in correlation studies, because it is a highly distinctive form with unusually great length, and a low degree of inflation. The other, Dunbarinella creekensis, n. sp. will be less useful for this purpose, for it is similar (small length, slightly inflated equator, narrow tunnel, heavy axial filling, elongate fusiform shape, and minute proloculus) to many of the older forms of this genus.

Because Dunbarinella creekensis of the Jim Creek limestone and the youngest fusulinid of this study, was similar to the older Permian forms, and also similar to Dunbarinella lyonensis, n. sp. of the Brownville limestone, save for differences in length and degree of inflation, it was felt that no significant faunal differences existed between the Permian and Pennsylvanian forms. In fact the persistence of this highly specialized genus across the presently defined Pennsylvanian-Permian boundary may be considered evidence that the environment was essentially the same in both systems.

Seven different forms of Triticites were described in this paper. Only one of these, Triticites havenensis, n. sp., was of Pennsylvanian age. The others, Triticites cf. T. pointensis, Triticites meeki, Triticites ventricosus, Triticites ventricosus var. inflatus, and Triticites rockensis var. paxicoensis, n. var., were all of Permian age.

The Pennsylvanian species, Triticites havenensis, was similar in many respects to Triticites ventricosus, a Permian form. Both had large shells, were fusiform, thick walled, and coarsely alveolar, but the former was easily distinguished from the latter by its greater form ratio and larger tunnel. The other members of this genus, herein described, occurred within the stratigraphic interval that separated Triticites ventricosus and Triticites havenensis. No general statement can be made concerning their relationship with one another or with Triticites ventricosus and Triticites havenensis, for they are a diverse group, with each species distinctly different from all others. Thus Triticites havenensis, the oldest and a Pennsylvanian form, was similar to Triticites ventricosus, the youngest member of this genus and a Permian species. But since Triticites havenensis differed from the intervening species, no evolutionary trend was discernable. One may consider this evidence for or against the supposition that a faunal change occurred at the presently defined Pennsylvanian-Permian boundary, depending upon ones prejudice.

It was the belief of the author that no significant faunal differences existed between fusulinids of the Pennsylvanian and Permian rocks, because certain undescribed fusulinids of the Tarkio limestone were similar to the species (Triticites ventricosus and Triticites ventricosus var. inflatus) of the Hughes Creek shale. In fact Dunbar and Condra (1928) considered the specimens of the Tarkio limestone cospecific with Triticites ventricosus, but Thompson (1954) has shown that subtle differences do exist, which serve to distinguish Triticites ventricosus from the other species of this genus that were found in rocks of the Pennsylvanian system.

Any species of a fossil or neozoological population may reasonably be expected to show variation that will depend upon environmental conditions (Burma, 1948). This variation may be of such an extent that geographically separated portions of a population may be given independent status, i.e., established as different species. It is therefore important that the degree of variation of any population of a region be established before interregional stratigraphical correlations are attempted. It was felt that the main contribution resulting from this study of the Permian Wolfcampian rocks was the partial delineation of variation in the species found therein. Of particular importance was the delineation of the two new variations Triticites confertus var. inflatus Matthews and Triticites rockensis var. paxicoensis Matthews.

The study of Pennsylvanian strata was more rewarding, for several previously undescribed species were examined for the first time, and at least one of them, Dunbarinella lyonensis Matthews, n. sp. should prove useful in correlation studies because of its unique form.

ACKNOWLEDGMENT

The writer wishes to offer his sincere appreciation and gratitude to William K. Clark, the author's major instructor, for his assistance and guidance during the course of the investigation.

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APPENDIX

## Lithologic Description of Collecting Horizon

Sample Number 1.

Grandhaven limestone, S.W. 1/4, S.W. 1/4, S.W. 1/4, Sec. 25, T. 16 S., R. 12 E., Lyon County, Kansas.

Limestone, argillaceous, massive, gray weathering to brown, contains Derbyia sp., Chonetes granulifera, crinoids, and a profusion of fusulinids . . . . . . 2.8'

Sample Number 2.

Jim Creek limestone, center of S.W. 1/4, Sec. 13, T. 16 S., R. 12 E., Lyon County, Kansas

Limestone, fine grained, hard, massive, stained brown with limonite, contains Dictyoclostus americanus, Composita sp., crinoids, and fusulinids . . . . . . 0.8'

Sample Number 3.

Brownville limestone, N.W. 1/4, N.W. 1/4, Sec. 33, T. 16 S., R. 12 E., abandoned stone quarry, Lyon County, Kansas.

Limestone, hard, massive, blue weathering brown, contains Margnifera wabashensis, Chonetes granulifer, Derbyia sp., Meekopora sp., Straporolus sp., and numerous crinoids and fusulinids. . . . . . . . . . 1.9'

Sample Number 4.

Five Point limestone, N.W. 1/4, N.W. 1/4, N.W. 1/4, Sec. 4, T. 16 S., R. 12 E., Lyon County, Kansas.

Limestone, hard, massive, gray weathers brown, contains Chonetes granulifera, Dictyoclostus sp., Neospirifera sp., Composita sp., Lissochonetes geinitzianus, Marginifera sp., and fusulines. . . . 1.5'

Sample Number 5.

Hughes Creek shale, Blue Mount north of Manhattan, Sec. 7, T. 10 E., R. 8 E., Riley County, Kansas.

Shale, silty, gray weathers brown, small geodes, and calcite veins . . . . . . . . . . . . . . . . . . . . 2.0'

Limestone, argillaceous, abundant fusulines . . . . . . 1.2'

Shale, fissile, black, fusulines abundant . . . . . . . 2.2'

Limestone, argillaceous, massive, dark gray weathers brown . . . . . . . . . . . . . . . . . . . . . . . . . 0.6'

Shale, fissile, silty near top, dark gray weathers black, contains fusulines, crinoids, Neospirifera sp. . . . . . . . . . . . . . . . . . . . . 6.2'

Limestone, massive, dark gray weathers brown. . . . . 0.9'

Shale, fissile, gray weathers brown, numerous fusulinids, collecting horizon. . . . . . . . . . . . 2.0'

Limestone, argillaceous, massive, grey weathers brown, has thin band of Orbiculoidea missouriensis near center, remainder contains Ambocoelia planoconvexa, Ripidomella carbanaria, fusulinids, Chonetes sp., and Marginifera sp. . . . . . . . . . . . . . . . . . 1.8'

Sample Number 6.

Hughes Creek shale, S.W. 1/4, S.W. 1/4, S.W. 1/4, Sec. 27, T. 11 S., R. 12 E., Wabaunsee County, Kansas.

Incomplete section, top eroded.

Shale, gray weathers brown, very fossiliferous, collecting horizon . . . . . . . . . . . . . . . . . . . 3.0'

Limestone, hard, brown weathering buff, fine fossil fragments and a few brachipod shells. . . . . . . . . 3.4'

Shale, fossiliferous, gray weathers brown . . . . . . . 0.7'

Limestone, dense, massive, sparcely fossiliferous . . 0.9'

Shale, upper half gray weathering brown, center is composed of three foot calcareous zone which is blocky, entire unit highly fossiliferous. . . . . . 12.5'

Sample Number 7.

Glenrock limestone, 2 1/2 miles east of Paxico, Kansas from road cut on north side of abandoned State Highway 10.

Limestone, massive, contains brecciated limestone fragments 5 mm. across, and abundant fusulines. . . 2.1'

Sample Number 8.

Neva limestone, Blue Mount north of Manhattan, Sec. 7, T. 10 E., R. 8 E., Riley County, Kansas.

Limestone, argillaceous, thin bedded, gray weathers light gray, contains fossil fragments . . . . . . . . 2.1'

Shale, contains several thin limestone stringers, covered . . . . . . . . . . . . . . . . . . . . . . . . 3.2'

Limestone, hard, brecciated, gray weathers buff, rotten-appearing when weathered, contains brachiopod fragments. . . . . . . . . . . . . . . . . 5.0'

Limestone, argillaceous, contains several shale partings, lowest parting contains fusulines and Ambocoelia sp., collecting horizon. . . . . . . . . . 4.2'

Sample Number 9.

Cottonwood limestone, N.E. 1/4, N.E. 1/4, Sec. 4, T. 9 S., R. 7 E., Riley County, Kansas.

Limestone, massive, light gray weathers gray, contains scattered chert nodules, upper half contains Derbyia sp., Composita sp., crinoids, and a profusion of fusulinids. . . . . . . . . . . . . . . . . . . . . . 5.0'
(base not exposed)

# FUSULINID SPECIES ASSOCIATED WITH THE PENNSYLVANIAN - PERMIAN CONTACT OF THE MANHATTAN, KANSAS AREA

by

JERRY LEE MATTHEWS

B. S., Allegheny College, 1953

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AN ABSTRACT OF A THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Geology and Geography

KANSAS STATE UNIVERSITY
OF AGRICULTURE AND APPLIED SCIENCE

1959

In this investigation fusulinids that occurred in formations stratigraphically close to the presently defined Pennsylvanian-Permian boundary in the vicinity of Manhattan, Kansas were described. It was thought that such a study might reveal the existence of undescribed species, and help establish the degree of variation for those species previously described by other workers. This investigation also attempted to study evolutionary trends among species of the different genera. Fusuline samples were collected from the Pennsylvanian Grandhaven, Jim Creek, and Brownville limestones, and from the Permian Five Point limestone, Hughes Creek shale, Glenrock limestone, Neva limestone, and Cottonwood limestone. Approximately 250 thin-sections were prepared for this study.

One new species (Dunbarinella creekensis) was described from the Jim Creek limestone, one from the Grandhaven limestone (Triticites havenensis), and another from the Brownville limestone (Dunbarinella lyonenensis), all of Pennsylvanian age. The Five Point limestone contained species of Triticites cf. T. pointensis Thompson, and Triticites confertus var. inflatus, n. var. The Hughes Creek shale contained Triticites meeki Moller, Triticites ventricosus Meek and Hayden, and Triticites ventricosus var. paxicoensis, n. var., were described from the Glenrock limestone. Dunbarinella obesa Beede and Dunbarinella tumida Skinner occurred in the Neva limestone, while the Cottonwood limestone contained specimens of Schwagerina jewetti Thompson.

A comparison of Dunbarinella creekensis and Dunbarinella lyonensis showed them to be similar in many respects. It was concluded that these forms were also similar to species of that genus from the Permian Wolfcampian rocks. The author was therefore of the opinion that no significant faunal change occurred within this genus across the presently defined Pennsylvanian-Permian boundary.

No evolutionary trend was found to exist between species of the genus Triticites. However similarities were observed between Triticites havenensis, n. sp., a Pennsylvanian form, and Triticites ventricosus Meek and Hayden, a Permian form. From this it was concluded that no faunal change occurred at the Pennsylvanian-Permian boundary.

It was the opinion of the author that one of the main contributions of this study of the Permian Wolfcampian rocks was the partial delineation of variation in the species found therein, an important consideration when interregional correlations are attempted. Of particular importance was the delineation of the two variations Triticites confertus var. inflatus Matthews and Triticites rockensis var. paxicoensis Matthews. Several previously undescribed species of Pennsylvanian strata were examined for the first time, and at least one of them, Dunbarinella lyonensis Matthews, n. sp., should prove useful in correlation studies because of its unique form.