UPPER DESMOINESIAN FUSULINIDS.

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ABSTRACT. Three species of fusulinids from the upper part of the Desmoinesian series are described and illustrated as *Fusulina? inconspicua* Girty, *F.? rickerensis*, n. sp., and *F.? arenaria*, n. sp. These forms are somewhat intermediate in nature between typical species of *Fusulinella* and typical species of *Fusulina*. They are referred with question to *Fusulina*, but it is realized they may be descendants of a species of *Fusulinella* and are not generically related to any species of *Fusulina*. For direct comparisons, topotype specimens of the genotypes of *Fusulinella* and *Fusulina* are described and illustrated.

THE Desmoinesian rocks of North America generally are referred to paleontologically as the Zone of *Fusulina*. Species of this genus are known from throughout the Desmoinesian, and no species of the genus is known from American rocks not of Desmoinesian age. Many American species of the genus *Fusulina* Fischer-de-Waldheim seem to have short stratigraphic ranges, and they are useful for detailed stratigraphic correlations.

The upper part of the Derryan rocks of North America generally are referred to paleontologically as the Zone of *Fusulinella*, for a closely related group of species of the genus *Fusulinella* Möller more or less predominates the fusulinid fauna of that part of the stratigraphic section. The genus *Fusulinella* has not been found in rocks of lower Derryan age, but species of the genus have been reported from the lower part of the type section of the Desmoinesian series of Iowa,(1)* and from the Desmoinesian of Ohio,(2) New Mexico(3) and Illinois.(4) However, no species of *Fusulinella* has been reported from the middle or upper part of the American Desmoinesian. Many species of the genus *Fusulinella* seem to have short stratigraphic ranges, and they are useful for detailed stratigraphic correlations. Therefore, representatives of both *Fusulina* and *Fusulinella* have assumed considerable importance in the correlation and zonation of lower Pennsylvanian rocks.

Several species of fusulinids of somewhat uncertain generic affinities have been discovered in the upper part of the Desmoinesian rocks in the Mid-Continent region. They seem to be somewhat intermediate in nature between the genotype of

* Numbers in parentheses refer to the References at the end of the paper.

Fusulinella, *F. bocki* Möller, and the genotype of *Fusulina*, *F. cylindrica* Fischer-de-Waldheim, although they occur stratigraphically near some of the biologically most highly developed American species of *Fusulina*. As mentioned above, however, typical species of *Fusulinella* are not known in America above the lower part of the Desmoinesian. The structural features of these forms suggest that they are biologically highly developed descendants of a species of *Fusulinella* and not of a species of *Fusulina*.

Although these species are not closely similar to either the genotype of *Fusulina* or the genotype of *Fusulinella*, I prefer to refer them for the present with question to the genus *Fusulina*. I realize that they possibly are not closely related to any species of that genus.

One of these species was described by Girty(5) in 1911 from the lower part of the Wewoka formation of Oklahoma as *Fusulina inconspicua* Girty. Another species from the Ricker limestone of Texas is being described below as *Fusulina? rickerensis*, n. sp., and still another from the upper part of the Boggy formation of Oklahoma is being described below as *Fusulina? arenaria*, n. sp.

In many respects these forms resemble some of the highly elongate species of *Fusulinella* from the upper part of the Derryan, such as *F. prolifica* Thompson. In other respects they resemble some of the primitive species of the genus *Fusulina* from the lower part of the Desmoinesian, such as *F. carmani* (Thompson). Still in other respects they have characteristics similar to those of species of *Fusulina* from the upper Desmoinesian. As so many species of both *Fusulinella* and *Fusulina* are now recognized to be of great value in the correlation and zonation of lower Pennsylvanian rocks, it seems important that the occurrence of these questionable species of *Fusulina* in the upper part of the Desmoinesian should be emphasized.

A general trend in evolution can be recognized among species of *Fusulinella* during Derryan time. The stratigraphically older species of this genus have spirotheca with thin diaphanotheca, well developed chomata and tectoria, and practically unfluted septa. Many species of *Fusulinella* in upper Derryan and lower Desmoinesian rocks have spirotheca with thicker diaphanotheca but relatively thinner tectoria, more highly fluted septa, and less massive chomata. The primitive species of *Fusulina* in basal Desmoinesian rocks resemble upper Derryan and lower Desmoinesian species of *Fusulinella* in most respects except that their septa are more highly fluted across the central part of the shell. The general trend in the evolution of *Fusulina* during Desmoinesian time is an increase in the height and intensity of the septal fluting, a general thickening of the diaphanotheca, a reduction in the thickness of the tectoria, and a reduction in the height and width of the chomata. In some highly developed species of *Fusulina*, fillings of dense calcite deposits occur in the axial region.

All three of these somewhat questionable species have thin tectoria, poorly developed chomata, and septa that are fluted throughout the length of the shell. However, the fluting of the septa across the central one-half of the shell is low. In most of these forms the septa are not brought in contact by the fluting in the central part of the shell. Axial fillings are fairly well developed in one of them, *F. arenaria.* Although these species resemble *Fusulinella* somewhat closely in regard to septal fluting, they resemble *Fusulina* in regard to spirothecal and chomata development and in that the septa are fluted to some degree across the central part of the shell.

If these upper Desmoinesian fusulinids are in reality descendant from a species of *Fusulinella* rather than from a species of *Fusulina*, it seems obvious that they have taken a trend in evolution similar to that taken by the genus *Fusulina.* It should be pointed out that the ancestral form of the Missourian genus *Triticites* is not known. It is possible that these upper Desmoinesian species of *Fusulina?* are ancestral to *Triticites.*

All three of these species are exceedingly abundant in thin widespread zones in upper Desmoinesian rocks of the Mid-Continent region. They occur in sandstones or arenaceous limestones and are seldom found in pure limestones. Further study, however, may demonstrate that this lithologic association is not characteristic of the group. *F. arenaria* occurs in slightly calcareous sandstone in the upper part of the Boggy formation, and the type specimens are concentrated in elongated zones that seem to be troughs of ripple marks. Although highly developed species of typical *Fusulina* occur stratigraphically near these forms, they are seldom found in direct association with them. A few specimens of a highly developed species of *Fusulina* (Plate 2, Fig. 10) is associated with *F.? inconspicua* in the Wewoka formation, but no typical species of *Fusulina* has been found directly associated with the other two forms described below.

For a more detailed comparison of these three questionable species of *Fusulina* with the type species of the genera *Fusulina* and *Fusulinella*, I am illustrating and giving below detailed descriptions of topotype specimens of the genotypes of both *Fusulina* (Plate 1, Figs. 12-14) and *Fusulinella* (Plate 1, Fig. 15).

Description of topotype specimens of Fusulina cylindrica Fischer-de-Waldheim:—Shell small, elongate subcylindrical, straight to slightly curving; with essentially straight to broadly arcuate axis of coiling, horizontal to slightly sloping lateral slopes, and bluntly pointed to rounded poles. Mature specimens of about five volutions measure 5.5 to 6.0 mm. in length and 1.3 to 1.6 mm. in width, giving a form ratio of 1 : 3.6 to 1 : 4.8. The general development of the shell of this species varies considerably among different specimens. In some, the shell retains essentially the same shape throughout growth. In others, as maturity is approached, the shell becomes broadly curved, the poles are greatly extended, and the form ratio of outer volutions becomes small. The latter type is similar to the illustrated axial section. The form ratios of the first to the fifth volution of the illustrated axial section are 1 : 2.3, 1 : 3.1, 1 : 5.0, 1 : 5.4, and 1 : 4.8, respectively. The form ratios of the first to the fourth volution of another topotype specimen are 1 : 2.2, 1 : 2.6, 1 : 3.0, and 1 : 3.6, respectively.

The spirotheca is composed of a tectum, a relatively thick diaphanotheca, and thin upper and lower tectoria. The upper tectorium is not recognizable in all parts of the inner volutions. Dunbar and Henbest (4) recognized fine alveoli or pores in the spirotheca of topotype specimens of this species, and what appears to be alveoli or pores are poorly developed in the fifth volution of the illustrated sagittal section. The thicknesses of the spirotheca in the first to the fifth volution of the illustrated sagittal section measure 13.6, 20.4, 17.0, 20.4, and 23.8 microns, respectively.

The proloculum is spherical to slightly irregular in shape, and its outside diameter measures about 200 to 250 microns. The shell expands gradually, and the heights of the first to the fifth volution immediately over the tunnel in the illustrated sagittal section measure 75, 102, 129, 143, and 150 microns, respectively. Poleward from the tunnel, the heights of the chambers increase gradually.

The septa are thin. They are composed of the downward deflection of the tectum and diaphanotheca of the spirotheca of the preceding chamber and anterior clear layer that is continuous with the diaphanotheca of the spirotheca of the following chamber. However, this anterior clear layer decreases in thickness downward from the top of the septa. Thin and discontinuous layers of tectoria partly cover the septa in the inner volutions. Poleward from the tunnel, the septa decrease in thickness. The septa are fluted throughout the length of the shell. In the polar one-third of the shell, the fluting extends completely to the tops of the chambers, and there the adjacent septa are brought in contact by the fluting for more than one-half the heights of the chambers. Immediately over the tunnel, however, the fluting of the septa forms closed chamberlets for only about one-half the heights of the chambers.

The tunnel is essentially straight. In the fourth volution of mature specimens, the tunnel is slightly more than one-half as high as the chambers. The tunnel angle is relatively large, and in the second, third, and fourth volutions of the figured axial section it measures 40, 47, and 45 degrees, respectively. Narrow and irregular chomata are developed throughout the shell. Dark-colored deposits essentially fill the chambers in the extreme polar regions of the second to the fourth volution.

Fusulina cylindrica is believed to be biologically a highly developed species of the genus. It has an unusually thick diaphanotheca, its septa are more highly fluted than in many of the species of *Fusulina*, its tectoria are thinner than in many species of this genus, its chomata are more poorly developed than in many species of the genus, and it has more dense deposits in the axial regions than in most species of the genus. The shell development of *F. cylindrica* is closely similar to that of upper Desmoinesian American species, such as *F. eximia* Thompson and *F. lonsdalensis* Dunbar and Henbest. These two species are stratigraphically among the youngest known American representatives of the genus *Fusulina*, and they are believed to be biologically among the most highly developed species of the genus in America.

Description of topotype specimens of Fusulinella bocki Möller:—Shell minute, short, inflated fusiform; with bluntly pointed poles, steep convex lateral slopes, and essentially straight axis of coiling. The extreme polar region of the fifth and sixth volutions is slightly extended, and the lateral slopes near the poles tend to become slightly concave. The illustrated axial section originally contained at least six volutions, but the outer part of the last volution was partly destroyed during fossilization. The remaining five volutions measure about 2.2 mm. in axial length and 1.25 mm. in width; giving a form ratio of about 1:1.8. The inner three volutions are ellipsoidal in shape, with broadly rounded poles. In the fourth and fifth volutions the poles become slightly extended and more narrowly rounded. The form ratios of the first to the fifth volution of the illustrated axial section are about 1:1.4, 1:1.7, 1:1.6, 1:1.6, and 1:1.7, respectively. As is obvious from these figures, the shell retains essentially the same shape throughout growth of the individual.

The spirotheca is composed of a thin tectum, a thin diaphanotheca, and relatively thick upper and lower tectoria. The diaphanotheca is not clearly recognizable in the inner two volutions, but it can be observed with ease in the outer volutions. Both upper and lower tectoria are recognizable throughout all parts of the shell in the specimen I am studying. However, the chomata are so heavy and broad that the upper tectoria can not be differentiated in most parts of the specimen. The thicknesses of the combined tectum and diaphanotheca in the third and fourth volutions of the illustrated axial section are 8.5 and 10.2 microns, respectively. The thicknesses of all four layers of the spirotheca immediately over the tunnel in the second to the fifth volution of this specimen are about 30, 44, 60, and 62 microns, respectively.

EXPLANATION OF PLATE 1.

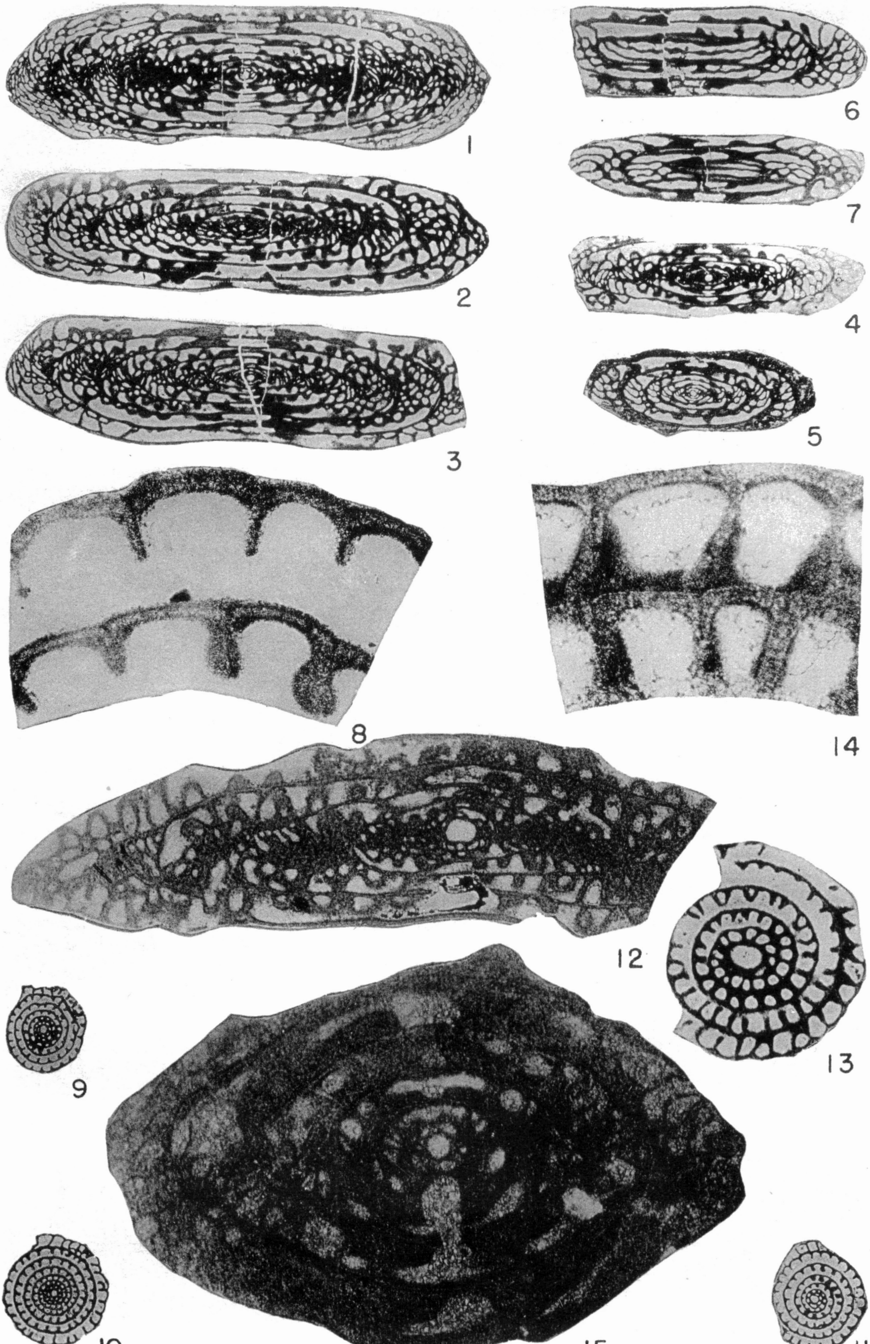
All illustrations on this plate are unretouched photographs.

Figs. 1-4, 6-11, *Fusulina? arenaria* Thompson, n. sp. 1, Axial section of the holotype, x10; 2-4 axial sections of paratypes, x10; 6, 7, tangential sections of paratypes, x10; 8, enlarged portion of the sagittal section of Fig. 11 that shows the structure of the spirotheca, x100; and 9-11, sagittal sections of paratypes, x10. Upper Boggy formation, Oklahoma.

Fig. 5. *Fusulina? rickerensis* Thompson, n. sp. Axial section of a paratype, x10.

Figs. 12-14. *Fusulina cylindrica* Fischer-de-Waldheim. 12, Axial section of a topotype, x20; 13, sagittal section of a topotype, x20; and 14, enlarged portion of the outer two volutions of the illustrated sagittal section of Fig. 13 that shows the thick "porous" diaphanotheca, tectum, thin discontinuous upper and lower tectoria, and the structure of the septa, x100. Mjatschkowo limestone, Mjatschkowo, Russia. State Univ., Iowa, No. 1617.

Fig. 15. *Fusulinella bocki* Möller. Axial section of a topotype specimen that shows the four layers of the spirotheca and the massive chomata, x40. Kresty, Government of Tver, Russia. Stanford Univ. Paleo. Type Coll. No. 5954.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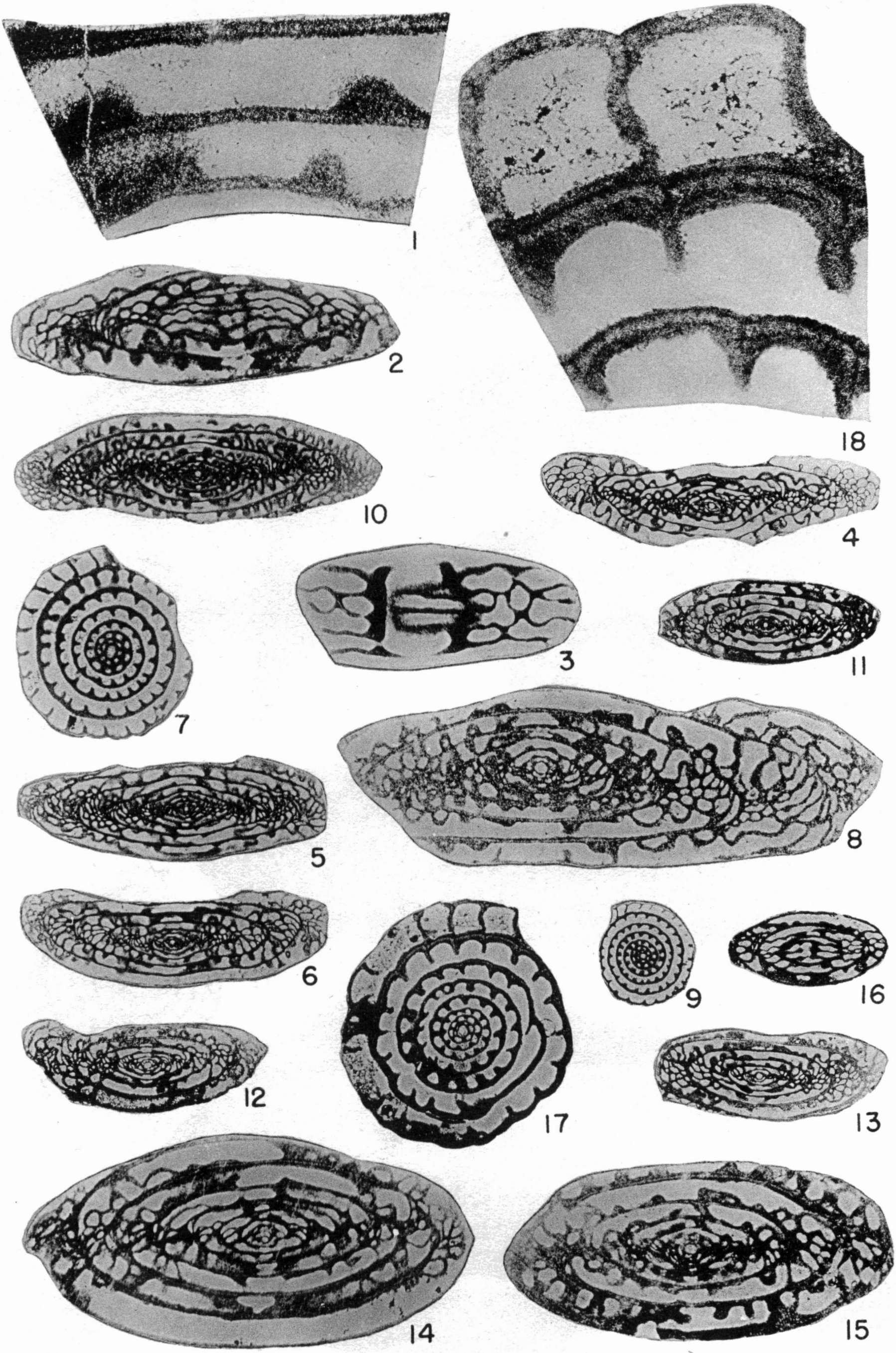
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The proloculum is minute in size and spherical in shape. Its outside diameter measures about 112 microns. The shell expands uniformly, and the heights of the chambers immediately over the tunnel in the first to the fifth volution measure about 44, 78, 119, 165, and 222 microns, respectively.

The septa are only slightly fluted in the polar regions, but they seem to be unfluted in the central part of the shell.

The tunnel is narrow, relatively high, and essentially straight. The tunnel angles of the second to the fifth volutions measure about 22, 18, 18, and 24 degrees, respectively. The chomata are high and broad. The tunnel side of the chomata is essentially vertical but the poleward slope is low, and the chomata extend more than half the distance to the poles in the inner four volutions of specimens of six volutions. In the fifth volution, the chomata are high and symmetrical and are about twice as broad as high.

The weak fluting of the septa, massive and broad chomata, and general shape of the shell of *Fusulinella bocki* are more closely similar to *Fusulinella fittsi* Thompson from the lower part of the Derryan Atoka formation of Oklahoma than to any other described American species. However, *F. bocki* obviously is more highly developed biologically than *F. fittsi*. *F. bocki* has a well defined diaphanotheca, but such is not observable in *F. fittsi*. Several undescribed species of *Fusulinella* from the Derryan of New Mexico, however, show a biological development very closely similar to that of *F. bocki*.

EXPLANATION OF PLATE 2.

All illustrations on this plate are unretouched photographs.

Figs. 1-9. *Fusulina? inconspicua* Girty. 1, Enlarged portion of an axial section that shows the structure of the spirotheca, x100; 2, 3, tangential sections, x20; 4-6, axial sections, x10; 7, sagittal section x20; 8, axial section, x20; and 9, sagittal section, x10. Lower part Wewoka formation, Oklahoma.

Fig. 10. *Fusulina* sp. Typical species of the genus associated with the above illustrated specimens of *Fusulina? inconspicua* Girty. Lower part Wewoka formation, Oklahoma.

Figs. 11-18. *Fusulina? rickerensis* Thompson, n. sp. 11-13, Axial sections of paratypes, x10; 14, axial section of a paratype, x20; 15, axial section of the holotype, x20; 16, tangential section of a paratype that shows the nature of the septal fluting, x10; 17, sagittal section of a paratype, x20; and 18, enlarged portion of the same specimen as Fig. 17 that shows the structure of the spirotheca, x100. Ricker limestone, Ricker, Texas.

By comparison of the above descriptions and the accompanying illustrations of topotype specimens of the genotypes of *Fusulina* and *Fusulinella* with the illustrations and descriptions of the three species described below, *F.? inconspicua*, *F.? arenaria*, and *F.? rickerensis*, it seems logical to refer these species to the genus *Fusulina* rather than to *Fusulinella*. It is realized, however, that they are not "typical" of the genus *Fusulina*. For instance, their septa are not nearly as highly or intensely fluted as are those of *Fusulina cylindrica*. On the other hand, their septa are much more intensely fluted than are those of *Fusulinella bocki*. Also, their chomata are not as well developed, their shells have different shapes, and their tunnels expand much more rapidly than do those of *F. bocki*.

Thanks are extended to Dr. A. K. Miller and Dr. Myra Keen for the loan of specimens; to Mr. E. N. K. Waering for collections; and to Dr. C. O. Dunbar for criticizing the manuscript.

FUSULINA? INCONSPICUA Girty

Plate 2, Figs. 1-9.

Fusulina inconspicua, Girty, *1911*, New York Acad. Sci. Annals, **21**, 120, 121.—Girty, *1915*, U. S. Geol. Survey, Bull. **544**, 15, 16, pl. 1, figs. 1-8.

Girty's original types of this species were obtained from a thin zone near the base of the Wewoka formation in the southwest corner of sec. 32, T. 5 N., R. 8 E., Colgate quadrangle, Oklahoma. The accompanying illustrations and description are based on specimens collected from a calcareous sandstone in the lower part of the Wewoka formation near the center of the NE¼ NE¼ sec. 6, T. 3 N., R. 7 E., Oklahoma.

Shell small, elongate, cylindrical and subcylindrical at maturity, with straight axis of coiling and bluntly pointed to rounded poles. Four mature specimens contain six volutions and they each measure about 1.1 mm. in width and 4.1 mm. in length, giving a form ratio of 1:3.6. The poles of the inner three volutions are sharply pointed, but the poles of the outer volutions gradually become more broadly rounded. The average form ratios of the first to the sixth volution of two specimens are 1:1.4, 1:1.7, 1:2.8, 1:3.5, 1:3.7, and 1:3.6, respectively.

The proloculum is minute in size, and its outside diameter measures 75 to 116 microns in nine specimens, averaging 95 microns. The heights of the first to the sixth volution of four specimens are 32 to 50, 43 to 71, 61 to 100, 89 to 107, 107 to 132, and 143 to 150 microns, respectively. The average heights of the first to the sixth volution of these same specimens are 39, 56, 77, 97, 119, and 145 microns, respectively.

The spirotheca is thin, and it is composed of a tectum, a diaphanotheca, and upper and lower tectoria. The thicknesses of the spirotheca in the third to the sixth volution of four specimens measure 14, 18 to 19, 20 to 25, and 25 to 36 microns, respectively; averaging 14, 18, 23, and 30 microns, respectively. The averages of the septal count of the first to the sixth volution of several specimens give 7, 10, 13, 18, 20, and 24. The septa are narrowly and highly fluted in the extreme polar regions, but across the middle part of the shell the septa are very broadly wavy and the fluting is confined to the lower portion of the septa.

The tunnel is low and broad, and its path is only slightly irregular. The averages of several measurements for the tunnel angle give 27 degrees in the third volution, 40 degrees in the fourth volution, 50 degrees in the fifth volution, and 65 degrees in the sixth volution. Chomata are developed throughout the shell. They average about one-third the height of the chambers, and they are slightly wider than high.

Discussion.—This species resembles somewhat closely *F.? rickerensis* and *F.? arenaria*. It differs from the former species especially in that it has a smaller form ratio at maturity, it is larger in size, and it has a different general shell outline. It differs from the latter species especially in that its form ratio is larger, it is larger at maturity, and it has a different shell shape at maturity.

Dr. C. O. Dunbar has examined Girty's type specimens and assures me they are conspecific with the specimens I am studying.

Occurrence—Girty's types came from near the base of the Wewoka formation in sec. 32, T. 5 N., R. 8 E., Oklahoma. The specimens on which the above description and accompanying illustrations are based came from the lower part of the Wewoka formation near the center of the NE¼ NE¼ sec. 6, T. 3 N., R. 7 E., Oklahoma, where they are associated with a highly developed species of the genus *Fusulina* (Plate 2, Fig. 10).

Types—Girty's type specimens presumably are deposited in the U. S. National Museum. The illustrated specimens of this report are deposited at the University of Kansas.

FUSULINA? RICKERENSIS Thompson, n. sp.

Plate 1, Fig. 5; Plate 2, Figs. 11-18.

Shell small, sub-cylindrical to ellipsoidal in shape; with straight axis of coiling, and rounded to very bluntly pointed poles. The inner three volutions have sharply pointed poles, but the poles become more broadly rounded in the outer volutions. Mature specimens of six to seven volutions measure 1.0 to 1.6 mm. in width and 2.9 to 3.5 mm. in length. The form ratio of mature specimens is 1:2.4 to 1:2.8, averaging 1:2.6 for five typical specimens. The form ratios of the first to the fifth volution of five specimens are 1:1.2 to 1:1.8, 1:1.6 to 1:2.8, 1:2.0 to 1:2.8, 1:2.3 to 1:2.9, and 1:2.5 to 1:2.9; averaging 1:1.5, 1:2.2, 1:2.6, 1:2.7, and 1:2.7, respectively.

The proloculum is minute, and its outside diameter measures 83 to 116 microns, averaging about 95 microns for seven specimens. The heights of the first to the sixth volution of seven typical specimens measure 32 to 36, 36 to 50, 50 to 86, 79 to 114, 107 to 157, and 136 to 196 microns, respectively; averaging 34, 44, 68, 96, 130, and 181 microns, respectively. The outermost volution of one specimen of seven volutions is 193 microns in height. As shown by these figures, the shell expands at an essentially uniform rate.

The spirotheca is composed of a tectum, a diaphanotheca, and upper and lower tectoria. The lower tectorium is thin and of essentially uniform thickness, but the upper tectorium varies considerably in thickness in different parts of the shell. Therefore, detailed measurements of the thickness of the spirotheca of any one specimen could be considered only a rough approximation of the species. The averages of the thicknesses of the spirotheca, measured over the tunnel, of the third to the sixth volution of seven typical specimens are 13, 19, 30, and 35 microns, respectively.

The septa of this species are highly fluted only in the extreme polar regions. Near the middle part of the shell the septa are straight to broadly wavy. However, the basal part of the septa are very broadly fluted even immediately over the tunnel of the outer volution of mature specimens. The septal counts of the first to the six volution of three specimens are 7 to 8, 8 to 10, 10 to 12, 11 to 14, 15 to 17, and 21, respectively; averaging 8, 9, 11, 13, 16, and 21, respectively.

The tunnel is low and broad. The tunnel angles in the third, fourth, fifth, and sixth volutions of five typical specimens measure 29 to 38, 27 to 42, 32 to 45, and 32 to 55 degrees, respectively; averaging 33, 36, 40, and 46 degrees, respectively. Chomata are well developed throughout the shell, and they are of essentially uniform shape and size throughout the shell. As can be seen in the accompanying illustrations, the chomata are about one-half as high as the chambers and they are slightly broader than high.

Discussion.—*F.? rickerensis* is more closely similar to *F.? inconspicua* and *F.? arenaria* than to any other described species, but it is smaller at maturity, has a larger form ratio at maturity, and has a different shell type at maturity than either of these species.

Occurrence.—The type specimens on which the above description is based were obtained from the highly arenaceous limestone near the depot at Ricker, Brown County, Texas. This limestone is commonly known as the "Ricker limestone" and occurs immediately below the Ricker conglomeratic sandstone; that is, in the lower part of Drake's (7) Ricker bed.

FUSULINA? ARENARIA Thompson, n. sp.

Plate 1, Figs. 1-4, 6-11.

Shell small, elongate, cylindrical to sub-cylindrical in shape; with broadly rounded poles and straight to broadly curving axis of coiling. Mature specimens of seven to eight volutions measure 5.5 to 7.3 mm. in length and 1.5 to 1.8 mm. in width. The form ratio of mature specimens is 1 : 3.7 to 1 : 4.9, averaging 1 : 4.1 for five typical specimens. The poles of the inner five volutions are sharply pointed but beyond the fifth volution the poles gradually become rounded, and at maturity the poles are very broadly rounded. The form ratio decreases with growth of the shell. For five typical mature specimens the form ratios of the first, second, third, fifth, and seventh volutions average 1 : 1.8, 1 : 3.1, 1 : 3.6, 1 : 4.4, and 1 : 4.1, respectively.

The proloculum is minute, and its outside diameter measures 91 to 142 microns, averaging about 125 microns for nine typical specimens. The heights of the first to the eighth volution of eight typical specimens measure 39 to 47, 43 to 71, 57 to 94, 79 to 121, 107 to 150, 121 to 164, 154 to 179, and 143 microns, respectively; averaging 44, 56, 73, 99, 124, 145, 164, and 143 microns, respectively. As is indicated by these figures, the shell is tightly coiled and expands uniformly.

The spirotheca is exceedingly thin; it is composed of four layers, a tectum, a diaphanotheca, and upper and lower tectoria. However, the lower tectorium is extremely thin throughout the shell. The average thicknesses of the spirotheca, measured along the line of the tunnel, in the third to the eighth volution of eight typical specimens are 14, 21, 20, 26, 27, and 21 microns, respectively. The tectoria of the spirotheca vary markedly in thickess in different specimens and in different parts of the same volution of the same specimen. Therefore, the above figures have little significancc other than to indicate that the spirotheca is thin and that it decreases in thickness in the outer one or two volutions of mature specimens. The diaphanotheca increases in thickness slightly in the outer three volutions, but the tectoria decreases in thickness in that part of the shell.

The septa are thin. The septal counts in the first to the seventh volution of three typical specimens give 7 to 8, 11 to 12, 12 to 16, 16 to 19, 18 to 22, 22 to 27, and 29, respectively; averaging 8, 12, 14, 17, 20, 24, and 29, respectively. The septa are narrowly fluted in the extreme polar regions, and there the fluting forms chamberlets near the base of the chambers. Toward the tunnel the septa become very broadly fluted, and in the central two-thirds to one-half of the shell the fluting does not bring adjacent septa in contact. Immediately over the tunnel the septa are broadly wavy.

The tunnel is low and wide. The tunnel angle is large. The tunnel angles in the third to the eighth volution of six specimens measure 22 to 43, 41 to 53, 43 to 62, 43 to 66, 45 to 70, and 83 degrees, respectively; averaging 35, 47, 54, 54, 56, and 83 degrees, respectively. Chomata are well developed throughout the shell, and they are about two and one-half times as wide as high. The chomata are very steep to overhanging adjacent to the tunnel, and they are about one-half as high as the chambers. Axial fillings are developed in the second to the seventh volutions, but are best developed in the fourth volution of specimens of eight volutions.

Discussion.—This species is larger at maturity, has a smaller form ratio at maturity, and has a different shell shape at maturity than *F.? rickerensis* or *F.? inconspicua.*

Occurrence.—This species is extremely abundant in the upper part of the Boggy formation in a highly calcareous fusulinid-bearing sandstone about 20 feet above the "Campophyllum" limestone. The specimens are concentrated in what seem to be troughs of ripple marks in the sandstone. I have collections from Mayer Ranch, near the center of sec. 7, T. 3 N., R. 8 E., Pontotoc County, Oklahoma, and at the same horizon in the center of sec. 12, T. 3 N., R. 7 E., Pontotoc County, Oklahoma. The above specific description and all of the accompanying illustrations are based on specimens from the latter locality.

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