NEW GENERA OF PENNSYLVANIAN FUSULINIDS.[1]

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ABSTRACT. In this preliminary report on the classification of Pennsylvanian fusulinids, four new genera are established as follows: *Millerella*, n. gen., genotype *M. marblensis*, n. sp.; *Pseudostaffella*, n. gen., genotype *P. needhami*, n. sp.; *Waeringella*, n. gen., genotype *W. spiveyi*, n. sp.; and *Dunbarinella*, n. gen., genotype *D. ervinensis*, n. sp.

IN 1939 I undertook a detailed study of the stratigraphy and fusulinid faunas of the Pennsylvanian of New Mexico and adjacent areas for the New Mexico Bureau of Mines and Mineral Resources and this study alone has involved the examination of over 550 collections of fusulinids from measured sections of the Pennsylvanian of this area. During the preliminary stages of the preparation of a report on this study, the need of certain revisions of the general classification of the Pennsylvanian fusulinids has become obvious, including the establishment of several new generic groups. Since so many workers are interested in the Pennsylvanian fusulinids for purely scientific reasons as well as the application of these fossils to the solution of stratigraphic problems in the petroleum industry, it seems advisable to describe these new generic groups at this time in preference to waiting for the more detailed, general summary of the classification of the Pennsylvanian fusulinids which will be included in the larger New Mexico report. However, little discussion will be given at this time in regard to detailed stratigraphic distributions of these generic groups.

I am indebted to many workers for the loan of collections, information which led to better collecting localities outside of New Mexico, and specific information as to the stratigraphic distribution of certain of the Pennsylvanian fusulinids. I wish especially to mention the help given in this regard by Mr. Erik N. Kjellesvig-Waering and Mr. John W. Skinner. Prof. C. O. Dunbar and Mr. Kjellesvig-Waering have gone over all parts of this report and their constructive criticisms are appreciated; they must not be held responsible for concurrence in all the ideas presented, however.

[1] Published by permission of the Director of the New Mexico Bureau of Mines and Mineral Resources.

All of the illustrated specimens of species described in this report will be deposited in the Paleontological Repository of the State University of Iowa and the catalogue numbers will be designated SUI. A part of the unfigured syntypes and paratypes will be deposited in the Stanford University Paleontological Type Collection and at the Yale Peabody Museum, designated SUPTC and YPM, respectively. The remainder of the syntypes and paratypes are kept in our collections.

Genus MILLERELLA Thompson, new genus.

Genotype: *Millerella marblensis* Thompson, new species.

Diagnosis of Millerella.—Shell minute, discoidal, with short axis of coiling and narrowly rounded to sub-angular periphery; planispiral throughout growth. The inner three to four volutions are involute but the outer one or two volutions of mature specimens become partially evolute and they only reach approximately one-half the distance to the poles of the preceding volution. Polar regions of mature specimens are depressed (umbilicate). Mature specimens consist of four to seven volutions and measure about 0.3 to 0.6 mm. in width and less than 0.3 mm. in axial length. Spirotheca very thin, consisting of a thin middle layer (tectum and diaphanotheca?) and very thin upper and lower layers which may be tectoria. However, the middle layer is the only layer which can be recognized in all specimens. The rate of expansion of the shell is essentially uniform. Septa are very thin and numerous, and they show a prominent curving in well oriented sagittal sections. Proloculum minute; tunnel low and narrow and bounded by low, narrow chomata.

Representatives of *Millerella* can be distinguished from those of most of the other of the fusulinid genera by their short axis of coiling, narrowly rounded to sub-angular periphery, evolute outer volutions, and prominently curving septa. Representatives of *Millerella* differ from those of the genus *Ozawainella* Thompson by their evolute outer volutions, less sharply angular periphery, much more poorly developed chomata, and smaller size of mature specimens. The genotype of *Nummlostegina* Schubert, *N. velibitana* Schubert, is very poorly known but Schubert's illustrations of external views show completely involute specimens and they also indicate that representatives of the genus *Nummulostegina* are more highly inflated than are those of *Millerella*.[2]

As well as can be determined from the illustrations (drawings), *Staffella ciscoensis* Harlton from the upper Pennsylvanian Cisco and *Orobias radiata* [Brady] Galloway and Harlton from the lower Pennsylvanian Wapanucka limestone should be referred to the genus *Millerella*.

Age.—The genotype of *Millerella*, described below, occurs in the Marble Falls limestone (lower "Bend series") at Marble Falls, Texas; in the lower Magdalena formation (lower "Bend series") of the southern part of the Hueco Mountains of west Texas; and in the lower portion of the "Bend series" of many areas in southern New Mexico. The form described by Galloway and Harlton as *Orobias radiata* came from the Wapanucka limestone (lower Pennsylvanian) and the form described by Harlton as *Staffella ciscoensis* came from the Cisco (upper Pennsylvanian). Apparently the genus has a range in the Pennsylvanian at least from the Wapanucka limestone to the Cisco. From a biological point of view, *Millerella* undoubtedly is the most primitive of all the fusulinids so far described and its stratigraphic occurrence also bears out this conclusion.

This genus is named in honor of Prof. A. K. Miller in whose laboratory I first became interested in fusulinids.

MILLERELLA MARBLENSIS Thompson, new species.

Plate 1, Figs. 3-14.

Shell minute, discoidal, with very short axis of coiling and narrowly rounded to sub-angular periphery. Planispiral throughout growth. Inner volutions involute; outer one or two volutions of mature specimens partially evolute with the symmetrical overlapping extending only about one-half the distance to the poles of the preceding whorl. Mature specimens of four to seven and one-half volutions measure 0.11 to 0.22 mm. in axial length and 0.23 to 0.64 mm. in width, with a form ratio of 1 : 0.38 to 1 : 0.30. The average form ratio of five typical specimens is 1 : 0.34. Inner volutions of young individuals

[2] Although representatives of *Millerella* could hardly be confused with those of *Nummulostegina*, it should be mentioned that the latter genus is so poorly known that its representatives are not recognizable at the present time. The original type specimens or topotype specimens of the genotype must be sectioned and studied by modern methods before the genus *Nummulostegina* will be understood.

slightly raised in the polar regions but gerontic individuals slightly umbilicate.

Septa are very thin and they are composed of a thin central layer and very thin outer layers which may be tectoria. The septal count of the first to the fourth volutions for five typical specimens gives 7 to 8, 10 to 13, 12 to 16, and 17 to 21, respectively. The averages of the septal count for the first to the fourth volutions of these same specimens give 8, 11, 14, and 18, respectively. The septa are inclined forward as they start downward but they change direction with further development and they become strongly curved dorsally. No evidence of fluting has been observed.

Spirotheca very thin and composed of a thin middle layer (tectum and diaphanotheca?) and upper and lower obscure layers which may correspond to tectoria of other of the fusulinids. Proloculum minute, its inside diameter measuring 25 to 36 microns, with an average inside diameter of about 31 microns for seven typical specimens. The expansion of the shell is essentially uniform and the heights of the first to the fourth volution of six typical specimens measure 17 to 36, 21 to 68, 43 to 109, and 89 to 140 microns, respectively. The averages of the heights of the first to the fourth volution of these same specimens are 26, 42, 68, and 106 microns, respectively. The tunnel is low and narrow and its path is essentially straight. Either side of the tunnel is bordered by very low and narrow chomata.

Discussion.—The specimens from the Wapanucka limestone of Oklahoma described by Galloway and Harlton as *Orobias radiata* (Brady) may be referable to *M. marblensis* but the description and illustrations (drawings) of the Oklahoma specimens are not sufficient for direct comparison. However, the size given for the Oklahoma specimens is much smaller than the size of the form herein described. *M. marblensis* is more than twice as large at maturity as *Staffella ciscoensis* but further than this brief statement little can be said in regard to the differences or similarities between these two forms without a re-study of type material of *S. ciscoensis.*

Occurrence.—Specimens which seem to be conspecific with the holotype of this species are very widespread in the lower part of the "Bend series" of Texas and New Mexico. The above description is based on the holotype and paratype specimens from the type locality of the Marble Falls limestone, near water level and 150 yards down stream from the bridge at Marble Falls, Texas, where they are associated with *Ozawainella?* sp.; on paratype specimens from the lower "Bend series" of the Pennsylvanian section on the south wall of Powwow Canyon, Hueco Mountains, Texas, and about 400 feet above the base of the fusulinid-bearing Pennsylvanian exposed at this locality, where they are associated with *Ozawainella?* sp., *Profusulinella*, n. sp., and *Pseudostaffella*, n. sp.; and on paratype specimens from the "Bend series" of Mud Springs Mountain of central New Mexico, 0 to 260 feet above the base of the Pennsylvanian of this region, where they are associated with *Pseudostaffella needhami*, n. sp., *Profusulinella*, n. spp., and two species of the genus *Fusulinella* Möller.

Types.—Figured specimens from the Marble Falls limestone, Marble Falls, Texas, holotype, SUI No. 3290 and paratypes, SUI No. 3291; Hueco Mountains, Texas, paratypes, SUI No. 3292; paratypes, SUPTC No. 6950, YPM No. 17061, 17063, and 17064.

Genus PSEUDOSTAFFELLA Thompson, new genus.

Genotype: *Pseudostaffella needhami* Thompson, new species.

In 1939 Licharew and others[3] published a description and illustrations of topotype specimens of the genotype of *Staffella* Ozawa, *Staffella moellerans* Thompson (=*Fusulinella sphaerica* Möller, not Abich) from the Arax sediments near Djoulfa, Transcaucasus, which brings to our attention some additional information concerning the structure of the innermost portions of the shell of this species. This information permits a better understanding of the relationship between representatives of the Permian genus *Staffella* and the lower Pennsylvanian fusulinids which previously have been referred to the genus *Staffella*. A part of Licharew's illustrations of *S. moellerana* from Transcaucasus is here reproduced in order that it may be accessible to a larger number of American workers (Pl. 1, Fig. 1) and a translation from the Russian of Licharew's generic diagnosis of *Staffella* and the specific description of the genotype as based on topotype material are given below[4]:

[3] Licharew, B., and others: 1939, The Atlas of the leading forms of the fossil fauna USSR. Volume VI. Permian. Central Geological and Prospecting Institute, p. 34, Pl. 1, figs. 14, 15.

[4] Op. cit., p. 34.

Genus *Staffella* Ozawa.

Fig. 4.

Shell nautiloid, globular, spool-shaped or barrel-shaped; theca consists of tectum, diaphanotheca, and two tectoria; septa are flat or slightly curved, not fluted; aperture is singular; chomata are well developed.

From the systematically neighboring genera *Orobias*, *Nankinella*, and *Fusulinella* it differs thus: From *Orobias* and *Nankinella* in shape of shell, from *Fusulinella* in shape of shell and absence of septal fluting. Some *Staffella* in the primary whorls display a lenticular form of shell.

Staffella sphaerica (Abich, 1858) [=*S. moellerana* Thompson]

Pl. 1, Figs. 14 and 15.

Shell large, in the adult stage approaching spool-shaped, rather highly compressed with reference to the axis of coiling, in axial section it is oval; on each side are flat umbilici; the primary whorls

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EXPLANATION OF PLATE 1.

All original illustrations on this plate are unretouched photographs.

Fig. 1. *Staffella moellerana* Thompson [=*Staffella sphaerica* (Möller) Licharew]. Topotype specimen from the Arax sediments near Djoulfa, Transcaucasus, x15. (After Licharew).

Fig. 2. *Pseudostaffella ozawai* (Lee and Chen). Syntype, Huanglung limestone, Anshan, Hosien, China, x50. Illustrated for comparison with the genotype of the new genus *Pseudostaffella*, *P. needhami*, n. sp.

Figs. 3–14. *Millerella marblensis* Thompson, n. sp. 5, Axial section of the holotype, x100; 3, tangential section, x100; 4, 7, 9, tangential sections, x50; 6, 8, axial sections, x50; and 10–14, sagittal sections, x50. Specimens of figures 3-7 and 12-14 are from the type section of the Marble Falls limestone, and those of figures 8–11 are from the Magdalena formation of Powwow Canyon, Hueco Mountains, Texas.

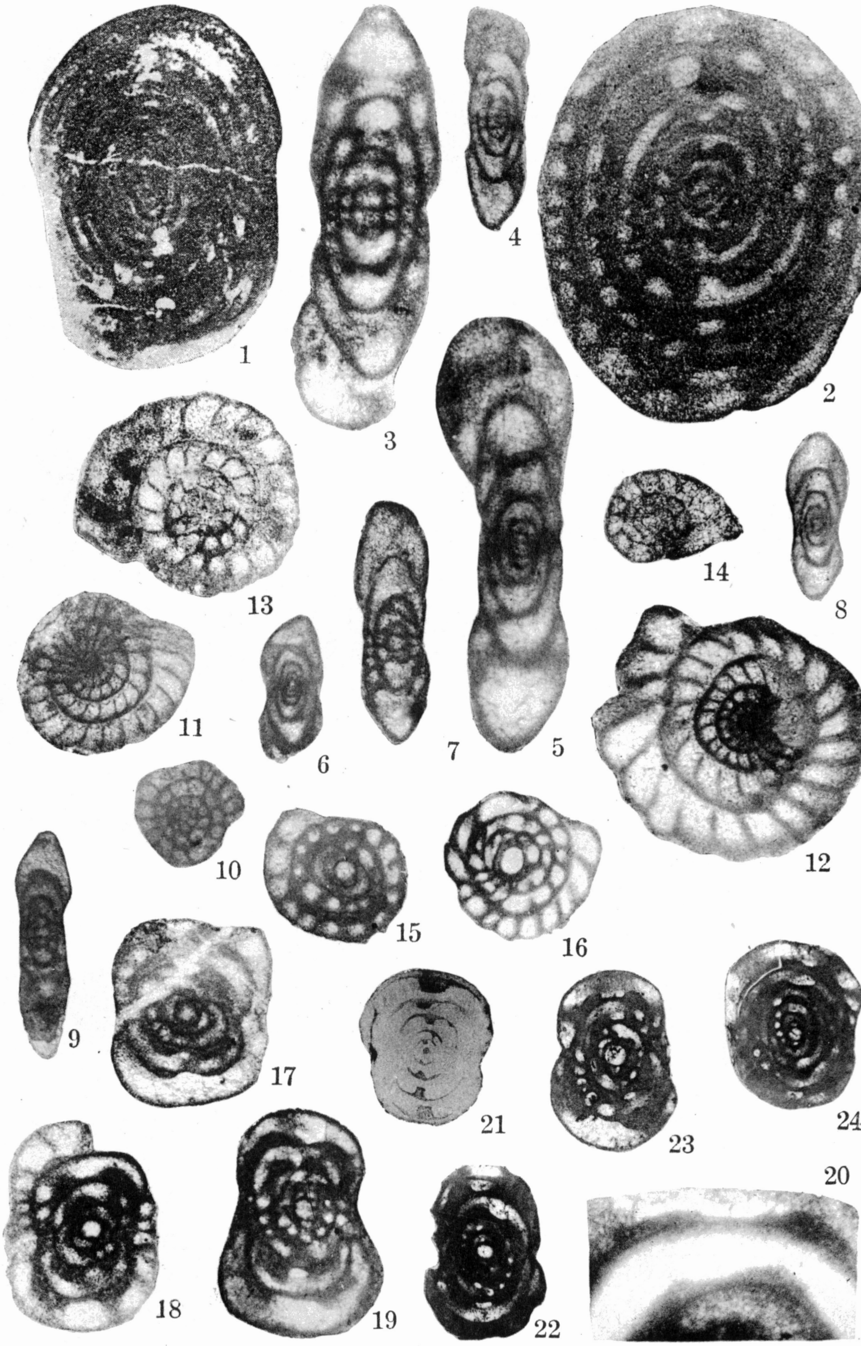
Figs. 15–20. *Pseudostaffella needhami* Thompson, n. sp. 15, 16, Sagittal sections, x50; 17–19, axial sections, x50; and 20, portion of the specimen illustrated as Figure 11, Plate 3, enlarged to show the three-layer structure of the spirotheca, x150. Magdalena formation, Mud Springs Mountain, New Mexico.

Fig. 21. *Pseudostaffella keytei* (Roth and Skinner). McCoy formation of Colorado, x32. (After Roth and Skinner).

Fig. 22. *Pseudostaffella atokensis* (Thompson). Atoka formation of Oklahoma, x40. (Syntype).

Fig. 23. *Pseudostaffella hollingsworthi* (Thompson). Boggy formation of Oklahoma, x40. (Syntype).

Fig. 24. *Pseudostaffella keytei* var. *maccoyensis* (Thompson). McCoy formation of Colorado, x40. (Syntype).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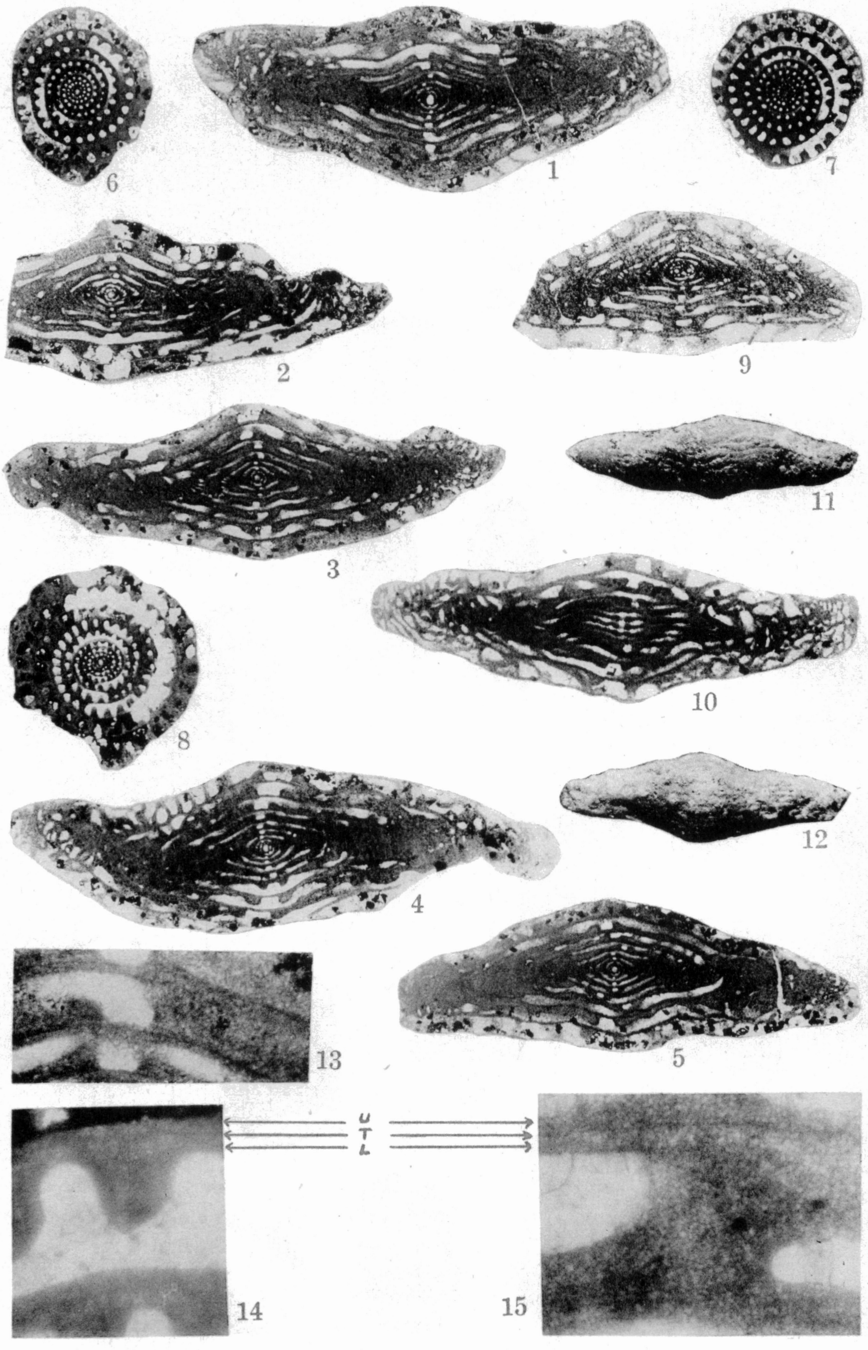
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are nautiloid or lens-shaped; the coiling is very even; there are many whorls; E. K. [proloculum] small, oval or spherical; the septa are flat; the aperture is in the shape of a somewhat narrow slit; along the sides of the tunnel are rather massive chomata which fade out in the last whorl.

From *Pisolina abichi* Dout., sp. nov., with which it is commonly found and to which it is outwardly akin, *Staffella sphaerica* differs (aside from generic features) in the appearance of nautiloid lenticular primary whorls and in smallness of dimensions.

Lower Permian. Transcaucasus section of dark limestone in the Arax valley. Outside of the U. S. S. R. it possibly is present in strata of Tsis of south China and in the Permian sediments of northern Iran.

From an examination of the accompanying illustration of a topotype specimen of the genotype (Pl. 1, Fig. 1), the above description of topotype specimens of the genotype, and Möller's original description and illustrations of *S. moellerana*, it is evident that the genus *Staffella* possesses a lenticular juvenarium in contrast to the more or less spherical juvenarium of the lower Pennsylvanian fusulinids which generally have been referred to *Staffella*. The spirotheca of the lower Pennsylvanian species has only three layers in contrast to the four layers of the spirotheca of the form described and illustrated by Möller and by Licharew. Also, illustrations of *S. moellerana* indicate that the chomata of this species are much more poorly developed than are those of the lower Pennsylvanian species usually referred to *Staffella*. It seems to me that most of the lower Pennsylvanian fusulinids which previously have been referred to *Staffella* constitute a distinct generic group and I am, therefore, proposing the name *Pseudostaffella* for them with *Pseudostaffella needhami*, described below, as the genotype.

In addition to the genotype, I would refer the following

EXPLANATION OF PLATE 2.

All illustrations on this plate are unretouched photographs.

Figs. 1–15. *Waeringella spiveyi* Thompson, n. sp. 1–5, Axial sections, x20; 6–8, sagittal sections, x20; 9, axial section of a specimen with two proloculi, x20; 10, tangential section showing the nature of the septal fluting, x20; 11 and 12, external views, x10; 13, portion of the specimen illustrated as Figure 1 on this plate, enlarged to show the wall structure, x100; and 14 and 15, enlargements of the sixth and seventh volutions of the specimens illustrated as Figures 8 and 9, respectively, on this plate, enlarged to show the three-layer structure of the spirotheca, composed of U=upper layer, T=tectum, and L=lower layer, x200.

American fusulinid species and varieties to the genus *Pseudostaffella*: *Staffella keytei* Roth and Skinner (Pl. 1, Fig. 21), *Staffella atokensis* Thompson (Pl. 1, Fig. 22), *Staffella hollingsworthi* Thompson (Pl. 1, Fig. 23), and *Staffella keytei* var. *maccoyensis* Thompson (Pl. 1, Fig. 24). All of these forms come from strata either equivalent to the Bend series or equivalent to the Des Moines series. From Europe and Asia the following forms have been described which seem to me referable to this genus: *Fusulinella sphaeroidea* Möller (?=*Melonia* [*Borelis*] *sphaeroidea* Ehrenberg), ?*Fusulinella quadrata* Deprat, *Staffella mölleri* Ozawa, *Staffella ozawai* Lee and Chen (=*Staffella confusa* Lee and Chen),[5] *Staffella para-sphaeroidea* Lee and Chen, *Staffella paradoxa* Doutkevitch, *Staffella antiqua* Doutkevitch, and *Staffella compressa* Rauser-Cernoussova.

The following generic diagnosis of the new genus *Pseudostaffella* is based on studies of the genotype, syntype and topotype specimens of the American species listed above which I am here referring to this genus, syntype and topotype specimens of many of the Eurasian species listed above; and all published descriptions and illustrations of the above mentioned species which I am referring to *Pseudostaffella*:

Diagnosis of Pseudostaffella.—Shell small, spherical to subspherical in shape, with rounded to slightly depressed (umbilicate) polar regions; form ratio of mature specimens 1:1 to 1:0.8; mature specimens consist of four to seven volutions and reach a maximum size of 0.5 to 1.8 mm. in width and 0.5 to 1.7 mm. in length; periphery broadly rounded throughout growth; in some representatives, axis of coiling of the juvenarium at a large angle to the axis of the outer volutions (endothyroid); chomata well developed, usually over one-half as high as the chambers; spirotheca thin and composed of a tectum, and upper and lower tectoria (in large species, a diaphanotheca has been reported in the outer volutions[6]);

[5] I have examined a part of the original type specimens of these species and they occur in the same slide of limestone. It seems to me that the type specimens of *confusa* merely represent young specimens of *ozawai* (see Pl. 1, Fig. 2).

[6] A reëxamination of syntype or topotype specimens of all of the American species which I am referring to this genus shows that the "diaphanotheca" which has been described for these forms more probably is a slightly less dense upper portion of the lower tectorium and not a true diaphanotheca. Also, syntypes of *Staffella ozawai* Lee and Chen (Pl. 1, Fig. 2) do not contain a well defined diaphanotheca.

tunnel singular, having a very irregular and asymmetrical path and narrow angle; septa numerous, unfluted, essentially straight to slightly curved in the polar regions.

Representatives of *Pseudostaffella* may be distinguished from those of most of the other fusulinid genera by their short axis of coiling, large form ratio, and broadly rounded periphery. With representatives of *Staffella* the juvenarium is discoidal and the shell and tunnel path are symmetrical throughout growth; whereas, with representatives of *Pseudostaffella* the juvenarium is essentially spherical and the path of the tunnel is asymmetrical. The chomata of *Pseudostaffella* are relatively very massive; whereas, Möller's illustrations of the genotype of *Staffella* do not show the presence of large chomata nor does the sagittal section published by Licharew show well developed chomata. The spirotheca of *Pseudostaffella* is composed of three layers; whereas, the spirotheca of the genotype of *Staffella* is described and illustrated by Möller and by Licharew as having four layers. Representatives of *Pisolina* Lee differ from those of *Pseudostaffella* by their much larger proloculum, different spirothecal structure, and more poorly developed chomata. Representatives of *Sphaerulina* Lee differ from those of *Pseudostaffella* by their lenticular juvenarium, different spirothecal structure, and more poorly developed chomata.

Age.—With the possible exception of *Fusulinella quadrata* Deprat, all of the species listed above which I am referring to *Pseudostaffella* came from strata equivalent in age to the American "Bend series" or Des Moines series of the lower Pennsylvanian.

PSEUDOSTAFFELLA NEEDHAMI Thompson, new species.

Plate 1, Figs. 15-20; Plate 3, Figs. 10-14.

Shell minute, ellipsoidal, with broadly rounded periphery and depressed axial regions (umbilicate). Mature specimens of three and one-half to four and one-half volutions measure 0.36 to 0.55 mm. in length and 0.37 to 0.59 mm. in width. For eight specimens the average length is 0.45 mm. and the average width is 0.51 mm. The form ratio of six typical specimens is 1:0.96 to 1:0.69, with an average form ratio of 1:0.89 for these same specimens. The periphery of all volutions are broadly rounded and the umbilical regions are slightly depressed in all volutions. The inner one to two volutions are coiled at a high angle to the axis of coiling of the outer two to three volutions. The angle between the axis of the juvenarium and the axis of the outer volutions varies between 24 and 90 degrees, with an average angle of 64 degrees for five typical specimens.

The proloculum is spherical in shape and its inside diameter measures 46 to 57 microns, with an average inside diameter of 52 microns for eight typical specimens. The heights of the first to the fourth volution of eight typical specimens measure 27 to 43, 39 to 61, 50 to 89, and 57 to 107 microns, respectively. The averages of the height of the first to the fourth volution of these same specimens are 34, 51, 68, and 83 microns, respectively. As is obvious from the above figures, the shell expands uniformly.

The spirotheca is thin and measures about 14 microns in thickness in the third and fourth volutions. It is composed of a tectum and upper and lower tectoria. In the outer volution of mature forms there is a suggestion of a lighter layer below the tectum that may correspond to the diaphanotheca of other fusulinids but it is thought to be only a slightly less dense porion of the lower tectorium. The septa are thin and they are unfluted. Near the poles the septa become curved. The septal count of seven typical specimens for the first to the fourth volution is 9, 10 to 13, 14 to 17, and 16. The averages of the septal count for these same specimens for the first to the fourth volution are 9, 12, 15, and 16.

The tunnel is low and its base is deeply rounded. The tunnel angle measures 20 to 28 degrees in the third volution and 23 to 33 degrees in the fourth volution. For six typical specimens the averages of the tunnel angle give 23 degrees in the third volution and 26 degrees in the fourth volution. The chomata are relatively very large and they reach one-half to two-thirds the height of the chambers and extend almost to the axial regions.

Discussion.—This species resembles *P. atokensis* (Thompson) more closely than any other previously described species. Some of the differences between specimens of these forms are that those of *P. needhami* are smaller at maturity, have a smaller form ratio and have a larger tunnel angle for corresponding volutions than representatives of *P. atokensis*. The major difference between representatives of these two species is that the juvenarium of almost all specimens of *P. needhami* are markedly asymmetrical, whereas the juvenarium of *P. atokensis* is no more highly asymmetrical than any of the outer volutions. In addition to other factors, this latter feature would serve to differentiate specimens of *P. needhami* from those of all other described American representatives of the genus *Pseudostaffella*.

This species is named in honor of Dr. C. E. Needham, who made one of the first studies of New Mexico fusulinids.

Occurrence.—The above description is based on specimens obtained from the upper part of the "Bend series" on the northwest side of Mud Springs Mountain, near the west end of Whiskey Canyon, 138 to 149 feet above the base of the section exposed at this locality and about 250 to 261 feet above the base of the Pennsylvanian of this region. The associated fusulinids include *Millerella marblensis*, described above, and two species of the genus *Fusulinella* Möller.

Types.—Figured syntypes SUI No. 3293; syntypes SUPTC No. 6951, YPM No. 17065.

Genus WAERINGELLA Thompson, new genus.

Genotype: *Waeringella spiveyi* Thompson, new species.

Diagnosis of Waeringella.—Shell small, fusiform to slightly irregular; poles sharply pointed; central portion inflated; mature specimens consist of eight to nine volutions and measure about 1.3 mm. in width and 3.6 mm. in length, with a form ratio of about 1:3; spirotheca composed of a tectum, a lower, thin, structureless layer and an upper layer which may correspond to the upper tectorium of other of the fusulinids; juvenarium endothyroid and asymmetrical; tunnel singular with very irregular path and narrow tunnel angle; chomata narrow and of moderate height; axial fillings developed; septa numerous and essentially straight in the central portion of the shell, with fluting confined mainly to the polar regions.

Representatives of *Waeringella* resemble rather closely those of the genus *Wedekindellina* Dunbar and Henbest on the bases of general appearance, size and shape. However, the wall structures of these two genera are different and the axial fillings of *Waeringella* are not so heavy as those in *Wedekindellina*. In *Wedekindellina* the spirotheca has a distinct four layer structure of upper and lower tectoria, tectum and diaphanotheca. Whereas in *Waeringella* the spirotheca has only two or possibly three layers; a tectum, a lower layer, and an upper layer which may represent an upper tectorium but which seems to correspond to the extended axial fillings rather than a true tectorium. In representatives of *Wedekindellina* the septa are unfluted throughout the length of the shell and the septa are curved in the extreme polar regions without any true fluting, but in representatives of *Waeringella* the septa are strongly fluted in the extreme polar regions and are broadly fluted to essentially straight in the central portion of the shell. Other than *Wedekindellina*, there is no genus of the fusulinids with which *Waeringella* is likely to be confused.

This genus is named in honor of Mr. E. N. Kjellesvig-Waering.

Age.—The genotype came from the Salem School limestone of the lower part of the Cisco of the upper Pennsylvanian. This form is very widespread in the Mid-Continent region in strata equivalent in age to the Salem School limestone. Also, undescribed representatives of this genus are known throughout most of the Virgil series of the upper Pennsylvanian.

WAERINGELLA SPIVEYI Thompson, new species.

Plate 2, Figs. 1-15.

Shell small, elongate irregularly fusiform, with inflated central portion and sharply pointed poles; axis of coiling straight to irregular. Mature specimens consist of eight to nine volutions and measure 1 to 1.3 mm. in width and 3.4 to 3.6 mm. in length. The form ratio of mature specimens is 1:3.4 to 1:2.8, with an average form ratio of 1:3.1 for five typical specimens. The form ratio of the first volution is equal to or slightly greater than one, and in some specimens the second volution has a form ratio of one or slightly less than one. Beyond the second volution the form ratio decreases gradually to about the sixth volution where the mature shape of the shell is first obtained. The innermost volution is endothyroid and its axis of coiling is at a large angle, in some specimens as great as 90 degrees, to the axis of coiling of the outer volutions. The shell is tightly coiled in all stages of growth and the heights of the first to the ninth volution of six typical specimens are 18 to 29, 25 to 36, 29 to 43, 36 to 57, 61 to 79, 71 to 111, 93 to 126, 100 to 143, and 125 to 154 microns, respectively. The averages of the heights of the first to the ninth volution of these same specimens are 23, 30, 36, 46, 70, 85, 111, 123, and 140 microns, respectively.

The proloculum is minute and its inside diameter measures 36 to 54 microns with an average inside diameter of 42 microns for eight typical specimens. The tunnel is narrow, it has an elliptical to circular cross-section, and its path is irregular. The tunnel angle measures 10 to 17 degrees in the fourth volution, 12 to 17 degrees in the sixth volution, and 15 to 22 degrees in the eighth volution. The averages of the tunnel angle in the fourth, sixth, and eighth volutions of five typical specimens are 14, 15, and 20 degrees, respectively. Chomata are well developed throughout the shell. Immediately adjacent to the tunnel the chomata are about two-thirds as high as the chambers. Poleward from the tunnel the chomata slope down rapidly. In the polar regions the chambers are completely filled with dense calcite which resembles in general density and structure the chomata and the upper layer of the spirotheca.

The spirotheca is thin and it is composed of a tectum, a lower layer, and an upper layer of dense calcite which may correspond to the tectoria of other of the fusulinids. The wall has the appearance of three layers in which the lower layer is less dense than the upper layer. The averages of the thickness of the spirotheca in the third to the ninth volution of six specimens are 11, 14, 18, 21, 21, 19, and 20 microns, respectively. The average thickness of the lower layer of the spirotheca in the fifth to the eighth volution of these same specimens gives 7, 11, 14, and 18 microns, respectively.

The septa are thin and are closely spaced. The septal count in three typical specimens for the first to the eighth volution is 9 to 11, 12 to 14, 16 to 19, 18 to 22, 21 to 24, 24 to 25, 26 to 27, and 30, respectively. The averages of these same septal counts are 10, 14, 17, 20, 23, 24, 26, and 30, respectively. The septa are straight to broadly wavy in the central portion of the shell but in the extreme polar regions the septa are narrowly and highly fluted.

Discussion.—This species is so markedly different than any other previously described American species that specific comparisons seem unnecessary.

This species is named in honor of Dr. R. C. Spivey.

Occurrence.—All of the specimens on which the above description is based were obtained from a highly calcareous shale near the base of the Salem School limestone on Herron Bend of the Brazos River, about 7.5 miles southeast of Graham, Texas, and near the base of the steep bluff just below the road, and they were collected by Dr. R. C. Spivey in 1940.

Types.—Illustrated syntypes SUI Nos. 3294 and 3295 (sections) and 3297 (external); syntypes SUPTC No. 6952, YPM No. 17066.

Genus DUNBARINELLA Thompson, new genus.

Genotype: *Dunbarinella ervinensis* Thompson, new species.

The large group of Permian fusulinids which possess a spirotheca composed of a tectum and a keriotheca and which also contain highly to moderately fluted septa throughout the length of their shells have been included under a number of generic terms but most of them are conservatively grouped under the generic term *Schwagerina* Möller by many workers. The following genera, with genotypes given in parentheses, have been proposed for portions of this large and varied group of fusulinids: *Schwagerina* Möller, 1877 (*Borelis princeps* Ehrenberg), *Paleofusulina* Deprat, 1912 (*Paleofusulina prisca* Deprat), *Pseudofusulina* Dunbar and Skinner, 1931 (*Pseudofusulina huecoensis* Dunbar and Skinner), *Leeina* Galloway, 1933 (*Fusulina vulgaris* var. *fusiformis* Schellwien), *Nagatoella* Thompson, 1936 (*Schellwienia ellipsoidalis* var. *orientis* Ozawa), *Rugosofusulina* Rauser-Cernoussova, 1937 (*Fusulina* [*Alveolina*] *prisca* (Ehrenberg) emend. Möller). Of these proposed generic groups I consider *Schwagerina*, *Paleofusulina*, ?*Pseudofusulina*, *Leeina*, and *Nagatoella* as being valid and distinct. If Möller has correctly identified the specimens illustrated and described by him as *Fusulina prisca* (Ehrenberg), then we can say beyond a reasonable doubt that *Rugosofusulina* Rauser-Cernoussova is a synonym of *Pseudofusulina* Dunbar

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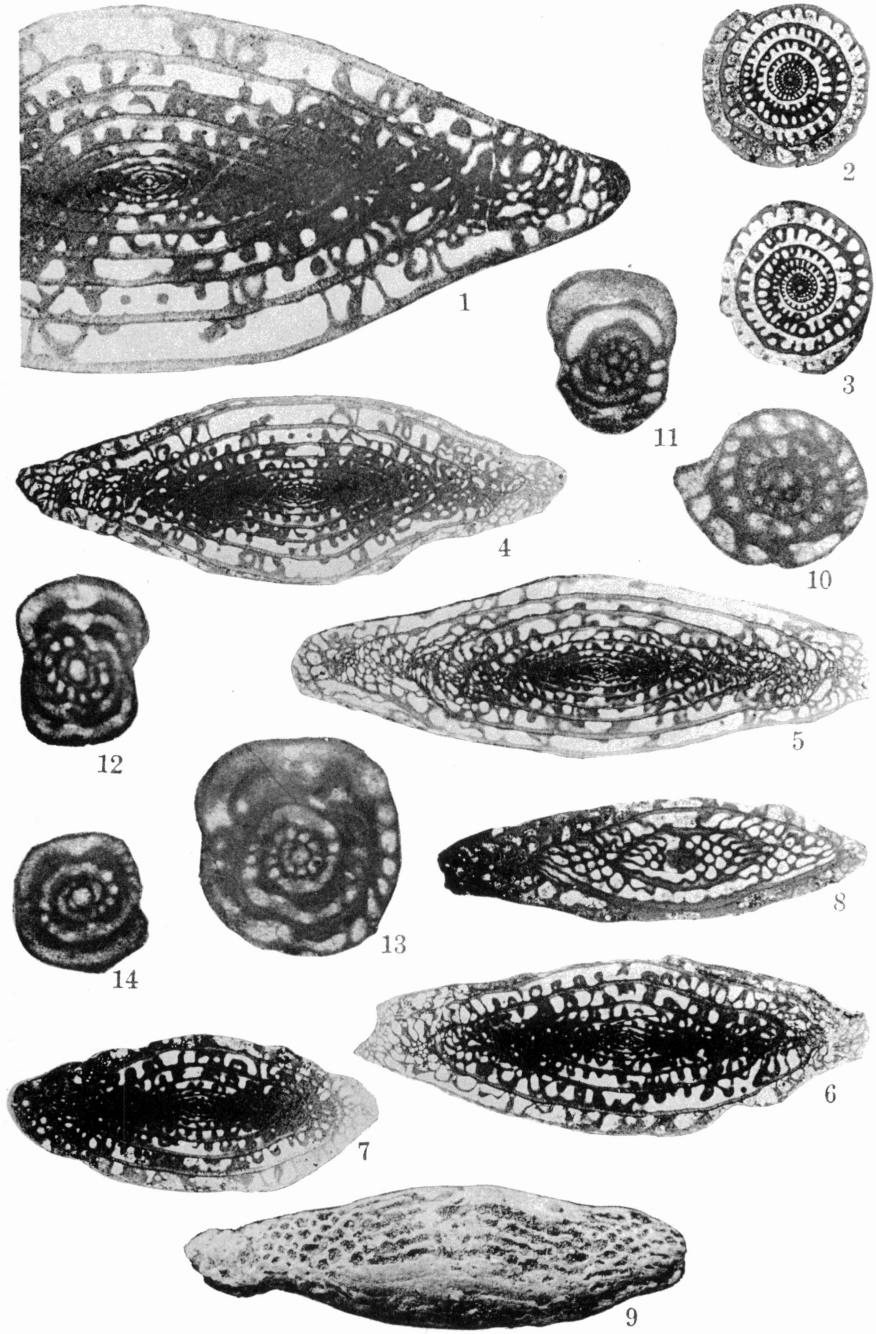
EXPLANATION OF PLATE 3.

All illustrations on this plate are unretouched photographs.

Figs. 1–9. *Dunbarinella ervinensis* Thompson, n. sp. 1, Enlargement of a portion of the specimen illustrated as Figure 4, x20; 2, 3, sagittal sections, x10; 4–7, axial sections, x10; 8, tangential section showing the nature of the septal fluting, x10; and 9, external view, x10. Ervine Creek member of the Deer Creek formation, Osage County, Oklahoma.

Figs. 10–14. *Pseudostaffella needhami* Thompson, n. sp. 10, Sagittal section, x50; and 11–14, axial sections, x50. Magdalena formation, Mud Springs Mountain, New Mexico.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and Skinner and perhaps synonymous with *Schwagerina* Möller. From Ehrenberg's illustrations and too brief discussion, it is impossible to determine any detailed information in regard to his types of *Alveolina prisca.* It seems to me probable that *Pseudofusulina,* which has priority over *Rugosofusulina,* must be considered as being valid for a rather large group of fusulinids which biologically seem to be closely related to *Pseudofusulina huecoensis* Dunbar and Skinner and considerably different than the genotype of *Schwagerina, S. princeps* (Ehrenberg).

In spite of this large number of genera proposed for the Permian fusulinids with highly fluted septa and spirotheca composed of a tectum and a coarsely alveoli keriotheca, of which well over 100 species have been described, a fusulinid species with highly fluted septa and a spirotheca composed of a tectum and a keriotheca recently discovered in the upper Pennsylvanian Virgil series does not seem to me referable to any of these genera. I am, therefore, proposing the new generic name *Dunbarinella* for it with *Dunbarinella ervinensis,* new species, here designated as the genotype. In addition to the genotype, *D. ervinensis,* n. sp., I would refer the American species *Triticites compactus* White from the Wolfcamp of Texas to the genus *Dunbarinella.*

The following diagnosis of the new genus *Dunbarinella* is based on a study of the genotype, *D. ervinensis,* n. sp., as well as studies of collections, descriptions, and illustrations of previously described species which I consider referable to the genus *Dunbarinella,* and undescribed representatives of this genus which I am studying from other localities.

Diagnosis of Dunbarinella.—Shell small, fusiform, with sharply pointed poles and straight axis of coiling. Mature specimens contain six to ten volutions, measure 5 to 10 mm. in length and have form ratios greater than 1 : 1.5 to smaller than 1 : 4 ; proloculum very small to minute ; juvenarium tightly coiled and composed of two to four volutions ; outer volutions expand uniformly ; tunnel singular and narrow ; chomata form definite ridges only in the inner three to four volutions but they are developed in all volutions except the outermost one to two volutions ; axial fillings heavy and they completely fill the chambers of all volutions except those of the inner one to three volutions and the outermost volution; spirotheca very thin in the inner three to five volutions but it becomes thick in the outer volutions, it is composed of a tectum and a keriotheca with coarse alveoli; septa narrowly and highly fluted throughout the length of the shell so as to form chamberlets.

Such a large number of apparently distinct types of fusulinids have been referred to the genus *Schwagerina* (also *Pseudofusulina*) that it seems undesirable to discuss at this time the differences and similarities between all of these types and the genotype of *Dunbarinella*. However, it should be pointed out that representatives of *Dunbarinella* differ from those of *Schwagerina* (as determined mainly on a basis of the genotype, *Borelis princeps* Ehrenberg), in that they possess heavy axial fillings which are lacking in representatives of the latter genus. Also, the general development of the shell of forms of these two genera seem to me entirely different. The general shape of the shells, development of individual growth, juvenaria, and axial fillings of representatives of *Leeina* seem to me different than these features found in representatives of *Dunbarinella*. In *Leeina* the axial fillings are irregular, very light, and more or less discontinuous. The proloculum of representatives of *Leeina* is large and the shell is loosely coiled throughout growth; also, the septal fluting of *Leeina* is narrow and high only in the polar regions. The marked difference in the development of the shell, general shape of the shells, the distribution of the axial fillings, and the low, continuous closed septal fluting of representatives of *Nagatoella* serve to distinguish them from representatives of *Dunbarinella*.

This genus is named in honor of Prof. C. O. Dunbar who has contributed much to our knowledge of American fusulinids.

Age.—The genotype was obtained from the Ervine Creek member of the Deer Creek limestone of Oklahoma and from equivalent strata in Texas and New Mexico, near the mid-portion of the Pennsylvanian Virgil series. *Dunbarinella compacta* (White) came from the Wolfcamp series of the Permian and representatives of this genus are known from the upper portion of the Chihsia limestone of southern China where they are associated with fusulinids which have been referred to the genus *Parafusulina*. This latter identification of *Parafusulina* needs verification but if it is correct, it suggests a stratigraphic range of the genus *Dunbarinella* from at least the Pennsylvanian to the mid-portion of the Permian.

DUNBARINELLA ERVINENSIS Thompson, new species.

Plate 3, Figs. 1-9.

Shell small, elongate fusiform, with sharply pointed poles and straight axis of coiling. Mature specimens consist of eight to ten volutions and measure 5.5 to 8.2 mm. in length and 2.0 to 2.7 mm. in width, giving a form ratio of 1:2.0 to 1:3.3. The average form ratio of six mature specimens is 1:2.0. The lateral slopes of this species are essentially uniform but in some mature specimens the extreme polar ends become extended and irregular in shape. The spirotheca is very thin in the inner three to five volutions but it becomes thick in the outer volutions. The spirotheca is composed of a tectum and a keriotheca with coarse alveoli. The thickness of the spirotheca of the third to the ninth volution of eight typical specimens measures 11 to 14, 18 to 21, 18 to 36, 32 to 57, 36 to 71, 61 to 82, and 68 to 89 microns, respectively, and the averages of the thickness of the spirotheca of the first to the ninth volution of these same specimens are 12, 19, 27, 43, 55, 70, and 76 microns, respectively. The spirotheca is covered by a thin layer of dense calcite throughout the length of the shell which resembles tectoria and seems to grade into the axial fillings.

The septa are thin and they are composed of the downward deflected tectum of the spirotheca and downward extensions of the keriotheca which do not reach the base of the septa. The septa are highly and narrowly fluted throughout the length of the shell so as to form chamberlets in the lower part of the chambers, even immediately over the tunnel. The average septal count of the first to the ninth volution of two typical specimens is 12, 16, 18, 23, 25, 28, 30, 29, and 33, respectively.

The proloculum is minute and its inside diameter measures 46 to 86 microns, with an average inside diameter of about 60 microns for six typical specimens. The inner three to four volutions are tightly coiled and the heights of the volutions increase uniformly beyond the fourth volution. The heights of the first to the tenth volution of eight typical specimens are 21 to 29, 25 to 39, 36 to 70, 57 to 100, 75 to 186, 129 to 239, 154 to 296, 171 to 296, 232 to 321, and 218 microns, respectively. The averages of the height of the first to the tenth volution of these same specimens are 27, 34, 52, 78, 116, 180, 223, 250, 280, and 218 microns, respectively.

The tunnel is low and narrow and its path is very irregular. The tunnel angle measures 20 to 24 degrees in the sixth volution, 21 to 29 degrees in the eighth volution and 27 to 31 degrees in the ninth volution. The averages of the measurements of the tunnel angle in the sixth, seventh and ninth volutions are 22, 26, and 29 degrees, respectively. Chomata are well developed throughout the shell, except in the outermost volution. However, the chomata form well developed ridges only in the inner five to six volutions. Axial fillings completely fill the chambers in the extreme polar regions of all volutions except those of the outermost volution.

Discussion.—*Dunbarinella ervinensis* is somewhat closely similar to *Dunbarinella compacta* (White). However, its axial fillings are not as heavy as those of *D. compacta* in the outer part of the shell and its shell is smaller at maturity and yet it contains a larger number of volutions at maturity than *D. compacta*. Detailed comparisons of statistical data show many other differences between these two forms.

Occurrence.—I have specimens of *D. ervinensis* before me from New Mexico, Oklahoma and Texas. This species is known to occur in the Deer Creek limestone of Kansas. In Oklahoma this species is common in the Ervine Creek member of the Deer Creek limestone. In Texas *D. ervinensis* is widespread geographically and it is confined to strata closely related in age to the Deer Creek. In the northern part of the Sacramento Mountains of New Mexico this species is found 700 feet below the top of the Magdalena formation; that is, 700 feet below the top of the Pennsylvanian rocks of this area. However, only specimens from the Ervine Creek member of the Deer Creek formation of Osage County, Oklahoma, have been used in drawing up the above specific description and all accompanying illustrations are from this locality. The specimens from the Deer Creek used in drawing up this description were collected by Erik N. Kjellesvig-Waering, John W. Skinner and the writer from an old quarry on the north side of Highway 11, about 3.7 miles west of the river bridge at Pawhuska, Osage County, Oklahoma, and from the north bank of the road-cut of Highway 11 about 200 feet west of the old quarry, near the southeast corner of sec. 2, T. 25 N., R. 8 E.; and from a small nearby quarry on the south side of Highway 11 in the NW 1/4 sec. 11.

Types.—Figured syntypes SUI No. 3296; syntypes, SUPTC No. 6953, YPM No. 17062.

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