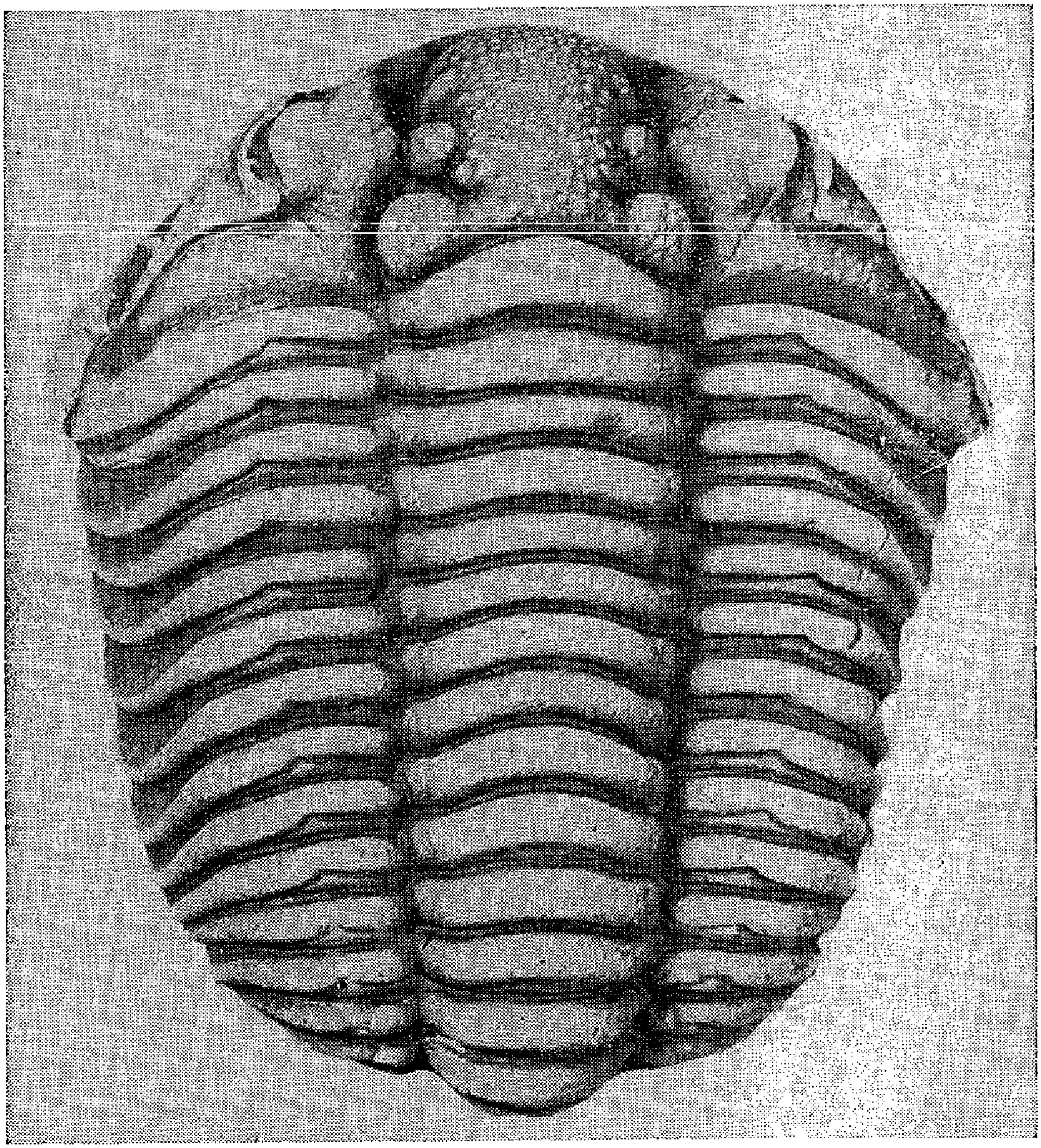
# OKLAHOMA GEOLOGY NOTES



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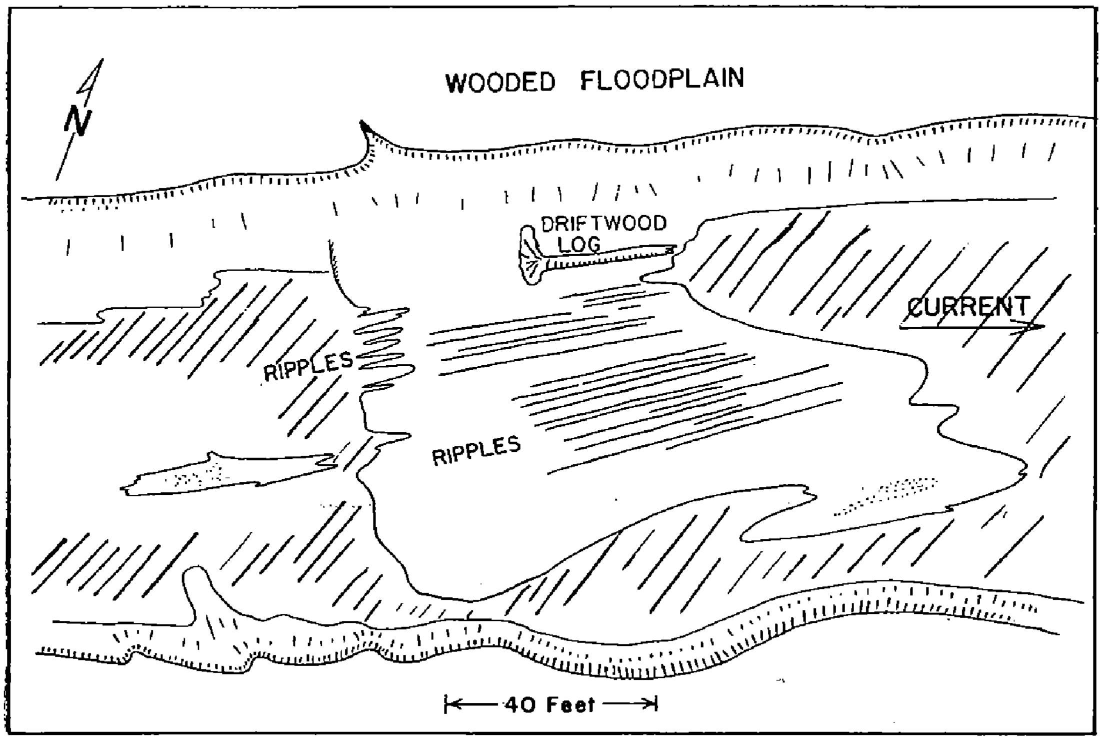
# An Unusual Type of Ripple Mark

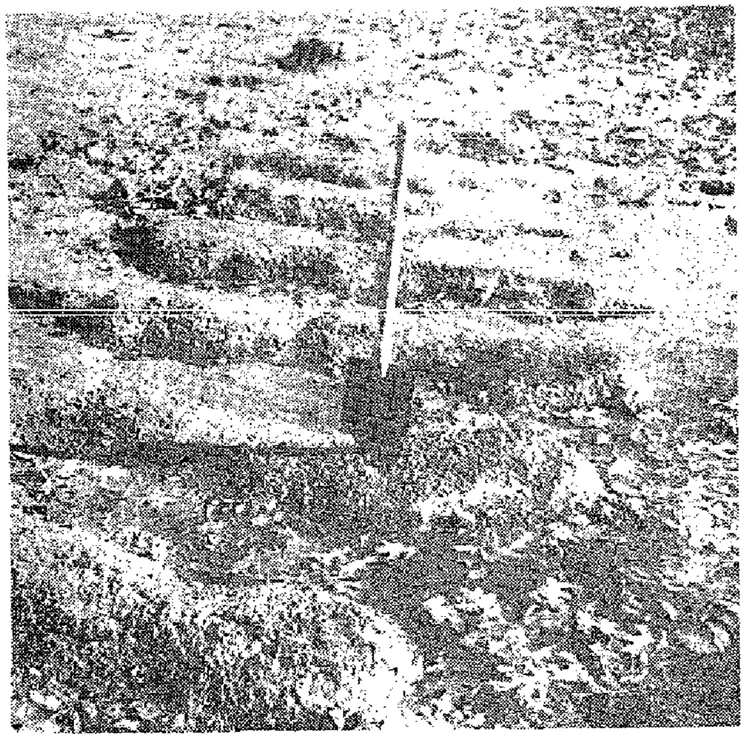
PHILIP A. CHENOWETH

The common types of ripple marks have formed so that the long dimension is roughly perpendicular to the direction of current or to the direction of wave motion. An occurrence of rather puzzling ripple marks which apparently contradict this rule has been observed in the bed of Wewoka Creek near Lima, Seminole County. Wewoka Creek is a permanent stream, carrying a very small amount of water, principally oil field waste, in the summer months, but subject to rapid increases in water level. During high-water periods the stream, which is 75 to 100 feet wide, is full of water ten or more feet deep moving at relatively high velocities. No doubt the stream carries a great load at such times for the bedrock over which it flows contains many layers of friable sandstone and conglomerate. At low-water times, of course, this load makes up the bed of the stream.



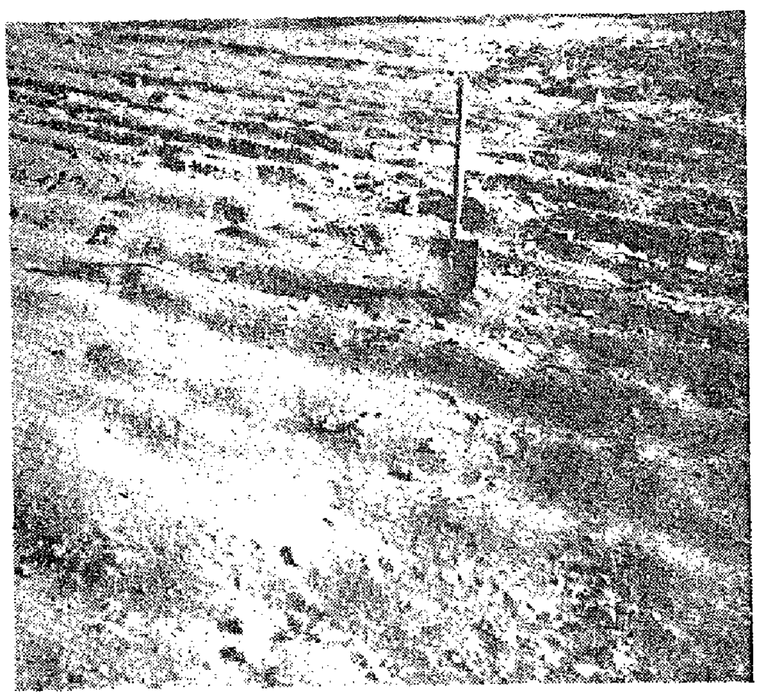

Sketch of Wewoka Creek showing position of ripples.

At the locality in question the creek has steep banks, 10 to 12 feet high, and is approximately 108 feet wide. A wide sand bar entirely spans the creek at low water, except for a 3 to 4 foot channel along the south bank (Sketch map, figure 1). On this sand bar, extending up and down stream about 50 to 100 feet, are large numbers of deep, evenly spaced furrows with intervening ridges that resemble in every way the large ripples so often found on Paleozoic limestones and called pararipples. In this instance the ripples (and it seems most appropriate to refer to these ridges and troughs as ripples) have an average amplitude of 4¼ inches and an average wave length measured from crest to crest of 25½ inches. They are remarkably parallel in comparison to the Paleozoic pararipples for the latter are most often anastomosing in plan where large exposures can be observed.



Near view of ripples.

Pararipples of the sort referred to in ancient limestones are considered to originate from strong currents, probably tidal currents augmented by storm waves, and are assumed to have formed perpendicular to the prin-



View of bed of Wewoka Creek showing ripples.

cipal current direction. In some instances the predominant current direction has actually been determined by study of oriented elements, fossil shells in particular, associated with the rippled strata.

View across Wewoka Creek.

The rippled sand bar in Wewoka Creek, however, presents quite the opposite picture. The long dimension of the ripples is very nearly parallel to the direction of the stream channel and most certainly the ripples, if such they may be called, formed parallel to, not perpendicular to, the current direction. A dead tree along the north bank of the stream provides a very effective current indicator; with a large mass of earth and rock still caught in the roots of the tree the trunk swings about this anchor like a weather vane. Cursory analysis of the size of the sediments that make up the ripples and the troughs shows that the troughs are floored with coarser heavier material and the crests made up of fine light material, a feature supposedly diagnostic of the more familiar oscillation-type ripple mark in which, due to the to-and-fro motion of the generating waves, a sorting of this kind is inevitable.

One possible explanation presents itself. The sand bar on which the ripples are exposed may be only a small segment of a much greater set of sand waves, or metaripples, which form in many streams during high water periods. The smaller grooves on the surface of this sand wave may be relatively tiny channels etched out by the waning currents. This could account for the orientation parallel to current direction and perhaps, in some obscure way for the difference in size of material in the troughs and on the crests—assuming that the fine material is washed out of the channels (or troughs) leaving a residue of coarser material. If this is the proper explanation, no doubt such features could be of any size depending on the strength of the currents and local conditions of stream load.

# TYPE OF GONIATITES CHOCTAWENSIS

CARL C. BRANSON, MAXIM K. ELIAS, and THOMAS W. AMSDEN

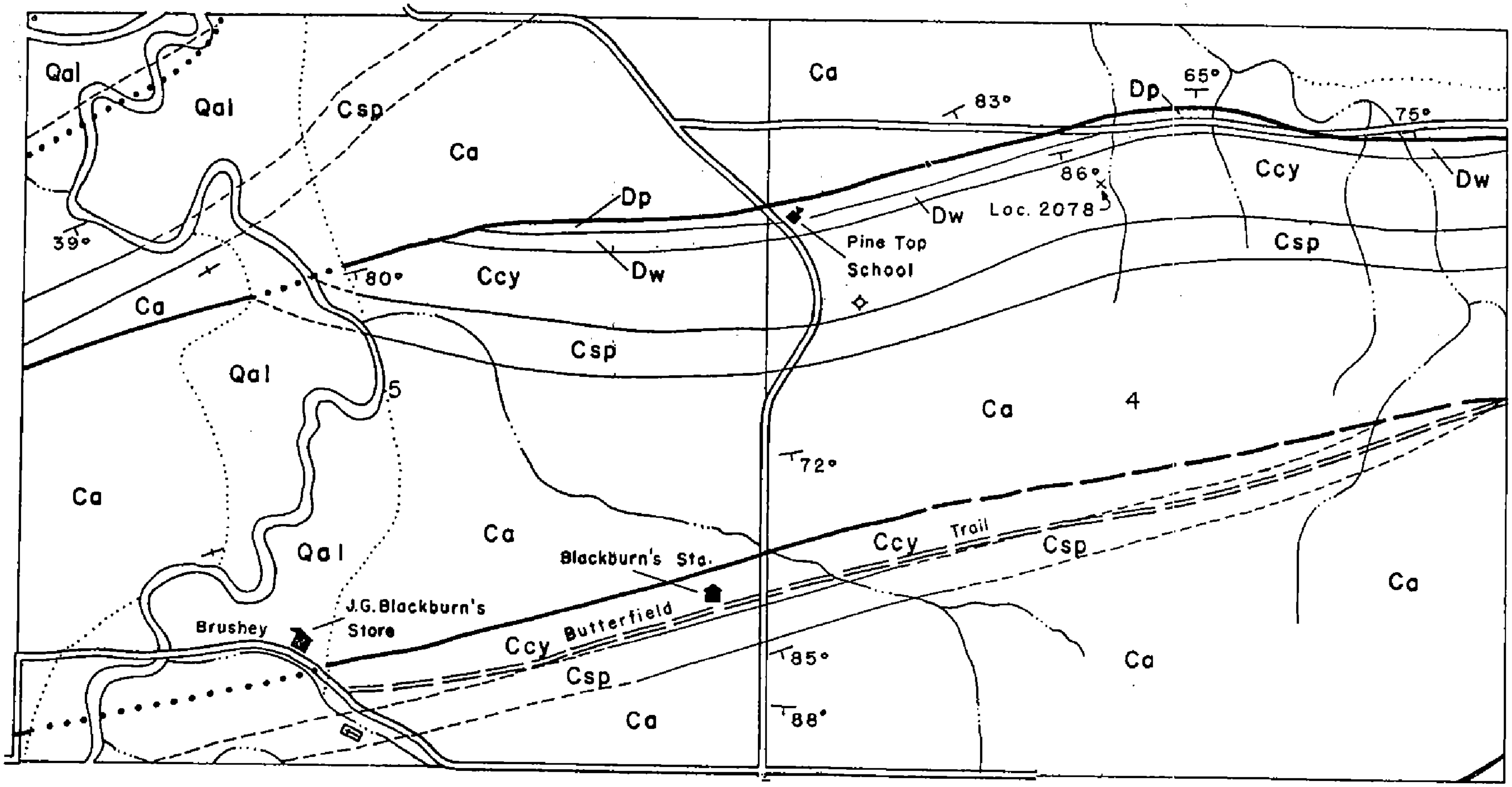
Two notes have been written by Branson on the subject of the original locality from which George Shumard collected the specimen described in 1863 by his brother Benjamin as *Goniatites choctawensis*. The locality was given merely as "a dark compact limestone supposed to belong to the Coal Measures, on the farm of Mr. J. Blackburn, in the Choctaw Nation." (B. F. Shumard, 1863, p. 109-110). R. H. Dott referred Branson to a map showing Mrs. Blackburn's and he wrote a second note on the locality (1959, p. 101-102). Dott recently called attention to Lang's book, which gives data on the Blackburn Station. The Oklahoma Historical Society has just issued a paper which settles the matter effectively. The stage station called Blackburn's Station was at the home of Casper B. Blackburn. J. G. Blackburn was known to have had a store at Brushey, a settlement of which only traces of the cemetery remain, the cemetery located at SE¼ SW¼ sec. 5, T. 2 N., R. 15 E. (Conkling, 1947, p. 258). The station itself was about a mile east of Brushy Creek near the east line of sec. 5, probably in the NE¼ SE¼, west of the present section-line road leading to Pine Top School (Okla. Hist. Society, 1959 p., 17). Incidentally, Pine Top School, about half a mile north, is the type locality of the Pinetop chert (Lower? Devonian). The locality from which Taff and Girty collected *Goniatites choctawensis* on November 28, 1898, and from which Taff and Ulrich collected later, is "Locality 2078, near center of sec. 4, T. 2 N., R. 15 E., where small run crosses chert ridge. Caney shale (lower part, but not base; from concretions in black shale)" (Girty, 1909, p. 73).

Dr. M. K. Elias examined the area for the Survey on June 5 to 7, 1959, and reports that the only occurrence of goniatite-bearing concretions is along the creek which runs just west of the east line of SE¼ NE¼ NW¼ sec. 4 from just south of the south line of the NW¼ to a point 120 feet south of the east-west graveled road. He found specimens of *Goniatites choctawensis* in a zone of large concretions about 125 feet above the base of the formation. In and associated with the concretions in Bed 22 of the measured section he also found:

*Caneyella vaughani* Girty (common). Topotypes.
*Caneyella percostata* Girty (common). Topotypes.
*Caneyella wapanuckensis* Girty (common).
*"Orthoceras" indianum* Girty (rare). Topotype.
*"Orthoceras"* cf. *"O." caneyanum* Girty (rare). Type locality.
*"Orthoceras'* cf. *"O." crebriliratum* Girty (rare). Type locality.
*Lyrogoniatites caneyanum* (Girty) (common). Topotypes.
*Idiotheca* new species (rare).

Girty (1909) described from this locality in addition to the above forms, *Trizonoceras lepidum* Girty, and reported *Caneyella richardsoni* Girty and *Girtyoceras meslerianum* (Girty). The several good specimens of *Goniatites choctawensis* are smaller than the largest of Girty's specimens, but agree closely with his figures.

A measured section of the Caney in NW¼ NE¼ sec. 3, T. 2 N., R. 15 E., was published by Hendricks and Gardner (1957, p. 23-24, 1959,




Map of sections 4 and 5, T. 2N., R. 15E., Pittsburg County, Oklahoma. Geology from Hendricks 1947.

p. 20-21). The locality given is probably in error for sec. 4. Hendricks' map shows a narrow belt of Caney shale south of a fault, the belt extending southwestward from south of the center of sec. 4 through the sites of Blackburn's Station and Blackburn's store. The weak nature of the Caney shale and of the overlying "Springer" shale has permitted the shales to weather to a valley between "Atoka" ridges, and their surface is thus the likely course of the stage road (U. S. Geol. Survey, Topographic Branch, McAlester quadrangle, 1909).

## COLUMNAR SECTION MEASURED ALONG CREEK AT GIRTY'S STATION 2078

by Maxim K. Elias, June 6, 1959.

From top down (starting at E-W barbed-wire fence):
*Goddard shale:*

| | *Thickness in feet* |
|---|---|
| 58. Shale, gray, clayey, mostly covered. In lower part dark gray-brown friable ferruginous concretions, disintegrated into soft fragments, probably a few inches across | 24. |
| 57. Shale, black, flaky and crumbly | 3. |
| 56. Shale, light-gray, flaky, with flakes of selenite | 4. |
| 55. Covered | 13.5 |
| 54. Shale, black, flaky to crumbly | 3. |
| 53. Covered | 38. |
| 52. Shale, black, flaky; 1.5 feet below top is a limonitic streak, sandy, fissile | 18. |
| Total: | 103.5 |

*Caney shale (Delaware Creek shale member)*

| | |
|---|---|
| 51. Shale, siliceous, black, very compact, fissile unfossiliferous; makes small water fall in creek; dip 80°-85° | 1.6 |
| 50. Shale, black, flaky to crumbly | 56. |
| 49. Covered | 10. |
| 48. Shale, black, fiaky to crumbly | 50. |
| 47. Clay, gray | 10. |
| 46. Shale, black, flaky to crumbly | 4.5 |
| 45. Shale, gray, flaky | 0.5 |
| 44. Shale, black, flaky | 18. |
| 43. Shale, black, fissile, medium-compact | 1. |
| 42. Covered | 14. |
| 41. Shale, black, flaky to crumbly | 6. |
| 40. Hard crust, crumbly, dark gray | 0.5 |
| 39. Shale, black, flaky to crumbly | 24. |
| 38. Covered | 14. |
| 37. Shale, black, fissile | 3. |
| 36. Shale, dark gray (black below), flaggy to fissile, with scattered conodonts: *Spathognathodus* cf. *S. commutatus* Branson and Mehl, 1941 (Caney | |

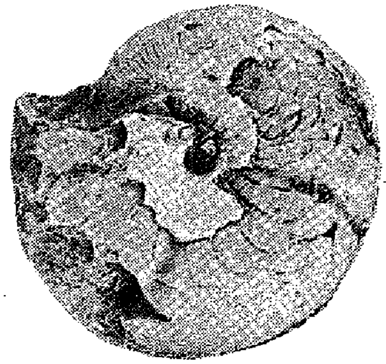
| | | Thickness in feet |
|---|---|---|
| | conodonts); *Prioniodella?* (new genus?) sp. *A* (same as undescribed species from Delaware Creek shale of Ardmore basin); and *Hamulosodina* n. sp., aff. *H. parilis* Cooper, 1931 (Woodford conodonts). Conodonts well preserved and fairly common | 4. |
| 35. | Shale, black, flaky | 6. |
| 34. | Covered | 12. |
| 33. | Shale, gray, fissile to flaky | 16. |
| 32. | Shale, gray, medium-compact, very fissile; makes bench | 2. |
| 31. | Shale, gray, fissile, with scattered conodonts and sponge spicules: *Spathograthodus* cf. *S. commutatus* Branson and Mehl, 1941 (Caney conodonts); *Neo-prioniodus* n. sp., aff. "*Prioniodus* ? sp.," Elias, 1956 Sand Branch conodonts) and aff. undescribed species from Delaware Creek shale of Ardmore basin; two kinds (thick and thin) of monaxon and one of tetraxon sponge spicules | 7. |
| 30. | Shale, gray, fissile | 3. |
| 29. | Shale, gray, thinly fissile; in upper part many scattered elliptical limestone concretions 0.5 feet in diameter | 14. |
| 28. | Shale, gray, fissile, compact; with many scattered conodonts: *Solenodella* (=*Subbryanthodus* of authors) aff. *S. roundyi:* Hass (Barnett sh.) | 2. |
| 27. | Shale, gray, fissile | 38. |
| 26. | Shale, black, flaky | 7. |
| 25. | Zone of large (to 2 feet across) gray limestone concretions, some partly irregularly septarian; with occasional goniatites | 2. |
| 24. | Shale, black, flaky | 12. |
| 23. | Shale, gray, flaky, with few thin (0.1 to 0.2 feet across) marly concretions, in which occasional goniatites and *Caneyella* | 8. |
| 22. | Main fossiliferous zone of large (2 feet plus in diameter) very dense gray limestone concretions; and roughly fissile light-gray marly lenticular concretions, with goniatites, *Caneyella*, "*Orthoceras*", and other fossils in both; also very few small phosphatic concretions with *Idiotheca* new species and *Caneyella wapanuckensis* Girty. | |
| 21. | Shale, gray, fissile | 4. |
| 20. | Zone of moderately large (0.7 feet across) gray elliptical limestone concretions, apparently unfossiliferous | 0.7 |
| 19. | Shale, black, flaky | 4.5 |
| 18. | Shale, dark-gray, fissile, moderately compact | 5.5 |
| 17. | Shale, gray, flaky | 1. |
| 16. | Shale, gray, fissile to flaky | 7.5 |

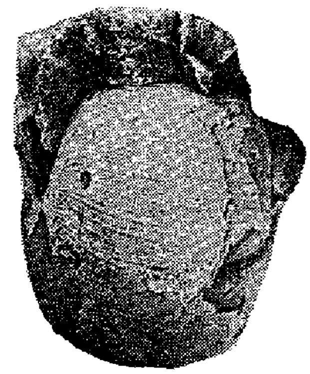
| | | Thickness in feet |
|---|---|---|
| 15. | Zone of 0.8 to 1 foot thick very dense gray elliptical limestone concretions, apparently unfossiliferous | 2. |
| 14. | Shale, gray, flaky to fissile; dip 80°-85° N. | 12. |
| 13. | Shale, siliceous, gray, mostly fissile | 26. |
| 12. | Covered | 44. |
| | (continued on east side of creek): | |
| 11. | Shale, dark-gray fissile, siliceous for about 1 foot at base | 5. |
| 10. | Shale, black, fissile, moderately compact | 6. |
| 9. | Shale, dark-gray, fissile, compact; upper 3 feet more massive and less fissile | 7. |
| 8. | Shale, black, fissile | 1. |
| 7. | Shale, dark-gray, fissile; many scattered (1 foot in diameter) dense elliptical limestone concretions | 2. |
| 6. | Shale, soft, gray, flaky | 6. |
| | Total: | 484.3 feet |
| | *"Woodford" chert:* | |
| 5. | Shale, siliceous, flaggy to fissile | 1.5 |
| 4. | Chert, dark-gray | 0.8 |
| 3. | Shale, gray, siliceous, coarsely fissile | 3.5 |
| 2. | Chert, flaggy, with many scattered phosphatic concretions (mostly subspherical) | 10.+ |
| | Total: | 15.8+ |
| 1. | Covered (measured south to middle of east-west graveled road | 128. |

Girty noticed slight differences in the finer ornamentation of *Goniatites choctawensis*, specimens from sec. 4 (U.S.G.S. Loc. 2078) showing "fine revolving lirae with very subordinate transverse ornamentation" (p. 61). Girty thought that Shumard's form more nearly approached his from sec. 14, T. 2 S., R. 7 E., Johnston County, and he based his description mainly on specimens from that locality. He was certainly incorrect in his assumption and he had no data on the site of Shumard's locality.

The locality is clearly Girty's Locality 2078 and is doubtless the one from which George Shumard obtained his specimen, now lost. The geology is shown on Hendrick's map (1947, Sheet 1), from which the accompanying figure is taken. The J. Blackburn farm may have included the site, or Shumard may have been taken to the locality, which is about half a mile from the old stage station, or Blackburn may have given him the specimen.

Dr. Thomas W. Amsden has taken pictures of a topotype specimen collected by Dr. Elias, and has prepared a suture diagram. The specimens are to be assigned to *Goniatites choctawensis choctawensis* Shumard, a designation of the typical subspecies given by Miller and Youngquist (1948, p. 659, pl. 98, figs. 4-5). Their specimen came from the east side of Oklahoma Highway 48 in sec. 1, T. 2 N., R. 6 E., Pontotoc County. It appears to belong to the typical subspecies.





View of left side of neoholotype of *Goniatites choctawensis.* Photograph by Thomas W. Amsden. X2. O. U. Paleontological Collection No. 3142.

The specimen figured here is designated the neoholotype inasmuch as the holotype is lost and it is the first specimen to be figured from the type locality. The specimen is a largely decorticated stout shell 2 cm in diameter and 1.7 cm wide. The umbilicus is small. The shell surface is ornamented by fine revolving lirae (about 40 to a centimeter) and by slightly coarser transverse lirae (about 33 to a centimeter). The neoholotype is No. 3142 in the O.U. Paleontological Collection.

View of shell surface of neoholotype showing ornamentation. Photograph by Thomas W. Amsden. X5.

Miller and Furnish (1940, p. 361-363, pl. 46, figures 1-13) have redescribed *G. kentuckiensis* S. A. Miller, 1889, from topotypes collected from Meramecian rocks in Rockcastle County, Kentucky. The action of Miller and Youngquist (1948, p. 659) in reducing the species to subspecies, *G. choctawensis kentuckiensis,* seems justified. The principal difference from the typical subspecies is in having strong revolving lirae and weak transverse lirae.

External suture of *Goniatites choctawensis choctawensis* Shumard, taken where shell is 18 mm in diameter. Drawn by Thomas W. Amsden.

Specimens from the Barnett shale near Mason, Texas, were referred to *G. choctawensis cumminsi* (Hyatt) by Miller and Youngquist (1948, p. 659, pl. 98, figs. 6-8). These are poorly preserved and inadequately known. Barnett specimens with a narrower conch and test with transverse lirae only were placed in a new subspecies, *G. choctawensis barnettensis* (Miller and Youngquist, 1948, p. 659, pl. 99, figs. 16-19). They are closely allied to typical *G. choctawensis choctawensis*. Specimens from Arkansas identified as *G. striatus*, *G. crenistria*, and *G. choctawensis* come from the Moorefield (Girty, 1911, p. 97-99, pl. 15, figs. 1-7), the Ruddell shale, the Batesville sandstone, and the Fayetteville shale. These appear to be more obese than *G. choctawensis choctawensis*. Youngquist has described specimens from the White Pine shale of Nevada (1949, p. 296-299, pl. 62, fig. 7, pl. 63, figs. 1-8, pl. 64, figs. 1-12) and has noted that his specimens include individuals of the choctawensis, barnettensis, and kentuckiensis types (see also Miller and others, 1949, p. 608, pl. 99, figs. 7-8). The species is also known from the Rancheria formation of West Texas and from Meramecian rocks of Utah (Miller and others 1952, p. 153-154, pl. 25, figs. 8-9, pl. 26, fig. 16).

View of left side of neoholotype (not whitened). Photograph by Thomas W. Amsden. X3.

Ventral view of neoholotype (not whitened). Photography by Thomas W. Amsden. X3.

In the absence of comparative material of young and mature specimens from the various localities, it is better to regard the subspecific names as denoting geographic occurrences. An attempt to secure sufficient topotype material of *G. choctawensis* to reveal ontogenetic changes and variation of specimens in the one locality and horizon will be made.

The specimens described and figured by Girty (1909, p. 59-62, pl. 13, figs. 1-11) are sufficiently like the neoholotype to be assigned to the same subspecies. The shape, ornamentation, and suture pattern vary within reasonable limits. Girty's figures 1 to 10 are of specimens from his Station 2083, center of north side of sec. 14, T. 2 S., R. 7 E., Johnston County. The specimen illustrated by his figures 11, 11a and 11b is from Station 2047, north of center of sec. 16, T. 3 N., R. 18 E., Latimer County. Shells from this locality are said to have appreciably coarser sculpture.

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# Fusulinid genera *Protriticites, Pseudotriticites,* and *Putrella*

MAXIM K. ELIAS

## Subfamily PSEUDOTRITICITINAE Putrja, 1948

In 1948 Putrja proposed to unite in a new subfamily Pseudotriticitinae three genera: *Protriticites, Pseudotriticites,* and *Hemifusulina,* primarily on the similarity of their wall structure.

However, subsequent investigations by various workers induced the following remarks by Rauser-Chernousova (1951, p. 22-23):

"Some of the genera here included in the subfamily Fusulininae have a wall structure somewhat different [from that in the more typical genera of the subfamily], and these are differentiated by some investigators (Putrja, 1948) into a separate subfamily Pseudotriticitinae. The wall in these genera is characterized by disappearance of diaphanotheca, reduction of number of layers, and conspicuous enlargement of the lumen of pores, which nevertheless preserve their simple, tubular character, clearly and invariably discernible under the microscope. Such is the structure of the wall in *Hemifusulina, Protriticites, Pseudotriticites, Putrella,* and *Quasifusulina.* Almost every genus of this group has its own special type of wall, which is understood to be a result of independent divergence of each genus at different levels of the fusulinid evolution, and also of a fast and diverse process of differentiation of their characters at a transitional period [in each]. Most significant is the fact that almost all of the genera occur in the upper part of the middle [Moscovian] and the lower part of the upper [Uralian] division (otdel) of the Upper Carboniferous, and only in one or another border parts of these divisions. Incidentally, four of these genera [except *Quasifusulina*] have been established by the Russian investigators and have particular significance for our columnar section in which a complete series of transitional Middle and Upper Carboniferous deposits is represented. However, their segregation into a subfamily is not justified, because they are blind and very short [phyletic] branches, which diverged from different forms at different levels in the development of the subfamily [Fusulininae] and they are not connected by common origin."

Taking all this into consideration Putrja modified his understanding of the subfamily Pseudotriticitinae thus (1956, p. 467):

"Shell from short-ventricose to subcylindrical, moderate to large in size. Wall multi-layered, coarsely porous in all or only in outer volutions. Septa intensely fluted. Additional deposits represented by chomata, usually only in early volutions, seldom (in earlier forms) also in later volutions. Aperture [tunnel] single.

The following genera belong to Pseudotriticitinae: *Pseudotriticites, Putrella, Rugosofusulina,* and *Pseudofusulina* (in part).

*Remark.* I have originally included in the subfamily Pseudotriticitinae the following three genera: *Protriticites, Pseudotriticites,* and *Hemifusulina,* primarily on the similarity of their wall structure. However, inasmuch as the enumerated genera belong to different phylogenetic branches, ascending toward the subfamily Schwagerininae, it became necessary to change the contents and volume of both subfamilies, thus establishing between their genera a closer relationship, than as shown in the existing [phy letic] schemes. Analysis of these generic relationships permits one to sug gest the following four onto-phylogenetic branches:

(1) Feebly fluted fusulinids: *Protriticites-Triticites-Schwagerina* (?) comprising the subfamily Schwagerininae;

(2) Strongly fluted fusulinids: subfamily Pseudotriticitinae;

(3) Strongly fluted fusulinids with conspicuous axial fillings: *Quasi fusulina-Pseudofusulina* (?) (in part), comprising subfamily Quasifusu lininae, new subfamily;

(4) Regularly fluted fusulinids: *Hemifusulina-Quasifusulina* (?) (in part)—*Pseudofusulina* (?) (in part), comprising subfamily Hemifusulini nae, new subfamily."

Obviously Putrja takes exception to Rauser-Chernousova's belief in the "blind" nature of the short phyletic branches represented by the five genera enumerated by her; and he attempts to connect them phyletically with some geologically later genera, such as *Schwagerina* and *Pseudo fusulina*.

## Genus *Protriticites*

The genus *Protriticites* was introduced in 1948 by Putrja (Putrya) for Russian fusulinids displaying structure transitional between *Fusulinella* and *Triticites*. The main character on which *Protriticites* became differentiated from *Fusulinella* is a distinct keriothecal (transversely striated) nature of the main layer of the wall called diaphanotheca. Putrja calls it "alveolar," but it is not alveolar in the sense of American students of fusulinids. They mean by alveolar the keriotheca in which some or all of the neighboring transverse "striae" fuse outwardly.

The transversely striated wall in *Protriticites* would correspond to that in "higher *Fusulina*" from Texas and Oklahoma, as shown diagrammatically by M. P. White (1932, fig. 1-C on p. 7), except that the holotype of the Russian genus has a much thicker inner tectorium, which besides has a coarser transverse striation than in the overlying diaphanotheca (White has united under *Fusulina* both *Fusulina* and *Fusulinella*). However, in the latest diagnosis of the genus *Protriticites* by Rozovskaya (1958, p. 79) no mention is made of coarser structure of the inner tectorium as a generic character, and in all of her diagnoses of the genus (1948, p. 1635; 1950, p. 9; also by Rauser-Chernousova and others, 1951, p. 317) there is no mention of great thickness of the inner tectorium as a generic character. Because several new species introduced by Rozovskaya are placed by her in *Protriticites* her somewhat broader understanding of the genus than that originally formulated by Putrja must be taken into account (see translation of her definitions below).

The earlier recognition of the porosity in the wall of fusulinids (by H. H. Hayden) was substantiated through observation and logical analysis by M. P. White (1932), and photomicrographically demonstrated by Henbest (1937) and Dunbar and Skinner (1937). It is now realized that the wall of *Fusulinella* (and other earlier fusulinids) is as porous as that of *Triticites*, but its porosity is much finer, its magnitude measured by few microns. It is because the coarseness of the porosity generally increases phylogenetically, that it was first discovered in *Triticites*, its visibility being the sharpest in the thickest layer of the wall, the keriotheca. Thus the

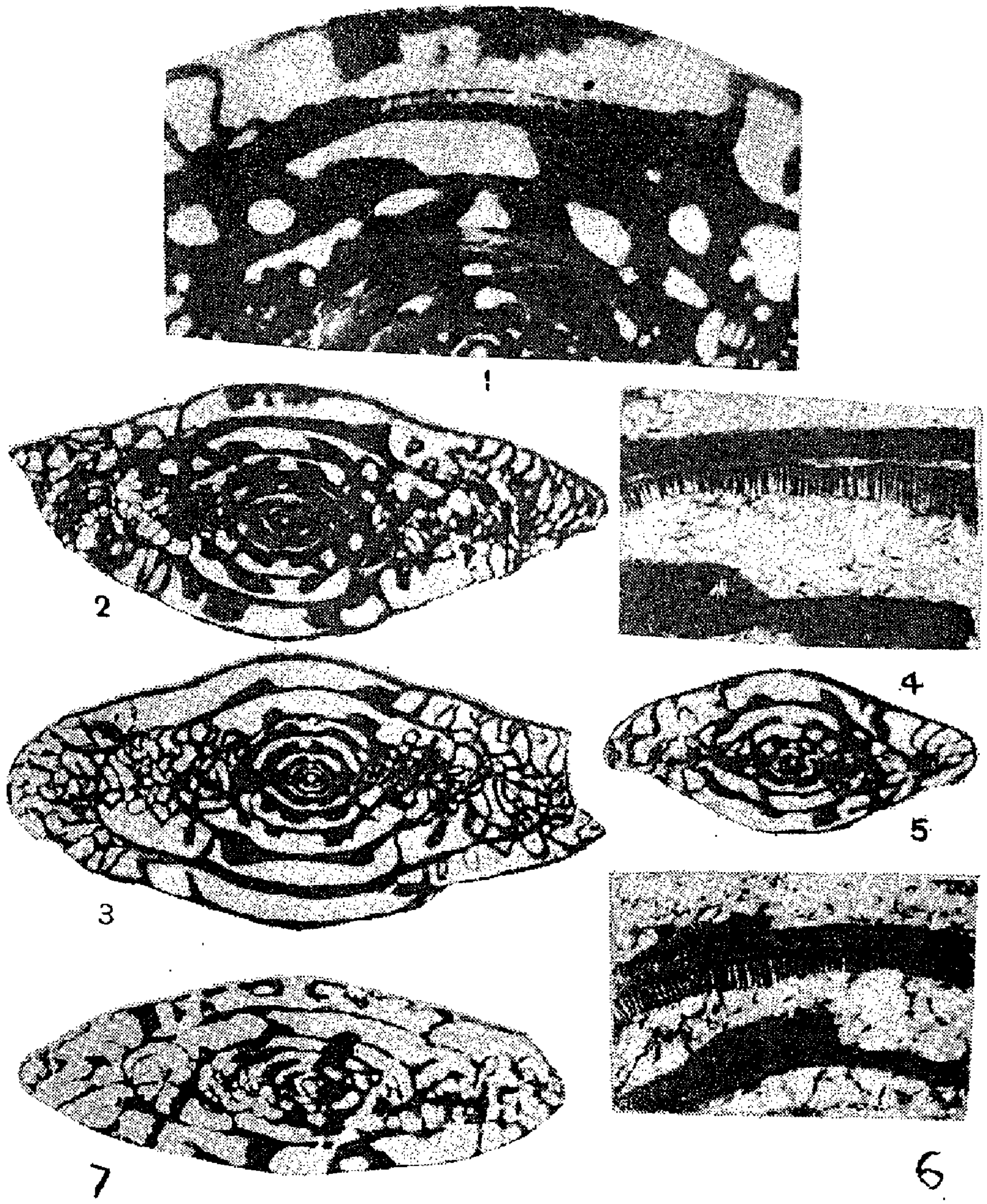



**Figure 1.** Reproduction of Plate 1 of Putrja 1948.

Figs. 1, 2, and 4—*Protriticites globulus* Putrja. Holotype. Fig. 1: x 33; fig. 2: x 13; fig. 4: x 67.

Fig. 6—*Protriticites*; probably *P. globulus*; probably x 67.

Fig. 3—Apparently *P. globulus*; probably x 13.

Note: The original explanation was not received, and therefore this explanation and magnifications have been composed by the translator, as per the translated text and the illustrations.

diaphanotheca of the earlier fusulinids (which corresponds to the keriotheca of the later fusulinids) is also porous, but its porosity is only rarely easily observable in the better preserved and more advanced forms. In view of all this the original character of the differentiation of *Protriticites* from *Fusulinella*, the coarsely porous wall of the former, becomes a quantitative rather than a qualitative distinction; and of greater diagnostic value becomes the number of layers in the wall, a character clarified by Rozovskaya in her modification of Putrja's original diagnosis of *Protriticites*. She emphasized that the four-layered nature of the wall in the inner volutions of *Protriticites* changes to the three-layered wall in the outermost ("mature") volutions. There is a discrepancy in the interpretation as to what the inner layer of the outermost volutions in *Protriticites* represents: Putrja believes that it is the inner tectorium, which is "crowding out the diaphanotheca in outer volutions" (1948, p. 91); Rozovskaya claims that it is the inner tectorium that is lost in the outermost volutions, though she admits that it is not always possible to detect diaphanotheca "in the median volutions" (1950, p. 9); and she calls the main layer of the ultimate volutions "protheca" (overlain by the tectum).

In spite of this difference of opinion the two authors agree that the wall in mature volutions of *Protriticites* is three-layered, with an outer tectorium in the outer side.

As White originally summarized, there is a phyletic change in the structure of the wall, from four-layered in "*Fusulina*" (=*Fusulina* and *Fusulinella* of authors) to two-layered in *Triticites* (1932, fig. 1 on p. 7). He also pointed out the existence of "intermediate form" (fig. 1-D) with three-layered wall, which he did not describe and left without generic assignment. We are now confronted with a taxonomic problem about such intermediate forms in America, with a possibility of their assignment (some or all) to the genera introduced in Russia.

## Genera *Pseudotriticites* and *Putrella*

The genus *Pseudotriticites* was introduced in 1940 by Putrja for Russian fusulinids comparable to *Fusulina* in the intense fluting of septa but having a wall with "finely-alveolar keriotheca" (1940, p. 61). In the course of further studies Putrja included in *Pseudotriticites* some forms which do not quite conform to his original diagnosis of the genus, as pointed out by Rauser-Chernousova, and she introduced for these a new generic name, *Putrella* (1951, p. 319). Because of the lucid analysis of the fusulinids involved (by Rauser-Chernousova), it seems desirable to translate in entirety both Putrja's original descriptions, and Rauser-Chernousova's subsequent discussions and re-definition of the genus *Pseudotriticites* in the light of her differentiation from it of the genus *Putrella*. Just as is the case with the genus *Protriticites*, no American species has been as yet assigned to *Pseudotriticites* or *Putrella*.

## Genus *Pseudotriticites* Putrja, 1940

After quoting the description of the generotype, *P. donbassicus* (Putrja) from Putrja, 1939, p. 139, Rauser-Chernousova emphasizes (Rauser-Chernousova and others, 1951, p. 322) that in this species "chomata are fairly well expressed in all volutions, while axial fillings are absent.

"Obviously the characters of the genotype do not quite correspond to the later diagnosis of the genus [Putrja, 1948]. *Pseudotriticites donbassicus* (Putrja) is substantially a mere *Fusulina* in which pores became coarser and are visible from the first volutions, whereas in *Fusulina* they usually appear only in latest volutions; and diaphanotheca became very obscure, while tectoria are feeble and inconstant. Such development is observable occasionally in *Fusulina* from the Myachkovo and *Teguliferina* horizons, and therefore in some cases it is difficult to draw a line between these two genera.

. . . When publishing his diagnosis of *Pseudotriticites* F. C. Putrja also described *P. fusulinoides,* which differs substantially from the genotype in several characters: (1) wall is thin, consisting of tectum and finely alveolar keriotheca, which according to Putrja is almost indistinguishable from the theca of *Quasifusulina,* that is, two-layered, with transverse pores; (2) chomata only in first two to three volutions, and in next volutions pseudochomata, and (3) axial fillings weak in first three volutions. Very

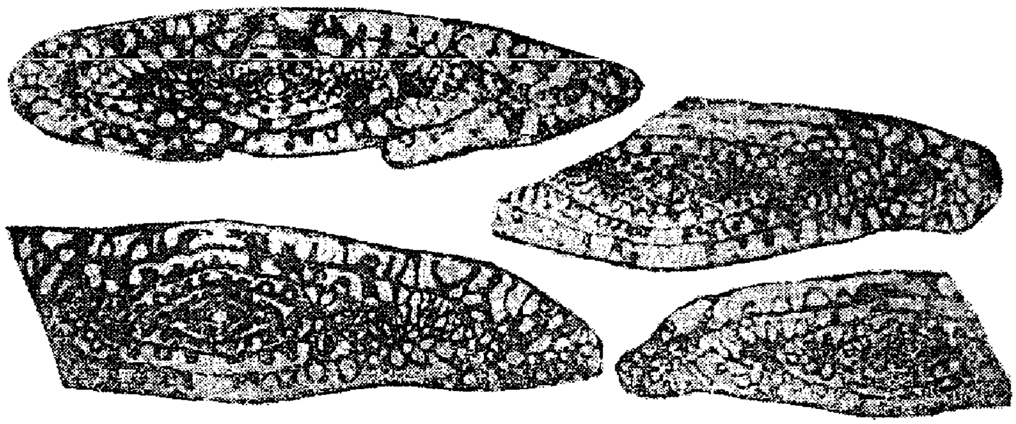


FIGURE 2. Reproduction of part of Plate 3 of Putrja 1939.

Figs. 14-17. *Pseudotriticites donbassicus* (Putrja).
Fig. 14—Specimen No. 3.
Fig. 15—Specimen No. 1.
Fig. 16—Specimen No. 2.
Fig. 17—Specimen No. 4.
Magnification slightly over x 12 for all figures.

NOTE: The original explanation was not received, and therefore this explanation and magnifications have been composed by the translator, as per the translated text and the illustrations.

No holotype for *P. donbassicus* designated by Putrja.

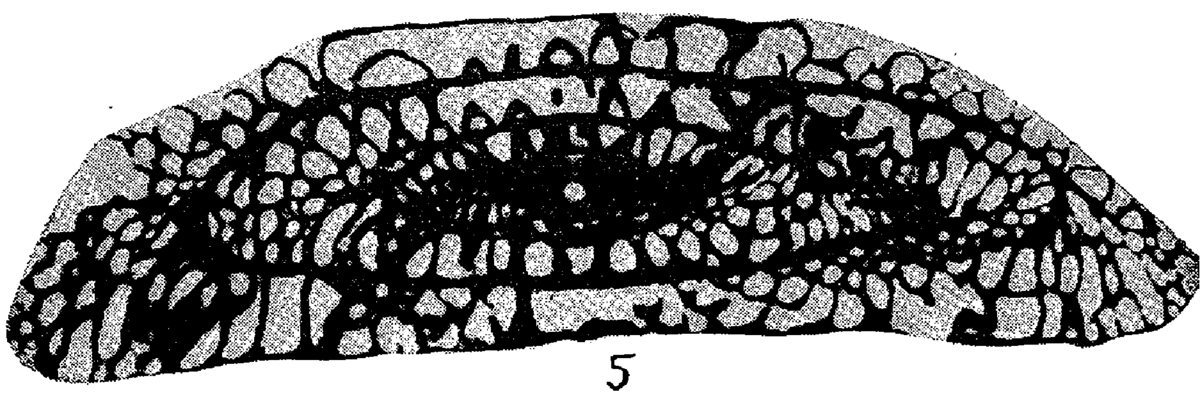
similar forms are widely distributed in the *Teguliferina* horizon of the Moscow basin. These forms are distinctive only by the inconstant and weak development of the inner tectorium and by the very rare transluscence of the diaphanotheca in the first volution. Because these characters indicate proximity of the forms of the *Pseudotriticites fusulinoides* type to the pseudotriticites of *P. donbassicus* type, it seems possible to refer the Moscow basin forms also to the genus *Pseudotriticites.* In the future, however, after working over the topotypes of *P. fusulinoides,* a problem is apt to arise regarding differentiation of a group of *P. fusulinoides* into (p. 323) a genus that would be closer to *Quasifusulina* than to *Fusulina.* These forms differ from *Quasifusulina* only by a inconstant presence of inner tectorium; more tightly coiled and not infrequently fusiform early volutions; presence of weak chomata in early volutions; and weaker axial fillings which are developed in narrow spots and only in the early volutions, while in *Quasifusulina* they are usually very wide and reach their greatest width in the last volutions."

## Genus *Putrella* Rauser, 1951

"*Generotype: Pseudotriticites brazhnikovae* Putrja, L'vovskogo Geologicheskogo Obshchestva, Trudy, paleontologischeskaya seriya, 1948, vypusk 1, p. 98-99; pl. 1, fig. 1.

"*Age:* Upper part of Moscow stage.

"*Remarks:* The genus *Putrella* is being differentiated from the genus *Pseudotriticites* on the evidence of different structure of wall, character of fluting, and different phyletic origin. Wall in *Putrella* two-layered, beginning from second volution fairly thick (to 50$\mu$), with distinct large pores; no trace of tectoria in which respect it reminds well of *Triticites*. Fluting is very characteristic: high though irregular, its archlets narrow, loop-like, wavy or triangular, with wide base and narrow apex. Chomata and pseudochomata practically absent, chomata occurring only in first volution; additional deposits in middle region common, from weak to moderate, and axial fillings absent. Putrellas occur at base of Podolsk horizon, possibly also from the very upper part of Kashirsk horizon; pseudotriticites (of *Pseudotriticites donbassicus* Putrja group)—from the upper part of Myachkovo horizon.



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6

FIGURE 3. Reproduction of Plate 57, figures 5 and 6 from Rauser-Chernousova and others, 1951. *Putrella brazhnikovae* (Putrja).
5. Axial section of a typical specimen. Vas'kino village. Basal part of Podol'skii horizon. x 17.
6. Same Svistunovo village, Podol'skii horizon. x 17.

"The later forms in their ontogeny clearly recapitulate wall structure of *Fusulina*, being very similar to the latter genus, whereas in *Putrella* the wall is two-layered from second volution. It is obvious that putrellas could not give rise to pseudotriticites of *Pseudotriticites donbassicus* group, and themselves originated from another stock. In the structure of wall they are close to *Hemifusulina*, but differ by absence of chomata, presence of additional deposits only in middle region (in *Hemifusulina* septa frequently are thickened along the axis), and high, irregular, angular fluting. Putrellas are nearest to fusulines of the *Fusulina ozawai* group, from which they probably originated through modification of wall structure at a very early stage of its development. To *Putrella* are referred, besides *P. brazhnikovae* (Putrja) and its variety *fusiformis* Putrja, also *Schwagerina* ? *donetziana* Lee and *Fusulina* (?) *susini* Putrja. Besides, Lee indicates and describes a wall, seemingly like that in *Putrella*, from the suite *M* of the Donetz basin as *Schwagerina* (?) sp. nov. (?) (Rauser-Chernousova and others, 1951, p. 319).

"Rauser-Chernousova illustrates and describes all mentioned forms. In 1956 Putrja described (p. 468-469) still another species of *Putrella, P. gurovi* n. sp., which occurs principally in the suite $C_2M$, rarely in the uppermost $C_2L$ (limestone $L_2$) of the Eastern Donetz basin; he repeats briefly Rauser-Chernousova's diagnosis of the genus *Putrella*."

NOTE

The translations in the following sections were made by Elias from photographic copies of extracts from the original papers of Putrja. The extracts were received from the Paleontological Institute of the Akademiya Nauk S.S.S.R., Moscow, letter of transmittal signed by N. N. Kramarenko, Learned Secretary. The translations were prepared for Humble Oil and Refining Company, which has given permission for their publication.

Translation of Original Definition of *Protriticites* Putrja, F. S.—1948 —*Protriticites*—novyi rod fusulinid: L'vovskogo Geologischeskogo Obshchestva pri Gosudarstvennom Universitete imeni Ivana Franko. Trudy, Paleontologicheskaya seriya vypusk 1.[1]

[1] The paper was already prepared for publication in 1940; it is now published without change of the text [footnote by Putrja].

(p. 89)

Wall structure is one of the most important generic characters in evolution of fusulines. White (1932) earlier noted the importance of this character, as he pointed out that the process of gradual differentiation of wall, accompanied by enlargement of its structural elements, is the most evident and principal trend disclosed in the study of the fusulines; and it permits one to trace their step-by-step development [evolution] in the course of time. D. M. Rauser-Chernousova has studied the phylogeny of fusulines in fair detail.

Definite stages in the evolution of the wall in fusulines are obviously correlated with their overall phyletic increase in size, and on them is based the differentiation of the fundamental classificatory units: subfamilies and genera.

When studying the Foraminifera of the Upper Carboniferous deposits of the eastern part of the Donetz basin I encountered a fairly peculiar group of fusulines, which does not possess very clearly expressed generic characters, but nevertheless deserves differentiation into a new genus: *Protriticites*.

The generic characteristics of *Protriticites* combine, on one side, the characters of the genus *Fusulinella* Moeller (theca with well expressed diaphanotheca and weak fluting of septa), and on the other side, the characters of the genus *Triticites* Girty (theca with obvious karyotheca in all volutions of shell). Thus, the newly described genus *Protriticites* has a wall that seems, at first glance, to possess a structure typical of *Fusulinella*. It is made of a fairly thin dark layer; tectum; a comparatively light and thick layer; diaphanotheca; and two tectoria: thin outer, and considerably thicker inner. However, it is also clear that its wall structure is unlike that of *Fusulinella* in other respects: its diaphanotheca, tectoria, and chomata have a finely alveolar texture, distinctly non-uniform for the different layers in the theca and the chomata; and the inner tectorium has the coarsest alveolar texture, its trabeculae being much sharper, the pore-canalicules being substantially wider than in the overlying diaphanotheca (pl. I, figs. 1, 4 and 6). The difference in the type of the alveolar texture between the inner tectorium and the diaphanotheca is fairly noticeable in medial volutions, but is particularly clear in outer volutions, where the contact of the two kinds of the alveolar texture is occasionally marked by a thin irregular line (fig. 1). In the course of the further development of the inner tectorium, as seen in the ultimate volution, the contact line disappears, so that the structural elements in the wall of *Protriticites* become but little different from the same in *Triticites* Girty.

The new genus thus confirms most obviously the gradualness of the evolution of the wall structure, expressed in complication of its structural elements not only in the phylogeny of the fusulines, but also in the individual development or ontogeny.

It seems possible that the complex, non-uniform wall structure of *Protriticites* has somewhat hindered gaseous exchange between the protozoan in the shell, and the surrounding water medium; and, if so, could have resulted in shortening of the geologic duration of *Protriticites* in time and space.

Thus, *Protriticites* is characteristic only for the deposits of suite (svita) $C_3N$, where it is associated with other fusulines, which preserve their transitional, that is Middle Carboniferous aspect. But in the lower part of the next formation, $C_3O$, *Protriticites* is replaced by a typical Upper Carboniferous triticitic complex of fusulines.

The mentioned characteristic features of *Protriticites* determine its place in the scheme of fusulinid classification between the genera *Fusulinella* and *Triticites*, and indicate its assignment to the subfamily Schwagerininae Dunbar and Henbest.

Genus *Protriticites*, n. gen.

Shell short-ventricose to sub-cylindrical, moderate in size. Wall moderately thick, less frequently quite thin, or quite thick.
(p. 91)

Wall structure quite complex, consisting of tectum, diaphanotheca, and two tectoria. Diaphanotheca, tectoria, and chomata have a finely alveolar texture, the inner tectorium having the coarsest alveolar texture among them. The vigorous development of the inner tectorium is crowding out the diaphanotheca in outer volutions. Septa weakly fluted. Chomata prominent in all volutions. Aperture single. Septal pores occasionally developed. Genotype: *Protriticites globulus*, sp. nov.

*Protriticites globulus*, sp. nov.
Pl. I, figs. 1-2

1939 *Fusulinella pseudobocki* [as identified by] Brazhnikova, Akad. Nauk S.S.S.R., Institut geologii, Trudy, vol. 6, fasc. 1-2, p. 259-260, pl. 3, figs. 1-2.

Shell ventricose, much inflated in the middle, with slightly convex sides, which rapidly narrow toward bluntly acuminate to rounded ends.

Size moderate: L = 3.0 to 5.5 mm; D = 1.2 to 2.3 mm; L:D averages 2.4:1. Dimensions of holotype: L = 5.04; D = 2:10; L:D = 2.4:1; at fourth volution: L:D = 1.56:1.

Spiral not wide in inner three to four volutions, but expands fairly rapidly in the succeeding volutions. Diameter of fourth volution from 0.70 to 0.90 mm, occasionally reaching up to 1.5 mm. Diameter of holotype: 1st volution = 0.20; 2nd volution = 0.32; 3rd volution = 0.56; 4th volution = 0.90; 5th volution = 1.29; 6th volution = 1.83; 6½ volution = .2.10 mm.

Number of volutions 5 to 7, occasionally to 7½

Proloculus spherical, with average outer diameter 0.10 mm.

Theca comparatively thick, gradually increasing in thickness toward ultimate volution. Thickness of theca in holotype: 1st volution = 0 016 mm; 2nd volution = 0.030; 3rd volution = 0.042; 4th volution = 0.052; 5th volution = 0.068; 6th volution = 0.072; 6½ volution = 0.076.

Septa thinner than theca; weakly fluted in equatorial region; moderately fluted in polar regions. Septal pores observed in polar regions of some specimens.

Aperture narrow; not high in inner and median volutions; noticeably widening in outer volutions. Width of aperture in last two volutions 0.48 and 0.62 mm respectively, with its height one-third of chamber lumen. (p. 92)

Chomata massive, occupying about two-thirds of height of chamber lumen; chomata developed in all volutions; chomata wide in inner volutions, narrower and subquadrate in outer volutions.

*Comparison.* Genotype of *Protriticites* approaches fairly closely *Triticites umbonoplicatus* Rauser and Beljaev in the shape and size of conch, height of spiral, fluting of septa, thickness of theca, and shape and size of chomata; but has a substantially different wall structure. The described difference in wall structure emphasizes close phylogenetic relationship of the compared forms.

*Occurrence.* Severo-Kamensky and Belo-Kalitvensky districts in limestones of $O_3$; and also in many districts of the central part of the Donetz basin, where Brazhnikova established the presence of *Protriticites globulus* in limestones of $CN_3$ and in $O_1$ of $CO_3$ suites. It is rarely encountered in limestone $N_1$ and $N_2$.

Translation of Definition of *Pseudotriticites* and Its Type Species
Putria, F. S., 1940, Foraminifery i stratigrafiya verkhne-kamennougol'nykh otlozheny vostochnoi chasti Donetskogo basseina: Azovsko-Chernomorskoe Geologischeskoe Upravlenie, Materialy po geologii i poleznym iskopaemym, Sbornik 11.

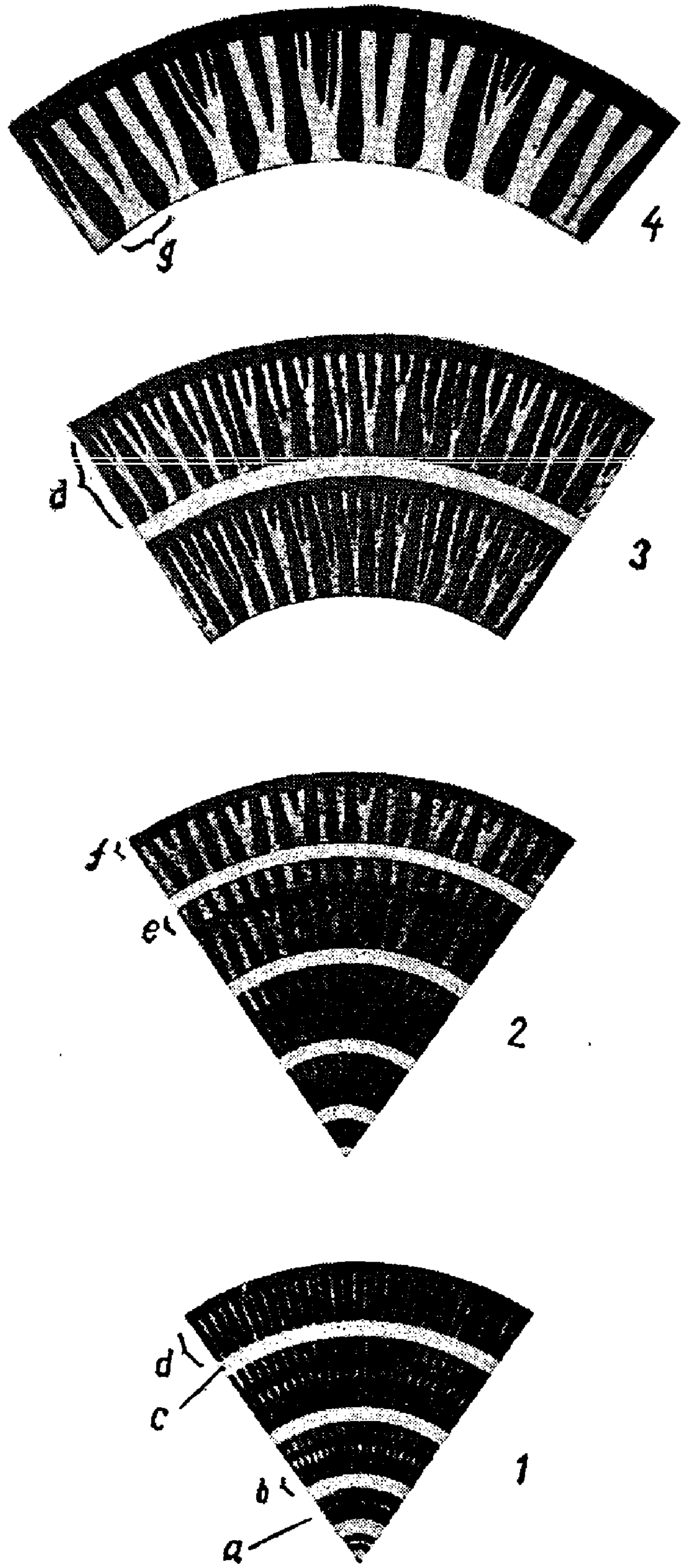


FIGURE 4. Reproduction of Figure 2 of Rozovskaya 195C.
Evolution of the stock of the genus *Triticites.*
1. *Protriticites.*
2. *Montiparus.*
3. *Triticites* and *Rauserites.*
4. *Jigulites* and *Pseudofusulina.*
a) diaphanotheca; b) inner tectorium; c) pores; d) keriotheca; e) outer tectorium; f) tectum; g) alveoli.

## Subfamily Schwagerininae Dunbar and Henbest 1930

### Genus *Pseudotriticites*, gen. nov.

(p. 61)

Shell elongate-fusiform to subcylindrical, of moderate to large size. Theca thin, made of tectum, finely-alveolar keriotheca, and outer tectorium. Theca may be four-layered, with finely alveolar diaphanotheca, in initial two to three volutions. Septa regular, moderately to intensely fluted along the whole length of volutions. Chomata in all volutions, less frequently in inner volutions only. No axial filling. Aperture single.

*Genoholotype:* (?) *Fusulina donbassica* Putrja, Azovsko-Chernomorskoe Geologicheskoe Upravlenie, Materialy po geologii i poleznym iskopaemym, Sbornik 10, 1939, p. 139-140, pl. III, figs. 14-17.

*Age:*—Upper part of middle and lower part of Upper Carboniferous of Donetz basin.

*Pseudotriticites donbassicus* Putrja

Typical specimens of the species, with the characteristic finely-alveolar keriotheca in the outer volutions, and a similar, finely-alveolar texture of diaphanotheca in the inner volutions, are not infrequent in the lower part of formation $CN_3$ in the eastern part of the Donetz basin. They do not differ from a form from Tsymlyansk bore-hole.

*Occurrence and age.* Fairly common in the limestone II above $N_3$ as exposed along Nizhne-zhernovaya balka [ravine] in VI-31 quadrangle of Donbas geological map.

Translation of Description of (?) *Fusulina donbassica* Putrja, F. S., 1939. Materialy k stratigrafii verkhnego karbona vostochnoi okrainy Donetskogo basseina: Azovsko-Chernomorskoe Geologicheskoe Upravlenie. Materialy po geologii i poleznym iskopaemym. Sbornik 10.

(?) *Fusulina donbassica*, sp. nov.

Pl. III, figs. 14-17

(p. 139)

Shell ventricose, much elongated along axis of winding, gradually narrowing toward poles, which are rounded, or occasionally acuminate. Surface with noticeable but not deep septal furrows.

Size large: L = 5.75-6.50 mm; D = 1.44-1.68 mm; L:D about 4:1.

Changes in length of shell L (in mm) and of L:D ratio in volutions:

Table 51

| Volutions | Specimens 1 | | 2 | | 3 | |
|---|---|---|---|---|---|---|
| | L | L:D | L | L:D | L | L:D |
| 1 | 0.45 | 1.80:1 | 0.34 | 1.36:1 | 0.48 | 1.76:1 |
| 2 | 0.73 | 2.03:1 | 0.70 | 1.94:1 | 0.78 | 1.86:1 |
| 3 | 1.37 | 2.54:1 | 1.29 | 2.30:1 | 1.40 | 2.37:1 |
| 4 | 2.18 | 2.83:1 | 2.38 | 3.05:1 | 2.41 | 2.87:1 |
| 5 | 3.78 | 3.38:1 | 4.09 | 3.65:1 | 4.20 | 3.56:1 |
| 6 | 5.75 | 4.00:1 | 6.50 | 4.14:1 | 6.44 | 3.82:1 |

Spiral increases in height gradually: from compactly wound in the inner volutions to looser coiling in the outer ones.

Change of shell diameter (D) in volutions:

Table 52

| Volutions | Specimens | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| proloc. | .170 | .150 | .180 | .170 |
| 1 | .250 | .250 | .280 | .270 |
| 2 | .360 | .360 | .460 | .420 |
| 3 | .540 | .560 | .700 | .590 |
| 4 | .770 | .780 | .980 | .840 |
| 5 | 1.120 | 1.120 | 1.340 | 1.180 |
| 6 | 1.140 | 1.570 | --- | 1.680 |

Volution number: 6, less frequently smaller. Proloculus spherical, of moderate size, 0.150 to 0.180 mm, diameter.

Theca thin, made of very thin tectum, broad and light diaphanotheca, and two tectoria. However, only inner tectorium is more or less well developed. Diaphanotheca thinly alveolar in all volutions; alveoli thread-like (pores?), traverse not only diaphanotheca, but also remaining layers of wall, and occasionally even chomata.

Changes in thickness of theca in volutions:

Table 53

| Volutions | Specimen Numbers | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| 1 | .016 | .018 | .018 | .018 |
| 2 | .020 | .025 | .023 | .023 |
| 3 | .030 | .031 | .030 | .030 |
| 4 | .032 | .034 | .036 | .031 |
| 5 | .032 | .035 | .030 | .034 |
| 6 | .032 | .030 | --- | .036 |

Septa fluted uniformly and intensely along the whole length of volutions. Archlets have an appearance of loops with expanded base and rounded upper part, their height up to two-thirds of lumen of chamber. Thickness of septa much smaller than thickness of theca.

Number of septa not observed. Aperture elongate-ovate, regularly disposed in all volutions (when displacement is observed, it is always insignificant).

Changes in size, width and height of aperture in volutions:

Table 54

| Volutions | Specimen Numbers | | | |
|---|---|---|---|---|
| | 3 | | 2 | |
| | width | height | width | height |
| 1 | .045 | .020 | .044 | .020 |
| 2 | .050 | .024 | .065 | .025 |
| 3 | .073 | .033 | .110 | .043 |
| 4 | .150 | .040 | .160 | .043 |
| 5 | .252 | .073 | .336 | .073 |
| 6 | .450 | .090 | | |

Chomata present in all volutions, and fairly distinct; they are subquadrate or tubercle-like, about one-half the height of chamber lumen.

*Comparison.* Because of the shape, fluting of septa, development of chomata, and thickness of theca, the described specimens are referred to the genus *Fusulina* Fischer von Waldheim. However, the well-developed alveolar structure in all layers of theca, and occasionally also in chomata, distinguishes the described form from the known representative of genus *Fusulina*, this difference being apparently of generic significance.

*Occurrence.* Eastern part of Donetz basin, bore-hole No. 14 (Stanitsa Tsymlianskaya), in limestones from 692.65 to 693.00 meters depth. Upper Carboniferous, lower part of suite N.

Comment on Stratigraphic Terminology in the U.S.S.R.

The Carboniferous is divided into three parts: Lower, Middle, and Upper, which correspond approximately to the Mississippian, Lower Pennsylvanian (Springer—Des Moines) and Upper Pennsylvanian (Missouri—Virgil) of North America. The stratigraphic column of the Donetz coal basin is not differentiated into named units, but is divided into suites of limestones, characterized chiefly by brachiopods (by Theo. Tschernyshev), and designated by capital letters in the order of the Latin alphabet in ascending order. Individual limestones in a suite are given arabic numbers.

The boundary between the Middle and the Upper Carboniferous is placed on the paleontological evidence between the limestone suites N and O, and in these limestones Putrja discovered his transitional genera of fusulines.

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# Available Federal Publications on Oklahoma Geology

Nearly all U. S. Geological Survey publications on Oklahoma which are more than ten years old are out of print.

The available reports are:

(Bulletins and water supply papers are for sale by Superintendent of Documents, Government Printing Office, Washington 25, D. C.)

## BULLETINS

1015-F. Geology and coal resources of the Henryetta mining district, Okmulgee County, Okla., by R. J. Dunham and J. V. A. Trumbull. 1955. p. 183-225. $1.00.

1042-J. Coal resources of Oklahoma, by J. V. A. Trumbull. 1957. p. 307-382. $1.00.

1227-B. Floods of May 1951 in western Oklahoma and northwestern Texas. 1954. p. 135-199. 70c.

1300. The industrial utility of the public water supplies of the United States, 1952, pt. 2, States west of the Mississippi River, by E. W. Lohr and S. K. Love. 458 p. $1.75.

1311. Compilation of records of surface waters of the United States through September 1950, part 7, lower Mississippi River basin. 1955 (1956). 606 p. $2.50.

Also annual data on quality of surface waters, on observation wells, on stream measurements.

## CIRCULAR

361. Summary of annual records of chemical quality of water of the Arkansas River in Oklahoma and Arkansas, 1945-52, a progress report, by T. B. Dover and J. W. Geurin. 1955. 20 p. Free.

(Write to Director, U. S. Geological Survey, Washington 25, D. C. All maps listed are obtainable from that office.)

## COAL INVESTIGATIONS MAPS

Northern LeFlore County, Okla., by M. M. Knechtel, assisted by W. J. Souder. 1944. Shows geologic structure, coal beds, natural gas fields, location of coal mines and prospects, and status of wells drilled for gas. Scale, 1 inch = 4,000 feet. Size, 37 by 64 inches. 50c.

Coal maps of four areas in southeastern Oklahoma:

Howe district, LeFlore and Latimer Counties, by T. A. Hendricks and others. 1935. Scale, 1 inch = ½ mile. Size, 32 by 64 inches. $1.00. (See also Bulletin 874.)

Lehigh district, Coal and Atoka Counties, by T. A. Hendricks and others. 1935. Scale, 1 inch = ½ mile. Size, 32 by 64 inches. $1.00.

McAlester district, Pittsburg and Latimer Counties, by T. A. Hendricks, and others. 1935. Scale, 1 inch = ½ mile. Size, 32 by 64 inches. $1.00. (See also Bulletin 874.)

Wilburton district, Latimer County, by T. A. Hendricks and others. 1935. Scale, 1 inch = ½ mile. Size, 30 by 64 inches. $1.00.

Geologic map of the Lehigh district, Coal, Atoka, and Pittsburg Counties, Okla., by M. M. Knechtel and others. 1935. Scale, 1 inch = 1 mile. Size 32 by 27 inches. 25c.

Preliminary map showing geologic structure of the Quinton-Scipio district, Pittsburg, Haskell, and Latimer Counties, Okla., by Carl H. Dane and others. 1935. Scale, 1 inch = 1 mile. Size, 43 by 44 inches. 25c.

OIL AND GAS FIELDS OF THE STATE OF OKLAHOMA, by G. B. Richardson, assisted by Jane Hanna. 1939. Shows the productive oil and gas fields in the State. Scale, 1:500,000, or 1 inch = about 8 miles. Size, 34 by 64 inches. 50c.

## OIL AND GAS INVESTIGATIONS CHARTS:

5. Correlation and subdivision of subsurface Lower Ordovician and Upper Cambrian rocks in northeastern Oklahoma, by H. A. Ireland, assisted by A. P. Wishart. 1944. Geologic section from southwestern Missouri across northeastern Oklahoma. Scales, 1 inch = 4 miles and 1 inch = 16 miles. Size, 28 by 43 inches. 35c.

OC 47. Subsurface cross sections of pre-Pennsylvanian rocks from Morton County, Kans., to Gray County, Tex., by J. B. Collins. 1952. 40c.

## OIL AND GAS INVESTIGATIONS MAPS

15. Geologic map of the Dougherty asphalt area, Murray County, Okla., by J. M. Gorman, assisted by G. M. Flint, Jr. 1944. Map of about a quarter of a square mile. Scale, 1 inch = 300 feet. Size, 16 by 23 inches. 25c.

22. Geologic map of the Sulphur asphalt area, Murray County, Okla., by J. M. Gorman, G. M. Flint, Jr., C. E. Decker, and W. E. Ham. 1945. Map of about 1 square mile. Scale, 1 inch = 300 feet. Size, 28 by 41 inches. 40c.

52. Maps of northeastern Oklahoma and parts of adjacent States showing the thickness and subsurface distribution of Lower Ordovician and Upper Cambrian rocks below the Simpson group, by H. A. Ireland and J. H. Warren. 1946. Scale, 1 inch = 8 miles. Size, 37 by 43 inches. 60c.

66. Geology of the western part of the Ouachita Mountains, Okla., by T. A. Hendricks, L. S. Gardner, M. M. Knechtel, and Paul Averitt. 1947. Geologic map of about 957 square miles in southeastern Oklahoma. Scale, 1 inch = ⅔ mile. 3 sheets, each 44 by 56 inches. $1.00 a set.

101. Pre-Pennsylvanian geology of southwestern Kansas, southeastern Colorado, and the Oklahoma Panhandle, by J. C. Maher and J. B. Collins. 1949. Scale, 1 inch = 16 miles. 4 sheets, each 34 by 43 inches. $1.00 a set.