THE OHIO JOURNAL OF SCIENCE

VOL. 57 SEPTEMBER, 1957 NO. 5

FUSULINIDS FROM THE PENNSYLVANIAN ROCKS OF OHIO

PAULINE SMYTH

The Ohio Geological Survey, Columbus 10, Ohio

INTRODUCTION

The Fusulinidae are a family of Foraminifera whose shells are present in late Mississippian, Pennsylvanian, and Permian marine rocks. They are large enough to be detected in the field and small enough to be identified in cores and cuttings. Not only are genera and species of this family widely distributed, but their definite and rapid evolution makes them good index fossils within their range.

Although several authors (Stout, 1918, 1927; Condit, 1912; Conrey, 1921) mentioned the occurrence of fusulinids in Ohio, and Morningstar (1922) described two species, the names used in these publications are now obsolete. Thompson (1936) described and illustrated six species and one variety according to modern classification in his paper on fusulinids in Ohio. The present writer gave a brief review of work in Ohio in 1951, and has made several small contributions since that time in unpublished masters' theses and doctoral dissertations (Blake, 1952; Teflian, 1952; Gray, 1954; Multer, 1955).

It is the purpose of this paper to report the progress which has been made in the study of Ohio fusulinids from 1951 to the present time, and to make available to Pennsylvanian stratigraphers in Ohio information which might aid them in identifying certain marine horizons both in the field and in the laboratory. Collections of fusulinids have been made from 117 localities, but there are many more known localities and work will continue.

No fusulinids have been reported from Mississippian rocks in Ohio. The Permian rocks of the State do not contain marine faunas. Fusulinids do occur, however, in the Pennsylvanian rocks of southeastern and eastern Ohio, which consist of shales, sandstones, clays, limestones, and coals in cyclic sequences. When fusulinids are present, they are in the marine limestone or in shale associated with it.

Fusulinids have been reported in 12 different marine limestones of the Pennsylvanian rocks of eastern Ohio. They are abundant in the Lower Mercer and Upper Mercer limestones of Pottsville age, the Putnam Hill and Vanport limestones of Allegheny age, and the Cambridge and Ames limestones of Conemaugh age. They are scarce in the Boggs, Zaleski, Hamden, Brush Creek, Portersville, and Gaysport marine members. Except for the Brush Creek, these last mentioned limestones are so limited in extent that the paucity of fusulinids may be due to the limited exposures of the units.

Fusulinids can be very useful in identifying certain members in the Pennsylvanian series of Ohio. It is necessary to grind thin sections of individual specimens in order to make positive species identification, but the different genera which are known in Ohio can be distinguished in the field with a hand lens. The genus

Fusulinella is found in rocks of Pottsville age, *Fusulina* and *Wedekindellina* in Allegheny rocks, and *Triticites* in Conemaugh rocks (fig. 1).

FUSULINID ZONES

Fusulinella iowensis and *F. iowensis* var. *stouti* are present in the Boggs, Lower Mercer, and Upper Mercer limestones, all of Pottsville age. These units cannot be distinguished from each other on the basis of fusulinids.

Fusulina leei is the only species which has been found in the Putnam Hill limestone. It closely resembles *F. carmani* of the Vanport limestone. The two species cannot be distinguished in the field. *Wedekindellina euthysepta* is associated with *Fusulina carmani* in the Vanport limestone and flint in about one half of the outcrops investigated and it has never been reported in the Putnam Hill limestone. Its slim pointed shape is easy to recognize and it serves to distinguish the Vanport horizon. The author has not found any fusulinid specimens in the Zaleski black flint although Morningstar (1922) reported them present. One specimen belonging to the genus *Fusulina* has been found in the Hamden Limestone; it is a little larger and more obese than *F. carmani*.

The author has examined several exposures of Brush Creek limestone without finding any fusulinids. Thompson (1936) describes *Triticites ohioensis* from the Brush Creek of Gallia County, and Blake collected some of the same species in two other places in Gallia County (localities 14 and 15).

The Cambridge limestone is a coquina of fusulinid shells in some exposures in southern and east-central Ohio. These shells are *Triticites ohioensis*, the same species which is known from the Brush Creek limestone and possibly from the Portersville horizon. No fusulinids have been reported from the Cambridge limestone northeast of Muskingum and Guernsey counties.

Triticites skinneri and *T. cullomensis* are the species known from the Ames limestone. They are both somewhat shorter and more obese than *T. ohioensis*. Differentiation is possible in the field. *T. skinneri* is known from one outcrop of the Gaysport limestone in Athens County.

No fusulinids have been found in the Skelley limestone, which is stratigraphically the highest member bearing a marine fauna in this state.

FOSSILIFEROUS BEDS

Boggs Member

The Boggs member of the Pottsville formation is the oldest marine horizon in which fusulinids have been found in Ohio. In southern Ohio the Boggs member consists of iron ore and some fossils have been found in dark shales associated with the ore (Morningstar, 1922, p. 37, 38). In a number of places in Muskingum County a hard limestone which contains marine fossils is developed at the Boggs horizon. The author found *Fusulinella iowensis* sparingly present in this limestone in Blunt Run, Muskingum County (loc. 28) and Thompson (1936) reported *F. iowensis* var. *stouti* from the same locality. *F. iowensis* is present in an outcrop of Boggs limestone in Wayne Township, Tuscarawas County (loc. 60).

Lower Mercer Member

The Lower Mercer fossiliferous limestone and shale can be traced across southeastern Ohio from Lawrence County in the south to Mahoning County in the northeast. It appears in all the counties where it might be expected and it is everywhere fossiliferous. Morningstar (1922) does not list fusulinids among the fossils found in the Lower Mercer limestone anywhere south of Muskingum County. The author has examined a few outcrops of Lower Mercer limestone in southern Ohio without finding fusulinids. In Muskingum County and northeastward fusulinids have been found in more than half of the outcrops examined. They are very

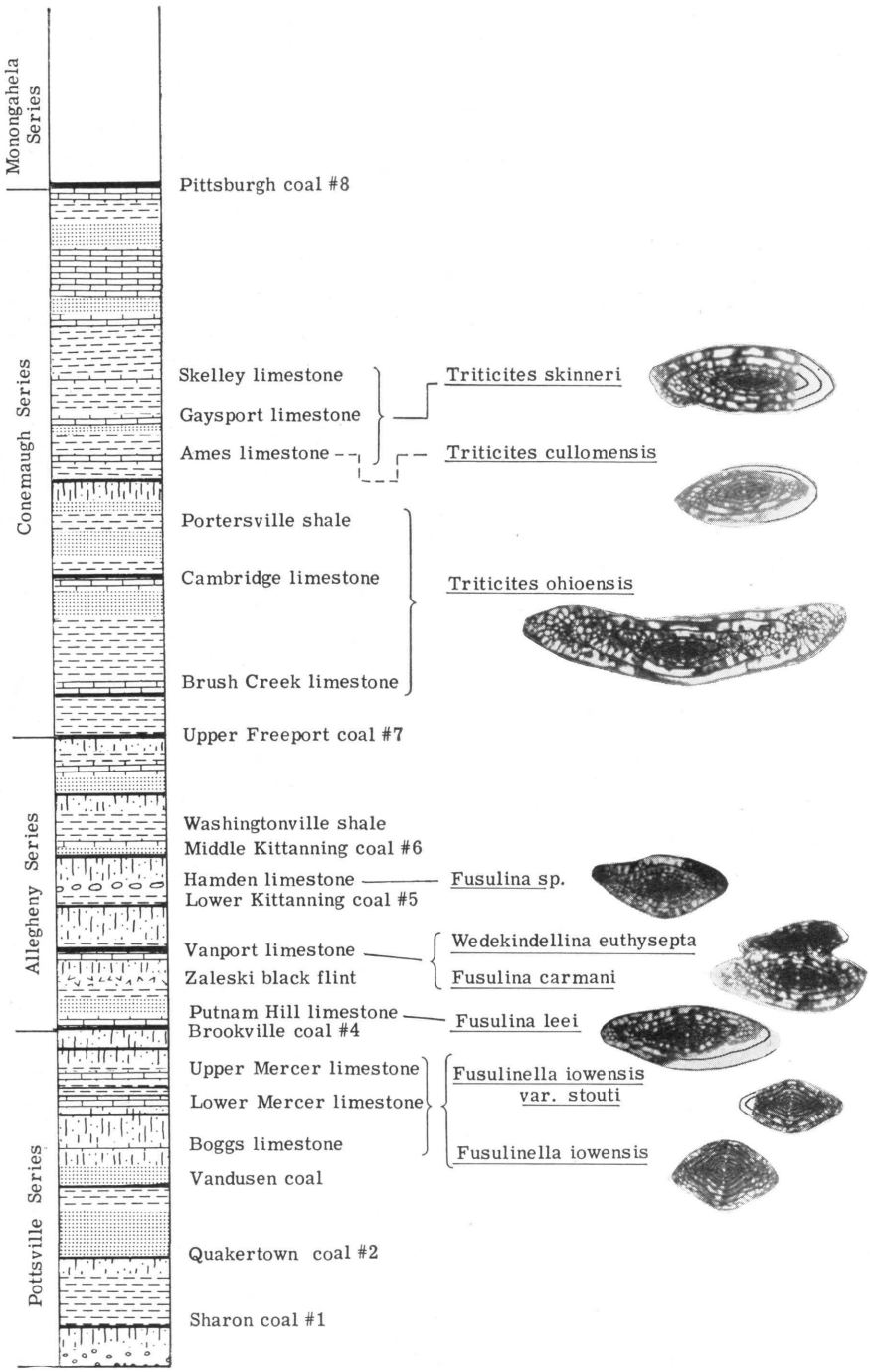


FIGURE 1

Stratigraphic Distribution of Fusulinids in Pennsylvanian Rocks of Ohio

abundant in some outcrops in Muskingum, Licking, and Coshocton counties (localities 31, 73, and 115). They are less abundant to the north and east but one specimen was found near the Pennsylvania border in Columbiana County (loc. 109).

Fusulinella iowensis was present in all the exposures of Lower Mercer limestone in which any fusulinids were found. *F. iowensis* var. *stouti* is associated with it at localities 31, 4, and 73 in Licking and Muskingum counties, and Thompson (1936, p. 677) reported the variety in Muskingum Township, Muskingum County.

Upper Mercer Member

Almost as continuous as the Lower Mercer limestone is the Upper Mercer limestone which lies from 15 to 50 feet higher. In southern Ohio this horizon is represented in most exposures by fossiliferous iron ore. In central and northeastern Ohio dark limestone and flint are characteristic. Because some phases of the Upper Mercer resemble the Lower Mercer, the two units are difficult to distinguish from each other unless both are present. So far no distinguishing fusulinid features have been found. *Fusulinella iowensis* and *F. iowensis* var. *stouti* are present in both members.

Up to the present time the author has made no collections from the Upper Mercer in southern Ohio. The southernmost locality investigated is number 47 in Hocking County where a very few specimens of *Fusulinella iowensis* were found in the black flint. Morningstar (1922) does not report any fusulinids in the Upper Mercer south of Clayton Township, Perry County. Fusulinids are present in most of the outcrops investigated in central and northeastern Ohio. They are abundant at localities 65 and 77 in Tuscarawas County. In the black flint phase of this member white fusulinids are conspicuous, but it is impossible to make satisfactory thin sections from this material.

Putnam Hill Member

The Putnam Hill limestone, which is the lowest marine horizon in the Allegheny series, is a gray limestone several feet thick in central Ohio. The type locality is at Putnam Hill in Zanesville, Muskingum County. The limestone thins from the type area, both to the south and to the northeast and is wanting in Lawrence and Scioto counties in the south and Mahoning and Columbiana counties in the northeast.

Fusulina leei is the only species of fusulinid which has been found in the Putnam Hill limestone. It is abundant at localities 1 and 54 in southern Coshocton County and also at localities 45 and 62 in Wayne and Stark counties respectively. It is less abundant to rare in 24 other localities from which the author has collections.

Zaleski Member

In southern Vinton and northern Jackson counties a marine horizon named the Zaleski member (Stout, 1927, p. 181) is developed in the interval between the Putnam Hill and Vanport members. This horizon, which is referred to as the Black Flint member by Morningstar (1922), consists chiefly of dark flint and siliceous limestone, bearing a marine fauna.

Morningstar (1922, p. 133, 134) found some specimens of fusulinids in this member but these specimens have been lost and the author was not able to find any in the field.

Vanport Member

In 1846 a French scientist, E. de Verneuil, traveling in the United States noted fusulinids in the buhrstone of Ohio. In his letter to the American Journal of Science he expressed surprise at finding this fossil, which was common in Russia, in this place half way around the world. The buhrstone to which he referred

was the Vanport member of the Allegheny series, and fusulinids were very likely *Fusulina carmani*. This is one of the earliest references to fusulinids in America.

The Vanport limestone is well developed in northeastern Ohio and southern Ohio but its occurrence across the middle part of the state is spotty, in some places missing or represented by nodules of fossiliferous limestone or flint. In Hopewell townships of Licking and Muskingum counties the flint is up to 10 feet thick and continuous. It is responsible for the ten mile long feature known as Flint Ridge. Fusulinids are conspicuous fossils in the blocks of flint in this area. The flint is underlain by unfossiliferous limestone.

In southern Ohio this horizon is referred to as the Ferriferous limestone, because of its association with the Ferriferous ore which was the foundation of the iron industry in Ohio in the last century.

The fusulinid species which is most common in the Vanport member is *Fusulina carmani*. The cotypes for this species were collected near the eastern end of Flint Ridge. Associated with *F. carmani* in many places is the distinctive pencil-shaped *Wedekindellina euthysepta*. Where the latter genus is present the Vanport limestone can be easily distinguished from the Putnam Hill limestone in the field.

Hamden Member

The Hamden member of the Allegheny series is composed of iron ore in southern Ohio and nodular limestone and ore in central Ohio. The limestone, which is best developed in Muskingum County, lies above the Lower Kittanning coal and below or within the Oak Hill clay. Nodules of black, fossiliferous, dense limestone from this member lie along the road west of Dillon in Muskingum County (loc. 75). One specimen of a fusulinid was found in this material. It belongs to the genus *Fusulina* and is more highly developed than *F. carmani* of the Vanport horizon.

Washingtonville Member

In north-central and northeastern Ohio a fossiliferous dark shale, the Washingtonville member, occurs in the upper part of the Allegheny series. Lamborn (1930) lists a few fossils from this horizon in Jefferson County, but fusulinids have not been found in it.

Brush Creek Member

The lowest marine horizon in the Conemaugh series of Ohio is the Brush Creek limestone. Its outcrop is fairly continuous where it might be expected, and ordinarily consists of two beds of fossiliferous limestone separated by 20 to 30 feet of fossiliferous shale.

The author has spent very little time looking for fusulinids in the Brush Creek limestone. Condit (1912) does not list fusulinids among the fossils found in the Brush Creek. Thompson (1936) reports *Triticites ohioensis* in the Brush Creek of Gallia County and Oliver Blake found fusulinids in this bed in two other localities in Gallia County. Thin sections of Blake's material made by the author show *T. ohioensis*.

Cambridge Member

The Cambridge limestone, named for exposures at Cambridge in Guernsey County, Ohio, is variable in lithology and discontinuous in occurrence. No fusulinids have been reported among the fossils from outcrops of this unit in areas north and northeast of the type area. South and southwestward from Cambridge fusulinids have been reported in this limestone in every county where it crops out. In York Township, Morgan County (loc. 38) a coquina of fusulinid shells forms the top 8 inches of a two-foot limestone. *Triticites ohioensis*, the species which is found in the Cambridge limestone, is the longest species of fusulinid known in Ohio, the shells being about the size of a wheat grain. Cotypes for this species were collected in Gallia County (Thompson, 1936, p. 682).

Portersville Member

The Portersville member is a dark shale which contains a marine fauna and lies from 12 to 30 feet above the Cambridge limestone in central Ohio. Myron Sturgeon and William Merrill found fusulinids in limestone nodules at the Portersville horizon in sections 28, 29, and 30 in Alexander Township, Athens County. The author tentatively identified them as *Triticites ohioensis*.

Ames Member

Because of its distinctive lithology and fossil content and its wide spread distribution, the Ames limestone is an important horizon marker in the Conemaugh series. This coarsely crystalline, gray or greenish-gray limestone has been called the crinoidal limestone because of the abundance of crinoid fragments which it contains. The member is thin, nodular, or missing in parts of Lawrence and Gallia counties, but northward it is more continuous and forms a single bed one to three feet thick.

Fusulinids are abundant in the Ames limestone; *Triticites skinneri* occurs in central Ohio, and T. *cullomensis* in southern Ohio. The white fusulinid shells are conspicuous on weathered surfaces of the gray limestone. Fusulinids are less abundant northward, and have not been reported from this member in Guernsey, Harrison, and Carroll counties. The author found a few specimens of *T. skinneri* in a roadside outcrop in Madison Township, Columbiana County (loc. 108) and believes that further search will uncover specimens in areas where they are not now known.

Gaysport Member

In Muskingum, Morgan, and Athens counties the Gaysport limestone is an impure fossiliferous limestone which lies about 16 feet above the Ames limestone. *Triticites skinneri* was collected from the Gaysport horizon in Athens Township, Athens County (loc. 18). This is presently the only known occurrence of fusulinids in the Gaysport.

Skelley Member

The highest marine limestone of the Pennsylvanian series in Ohio is the Skelley limestone, a thin bed of variable composition. No fusulinids have been reported among the fossils of this unit.

DESCRIPTION OF SPECIES

Terms used in this paper follow Dunbar and Henbest. 1942.

Fusulinella iowensis Thompson, 1934

Figures 5, 6, 7, 10, and 11

Girtyina ventricosa Morningstar. 1922. Ohio Geol. Survey Bull. 25: 153, pl. 6, fig. 4. Upper Mercer limestone, central Ohio.

Fusulinella iowensis Thompson. 1934. Iowa Univ. Stud. Nat. Hist. 16: 296–297, pl. 20, figs. 28–30. Cherokee shale, 90 feet below Whitebreast coal, Davis County, Iowa.

Fusulinella iowensis Thompson. 1936. Jour. Paleont. 10: 675, pl. 90, figs. 12–16. Upper Mercer and Lower Mercer limestones, Muskingum County, Ohio.

Fusulinella iowensis has a small, almost spherical shell with bluntly pointed poles. The axis of coiling is straight; lateral slopes are straight or concave. The first and second whorls are spherical in shape; outer whorls have poles extended to blunt points. Mature specimens have 8 or 9 whorls with half lengths from 0.60 mm. to 1.00 mm. in the 6th whorl and form ratios from 1: 1.2 to 1: 1.7 in the same whorl. Average half length in the 8th whorl is 1.09 mm. with a form ratio of 1: 1.5.

The proloculum is small with an average inside diameter of 0.06 mm. Dimorphism is common in this species. The two forms are similar in external appearance. A microspheric specimen with its juvenarium is shown in figure 7.

The protheca is thin in all whorls. The epitheca is thick and massive, almost filling the chamber space in the inner whorls from the well developed chomata to the poles. In the outer whorls the chomata are almost as high as the chambers and about 3 times as wide as high. They are asymmetrical in shape, rising steeply from the tunnel and tapering towards the poles.

Septal count averages 10, 18, 20, 22, 27, 33, and 37 for the first seven whorls of 15 specimens. The septa are plane in inner whorls and near the equatorial part of all whorls. They have gentle undulations near the poles of outer whorls.

The tunnel is narrow and well defined. It is crooked in some specimens and straight in others. The tunnel angles vary from 10° to 30° with gradual increase from inner whorls outward and less than 10° difference from the first whorl to the last whorl in most shells.

TABLE 1

Measurements for Fusulinella iowensis *Thompson*

Whorl	Half length in mm.				Radius vector in mm.				Form ratio				Tunnel angle					Septal count		
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	5	6	7	8
1	0.08	0.09	0.08	0.12	0.06	0.07	0.05	0.12	1.3	1.3	1.6	1.0	—	19°	15°	15°	14	—	12	—
2	0.14	0.16	0.16	0.25	0.11	0.11	0.08	0.19	1.3	1.5	2.0	1.3	16°	14°	12°	10°	17	14	15	17
3	0.22	0.24	0.25	0.37	0.16	0.17	0.12	0.29	1.4	1.4	2.0	1.3	12°	14°	14°	10°	23	16	18	23
4	0.33	0.33	0.33	0.49	0.25	0.25	0.18	0.39	1.3	1.3	1.8	1.3	13°	12°	12°	12°	27	24	24	28
5	0.43	0.47	0.43	0.67	0.33	0.37	0.27	0.52	1.3	1.3	1.6	1.3	13°	14°	10°	16°	32	26	28	32
6	0.53	0.73	0.59	0.90	0.43	0.47	0.35	0.65	1.2	1.6	1.7	1.4	16°	15°	10°	11°	33	27	29	42
7	0.76	0.84	0.76	1.12	0.55	0.59	0.47	0.84	1.4	1.4	1.6	1.3	19°	16°	19°	11°	39	30	34±	41
8	0.96	0.96	0.96	1.57	0.69	0.73	0.59	1.00	1.4	1.3	1.6	1.6	—	12°	12°	—	—	34	38±	42±
9		1.22	1.10			0.88	0.71			1.4	1.5			—	—			34±		
	Diameter of inside of proloculum in mm.																			
	0.06	0.06	0.08	0.09													0.06	—	0.06	—

Specimen 1 is a microspheric specimen; specimen 2 is illustrated in figure 7; specimens 3, 4, and 8 are from the Upper Mercer limestone, the rest are from the Lower Mercer limestone.

Remarks.—*Fusulinella iowensis*, the smallest species of fusulinid found in Ohio, is easily recognized in the field by its small size and spherical shape. It is associated with *F. iowensis* var. *stouti* from which it can be distinguished by its smaller form ratio. It is widely distributed in the Pottsville limestones of central and northeastern Ohio and has been reported from as far west as New Mexico (Henbest and Read, 1944).

Distribution.—This species is abundant or present in many localities where the Lower Mercer limestone is exposed in east-central and northeastern Ohio. It is also widely found in the Upper Mercer limestone and black flint, and has been identified from the Boggs limestone and Muskingum and Tuscarawas counties. It has been reported in the Seville limestone of northwestern Illinois (Dunbar and Henbest, 1942), in the Cherokee shale, 90 feet below the Whitebreast coal, Davis and Jefferson counties, Iowa (Thompson, 1934), and possibly in the Madera limestone of Sandoval County, New Mexico (Henbest and Read, 1944).

Fusulinella iowensis var. stouti Thompson 1936

Figures 8 and 9

Fusulina secalica Morningstar. 1922. Ohio Geol. Survey Bull. 25: 153, pl. 6, fig. 3. Lower Mercer limestone, Upper Mercer limestone, and Zaleski black flint of Ohio.

Fusulinella iowensis var. *stouti* Thompson. 1936. Jour. Paleont. 10: 677, pl. 90, figs. 5–11. Boggs limestone, Lower Mercer limestone, and Upper Mercer limestone, Muskingum County, Ohio.

Fusulinella iowensis var. *stouti* Dunbar and Henbest. 1942. Illinois Geol. Survey Bull.

67: 95, pl. 3, figs. 7, 8, 9. Seville limestone, Fulton County, Illinois and possibly in Boskydell (?) marine zone, Pope County, Illinois.

The shell of this variety is small with inflated center section and bluntly pointed ends. The first three whorls are subspherical in shape but the outer whorls are more elongate. The lateral slopes are straight. A number of specimens are bluntly diamond-shaped from the 5th whorl outward.

The mature specimens have 7 whorls with half lengths from 0.82 to 1.47 mm. in the 7th whorl and form ratios of 1: 1.7 to 1: 2.2 in that whorl. Very few specimens which can be identified as this variety have as many as 8 whorls.

The proloculum is small with an average inside diameter of 0.06 mm. One specimen has a double proloculum (fig. 9). It is unusually elongate for this variety and its measurements have not been included in the averages given.

The walls are similar to *F. iowensis*; the protheca is thin and the epitheca thick and massive. In most specimens this secondary deposit extends from the chomata to the poles in all but the outer whorl. The chomata are asymmetrical in shape. They have a steep side toward the tunnel and merge into a long taper towards the poles. The chomata are more than one half as high as the chambers.

Septal count for one specimen was 9, 13, 16, 20, 24, and 32 for the first six whorls. Septa are plane across the middle and gently undulating in the polar areas.

TABLE 2

Measurements for Fusulinella iowensis *var.* stouti *Thompson*

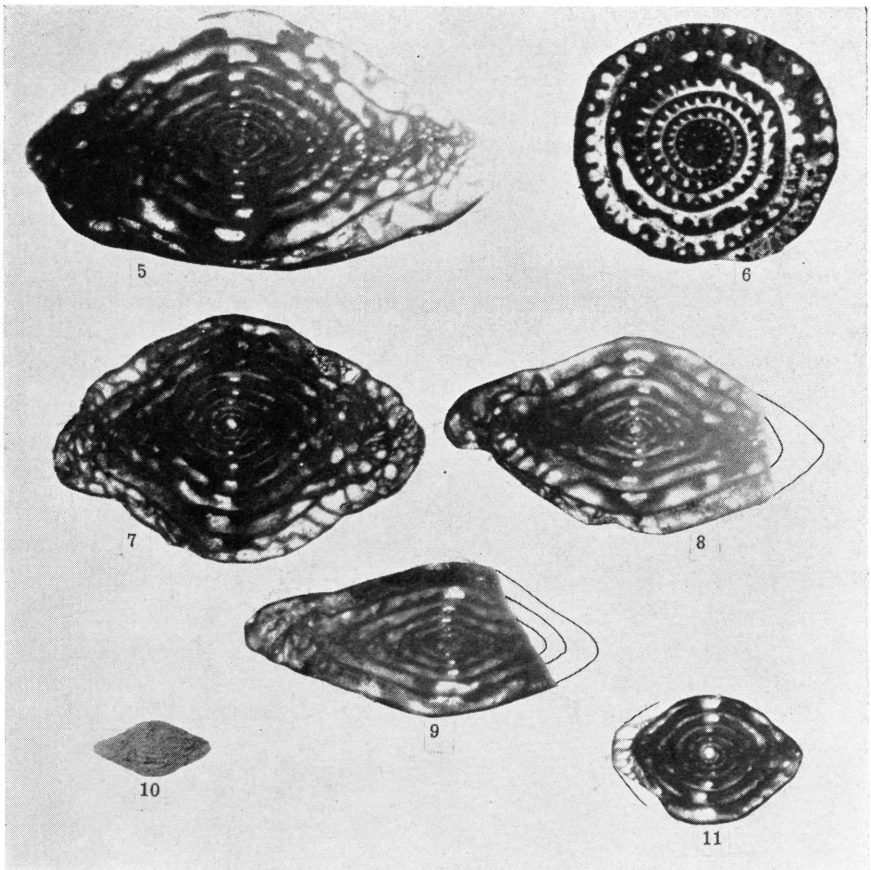
Whorl	Half length in mm.				Radius vector in mm.				Form ratio				Tunnel angle				Septal count
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	5
1	0.18	0.12	0.08	0.10	0.06	0.08	0.06	0.06	3.0	1.5	1.3	1.7	14°	13°	25°	28°	9
2	0.28	0.24	0.20	0.20	0.10	0.14	0.10	0.10	2.8	1.7	2.0	2.0	17°	14°	18°	20°	13
3	0.47	0.37	0.29	0.35	0.18	0.20	0.14	0.17	2.6	1.8	2.0	2.0	19°	15°	17°	16°	16
4	0.61	0.65	0.49	0.47	0.27	0.31	0.22	0.25	2.3	2.1	2.2	1.9	31°	18°	15°	18°	20
5	0.96	0.76	0.71	0.63	0.37	0.43	0.33	0.34	2.6	1.8	2.2	1.9	24°	22°	14°	20°	24
6	1.39	0.94	0.90	0.80	0.49	0.57	0.43	0.45	2.8	1.6	2.1	1.8	—	—	18°	25°	32
7		1.22	1.02			0.71	0.55			1.7	1.9			—	—		
	Diameter of inside of proloculum in mm.																
	double	0.06	0.05	0.04													—

Specimen 1 is the specimen with the double proloculum illustrated in figure 9; specimen 2 is illustrated in figure 8; all specimens from the Lower Mercer limestone.

The tunnel is narrow but rather crooked in most specimens. Tunnel angles vary from 10° to 26° in all specimens measured, but the range was less on individual ones.

Remarks.—This variety differs from *F. iowensis* in the form ratio. The form ratios in outer volutions are from 1: 1.71 to 1: 2.15 while in *F. iowensis* they exceed 1: 1.70 only in a few sections. In the ones examined *F. iowensis* var. *stouti* has fewer volutions than mature shells of *F. iowensis* and microspheric specimens are not as common. It is distinguished from *Fusulina leei* of the Putnam Hill limestone by smaller size, smaller form ratio, more massive chomata, and smaller proloculum.

Distribution.—The author has found *F. iowensis* var. *stouti* in the Lower Mercer limestone in localities 4 and 73 in Muskingum County, locality 31 in Licking County and locality 1 in Coshocton County. Thompson (1936) identified it in the Boggs, Lower Mercer, and Upper Mercer limestones of Muskingum County; it has also been reported in the Seville limestone of Fulton County, Illinois (Dunbar and Henbest, 1942) and the Madera limestone of Sandoval County, New Mexico (Henbest and Read, 1944).



EXPLANATION OF FIGURES IN PLATE I

All figures magnified ×20 except figure 10.

5. *Fusulinella iowensis* Thompson, axial section from Upper Mercer limestone, Wayne County, locality 67. O. S. U. No. 22240.
6. *Fusulinella iowensis* Thompson, sagittal section from Lower Mercer limestone, Mahoning County, locality 79. O. S. U. No. 22241.
7. *Fusulinella iowensis* Thompson, axial section from Lower Mercer (?) limestone, Portage County, locality 80. O. S. U. No. 22242.
8. *Fusulinella iowensis* var. *stouti* Thompson, axial section from Lower Mercer limestone, Muskingum County, locality 73. O. S. U. No. 22243.
9. *Fusulinella iowensis* var. *stouti* Thompson, axial section of unusually elongate specimen with a double proloculum from Lower Mercer limestone. Muskingum County, locality 73. O. S. U. No. 22244.
10. *Fusulinella iowensis* Thompson, free specimen from Lower Mercer limestone, Muskingum County, locality 4 (×7).
11. *Fusulinella iowensis* Thompson, axial section of immature specimen from Boggs limestone, Muskingum County, locality 28. O. S. U. No. 22245.

Fusulina leei Skinner 1931

Figures 17, 18, and 19

Fusulina sp. Stout. 1918. Ohio Geol. Survey Bull. 21: 129, 134. Putnam Hill limestone, Muskingum County, Ohio.

Fusulina secalica Conrey. 1921. Ohio Geol. Survey Bull. 24: 115. Putnam Hill limestone, Wayne County, Ohio.

Fusulina leei Skinner. 1931. Jour. Paleont. 5: 257, 258, pl. 30, figs. 4, 6. Cherokee shale, overlying Bluejacket sandstone, Mayes County, Oklahoma.

Fusulina leei Thompson. 1934. Iowa Univ. Stud. Nat. Hist. 16: 301–303, pl. 21, figs. 3, 7, 10, 18. Cherokee shale, 35 feet below the Whitebreast coal, Lucas and Monroe counties, Iowa.

Fusulina leei Thompson. 1935. Jour. Paleont. 9: 305, pl. 26, figs. 17–19. Upper part of Boggy formation, Pontotoc County, Oklahoma.

Fusulinella serotina Thompson. 1936. Jour. Paleont. 10: 677, 678, pl. 90, figs. 1–4; pl. 91, fig. 9. Putnam Hill limestone, Muskingum County, Ohio.

Fusulina leei Dunbar and Henbest. 1942. Illinois Geol. Survey Bull. 67: 109–111, pl. 5, figs. 1–8; pl. 6, figs. 1–10. Curlew limestone, Saline and Gallatin counties, Illinois.

Fusulina leei Alexander. 1954. Oklahoma Geol. Survey Circular 31: 33–34, pl. 2, figs. 19–20. Lower Inola limestone, Mayes County, Oklahoma.

TABLE 3

Measurements for Fusulina leei *Skinner*

Whorl	Half length in mm.				Radius vector in mm.				Form ratio				Tunnel angle				Septal count			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	5	6	7	8
1	0.20	0.22	0.12	0.16	0.10	0.11	0.09	0.10	2.0	2.0	1.3	1.6	25°	19°	18°	18°	11	11	11	9
2	0.38	0.41	0.20	0.33	0.15	0.19	0.15	0.16	2.5	2.2	1.3	2.0	22°	23°	30°	23°	14	14	19	14
3	0.53	0.61	0.35	0.61	0.23	0.29	0.25	0.24	2.2	2.1	1.4	2.5	20°	23°	30°	24°	18	16	21	17
4	0.73	1.18	0.71	0.86	0.33	0.41	0.37	0.33	2.2	2.9	1.9	2.6	27°	23°	28°	32°	18	17	21	20
5	1.22	1.59	1.18	1.12	0.45	0.55	0.54	0.43	2.7	2.9	2.2	2.6	28°	24°	27°	45°	22	25	29	30
6	1.57	2.16	1.73	1.47	0.63	0.71	0.76	0.55	2.5	3.0	2.3	2.7	24°	—	—	—	21	24	32	22
7	—		2.12	2.69	0.86		0.94	0.70	—		2.3	3.8	—		—	—	32	30	36	
	Diameter of inside of proloculum in mm.																			
	0.08	0.10	0.10	0.10													0.05	0.09	0.09	0.06

Specimen 2 is illustrated in figure 17; specimen 6 is illustrated in figure 18; all specimens from the Putnam Hill limestone.

The small shell of this species is fusiform in shape. Mature specimens have 7 or 8 whorls with half lengths for the 7th whorl ranging from 1.6 to 2.7 mm. and form ratios of 1: 2.1 to 1: 3.7. The axes of many specimens are broadly curved. Lateral slopes are straight or rarely concave. The ends are blunt.

The proloculum is small with an average inside diameter of 0.09 mm. Shells showing dimorphism are rare.

The protheca consists of tectum and diaphanotheca. This structure is evident in the walls of outer whorls where the lighter diaphanotheca shows up well, especially near the tunnel area. The epitheca is thin on the outer side of the wall and a little thicker on the inner side. The walls of the inner four whorls, which are more primitive than the outer whorls, have secondary deposits extending from the chomata to the poles. From the fifth whorl outward the chomata are symmetrical and higher than they are wide. They are about three fourths as high as the chamber.

The septa are highly fluted near the poles but only broadly fluted across the equator. The average septal count for 6 specimens was 10, 16, 18, 20, 25, 29, and 35 for 7 whorls.

The tunnel is well defined but crooked in most shells. Tunnel angles are mostly between 20° and 40° but the range is from 11° to 52°.

Remarks.—*Fusulina leei* is one of the more primitive species of this genus. The inner whorls are fusulinelloid with the thick deposits of epitheca on either side of the chomata. The fluting of the septa is not nearly as deep as it is in later species of *Fusulina*. Ohio specimens from the Putnam Hill limestone were originally classed as *Fusulinella serotina* by Thompson (1936). In 1944 the Pennsylvanian Committee of the National Research Council Committee on Stratigraphy (Moore *et al.*, 1944) listed *Fusulina serotina* and *Fusulina leei* from the Putnam Hill limestone of Ohio. The author believes that the specimens from Putnam Hill in Muskingum County, where the cotypes for *F. serotina* were collected, are indistinguishable from specimens found in the Putnam Hill limestone in northeastern Ohio and that they all fit the published descriptions of *Fusulina leei*.

Fusulina leei can be distinguished from *F. iowensis* var. *stouti* of the Pottsville formation by its slightly larger size, greater form ratio, and narrower chomata in outer whorls. It is more difficult to distinguish from *Fusulina carmani* of the Vanport limestone. The distinguishing features are mentioned under the description of that species.

Distribution.—This species occurs in the Putnam Hill limestone of central and northeastern Ohio; the Curlew limestone in Saline and Gallatin counties, Illinois (Dunbar and Henbest, 1942); the Cherokee shale of Lucas and Monroe counties, Iowa (Thompson, 1934), and Mayes (Skinner, 1931) and Pontotoc (Thompson, 1935) counties, Oklahoma; the Madera limestone of Sandoval County, New Mexico (Henbest and Read, 1944); the Hartville formation, Platte County, Wyoming (Love, Henbest, and Denson, 1953); and possibly in the Tensleep sandstone of Fremont County, Wyoming (Henbest, 1954).

Fusulina carmani (Thompson) 1936

Figures 13, 14, and 20

Fusulina cylindrica de Verneuil. 1846. Amer. Jour. Sci. 2nd S. 2: 293. Buhrstone, Ohio.

Fusulina cylindrica Herrick. 1887. Denison Univ. Sci. Lab. Bull. 2: 50, pl. 3, fig. 20. Vanport flint, Licking County, Ohio.

Fusulina secalica Mark. 1911. Denison Univ. Sci. Lab. Bull. 16: 278, 286. Vanport flint, Licking County, Ohio.

Fusulina sp., Stout. 1918. Ohio Geol. Survey Bull. 21: 149, 155, 157. Vanport horizon, Muskingum County, Ohio.

Fusulinella carmani Thompson. 1936. Jour. Paleont. 10: 678–679, pl. 91, figs. 10–12. Vanport horizon, Muskingum County, Ohio.

The shell of this species is small and fusiform in shape. Lateral slopes are straight in most specimens and the ends are bluntly pointed. The axis is straight or slightly curving. The first whorl is subspherical, but subsequent whorls are elongate. Mature specimens have 7 or 8 whorls. The half length is about 1.9 mm. in the 6th whorl and 2.2 mm. in the 7th whorl, and the form ratios average 1: 2.6 and 1: 2.0 in those two whorls respectively.

The proloculum is round with an average inside diameter of 0.09 mm., but some specimens measure up to 0.12 mm. Dimorphism has not been noted in any of the material collected.

The shell walls are thin. The protheca consists of a tectum and diaphanotheca. The diaphanotheca can be seen in the outer whorls of most thin sections on either side of the tunnel area. The epitheca deposits are thin. The chomata are small; on the first two whorls they are flat and extend towards the poles, but on the outer whorls they are symmetrical and as high as they are wide.

The septa are fluted along their length, especially in the polar regions. The septal count for 6 sagittal sections averages 11, 16, 18, 21, 23, 25, and 30 for seven whorls.

The tunnel is narrow and in most shells it is straight. The tunnel angles in the specimen pictured in figure 13 are 23°, 27°, 29°, 30°, and 32°, for five whorls. This is average for this species in Ohio but some specimens have tunnel angles up to 44° in the fifth whorl.

Remarks.—This species was originally placed in the genus *Fusulinella* with the observation that it was a transitional form between *Fusulinella* and *Fusulina* (Thompson, 1936, p. 679). In Correlation of Pennsylvanian Formations of North America (Moore *et al.*, 1944) it is called *Fusulina carmani* on page 684; and this name is also used in later publications (Henbest and Read, 1944; Thompson and Thomas, 1953). In the specimens examined, the fluting of the septa

extends across the middle of the shell and the chomata are narrow. Because these are characteristics of the genus *Fusulina* the author believes that these Ohio specimens belong to that genus.

F. carmani resembles *F. leei*, which is found in the Putnam Hill limestone of Ohio but it is slightly longer with greater form ratio and greater tunnel angle, while the proloculum is somewhat smaller and the septa are more highly fluted.

Distribution.—In Ohio *F. carmani* has been found in the Vanport limestone and flint in Licking, Muskingum, Tuscarawas, and Wayne counties. Henbest and Read (1944) compared specimens which they found in the Madera limestone, Sandoval County, New Mexico, to this species.

TABLE 4

Measurements for Fusulina carmani *(Thompson)*

Whorl	Half length in mm.				Radius vector in mm.				Form ratio				Tunnel angle				Septal count			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	5	6	7	8
1	0.16	0.20	0.14	0.16	0.08	0.08	0.10	0.08	2.0	2.5	1.4	2.0	27°	23°	20°	31°	—	10	9	12
2	0.39	0.40	0.27	0.31	0.14	0.14	0.15	0.14	2.9	2.8	1.8	2.2	29°	27°	33°	28°	15	13	13	17
3	0.67	0.69	0.47	0.55	0.20	0.22	0.22	0.22	3.3	3.1	2.1	2.5	—	29°	29°	25°	17	19	16	18
4	0.92	1.31	0.92	0.73	0.30	0.35	0.36	0.35	3.1	3.8	2.6	2.1	—	30°	35°	34°	25	23	19	20
5	1.33	1.67	1.16	1.16	0.45	0.53	0.49	0.47	3.0	3.2	2.4	2.4	—	32°	31°	33°	23	26	20	24
6	1.76	2.41	1.49	1.70	0.62	0.71	0.65	0.65	2.8	3.4	2.3	2.6	—	—	35°	25°	25	—	24	24
7	2.24		—	2.39	0.82		0.86	0.82	2.7		—	2.9	—		—	—				30
	Diameter of inside of proloculum in mm.																			
	0.06	0.09	0.07	0.08													0.07	0.09	0.06	—

Specimen 2 is illustrated in figure 13; specimen 5 is illustrated in figure 14; all specimens from the Vanport limestone.

Fusulina sp.

Figure 12

Fusulina sp. Stout. 1917. Ohio Geol. Survey Bull. 21: 175. Hamden limestone, Muskingum County, Ohio.

The one fusulinid specimen which the author found in the Hamden limestone is not considered enough basis for specific designation. An axial section of the specimen shows the deeply fluted septa of the genus *Fusulina*. The shell is thickly fusiform with bluntly pointed ends. From the 6th whorl outward the ends are elongated. There are 8 whorls with a total half-length of 1.63 mm. and a form ratio of 1: 2.3.

This specimen is microspheric. There is a small proloculum and a juvenarium consisting of one whorl (not clearly seen in the photograph).

The spirotheca is thin in all whorls but slightly thicker in the outer whorls. The tectorium is thicker on the inside of the spiral than on the outside. In whorls seven and eight the diaphonotheca is the widest part of the wall over the tunnel.

On the inner whorls the chomata are asymmetrical, tapering to the poles. From the fourth whorl outward the chomata are narrow and small.

Septa are slightly fluted on the inner whorls and highly fluted on the outer whorls throughout their length.

The tunnel is narrow and crooked. The tunnel angle increases from 11° in the second whorl to 31° in the seventh whorl.

Remarks.—The septa are more highly fluted in this specimen than in *Fusulina carmani* of the Vanport limestone. While this specimen resembles several described species from rocks of similar age in the mid-continent region, the measurements do not fall within the range of the published measurements of any one of them. Its classification must await the finding of more specimens.

Distribution.—This specimen was found in nodular Hamden limestone at locality 75 in Cass Township, Muskingum County. No fusulinids have been found in other exposures of this member.

TABLE 5

Measurements for Fusulina *sp.*

Whorl	Half length in mm.	Radius vector in mm.	Form ratio	Tunnel angle	Diameter of inside of proloculum in mm.
1	0.06	0.05	1.2	—	0.03
2	0.12	0.08	1.5	11°	
3	0.20	0.13	1.5	13°	
4	0.32	0.18	1.8	19°	
5	0.45	0.25	1.8	16°	
6	0.67	0.35	1.9	29°	
7	1.06	0.49	2.2	31°	
8	1.63	0.71	2.3		

Specimen from the Hamden limestone, illustrated in figure 12.

TABLE 6

Measurements for Wedekindellina euthysepta (*Henbest*)

Whorl	Half length in mm.				Radius vector in mm.				Form ratio				Tunnel angle					Septal count		
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	5	6	7	8
1	0.10	0.10	0.08	0.08	0.05	0.07	0.05	0.06	2.0	1.4	1.6	1.3	—	—	—	—	—	11	—	10
2	0.22	0.22	0.14	0.20	0.08	0.09	0.06	0.08	2.8	2.4	2.3	2.5	—	19°	—	—	—	16	13	13
3	0.38	0.32	0.26	0.30	0.11	0.11	0.09	0.10	3.4	2.9	2.9	3.0	19°	27°	—	—	14	17	17	15
4	0.51	0.48	0.53	0.41	0.14	0.16	0.12	0.14	3.6	3.0	4.4	2.9	17°	23°	28°	—	15	17	19	18
5	0.77	0.64	0.75	0.57	0.19	0.21	0.15	0.19	4.0	3.1	4.9	3.0	25°	25°	27°	23°	17	—	22	23
6	1.06	0.86	0.90	0.71	0.24	0.27	0.20	0.25	4.4	3.2	4.5	2.9	23°	30°	27°	14°	20	—	—	20
7	1.25	1.15	—	0.82	0.32	0.34	0.25	0.33	3.9	3.4	—	2.5	22°	28°	—	—	20	—		22
8	—	1.60	—	1.02	0.42	0.42	0.32	0.39	—	3.8	—	2.6	—	—	—			—		—
9		—			0.54					—				—				—		
	Diameter of inside of proloculum in mm.																			
	0.05	—	0.04	—													—	0.05	—	0.05

Specimen 2 is illustrated in figure 15; all specimens are from the Vanport limestone.

Wedekindellina euthysepta (Henbest) 1928

Figures 15, 16, and 20

Fusulinella euthusepta Henbest. 1928. Jour. Paleont. 2: 80–81, pl. 8, figs. 6–8; pl. 9, figs. 1, 2, 5. Stonefort limestone, Saline and Williamson counties, Illinois.

Wedekindella euthysepta Dunbar and Henbest. 1930. Amer. Jour. Sci. 5th S. 20: 357–364.

Wedekindia euthysepta Dunbar and Henbest. 1931. Amer. Jour. Sci. 5th S. 21: 458. (The generic name *Wedekindella* was preoccupied).

Fusulina euthusepta White. 1932. Univ. Texas Bull. 3211: 24–25, pl. 1, figs. 1–3. Dennis limestone, Parker County, Texas.

Wedekindellina euthysepta Dunbar and Henbest. 1933. Cushman Lab. Foram. Research Special Publ. 4: p. 134, key plate 10, figs. 13–15. (The generic name *Wedekindia* was preoccupied).

Wedekindellina euthysepta Thompson. 1934. Univ. Iowa Stud. Nat. Hist. 16: 282–285, pl. 20, figs. 1, 2, 7, 9, 12, 13, 17, 22, 24–27. Cherokee shale, Lucas, Monroe, and Van Buren counties, Iowa.

Wedekindellina dunbari Thompson. 1934. Univ. Iowa Stud. Nat. Hist. 16: 285–287, pl. 20, figs. 3, 6, 15, 16, 20, 21. Cherokee shale, Lucas and Monroe counties, Iowa.

Wedekindellina euthysepta Needham. 1937. New Mexico School of Mines 14: 27–29, pl. 3, figs. 6–8. Lower part of Magdalena formation in central New Mexico.

Wedekindellina euthysepta Dunbar and Henbest. 1942. Illinois Geol. Survey Bull. 67: 98–100, pl. 8, figs. 1–23; pl. 9, figs. 1–4. Stonefort limestone, Saline and Williamson counties; Stonefort (?) limestone, Jackson County; marine zone above Colchester No. 2 coal, Madison, Greene and Adams counties; and Seahorne limestone, Mercer County, all in Illinois.

Wedekindellina euthusepta Alexander. 1954. Oklahoma Geol. Survey Circular 31: 20–21, pl. 1, fig. 9. Fleming cap rock, southern Kansas.

Wedekindellina euthysepta has a small, tightly-coiled, elongate, pointed shell. Lateral slopes are straight with a slight tendency to be convex. The axis of coiling is straight, or nearly so, in all of the specimens sectioned. The proloculum is round, but all the whorls are elongate along the axis. The form ratio increases from about 1: 2.3 in the second whorl to about 1: 4.0 in the eighth whorl. Mature specimens have 8 whorls and an average half length of 1.5 mm.

The proloculum is very small with an average inside diameter of 0.05 mm. Dimorphism was not observed in any of the specimens sectioned.

The protheca is thin, but there are massive secondary deposits on the wall in all whorls except the outermost one, especially along the axis. The axial region is completely filled in on most specimens. The chomata are low and flat, and extend outward towards the poles.

The septa are straight and numerous. No fluting is evident in any of the sections prepared. The septal count on one characteristic section was 10, 13, 15, 18, 23, 20, and 22 for seven whorls.

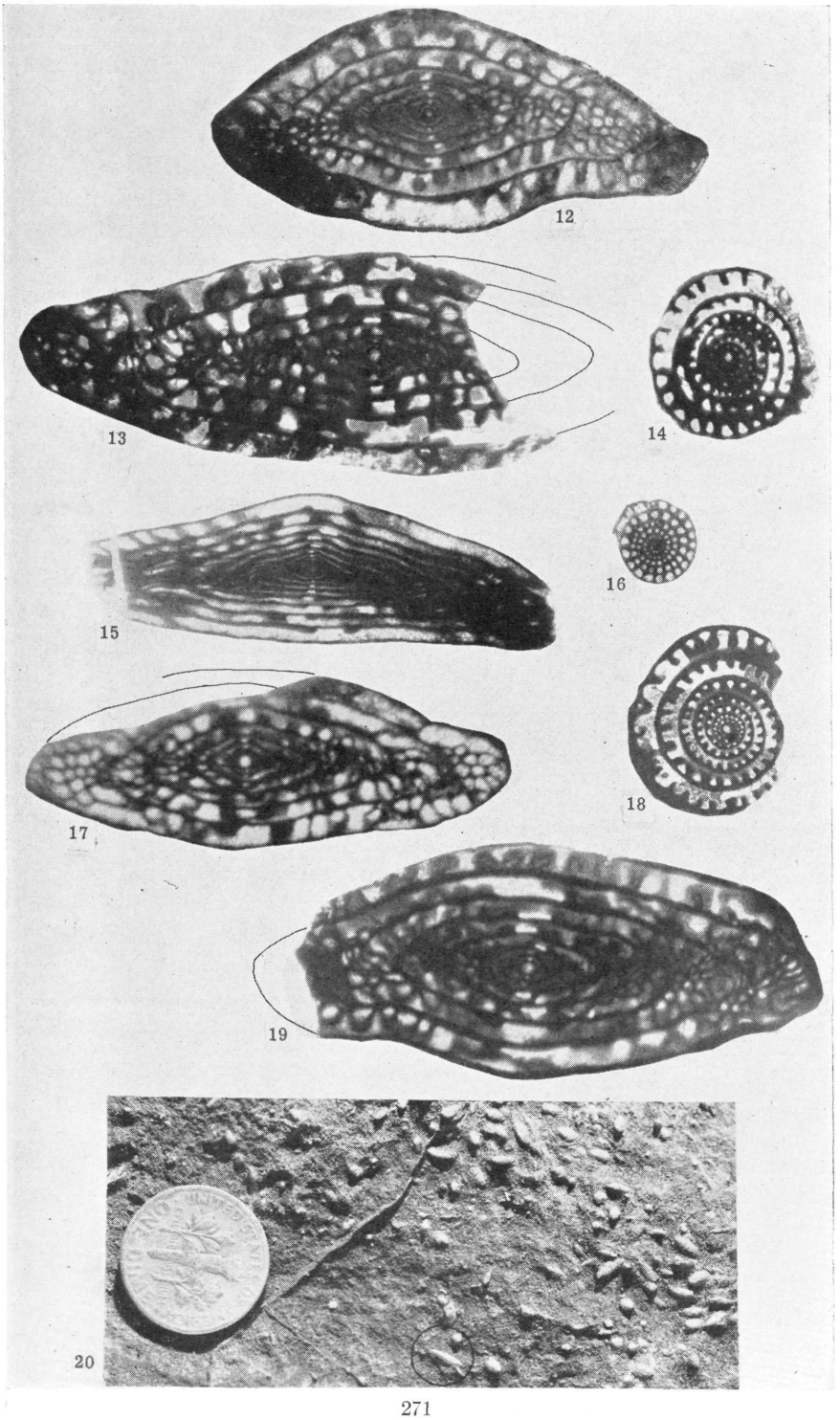
The tunnel is narrow; it is straight on most specimens but erratic on a few. The tunnel angle ranges from 17° to 30° with only a few degrees difference in angle on any one specimen from inner whorls outward.

Remarks.—Even in the field, *Wedekindellina euthysepta* is not likely to be confused with any other species of fusulinid found in Ohio, for its characteristic thin, pointed shape is discernible with the naked eye. It has been found associated with *Fusulina carmani* in the Vanport limestone and flint in all the outcrops of that horizon examined in which fusulinids were numerous.

EXPLANATION OF FIGURES IN PLATE II

All figures magnified ×20 except figure 20.

12. *Fusulina* sp., axial section from Hamden limestone, Muskingum County, locality 75. O. S. U. No. 22246.
13. *Fusulina carmani* (Thompson), axial section from Vanport limestone, Muskingum County, locality 17. O. S. U. No. 22247.
14. *Fusulina carmani* (Thompson), sagittal section from same locality. O. S. U. No. 22248.
15. *Wedekindellina euthysepta* (Henbest), axial section from Vanport limestone, Tuscarawas County, locality 9. O. S. U. No. 22249.
16. *Wedekindellina euthysepta* (Henbest), section perpendicular to the axis from the same locality. O. S. U. No. 22250.
17. *Fusulina leei* Skinner, axial section from Putnam Hill limestone, Stark County, locality 62. O. S. U. No. 22251.
18. *Fusulina leei* Skinner, sagittal section from Putnam Hill limestone, Coshocton County, locality 1. O. S. U. No. 22252.
19. *Fusulina leei* Skinner, axial section from Putnam Hill limestone, Coshocton County, locality 54. O. S. U. No. 22253.
20. *Fusulina carmani* and *Wedekindellina euthysepta* (circled) on the weathered surface of a piece of Vanport limestone from Tuscarawas County, locality 9 (slightly enlarged).


12
13
14
15
16
17
18
19
20

Distribution.—In Ohio *Wedekindellina euthysepta* has been found in the Vanport limestone at locality 24 in Licking County, localities 2, 17, and 40 in Muskingum County, locality 58 in Tuscarawas County, and locality 110 in Wayne County. It has been reported in the Stonefort limestone in southern Illinois (Henbest, 1928; Dunbar and Henbest, 1942); in the Cherokee shale in southern Iowa (Thompson, 1934); in the Fleming cap rock, southern Kansas (Alexander, 1954); in the Dennis limestone, Parker County, Texas (White, 1932); in the lower part of the Magadalena formation in central New Mexico (Needham, 1937), and in the Tensleep sandstone of Fremont County, Wyoming (Henbest, 1954).

Triticites ohioensis Thompson 1936

Figures 25, 26, 27, and 28

Fusulina secalica Condit. 1912. Ohio Geol. Survey Bull. 17. Cambridge limestone, southeastern Ohio.

Triticites ohioensis Thompson. 1936. Jour. Paleont. 10: 680, pl. 91, figs. 1–3. Brush Creek and Cambridge limestones, Gallia County, Ohio.

Triticites ohioensis Dunbar and Henbest. 1942. Illinois Geol. Survey Bull. 67: 130–132, pl. 19, figs. 1–22; pl. 20, figs. 20–24.

Triticites ohioensis, which is somewhat cigar-shaped, has the longest shell of all the fusulinid species found in Ohio; the mature specimens collected average 8 to 9 mm. in length. The first

TABLE 7

Measurements for Triticites ohioensis *Thompson*

Whorl	Half length in mm.				Radius vector in mm.				Form ratio				Tunnel angle				Septal count			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	5	6	7	8
1	0.14	0.12	0.14	0.16	0.08	0.07	0.08	0.10	1.8	1.6	1.8	1.6	20°	18°	17°	29°	10	10	9	13
2	0.24	0.19	0.28	0.35	0.14	0.09	0.14	0.14	1.6	2.0	2.0	2.5	21°	21°	21°	29°	14	—	14	15
3	0.45	0.38	0.71	0.51	0.22	0.17	0.22	0.22	2.0	2.2	3.2	2.3	27°	29°	23°	34°	17	20	20	18
4	0.73	0.62	1.12	0.96	0.33	0.26	0.37	0.34	2.2	2.4	3.0	2.8	27°	30°	27°	38°	20	22	21	20
5	1.47	1.09	1.94	1.31	0.47	0.40	0.53	0.44	3.1	2.7	3.7	3.0	45°	25°	39°	60°	23	22	28	22
6	3.16	1.76	2.80	2.78	0.69	0.62	0.76	0.64	4.6	2.8	3.7	4.3	62°	—	52°	72°	23	29	31	26
7	4.28	2.90	3.67	4.00	0.92	0.84	1.02	—	4.7	3.5	3.6	—	—	—	—	—	27	31	34	26
8		4.13				1.05				3.9				—						
	Diameter of inside of proloculum in mm.																			
	0.06	0.06	0.08	0.09													0.08	—	0.06	—

Specimen 1 is illustrated in figure 25; specimen 5 is illustrated in figure 27; specimens 2, 3, and 7 are from the Brush Creek limestone, the rest are from the Cambridge limestone.

three or four whorls are fusiform in shape, but outer whorls are more elongate. Form ratio increases from 1: 2.7 in the third whorl to 1: 3.6 in the seventh.

The proloculum is small compared with the rest of the shell. Inside diameters average about 0.06 mm., except in specimens from localities 29 and 33 in Meigs and Perry counties respectively. The proloculi of these specimens average 0.1 mm. for inside diameter. No dimorphism was seen in the specimens sectioned.

The spiral wall is thin on the inner volutions. From the fourth whorl outward the typical schwagerinid details are evident: the thin tectum and the keriotheca with coarse alveoli. Chomata are asymmetrical on the inner volutions with epithecal deposits extending poleward. On outer whorls the chomata are small and narrow.

The septa are numerous in this species. The average septal count for the first seven whorls of 14 specimens was 11, 16, 19, 21, 23, 26, and 27. The septa are fluted in the polar regions of the shell, especially near the axis. They are essentially plane near the tunnel.

The tunnel angle, which is narrow in the inner volutions, widens considerably in the outer whorls. The tunnel angles for a typical specimen are: 20°, 21°, 27°, 27°, 45°, and 62°. The change in the size of the angle in this specimen comes in the fifth whorl, the same whorl in

which the chomata are small and narrow in contrast to the wide chomata of the first four whorls (fig. 25).

Remarks.—*T. ohioensis* may be distinguished from *T. cullomensis* and *T. skinneri* of the Ames limestone of Ohio by its greater length and greater form ratio in mature specimens. The specimens from Meigs and Perry counties with larger proloculi may prove to be a different species or a variety, but there is not enough evidence in the thin sections made to establish this. The published measurements of Illinois specimens of *T. ohioensis* (Dunbar and Henbest, 1942) average greater than measurements made by the author of Ohio specimens, but they fall within similar limits. Specimens from locality 7 were collected in the same township as the cotypes for this species.

Distribution.—*T. ohioensis* has been found in the Cambridge limestone in Lawrence, Gallia, Meigs, Perry, and Muskingum counties, and in the Brush Creek limestone in Gallia County, Ohio. Specimens found in the Portersville limestone in Athens County, Ohio compare in measurements and appearance to this species. In Illinois it is described from the Livingston limestone of Edgar and Christian counties, the Omega limestone of Effingham County (Dunbar and Henbest, 1942), and the Millersville limestone of Coles County (Wanless, 1955). It has also been reported in the Graford formation of West Texas (Myers, Stafford, and Burnside, 1956), and forms compared to *T. ohioensis* are listed from Division II of the Hartville formation, Platte County, Wyoming (Love, Henbest, and Denson, 1953).

TABLE 8

Measurements for Triticites cullomensis *Dunbar and Condra*

Whorl	Half length in mm.				Radius vector in mm.				Form ratio				Tunnel angle				Septal count	
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	5	6
1	0.18	0.16	0.14	0.16	0.10	0.06	0.04	0.08	1.8	2.7	3.5	2.0	23°	28°	—	—	—	9
2	0.37	0.28	0.28	0.35	0.16	0.09	0.09	0.14	2.3	3.1	3.1	2.5	31°	31°	—	31°	15	13
3	0.59	0.42	0.44	0.64	0.24	0.14	0.19	0.22	2.5	3.0	2.3	2.9	41°	43°	51°	40°	16	15
4	0.82	0.82	0.81	0.86	0.32	0.21	0.29	0.35	2.6	3.9	2.8	2.5	42°	39°	51°	64°	18	17
5	1.33	1.22	1.14	1.18	0.47	0.30	0.43	0.48	2.8	4.0	2.7	2.5	—	—	53°	45°	20	16
6		1.63	1.74	1.44		0.45	0.63	0.67		3.6	2.7	2.1		—	—	43°	22	19
7		2.04	2.15	2.02		0.55	0.81	0.83		3.7	2.6	2.4		—	—	—	23	23
	Diameter of inside of proloculum in mm.																	
	0.08	0.04	0.06	—													0.06	—

Specimen 1 is illustrated in figure 23; specimen 5 is illustrated in figure 24; all specimens from the Ames limestone.

Triticites cullomensis Dunbar and Condra 1927

Figures 23 and 24

Fusulina secalica Condit. 1912. Ohio Geol. Survey Bull. 17: 84, 289. Ames limestone, Gallia County, Ohio.

Triticites cullomensis Dunbar and Condra. 1927. Nebraska Geol. Survey 2nd S. 2: 93–95, pl. 5, figs. 5–10. Shawnee group, eastern Kansas and Nebraska.

Triticites cullomensis emend. Dunbar and Henbest. 1942. Illinois Geol. Survey Bull. 67: 135, 136, pl. 23, figs. 13–18.

Triticites cullomensis is medium in size for the genus. The shell is fusiform in shape with gently sloping sides and bluntly pointed ends. The axis of coiling is straight. Mature specimens have seven or eight whorls, a total length of about 4.3 mm., and a form ratio between 1: 3.0 and 1: 3.8.

The proloculum is small. Inside diameters range from 50 to 80 microns.

The spirotheca consists of a thin outer tectum and a keriotheca. On outer whorls the keriotheca is thick, with coarse alveoli; on inner whorls it is thin with little evident structure. The septa are fluted in the polar regions and plane across the center of the shell. The septal count for an average sagittal section is 9, 15, 15, 17, 18, 19, 23.

The tunnel is straight in most specimens with a regular increase of tunnel angle outward. The tunnel angles for the first five whorls of a typical specimen are 23°, 31°, 41°, 45°, and 55°.

The chomata are small. In the inner whorls they are flat and wide and on the outer whorls they are higher and asymmetrical on some specimens.

Remarks.—Although *T. cullomensis* resembles very closely *T. skinneri*, which occurs in the Ames limestone of central Ohio, it has a larger proloculum and somewhat larger tunnel angle. The length and form ratio of the shell is smaller for *T. cullomensis* than it is for *T. ohioensis* of the Cambridge limestone of Ohio.

Distribution.—*T. cullomensis* is found in the Ames limestone of Gallia County in southern Ohio and at Pittsburgh, Pennsylvania (Dunbar and Henbest, 1942). The holotype is from the Cullom limestone (Westerville limestone) of Nebraska. It has also been found in the Graham group in Jack County, Texas (White, 1932), in the Wendover group of Wyoming (Condra, Reed, and Scherer, 1940), and the Oquirrh formation of Utah (Thompson, Verville, and Bissell, 1950).

Triticites skinneri Thompson 1936

Figures 21 and 22

Fusulina secalica Condit. 1912. Ohio Geol. Survey Bull. 17: 127, 138, 287. Ames limestone, Perry and Morgan counties, Ohio.

Triticites skinneri Thompson. 1936. Jour. Paleont. 10: 682, pl. 91, figs. 4–7. Ames limestone, Perry County, Ohio.

TABLE 9

Measurements for Triticites skinneri *Thompson*

Whorl	Half length in mm.				Radius vector in mm.				Form ratio				Tunnel angle					Septal count		
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	5	6	7	8
1	0.06	0.10	0.16	0.10	0.06	0.06	0.08	0.06	1.0	1.7	2.0	1.7	19°	—	—	—	10	—	—	—
2	0.16	0.22	0.32	0.22	0.08	0.09	0.13	0.10	2.0	2.4	2.5	2.2	—	—	15°	25°	15	—	17	—
3	0.31	0.39	0.54	0.35	0.12	0.12	0.24	0.16	2.5	3.2	2.3	2.1	35°	—	24°	38°	20	—	21	17
4	0.53	0.65	0.86	0.61	0.18	0.18	0.32	0.27	2.9	3.6	2.7	2.3	36°	—	21°	32°	20	17	23	18
5	0.92	0.94	1.22	1.08	0.29	0.27	0.48	0.39	3.2	3.5	2.5	2.8	44°	—	—	36°	24	22	28	21
6	1.43	1.16	1.47	1.69	0.43	0.39	0.67	0.55	3.4	3.0	2.2	3.1	45°	—	—	53°	25	25	27	21
7	1.94	1.39	1.72	2.55	0.61	0.57	0.93	0.73	3.2	2.4	1.9	3.5	42°	—	—	—	32	31	—	—
8	2.24	2.00			0.86	0.80			2.6	2.5			—	—						
	Diameter of proloculum in mm.																			
	0.03	0.04	0.03	0.04													0.06	0.04	—	—

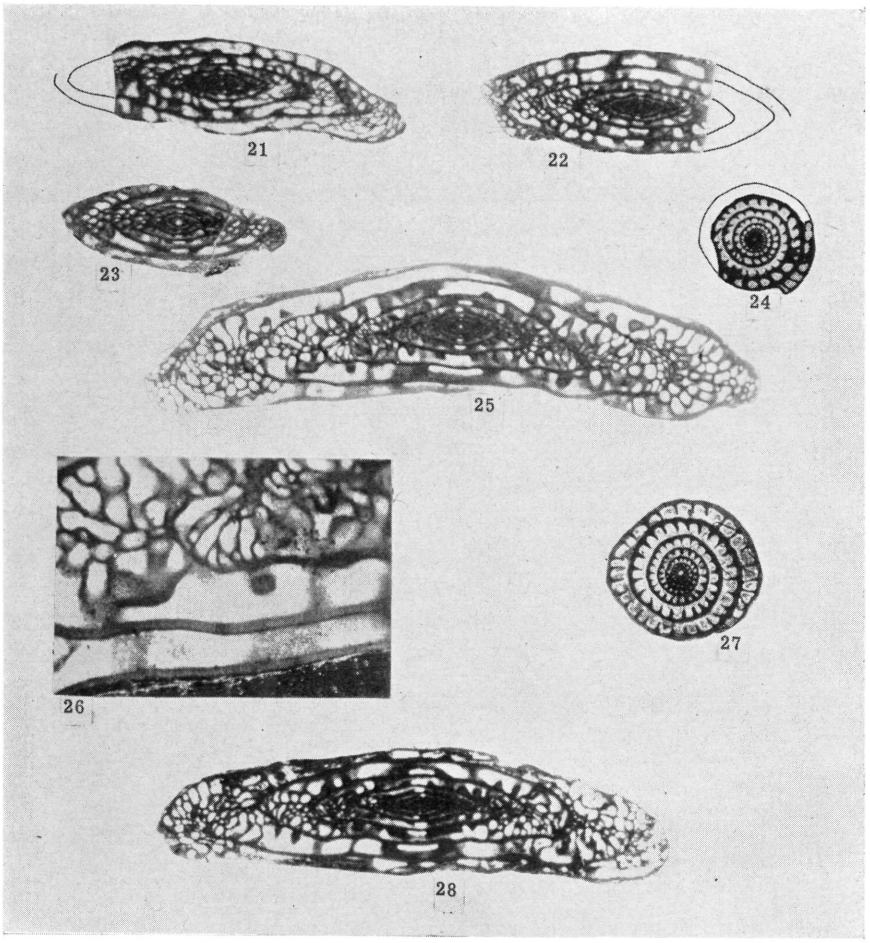
Specimen 1 is illustrated in figure 22; specimen 4 is illustrated in figure 21; specimen 4 is from the Gaysport limestone, all others are from the Ames limestone.

The shell of *Triticites skinneri* is small with a slightly inflated fusiform shape. The first whorl is subspherical in some specimens, but all other whorls are fusiform. The axis of coiling is straight. Mature specimens have seven or eight whorls. Measurements for the seventh whorl of a typical specimen are: half length, 1.9 mm.; radius vector, 0.79 mm.; and form ratio, 1: 2.4. The largest specimen measured had 8 whorls and a total length of 5.2 mm. with a form ratio of 1: 3.0.

The distinguishing feature of this species is the very small proloculum. The largest proloculum measured had an inside diameter of 61 microns, but the average is between 40 and 50 microns.

The spirotheca is thin in the inner volutions and somewhat thicker on outer whorls. Wall thickness for one specimen from Perry County was 10, 10, 15, 20, 31, 51, 61, and 73 microns in the first eight volutions. The wall is composed of tectum and keriotheca. Rather coarse alveoli are evident in the keriotheca from the fourth whorl outward.

The septa are highly fluted near the poles and straight or gently folded across the center. The septal count for a typical specimen is 10, 15, 20, 20, 24, 25, and 32 for seven whorls.



EXPLANATION OF FIGURES IN PLATE III

All figures magnified ×10 except figure 26.

21. *Triticites skinneri* Thompson, axial section from Gaysport limestone, Athens County, locality 18. O. S. U. No. 22254.
22. *Triticites skinneri* Thompson, axial section from Ames limestone, Perry County, locality 33. O. S. U. No. 22255.
23. *Triticites cullomensis* Dunbar and Condra, axial section from Ames limestone, Gallia County, locality 6. O. S. U. No. 22256.
24. *Triticites cullomensis* Dunbar and Condra, sagittal section from same locality. O. S. U. No. 22257.
25. *Triticites ohioensis* Thompson, axial section from Cambridge limestone, Gallia County, locality 7. O. S. U. No. 22258.
26. Detail of wall from same thin section showing alveoli in outer whorls (×30).
27. *Triticites ohioensis* Thompson, sagittal section from Cambridge limestone, Gallia County, locality 7. O. S. U. No. 22259.
28. *Triticites ohioensis* Thompson, axial section from Brush Creek limestone, Gallia County, locality 14. O. S. U. No. 22260.

The tunnel angle varies from 15 to 53 degrees in the specimens measured. In most specimens it is about 30° with not much increase from the inner whorls outward. The tunnel is not well defined in axial sections because the chomata are small and inconspicuous. On inner whorls they are low and wide. On outer whorls the height of the chomata is about as great as the width of it, but only half as high as the chamber.

Remarks.—*T. skinneri* is very similar to *T. cullomensis* which also occurs in the Ames limestone. The two species cannot be distinguished in the field. In thin sections they may be differentiated by the smaller proloculum and somewhat smaller tunnel angle of *T. skinneri*. It is distinguished from *T. ohioensis* of the Cambridge limestone of Ohio by its smaller size and more obese shell. The difference is great enough to be seen in the field without the use of thin sections.

Distribution.—*T. skinneri* has been found in central and eastern Ohio in the Ames limestone in Athens, Perry, Morgan, Muskingum, and Columbiana counties, and in the Gaysport limestone of Athens County. Thompson's cotypes came from Bearfield Township, Perry County, Ohio (loc. 33).

COLLECTING LOCALITIES

A representative list of collecting localities is given here. Collections were made by the author unless otherwise indicated.

Loc. 1.—Lower Mercer and Putnam Hill limestones, Coshocton County, Washington Township (Frazeysburg quadrangle), southwestern part of the township, one-half mile south of Graham Corners. Lower Mercer limestone in bed of Opossum Run at waterfall and Putnam Hill limestone near the top of ridges east and west of Opossum Run. *Fusulinella iowensis* and *F. iowensis* var. *stouti* in Lower Mercer limestone and *Fusulina leei* in Putnam Hill limestone.

Loc. 2.—Vanport limestone, Muskingum County, southwest Muskingum Township (Frazeysburg quadrangle), outcrop along township road at 977 feet elevation, three-fourths mile north of Ohio Route 156 and three-fourths mile east of Big Run. *Fusulina carmani* and *Wedekindellina euthysepta*.

Loc. 4.—Lower Mercer limestone, Muskingum County, Hopewell Township (Zanesville quadrangle), ledge of limestone in small waterfall near the headwaters of a small stream which enters a branch of Poverty Run one and one-half miles north of Sterling. *Fusulinella iowensis* and *F. iowensis* var. *stouti*.

Loc. 5.—Ames limestone, Gallia County, Morgan Township (Bidwell quadrangle), SW ¼, sec. 28. Small outcrop of nodular limestone near top of hill near old road. *Triticites cullomensis* abundant.

Loc. 6.—Ames limestone, Gallia County, Morgan Township (Bidwell quadrangle), west edge SW ¼, sec. 19. Limestone on top of bank along road at about 700 feet elevation. *Triticites cullomensis* abundant.

Loc. 7.—Cambridge limestone and shale, Gallia County, Perry Township (Bidwell quadrangle), SW ¼, sec. 35. Fossils in shale under limestone in creek near road, one mile east of Patriot. *Triticites ohioensis* very abundant.

Loc. 8.—Cambridge limestone and shale, Gallia County, Harrison Township (Bidwell quadrangle), SE ¼, sec. 30. Fossils in shale over limestone along Fox Brook, 0.6 mile south of its mouth and just west of road. *Triticites ohioensis* very abundant.

Loc. 9.—Putnam Hill and Vanport limestones, Tuscarawas County, Sandy Township (Dover quadrangle). North of Ohio Route 8, one mile southwest of Mineral City; Putnam Hill limestone near the railroad level, and Vanport limestone 44 feet higher. *Fusulina leei* rare in Putnam Hill limestone; *Wedekindellina euthysepta* and *Fusulina carmani* very abundant in the Vanport limestone.

Loc. 12.—Ames limestone, Athens County, Trimble Township (New Lexington quadrangle), NW ¼, NE ¼ sec. 6. Collected by M. T. Sturgeon and R. E. Abbott. *Triticites skinneri*.

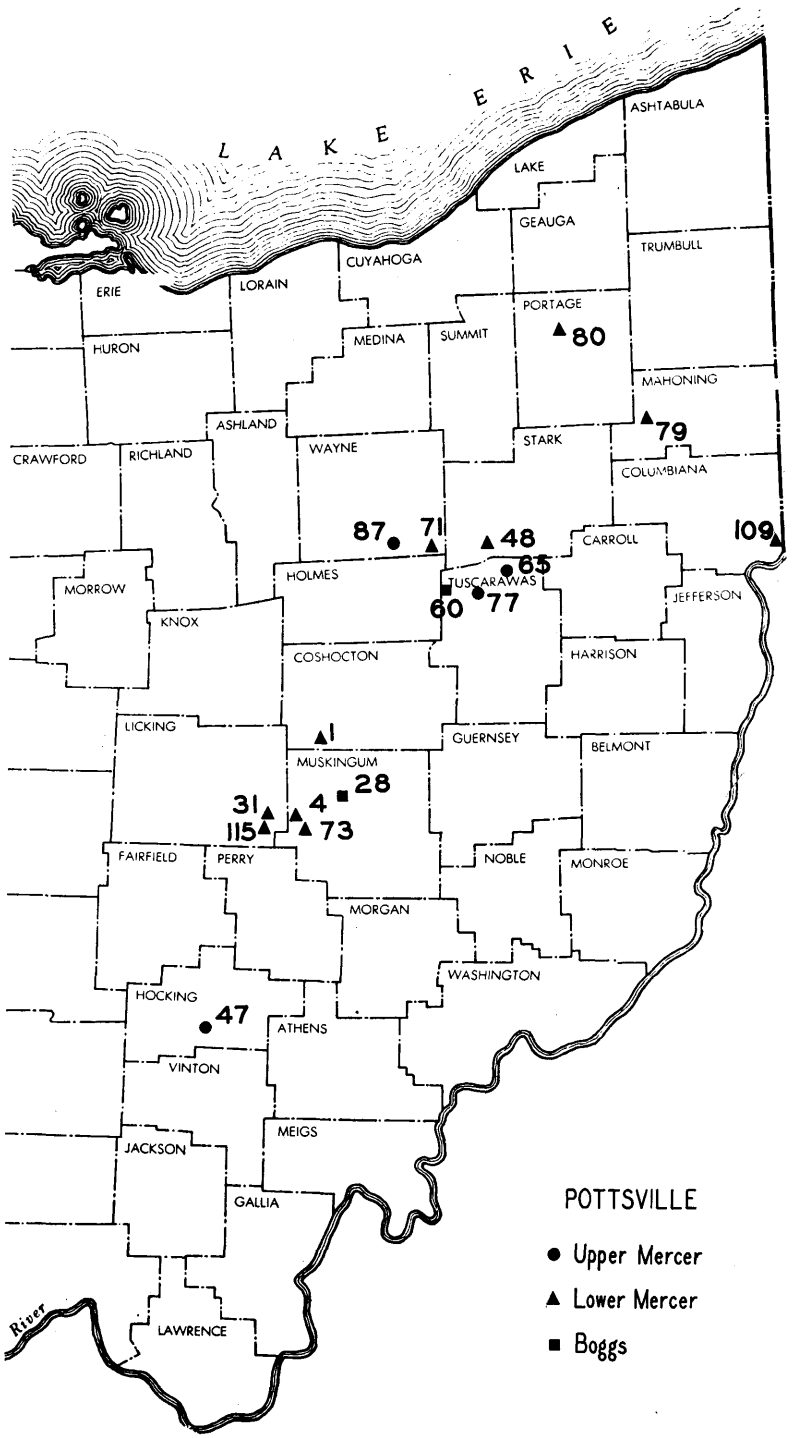


FIGURE 2. Collecting Localities in the Pottsville Series

Loc. 14.—Brush Creek horizon, Gallia County, Perry Township (Bidwell quadrangle), NE ¼, sec. 28. Sandy, fossiliferous material along road at top of hill west of Gage. Fusulinids preserved as silicified molds. Collected by Oliver Blake. *Triticites ohioensis.*

Loc. 15.—Brush Creek limestone, Gallia County, Raccoon Township (Bidwell quadrangle), east center sec. 35. Along the road. Collected by Oliver Blake. *Triticites ohioensis.*

Loc. 16.—Putnam Hill limestone, Muskingum County, Springfield Township (Zanesville quadrangle). Ledge of limestone in high bank across U. S. Route 40 from roadside park just west of western city limits of Zanesville. *Fusulina leei* rare.

Loc. 17.—Vanport flint and limestone, Muskingum County, Hopewell Township (Zanesville quadrangle), SE ¼, SE ¼, partial sec. 15 N. Outcrop along abandoned road. This is near the collecting locality for cotypes of *Fusulina carmani. Fusulina carmani* very abundant, *Wedekindellina euthysepta.*

Loc. 18.—Gaysport limestone, Athens County, Athens Township, (Athens quadrangle), SW ¼, NW ¼, sec. 17. Collected by M. T. Sturgeon. *Triticites skinneri.*

Loc. 20.—Ames limestone, Athens County, Dover Township (Athens quadrangle), SW ¼, SW ¼, sec. 1. Collected by M. T. Sturgeon. *Triticites skinneri.*

Loc. 22.—Ames limestone, Muskingum County, Blue Rock Township (Philo quadrangle), east central sec. 27. Limestone in north bank of Dry Riffle Run near Ohio Route 340. *Triticites skinneri* abundant.

Loc. 24.—Vanport flint, Licking County, Hopewell Township (Thornville quadrangle). Exposure of flint along Flint Ridge Road, near crossroads one-half mile from western edge of township. *Fusulina carmani* and *Wedekindellina euthysepta* abundant.

Loc. 28.—Boggs limestone, Muskingum County, Muskingum Township (Frazeysburg quadrangle). Limestone in bed of Blunt Run just east of sec. 20. *Fusulinella iowensis* rare.

Loc. 29.—Cambridge limestone and shale, Meigs County, Rutland Township (Pomeroy quadrangle), SE ¼, NW ¼, sec. 35. Collected by Herb Feldsted. *Triticites ohioensis* very abundant.

Loc. 30.—Putnam Hill limestone, Tuscarawas County, Fairfield Township (Dover quadrangle), NW ¼ ,SW ¼, sec. 6. Along Ohio Route 8 at Dover Dam, ledge of limestone about 6 feet above road level. *Fusulina leei* rare.

Loc. 31.—Lower Mercer limestone, Licking County, southwest part of Hopewell Township (Thornville quadrangle). Outcrop of shaly limestone at an elevation of 1130 feet, along north-south township road one half mile east of township boundary and one mile north of U. S. Route 40. *Fusulinella iowensis* and *F. iowensis* var. *stouti* both abundant.

Loc. 33.—Cambridge and Ames limestones, Perry County, Bearfield Township (New Lexington quadrangle), west central sec. 24. Ledge of Cambridge limestone in stream bed below Anderson coal, and blocks of Ames limestone in field near head of gully. *Triticites ohioensis* abundant in Cambridge limestone and *Triticites skinneri* in Ames. The collecting site for the cotypes of *Triticites skinneri* is nearby.

Loc. 38.—Cambridge limestone, Morgan County, York Township (McConnelsville quadrangle), SE ¼, SW ¼, sec. 35. Exposure in gully which is parallel to and west of hill road. The section is approximately:

	Feet	Inches
Coal	1	6
Interval	7	
Cambridge limestone with 8 inch fusulinid coquina at top	2	

Triticites ohioensis very abundant.

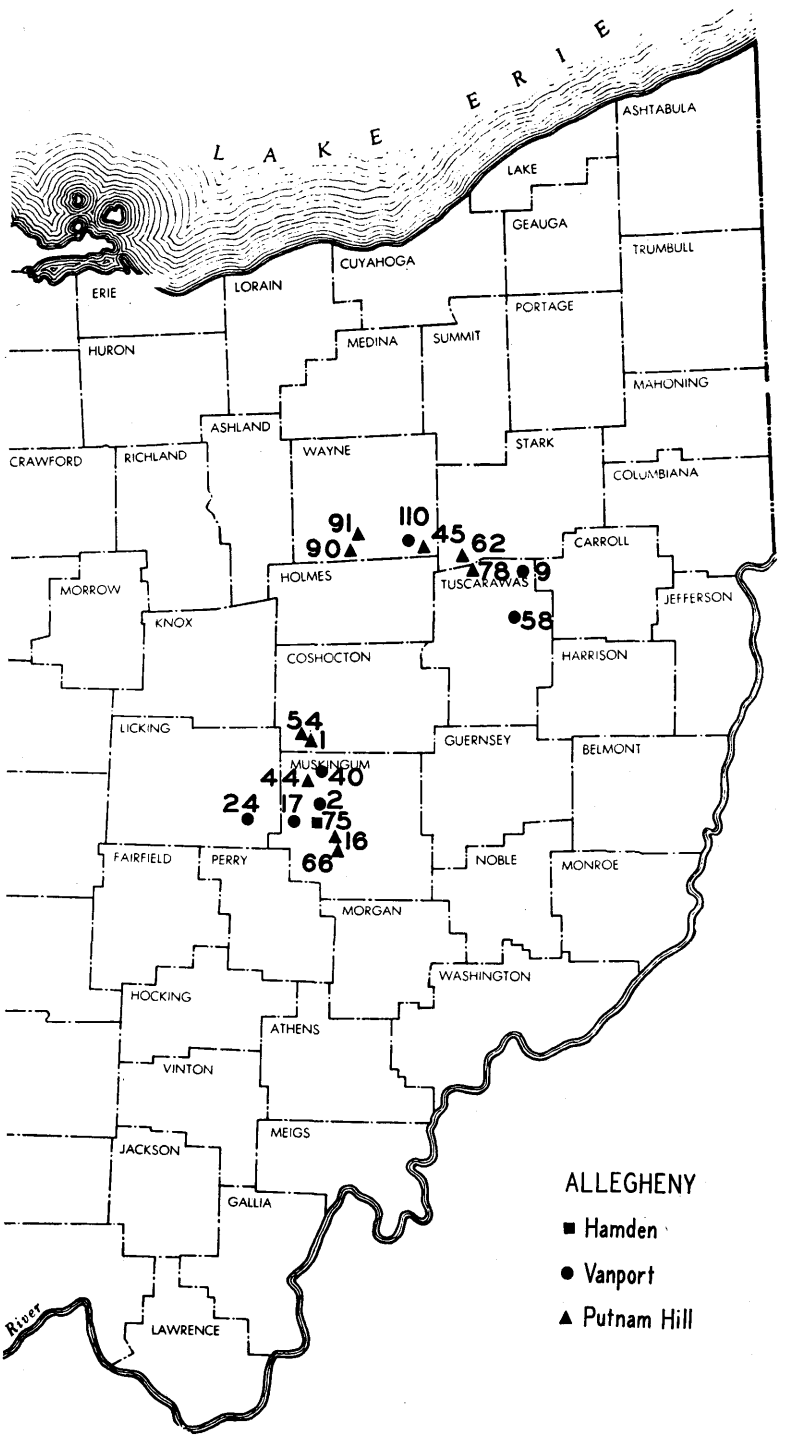


FIGURE 3. Collecting Localities in the Allegheny Series

Loc. 40.—Vanport limestone, Muskingum County, Cass Township (Frazeysburg quadrangle). Limestone exposure at an elevation of 1007 feet at the Y in the road which runs along The Highlands south of partial sec. 14. *Fusulina carmani* and *Wedekindellina euthysepta* abundant.

Loc. 44.—Putnam Hill Limestone, Muskingum Country, Cass Township (Frazeysburg quadrangle). Ledge of limestone at an elevation of approximately 1000 feet, by the road along The Highlands one and one-half miles east of Frazeysburg. *Fusulina leei.*

Loc. 45.—Putnam Hill limestone, Wayne County, Paint Township (Navarre quadrangle), SW ¼, SE ¼, sec. 9. Outcrop of Putnam Hill limestone near the top of the hill on the north side of the road cut on U. S. Route 250, three-quarters of a mile northwest of Mount Eaton. *Fusulina leei* abundant.

Loc. 47.—Upper Mercer flint, Hocking County, Washington Township(Zaleski quadrangle), SW ¼, NE ¼, sec. 5. Samples collected in strip mine by John Hall. *Fusulinella iowensis.*

Loc. 48.—Lower Mercer limestone, Stark County, Bethlehem Township (Navarre quadrangle), SW ¼, SW ¼, sec. 16. Ledges of Lower Mercer limestone on either side of railroad cut where Wheeling and Lake Erie Railroad passes under the road. *Fusulinella iowensis* common.

Loc. 54.—Putnam Hill limestone, Coshocton County, Pike Township (Frazeysburg quadrangle), east central sec. 20. Ledge of dark blue-gray limestone along the road at an elevation of 1036 feet. *Fusulina leei* abundant.

Loc. 58.—Vanport limestone, Tuscarawas County, Goshen Township (Uhrichsville quadrangle). Along Ohio Route 39, one and one half miles east of New Philadelphia, opposite the road which comes in from the north along Pleasant Valley. Collected by Raymond Lamborn. *Fusulina carmani and Wedekindellina euthysepta.*

Loc. 60.—Boggs limestone, Tuscarawas County, Wayne Township (Navarre quadrangle), center partial sec. 3. Shaly limestone on the west side of the road. *Fusulinella iowensis* rare.

Loc. 62.—Putnam Hill limestone, Stark County, Sugar Creek Township (Navarre quadrangle), SE ¼, NE ¼, NE ¼, sec. 36. Along private road. *Fusulina leei* abundant.

Loc. 65.—Upper Mercer limestone, Tuscarawas County, Lawrence Township (Dover quadrangle). Ledge of Upper Mercer limestone in railroad cut at Zoar Station at an elevation of 950 feet. *Fusulinella iowensis* common.

Loc. 66. —Putnam Hill limestone, Muskingum County, city of Zanesville (Zanesville quadrangle). Type section for the Putnam Hill limestone, west side of the Muskingum River, south of the Y bridge. *Fusulina leei.*

Loc. 67.—Upper Mercer (?) limestone, Wayne County, Paint Township (Navarre quadrangle), NE ¼, SE ¼, sec. 13. Abandoned, water-filled quarry; elevation at base of limestone, 1105 feet. Collected by H. Gray Multer.

Loc. 71.—Lower Mercer limestone, Wayne County, Paint Township (Navarre quadrangle), west central sec. 23. Limestone exposed by a small stream at an elevation of 1117 feet. Collected by H. Gray Multer. *Fusulinella iowensis.*

Loc. 73.—Lower Mercer limestone, Muskingum County, Hopewell Township (Zanesville quadrangle), center partial sec. 18. Limestone in roadside ditch about a mile north of Mt. Sterling. *Fusulinella iowensis* and *F. iowensis* var. *stouti* very abundant.

Loc. 75.—Hamden limestone, Muskingum County, Falls Township (Zanesville quadrangle). Nodules of limestone along either side of the road three miles east of Dillon and near the western edge of Falls township. *Fusulina* sp. rare.

Loc. 77.—Upper Mercer limestone, Tuscarawas County, Franklin Township (Navarre quadrangle), center S ½ partial sec. 8. Along road about three fourths mile north of Winfield near an elevation of 980 feet. Collected by Henry Gray. *Fusulinella iowensis* abundant.

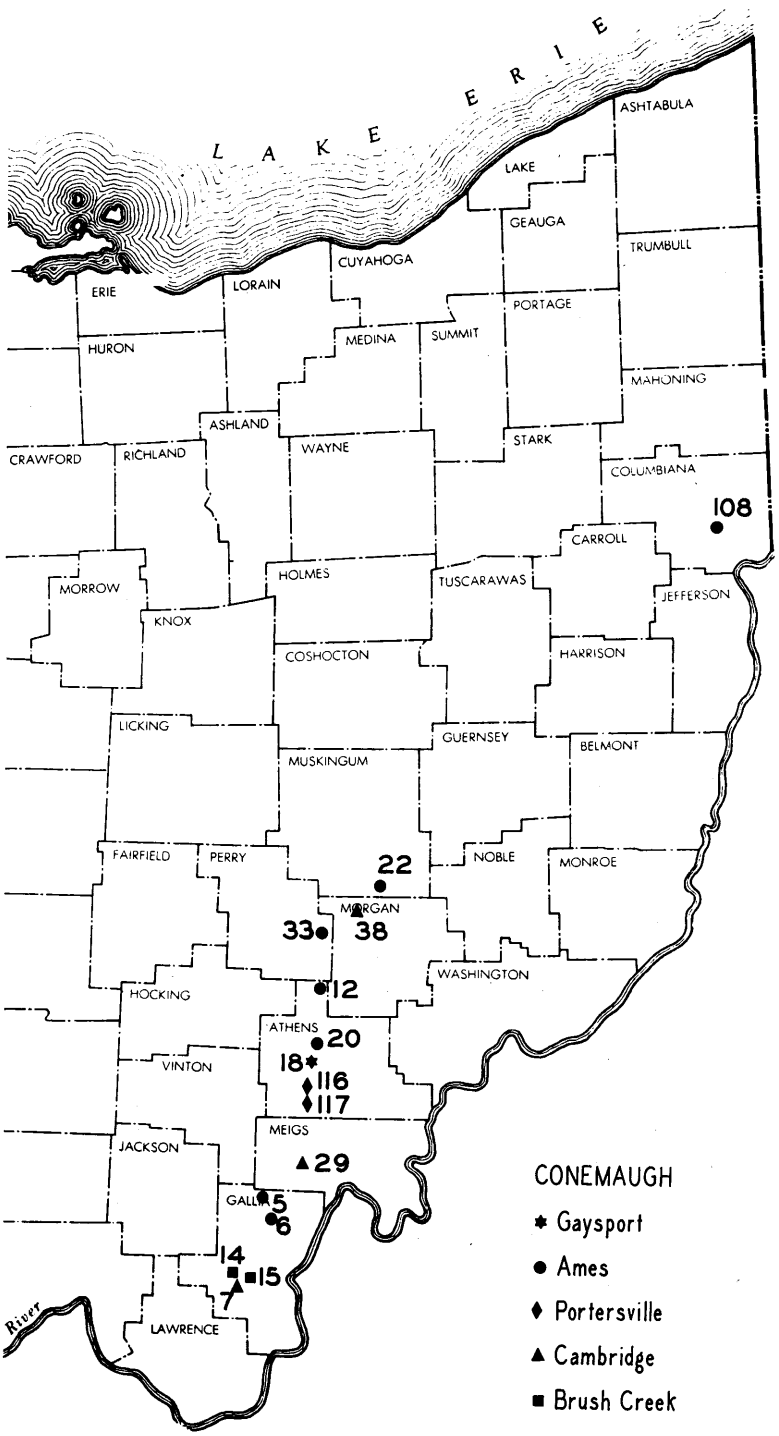


FIGURE 4. Collecting Localities in the Conemaugh Series

Loc. 78.—Putnam Hill limestone, Tuscarawas County, Franklin Township (Navarre quadrangle). In the northeastern part of the township at the Sowder School crossroads at an elevation of 1066 feet. Collected by Henry Gray. *Fusulina leei.*

Loc. 79.—Lower Mercer and Upper Mercer limestones, Mahoning County, Berlin Township (Warren quadrangle). Outcrop of Upper Mercer limestone at an elevation of 1020 feet where Turkeybroth Creek enters Mill Creek in the western part of the township; Lower Mercer limestone about one-half mile farther west where the north-south road crosses Mill Creek. Collected by John Winslow. *Fusulinella iowensis* abundant in the Upper Mercer limestone and present in the Lower Mercer limestone.

Loc. 80.—Lower Mercer (?) limestone, Portage County, Shalersville Township (Ravenna quadrangle). Limestone exposed in new road cut of the Ohio Turnpike about one mile east of Shalersville. *Fusulinella iowensis* abundant. Collected by John Winslow.

Loc. 84.—Ames limestone, Athens County, Ames Township (Athens quadrangle), SE ¼, NW ¼, sec. 21. A ledge of massive limestone at 723 feet elevation along a gravel road one mile northeast of Route 50A. *Triticites skinneri.*

Loc. 87.—Upper Mercer limestone, Wayne County, Salt Creek Township (Millersburg quadrangle), center of eastern edge sec. 4. Limestone in ditch opposite T road intersection. Collected by H. G. Multer. *Fusulinella iowensis.*

Loc. 90.—Putnam Hill limestone, Wayne County, Franklin Township (Millersburg quadrangle), NW ¼, NW ¼, sec. 22. In abandoned quarry, elevation 1182 feet. Collected by H. G. Multer. *Fusulina leei.*

Loc. 91.—Putnam Hill limestone, Wayne County, Franklin Township (Millersburg quadrangle), SE ¼, SE ¼, sec. 10. Limestone in a ravine south of a farm house, at an elevation of 1150 feet. Collected by H. G. Multer. *Fusulina leei.*

Loc. 108—Ames limestone, Columbiana County, Madison Township (Wellsville quadrangle), NW ¼, NE ¼, sec. 21. Limestone in the road bank on the west side of Ohio Route 45 at the top of the hill. *Triticites skinneri* rare.

Loc. 109.—Lower Mercer limestone, Columbiana County, St. Clair Township (Wellsville quadrangle), north center sec. 12. Pieces of Lower Mercer float found in Bieler Run near its mouth and east of the railroad trestle. *Fusulinella iowensis* rare.

Loc. 110.—Vanport limestone, Wayne County, Paint Township, (Millersburg quadrangle), NW ¼, NW ¼, sec. 18. In abandoned strip pit at elevation of 1232 feet. Collected by H. G. Multer. *Fusulina carmani.*

Loc. 115.—Lower Mercer limestone, Licking County, Hopewell Township (Thornville quadrangle). Limestone outcrop at the top of a knob in the southwest corner of the Township. Collected by George Franklin. *Fusulinella iowensis* abundant.

Loc. 116.—Portersville limestone, Athens County, Alexander Township (Athens quadrangle), SW ¼, NE ¼, sec. 30. Nodular limestone along road. Collected by M. T. Sturgeon and W. M. Merrill. *Triticites ohioensis* (?).

Loc. 117.—Portersville limestone, Athens County, Alexander Township (Athens quadrangle), N ½, NE ¼, sec. 28 and S ½, SE ¼, sec. 29. Nodular limestone in ravine. Collected by M. T. Sturgeon and W. M. Merrill. *Triticities ohioensis* (?).

LITERATURE CITED

Alexander, R. D. 1954. Desmoinesian fusulinids of northeastern Oklahoma. Oklahoma Geol. Survey Cir. 31: 67 pp.

Blake, O. D. 1952. Geology of Gallia County, Ohio. Unpublished dissertation. The Ohio State University, Columbus.

Condit, D. D. 1912. Conemaugh formation in Ohio. Ohio Geol. Survey Bull. 17: 366 pp.

Condra, G. E., E. C. Reed, and **O. J. Sherer.** 1940 Correlations of the formations of the

Laramie Range, Hartville uplift, Black Hills and western Nebraska. Nebraska Geol. Survey Bull. 13–A: 24–31.
Conrey, G. W. 1921. Geology of Wayne County. Ohio Geol. Survey Bull. 24: 155 pp.
Dunbar, C. O. 1933. Fusulinidae. Cushman Lab. Foram. Research Special Publ. 4: 126–140, pl. 13.
——— and **G. E. Condra.** 1927. The Fusulinidae of the Pennsylvanian system in Nebraska. Nebraska Geol. Survey 2nd S. 2: 135 pp.
——— and **L. G. Henbest.** 1930. The fusulinid genera *Fusulina*, *Fusulinella*, and *Wedekindella*. Amer. Jour. Sci. 5th S. 20: 357–365.
——— and ———. 1931. *Wedekindia*, a new fusulinid name. Amer. Jour. Sci. 5th S. 21: 458.
——— and ———. 1942. Pennsylvanian Fusulinidae of Illinois. Illinois Geol. Survey Bull. 67: 218 pp.
Gray, H. H. 1954. Stratigraphy and Sedimentation of Pottsville Rocks near Beach City, Ohio. Unpublished dissertation. The Ohio State University, Columbus.
Henbest, L. G. 1928. Fusulinellas from the Stonefort limestone member of the Tradewater formation. Jour. Paleont. 2: 70–85.
———. 1954. Pennsylvanian Foraminifera in Amsden formation and Tensleep sandstone, Montana and Wyoming. Billings Geol. Soc. Guidebook, 5th Ann. Field Conference, 1954: 50–53.
——— and **C. B. Read.** 1944. Stratigraphic distribution of the Pennsylvanian Fusulinidae in a part of the Sierra Nacimiento of Sandoval and Rio Arriba counties, New Mexico. U. S. Geol. Survey, Oil and Gas Investigations, Prelim. Chart 2.
Herrick, C. L. 1887. A sketch of the geologic history of Licking County, Ohio. Denison Univ. Sci. Bull. 2: 5–70, pl. 3, fig. 20.
Lamborn, R. E. 1930. Geology of Jefferson County. Ohio Geol. Survey Bull. 35: 304 pp.
Love, J. D., L. G. Henbest, and **N. M. Denson.** 1953. Stratigraphy and paleontology of Paleozoic rocks, Hartville area, eastern Wyoming. U. S. Geol. Survey, Oil and Gas Investigations, Chart OC 44.
Mark, Clara G. 1911. The Mercer limestone and its associated rocks in the Newark-Zanesville region. Denison Univ. Sci. Lab. Bull. 16: 267–314.
Moore, R. C., et al. 1944. Correlation of Pennsylvanian formations of North America. Geol. Soc. Amer. Bull. 55: 657–706.
Morningstar, Helen. 1922. Pottsville fauna of Ohio. Ohio Geol. Survey Bull. 25: 312 pp.
Multer, H. G. 1955. Stratigraphy, structure, and economic geology of Pennsylvanian rocks in Wayne County, Ohio. Unpublished dissertation. The Ohio State University, Columbus.
Myers, D. A., P. T. Stafford, and **R. J. Burnside.** 1956. Geology of the late Paleozoic Horseshoe Atoll in west Texas. Univ. Texas Bull. 5607: 133 pp.
Needham, C. E. 1937. Some New Mexico Fusulinidae. New Mexico School of Mines Bull. 14: 88 pp.
Northrop, S. A. and **G. H. Wood.** 1946. Geology of the Nacimiento Mountains, San Pedro Mountain, and adjacent plateaus in parts of Sandoval and Rio Arriba counties, New Mexico. U. S. Geol. Survey, Oil and Gas Investigations, Prelim. Map 57.
Skinner, J. W. 1931. New Permo-Pennsylvanian Fusulinidae from northern Oklahoma. Jour. Paleont. 5: 16–22, pls. 3–4.
Smyth, Pauline. 1951. Fusulinidae in the Pennsylvanian of Ohio (Ab.). Geol. Soc. Amer. Bull. 62: 1481.
Stout, W. 1918. Geology of Muskingum County. Ohio Geol. Survey Bull. 21: 351 pp.
———. 1927. Geology of Vinton County. Ohio Geol. Survey Bull. 31: 402 pp.
Teflian, S. 1952. A study of the Vanport limestone in the Oak Hill area, southern Ohio. Unpublished thesis. The Ohio State University, Columbus.
Thompson, M. L. 1934. The fusulinids of the Des Moines series of Iowa. Univ. of Iowa Stud. Nat. Hist. 16: 273–332, pls. 20–23.
———. 1935. Fusulinids from the Lower Pennsylvanian Atoka and Boggy formations of Oklahoma. Jour. Paleont. 9: 291–306, pl. 26.
———. 1936. Pennsylvanian fusulinids from Ohio. Jour. Paleont. 10: 673–683, pls. 90–91.
——— and **H. D. Thomas.** 1953. Systematic paleontology of fusulinids from the Casper formation. Wyoming Geol. Survey Bull. 46, pt. 2: 15–56.
———, **G. J. Verville,** and **H. J. Bissell.** 1950. Pennsylvanian fusulinids of the south-central Wasatch Mountains, Utah. Jour. Paleont. 24: 430–465, pls. 57–64.
de Verneuil, E. 1846. On the *Fusulina* in the Coal formation of Ohio. Amer. Jour. Sci. 2nd S. 2: 293.
Wanless, H. R. 1955. Pennsylvanian rocks of eastern interior basin. Amer. Assoc. Petrol. Geol. Bull. 39: 1753–1820
White, M. P. 1932. Some Texas Fusulinidae. Univ. Texas Bull. 3211: 1–104, pls 1–10.