Fusulinids of the Des Moines Series of Iowa

M. L. Thompson

New Series No. 284 October 1, 1934

UNIVERSITY OF IOWA STUDIES

STUDIES IN NATURAL HISTORY

Volume XVI Number 4

The Fusulinids of the Des Moines Series of Iowa

by

M. L. THOMPSON

Published by the University, Iowa City, Iowa

Issued semi-monthly throughout the year. Entered at the post office at Iowa City, Iowa as second class matter under the Act of October 3, 1917.

TRAVELING LIBRARY

OF THE STATE OF IOWA

To communities, and schools, books for reloaning are loaned for a three month's period. To individuals and to clubs for study use, books are loaned for two to four weeks.

Borrowers are requested to return the books as soon as the need for them is passed, and *always* when books are due. Where books are re-loaned, fines may be charged by the *local* library and *retained* when the books are returned.

DAMAGES. The pages of these books must not be marked and librarians are required to note the condition of books when loaned to borrowers and when returned by such borrowers and to report damages beyond reasonable wear to the State Traveling Library.

10M-SE-40

University of Iowa Studies in Natural History

G. W. MARTIN, Editor

Volume XVI Number 4

The Fusulinids of the Des Moines Series of Iowa

by

M. L. THOMPSON

Published by the University, Iowa City, Iowa

1934

CONTENTS

The Fusulinids of the Des Moines Series of Iowa[1]

INTRODUCTION

In 1932 the Iowa Geological Survey inaugurated an extensive study of the Pennsylvanian system of Iowa under the direction of Dr. A. C. Tester. Detailed stratigraphic studies were begun by Mr. D. G. Stookey of the State University of Iowa, and I undertook the paleontological portion of the work. All the fusulinids described below were obtained by me during the summer field-season of 1932 and 1933 from the Des Moines series of southeastern Iowa. Samples were collected from every fossiliferous horizon and locality found east of Lucas and Appanoose counties, and the collections obtained are believed to be fairly complete.

The rapid evolution, the wide geographic distribution, and the excellent state of preservation of large numbers of the shells of these foraminifera are rapidly being demonstrated, and the value of this group of fossils for detailed correlation over wide areas as well as within restricted regions is fast becoming recognized. Although the Upper Carboniferous Fusulinidae of Europe and Asia have long received a great deal of attention, it is only within recent years that American forms have been given the consideration they merit. Modern American studies were inaugurated by the well-known monograph of Dunbar and Condra, which is concerned chiefly with middle and upper Pennsylvanian forms. Our knowledge of the biologic nature of the fusulinids is rapidly increasing and specific characters are becoming more and more clearly understood.

With the exception of some representatives of *Wedekindellina euthysepta* described below, all of the Iowa species which I am referring to the genus *Wedekindellina* were obtained from a thin calcareous shale member of the middle portion of the Cherokee, about 1½ feet below a thin limestone, 35 feet below the White

---

[1] Published by permission of the Director of the Iowa Geological Survey.

Breast coal.[2] *W. euthysepta* occurs also in an 8 inch shale bed located about 8 feet above the White Breast coal between two thin limestones. Associated with these species of *Wedekindellina,* especially in the lower horizon, are many representatives of the genus *Fusulina* s.s.—this genus ranges throughout the remaining upper part of the Des Moines series. My study of these fusulinids indicates that the White Breast coal of Iowa is the stratigraphic equivalent of the so-called Coal No. 2 of the Liverpool formation of Illinois; that the fusulinid-bearing calcareous shale approximately 35 feet below the White Breast coal is very closely similar in age to the Stonefort limestone of the Tradewater formation of southern Illinois; that the so-called "eighteen-foot limestone" [18 feet above the Mystic coal] is the approximate stratigraphic equivalent of the "roof-rock" of Coal No. 6 of Illinois; and that the so-called "fifty-foot limestone" [50 feet above the Mystic coal] of Iowa is not greatly different in age from the Pawnee limestone of Kansas. Only one species is known from Iowa that is referable to the genus *Fusulinella, F. iowensis,* n. sp. It came from near the base of the Cherokee in a limestone which forms the cap of an unnamed coal that is rather extensively mined in Jefferson and Davis counties; this coal lies about 20 feet above the Mississippian limestone in southern Jefferson County and about 90 feet below the White Breast coal.

I wish to take this opportunity to acknowledge my indebtedness to Dean George F. Kay, Director of the Iowa Geological Survey, who has promoted and encouraged this study and has made possible the necessary field work; to Professor C. O. Dunbar who has read the entire manuscript and has made many valuable criticisms; and to Dr. A. K. Miller whose continued interest and advice were especially helpful.

SYSTEMATIC PALEONTOLOGY

Genus Wedekindellina Dunbar and Henbest

This genus was established by Dunbar and Henbest[3] in 1930 under the name *Wedekindella* with *Fusulinella euthysepta*[4] Hen-

[2] Name given by Lugn in 1927 in his report on the Geology of Lucas County, Iowa, in the Iowa Geological Survey, volume 32, pp. 105-237.

[3] Dunbar, C. O., and Henbest, L. G., The fusulinid genera *Fusulina, Fusulinella* and *Wedekindella*: *Am. Jour. Sci.*, ser. 5, vol. 20, pp, 357-364, 1930.

[4] The specific name was originally spelled "euthusepta," but Professor C. O. Dunbar has kindly pointed out to me that Article 19 of the International Rules

best as the genotype, and with only one other species, *Boultonia rawi* Lee, referred to it. The name *Wedekindella* was preoccupied and the original authors[5] proposed in 1931 to rename the genus *Wedekindia*; this name was also preoccupied and in 1933 the genus was given a new name, *Wedekindellina*, by its original establishers.[6] My concept of the genotype of *Wedekindellina*, *Fusulinella euthysepta*, is based on Henbest's original description and illustrations[7] (Henbest's pl. 8, figs. 6, 8, 8a, and 8b; and pl. 9, fig. 1, but not pl. 8, fig. 7, and pl. 9, figs. 2 and 5).

The validity of the genus *Wedekindellina* has been recognized by some students of Fusulinidae but by others the name has been placed in synonymy with other genera. It seems to me that forms of the type of *Fusulinella euthysepta* are so markedly different from those referable to well established genera that they should be recognized as representing a distinct genus; I would place the following American forms in *Wedekindellina*: *Fusulinella minuta* Henbest of the Tradewater formation of Illinois; *Wedekindella excentrica* Roth and Skinner, *W. excentrica magna* R. and S., *W. coloradoensis* R. and S., *W. coloradoensis perforata* R. and S. of the McCoy formation of Colorado; *Wedekindia henbesti* Skinner of the Cherokee of Oklahoma; and the forms from the Cherokee of Iowa described below as *Wedekindellina dunbari*, *W. elfina*, and *W. uniformis*. As can be seen from this list, the genus *Wedekindellina* is widespread in North America, and further study will most probably reveal even a greater geographic distribution; however its stratigraphic range is limited and representatives of it are not known to occur in beds younger than the Cherokee nor in beds older than the middle of the Atoka of Oklahoma.

On the basis of the original description and illustrations of the genotype, the specimens available for study, and the illustrations and descriptions of the species listed above, I have drawn up the following generic diagnosis of *Wedekindellina*: Shell small, subfusiform to fusiform, slender, elongate; mature specimens usually do not exceed 5 mm in length and 2 mm in width; form ratio of

---

of Zoological Nomenclature and Opinion 36 permitted him and Mr. Henbest to change the spelling to "*euthysepta*".

5 Dunbar, C. O., and Henbest, L. G., *Wedekindia*, a new fusulinid name: *Amer. Jour. Sci.*, ser. 5, vol. 21, p. 458, 1931.

6 Dunbar, C. O., and Henbest, L. G., in Cushman, J. A., Foraminifera: *Contr. Cushman Lab. Foram. Research*, Special pub. no. 4, p. 134, 1933.

7 Henbest, L. G., Fusulinellas from the Stonefort limestone member of the Tradewater formation: *Jour. Pal.*, vol. 2, pp. 70-85, pls. 8-10, 1928.

mature specimens 1:2.5 to 1:5.0. Septa unfluted, straight or broadly curved. The septa are composed of four layers: the two outer layers (anterior and posterior) are tectoria and are thicker near the base and thinner near the top of the septa where they continue onto the "floors" and "roofs" of the chambers to form the upper and lower tectorium respectively of the spirotheca; the anterior inner layer of the septa is the downward extension to the base of the septa of the tectum of the spirotheca; and the posterior inner layer is the downward continuation of the diaphanotheca of the spirotheca which may or may not extend entirely to the base of the septa. The spirotheca is composed of four layers: an upper very thick rather dense tectorium which is underlain by a still more dense and very thin layer, the tectum; a basal layer, tectorium, that is rather dense and thin and is overlain by a lighter and thicker layer, the diaphanotheca. The upper tectorium thickens rapidly from beyond the limits of the chomata to completely fill the chambers in the polar regions in all volutions except, in some forms, the inner one or two and/or the outer one or two. Proloculum small; tunnel low and broad and its intersection with axial sections usually irregular; tunnel bordered on either side by well defined asymmetrical ridges, chomata.

Wedekindellina is perhaps more closely related to *Fusiella*[8] than to any other recognized genus. Through the courtesy of Professor J. S. Lee of the National University of Peking I have had an opportunity to examine two of the figured types of *Fusiella typica* Lee and Chen of the Huanglung limestone (Moscovian) of southeast China, the genotype of *Fusiella*, and I concur with these authors in their description of this species. *Fusiella typica* is quite distinct from any other recognized genotype, and no similar form is known from America. Typical representatives of *Wedekindellina* differ from this genotype of *Fusiella* in that their spirotheca is composed of four layers (an upper tectorium, a tectum, a diaphanotheca, and a lower tectorium) whereas the spirotheca of *Fusiella* is composed of only three layers (an upper tectorium, a tectum, and

---

[8] This genus was established by Lee and Chen (Lee, J. S., Chen, S., and Chu, S., The Huanglung limestone and its fauna: *Mem. Nat. Research Inst. Geol.*, no. 9, p. 107) in 1930, who designated as the genotype *Fusiella typica* L. and C. of the Huanglung limestone (Moscovian) of southeast China. They also included in the genus *Fusiella paradoxa* L. and C. of the Huanglung limestone of southeast China, and stated that *Boultonia rawi* Lee of the Penchi series (Moscovian) of south Manchuria might represent it; however, *B. rawi* more probably is a representative of the genus *Wedekindellina*.

a lower tectorium) ; the tectum of *Fusiella* probably corresponds to the tectum and diaphanotheca of *Wedekindellina*. Also, representatives of *Fusiella* do not contain the heavy deposits of tectorium that tend to fill the chambers in the axial regions of *Wedekindellina*. In *Fusiella* the shells are shorter and more obese than are those of *Wedekindellina*, and the inner volutions of the two genera are somewhat different.

Representatives of the genus *Wedekindellina* can be readily distinguished from those of *Schubertella* by their much longer axis, smaller form ratio, more numerous volutions, and by the development of the tectorium of *Wedekindellina* that fills the chambers in the polar regions. Representatives of the genera *Fusulina* s. s. and *Fusulinella* are as a rule much larger than are those of *Wedekindellina*, they have fluted septa in at least part of the shell, and they lack the heavy tectorium of the axial regions found in species of *Wedekindellina*. The relation between *Boultonia willsi* Lee, the genotype of *Boultonia* Lee,[9] and typical representatives of *Wedekindellina* seem sufficiently distinct to avoid any possible confusion, for Lee states that the antetheca in *Boultonia* are regularly and gently fluted, and his illustrations show that the axial region does not contain thick deposits of tectorium; also, the stratigraphic range of these two genera is quite different. In his original discussion of *B. rawi*, Lee[10] compared that species with *Fusulina exigua* Schellwien-Staff[11] (not *F. vulgaris exigua* Schellwien-Dyhrenfurth) from

---

9 The genus *Boultonia* was proposed by Lee (Lee, J. S., Fusulinidae of North China: *Palaeontologia Sinica*, ser. B., vol. 4, fasc. 1, p. 10) in 1927 and *B. willsi* Lee of the Uralian of South Manchuria was designated as the genotype—only one other species, *B. rawi* Lee of the Moscovian of South Manchuria, was referred to it. *B. rawi* has subsequently been referred by Dunbar and Henbest to *Wedekindellina* and by Lee and Chen to *Fusiella*. In 1930 Galloway and Ryniker (*Oklahoma Geol. Survey*, circular 21, p. 23) and in 1933 Dunbar (in Cushman, J. A., Foraminifera, p. 132) placed *Boultonia* in synonymy with *Schubertella*. The very elongate and slender nature of the shells and the fluted septa of *B. willsi*, the genotype of *Boultonia*, indicates to me that it is generically distinct from the genotype of *Schubertella*, and in 1933 Galloway (A Manual of Foraminifera, p. 400) accepted *Boultonia* as a valid genus.

10 Lee, J. S., Fusulinidae of North China: *Palaeontologia Sinica*, ser. B., Vol. 4, fasc. 1, p. 12, 1927.

11 The name *Fusulina exigua* Schellwien-Staff is a homonym of *Fusulina vulgaris exigua* Schellwien-Dyhrenfurth according to Article 36 of the International Rules of Zoological Nomenclature, and the species figured and described by Schellwien-Staff as *Fusulina exigua* and by Dunbar and Condra as *Triticites exiguus* is therefore without a valid name. I propose to call this species *Triticites nebraskensis*, and since the locality and horizon of Schellwien-Staff's specimens was not given I wish to designate the specimens figured and described by Dunbar and Condra (Dunbar and Condra's pl. 8, figs. 1-5) from

Iowa, but he stated that it presented certain differences from the latter. Dunbar and Condra[12] have shown that *F. exigua* Schellwien-Staff has a different wall structure than *B. rawi*, and that it occupies a position much higher stratigraphically than *B. rawi*.

Species of *Wedekindellina* are not as easily distinguished from one another as are those of some of the other genera of the Fusulinidae; this is due largely to their very small size, unfluted septa, and heavy deposits of tectorium which tend to hide the nature of the septa in the polar regions. In my collections from Iowa there are a number of specimens which present certain differences from the forms that are here recognized as distinct species but which I do not feel justified at the present time to establish as types of separate species or varieties. Some of the characters which collectively are recognized to be of specific value are general size of mature specimens, form ratio during ontogenetic development, general outline of the shell, trace of the septa, number of volutions, number of septa per volution, axial fillings of tectorium, etc.

Wedekindellina euthysepta (Henbest) ?

Plate XX, figures 1, 2, 7, 9, 12, 13, 17, 22, 24-27

Fusulinella euthusepta Henbest, *1928*, Jour. Pal., vol. 2, pp. 80-81, pl. 8, figs. 6-8, pl. 9, figs. 1, 2, 5.

(?) *Fusulinella euthusepta* Galloway and Ryniker, *1930*, Oklahoma Geol. Survey, Circular no. 21, pp. 25-26, pl. 5, figs. 6-11.

(?) *Fusulinella euthusepta* Roth, *1930*. Am. Assoc. Petroleum Geologists, Bull., vol. 14, p. 1261.

(?) *Fusulinella euthusepta*? Roth, *1930*, Am. Assoc. Petroleum Geologists, Bull., vol. 14, p. 1274.

(?) *Fusulina euthusepta* White, *1932*, Texas Univ. Bull. 3211, pp. 24-25, pl. 1, figs. 1-3.

Wedekindellina euthysepta Dunbar and Henbest, *1933*, Contr. Cushman Lab. Foram. Research, Special Pub. no. 4, p. 134, Key, pl. 10, figs. 13-15.

Shell minute, long, slender, and fusiform, with sharply pointed poles. Mature specimens of 7½ to 8 volutions measure 2.77 to 3.54

---

the Avoca limestone, Richfield Quarry, 2½ miles south of Richfield, Nebraska, as the types of *Trititicites nebraskensis*.

[12] Dunbar, C. O., and Condra, G. E., The Fusulinidae of the Pennsylvanian System in Nebraska: *Nebraska Geol. Survey* Bull. 2, ser. 2, pp. 111-113, pl. 8, figs. 1-5, 1927.

mm in length and 0.62 to 0.73 mm in width. Axis of coiling usually straight but in some specimens slightly irregular. The rate of decrease of the form ratio is rather uniform throughout growth as is shown by the form ratio of about 1:3.4 in the third volution, 1:3.7 in the fourth volution, 1:4.0 in the fifth volution, 1:4.5 in the sixth volution, and 1:4.5 to 1:5.0 in mature individuals. The surface is smooth to irregular, and in some of the specimens the central portion is markedly inflated.

The septa are rather thick. That part of the anterior tectorium which is adjacent to the tectum is about equal in density to the diaphanotheca on the opposite side of the tectum, but it seems to be disconnected, at least in structure, with the diaphanotheca of the spirotheca of the succeeding chamber; this lighter part measures about 3.9 microns about midway between the center and the poles in the seventh volution. Measurements taken about halfway between the center and the poles in the seventh volution give thicknesses for the anterior tectorium 7.8 microns, for the diaphanotheca 9.8 microns, and for the posterior tectorium 5.8 microns. The external furrows are straight to sinuous and the septa are unfluted.

The proloculum is oval to irregular in shape and the diameter measures between 30 and 45 microns with the maximum diameter apparently parallel to the axis of coiling. The successive volutions develop with uniform increase in the height of the antetheca, and the number of septa increase rather rapidly in the first four volutions and then remain fairly constant in the remaining volutions. The septal count of a sagittal section of a typical specimen is 10 for the first volution, 12 for the second volution, 16 for the third volution, 20 for the fourth volution, 22 for the fifth volution, 22 for the sixth volution, and 23 for the seventh volution.

The four layers of the spirotheca or wall are not easily distinguishable in all parts of the sections. The upper tectorium may be divided into an upper very dense part and a lower much clearer part; the lower part is about one-third as thick as the upper part. The diaphanotheca is only slightly, if any, less dense than the lower part of the upper tectorium. The lower tectorium is very dense, and in some chambers it seems to be exceedingly thin or even absent. The thicknesses of three of the four layers of the spirotheca, measured in the seventh volution just beyond the limits of the chomata and beginning at the upper side, are: upper tectorium 10.0 microns, diaphanotheca 7.8 microns, and lower tectorium 4.0

microns. The upper tectorium, combined with the lower parts of the tectoria of the septa, completely fills all chambers in the polar regions in all volutions except the last chambers of the last volution. In most parts of the sections the spirotheca appears as a rather thick layer bordered on both sides by thinner darker layers and containing near its center a very dark line.

The cross section of the tunnel is very low and elongate; it is about one-fourth as high as the septa and about one-sixth as high as long. The line of intersection of the tunnel with sagittal sections is irregular and the tunnel angle measures about 23 to 30 degrees. The tunnel is bordered on either side by an asymmetrical ridge with a sharply rounded crest which is about one-half the height of the chambers and about twice as wide as high. The floor of the tunnel is covered by a material about equal to the lower part of the upper tectorium in density and thickness, and this layer is higher in the center of the tunnel than near its borders.

The specimens that I am referring with question to this species are quite variable and all of them may not be conspecific. They seem to be divisible into two general types or groups but neither of these is precisely similar with Henbest's figured cotypes of *W. euthysepta*. The specimens represented by figures 1, 2, 9, 17, and 22 on plate XX illustrate one of these groups which is characterized by a long slender uniform shell, a large tunnel angle, and straight external furrows. The specimens represented by figures 7, 12, 13, and 24-27 on plate XX illustrate the second of my groups which is characterized by long slender irregular shells which are distinctly inflated in the central portion, and by very irregular external furrows. In the figure cotypes of *W. euthysepta*, which come from approximately the same horizon as my forms, the shell, though long and slender, has a larger form ratio than any of my specimens and it is larger at maturity and has a greater number of volutions. It seems to me rather doubtful if all of the specimens from Oklahoma, Texas, South Dakota, and Colorado that Galloway and Ryniker, White, and Roth have referred to *W. euthysepta* are conspecific with the figured cotypes of that species, but I can not express a definite opinion in regard to their specific affinities without having an opportunity to examine either the cotypes or the Oklahoma, Texas, South Dakota, and Colorado specimens.

Occurrence.—Specimens which I am referring with question to this species have been found very abundantly in a calcareous shale immediately below a thin limestone ledge approximately 35 feet below the White Breast coal in the west road-ditch on the east line of Lucas County, Iowa, near the top of a north-sloping hill, east center SE¼ sec. 1, T. 73 N., R. 20 W. (pl. XX, figs. 2, 7, 9, 12, 13, 17, 24-27); from the same horizon on the south bank of a west-flowing creek, 10 feet above the creek bed, 75 yards south of County road L, ½ mile west of Lovilia, Monroe County, Iowa, NE¼SW¼ sec. 10, T. 73 N., R. 18 W. (pl. XX, fig. 22); and sparingly from a shale between two thin limestone layers 8 feet above the White Breast coal, in the bed of a small creek in the southeast corner NE¼ sec. 10, T. 70 N., R. 11 W., Van Buren County, Iowa (pl. XX, fig. 1). The cotypes came from the Tradewater formation of southern Illinois; also Galloway and Ryniker have referred specimens to this species from the Atoka formation of Oklahoma, White referred specimens to this species from the Millsaps formation of Texas, and Roth referred specimens to this species from beds of Cherokee age of South Dakota and Colorado.

Repository.—State University of Iowa, Catalogue Nos. 975-982, 990-995; the figured specimens are Nos. 990, 992-994, 978-982.

WEDEKINDELLINA DUNBARI Thompson, n. sp.

Plate XX, figures 3, 6, 15, 16, 20, 21

Shell minute, elongate, uniformly fusiform; poles sharply pointed; external furrows faint. Mature specimens of 8 volutions are 2.85 to 3.0 mm in length and 0.71 to 0.80 mm in width. The form ratio is about 1:3.2 in the third volution, 1:3.4 in the fourth volution, 1:3.5 to 1:3.8 in the fifth volution, and 1:3.4 to 1:4.0 in mature forms. Axis of coiling essentially straight. The profile throughout growth is rather uniform, but there is a slight inflation near the poles in some mature specimens.

The thicknesses of the septa differ considerably in the different volutions and from the center to the poles in any one volution. This variation is due mainly to the variation in the thicknesses of the tectoria. The tectoria are rather dense; they thicken toward the base where they continue onto the "floors" of the chambers to form the upper tectorium of the spirotheca, and they become thinner near the upper portion of the septa where they continue at least partially onto the "roofs" of the chambers to form the lower tectorium of the spirotheca. These layers of tectoria decrease in thickness anteriorly in the last volution, and they increase in thickness in passing laterally from the center to the poles where they, combined with the upper tectorium of the spirotheca, completely fill the chambers in all volutions except the last two. The diaphanotheca is about equal in thickness to the diaphanotheca of the spirotheca. The tectum is very thin and dense and is the downward extension to the base of the septa of the tectum of the spirotheca. The septa are unfluted and they are essentially straight throughout most of their length, but as they approach the poles they make sharp backward twists. There are about 13 septa in the second volution, 14 in the third volution, 15 in the fourth volution, 16 in the fifth volution, and 17 in the sixth volution.

The spirotheca or wall is composed of three complete layers and a fourth apparently incomplete layer. The upper tectorium is rather dense and is 12 microns thick in the fifth volution just beyond the limits of the chomata, and it increases to the entire thickness of the chambers in the polar regions where this layer, combined with the tectoria of the septa, completely fills the chambers in all volutions except those of the last one or two. The diaphanotheca is about 12 microns thick in the sixth volution. The lower tectorium seems to be only a partial covering that does not span the "roofs" of all the chambers, and it is formed by the continuation of the tectoria of the septa.

The proloculum is sub-spherical; it has a small flattened area around the aperture, and it is about 35 microns in diameter.

The cross section of the tunnel is elongate-elliptical. The tunnel does not increase in size uniformly during ontogenetic development but in mature individuals it is about one-half the height of the septa and about one-third as high as wide. The line of intersection of the tunnel with axial sections is not regular, but a determination of the tunnel angle made in the last volution gives 14 to 22 degrees. The chomata have a very steep slope toward the tunnel and a more gentle slope toward the poles; these ridges are very faint in the earlier stages of growth but they are about one-half the height of the chambers of the fifth and sixth volutions.

In general external appearances and form ratios of mature specimens *Wedekindellina dunbari* more closely resembles *W. euthysepta* (Henbest) than any other described species, but it differs from that form in that mature representatives of *W. euthysepta* are much larger than mature specimens of *W. dunbari*, and the form ratios of successive volutions in ontogenetic development of *W. dunbari* decrease gradually to maturity whereas the form ratios of successive volutions of *W. euthysepta* decrease rapidly to the seventh volution and then increase to maturity. *W. dunbari* is relatively shorter and wider for corresponding volutions and has a smaller number of volutions than *W. euthysepta*.

Occurrence.—This species has been found in only a calcareous shale approximately 35 feet below the White Breast coal, in the west road-ditch, on the east line of Lucas County, Iowa, near the top of a north-sloping hill, east center SE¼ sec. 1, T. 73 N., R. 20 W. (pl. XX, figs. 3, 6, 15, 16, 20, 21); and in the same horizon in the south bank of a small west-flowing creek, 10 feet above the bed of the creek, 75 yards south of County road L, ½ mile west Lovilia, NE¼SW¼ sec. 10, T. 73 N., R. 18 W., Monroe County, Iowa.

Repository.—State University of Iowa, Catalogue Nos. 983-989 (cotypes); the figured specimens are Nos. 986-989.

WEDEKINDELLINA ELFINA Thompson, n. sp.

Plate XX, figures 8, 10, 11, 18, 19

Shell very minute, sub-fusiform, with sharply pointed poles; central portion slightly inflated; external furrows shallow; axis of coiling straight to broadly curved. Mature specimens are about 1.90 mm in length and 0.56 mm in width. The form ratio of mature specimens of 8 volutions is between 1:3.3 and 1:3.5. The form ratio for the third, fourth, and fifth volutions is 1:3.3, showing a uniform rate of growth throughout the length of the shell.

The septa are fairly straight except near the poles where they curve backward rather strongly. The two outer layers of tectoria are of about equal thickness; they thin toward the top of the septa and they thicken toward the base of the septa. The line of separation of the diaphanotheca of the septa and the posterior tectorium is somewhat indefinite, but the former layer can be distinguished from the latter by its slightly more nearly transparent nature and by its slightly more coarsely crystalline structure. The septal count for two typical specimens is 15 for the second volution, 16 for the third volution, 19 for the fourth volution, 21 for the fifth volution, and 22 for the sixth volution.

The proloculum is roughly a triaxial ellipsoid with the major axis parallel to the axis of coiling. The three axes, as measured from a number of sections, are respectively about 50, 40, and 30 microns in length. The inner three volutions are slightly more tightly coiled than the outer volutions.

The spirotheca or wall is relatively thick. The upper tectorium is about 6.0 microns in thickness in the fifth volution just beyond the limits of the chomata; it is rather dense, and it, combined with the lower parts of the tectoria of the septa, thickens very rapidly from the outer limits of the chomata so that it completely fills the chambers in the polar regions of all volutions except the first two or three. The diaphanotheca is of about the same density as the lower part of the upper tectorium, and it is about 8.0 microns in thickness in the sixth volution beyond the limits of the chomata. The lowest layer of the spirotheca, tectorium, is slightly more dense than the diaphanotheca; it is well developed over the tunnel and is about one-half as thick as the diaphanotheca, but beyond the limits of the chomata it is very thin near the septa and is exceedingly thin or even absent in the mid-length of the chambers.

The cross section of the tunnel is roughly elliptical in shape and it is about one-half as high as the septa and about one-half as high as long. The width of the tunnel varies considerably from one volution to the next and its intersection with an axial section is irregular; however, a determination made in the sixth volution gives a tunnel angle of 22 degrees. The floor of the tunnel is depressed and is covered by a part of the tectorium of the spirotheca of the preceding volution. The chomata are very low and broad.

Wedekindellina elfina is somewhat similar to *W. minuta* (Henbest) of the Tradewater formation of Illinois, but it differs from that species particularly in that its proloculum is smaller, mature specimens contain a larger number of volutions, and the ends of *W. elfina* are sharply pointed while those of *W. minuta* are bluntly pointed. It seems to me that Henbest has included two forms in *W. minuta,* but neither of these is conspecific with *W. elfina.* *W. elfina* differs from *W. uniformis* in that its central portion is inflated whereas *W. uniformis* has a uniform profile, and the axial fillings of *W. uniformis* are better developed in the early volutions than in *W. elfina.*

Occurrence.—*Wedekindellina elfina* has been found only in a calcareous shale beneath a thin limestone 35 feet below the White Breast coal, in the west road-ditch of the east line of Lucas County, Iowa, near the top of a north-sloping hill, east center SE$\frac{1}{4}$ sec. 1,

T. 73 N., R. 20 W. (pl. XX, figs. 8, 10, 11, 18, 19) ; and in the same horizon in the south bank of a small west-flowing creek, 75 yards south County road L, 10 feet above the creek bed, ½ mile west Lovilia, Monroe County, Iowa, NE¼SW¼ sec. 10, T. 73 N., R. 18 W.

Repository.—State University of Iowa, Catalogue Nos. 962-968 (cotypes) ; the figured specimens are Nos. 965-968.

WEDEKINDELLINA UNIFORMIS Thompson, n. sp.
Plate XX, figures 4, 5, 14, 23

Shell minute, uniformly fusiform, with moderately sharply pointed poles; external furrows shallow. Mature specimens are about 2.00 mm in length and 0.70 mm in width. The rate of growth is very uniform throughout; the form ratio is 1:2.6 in the third volution, 1:2.9 in the fourth volution, and 1:3.0 in the fifth volution, and it remains constant in the outer portion of mature forms which consist of about 8½ volutions. The axis of coiling is straight.

The septa are very thick. They are composed of four layers. The outer two layers are each much thicker than the two inner layers combined. The combined thickness of these tectoria of the septa and the upper tectorium of the spirotheca completely fills the chamber in the polar regions in all volutions. The diaphanotheca is of about equal thickness to the diaphanotheca of the spirotheca. The diaphanotheca of the following chamber seems to extend about one-eighth the height of the septa down the anterior side of the tectum; this, however, may be considered as part of the spirotheca. The septa are unfluted and the external furrows are straight throughout the length of the specimen. There are about 13 septa in the second and third volutions, 15 in the fourth volution, 17 in the fifth volution, 18 in the sixth volution, and 22 in the seventh volution.

The spirotheca or wall is very thick laterally from the tunnel and is made up of four layers. The upper and lower tectoria are rather dense and are the continuations of the tectoria of the septa. The upper tectorium is about 10 microns in thickness in the line of the tunnel of the sixth volution and thickens very rapidly until it completely fills the chambers in the polar regions; the lower tectorium is extremely thin and only appears as a slightly darker line at the base of the diaphanotheca. The diaphanotheca is about 8 microns thick in the sixth volution and 12 microns thick in the last chamber of specimens of seven and one-half volutions. In some specimens the lower part of the upper tectorium of the spirotheca is about equal in density to the diaphanotheca, and the tectum appears as a dark line near the center of a thick homogeneous layer.

The proloculum is essentially spherical and measures 35 to 40 microns in diameter. The first four volutions are tightly coiled and the remaining volutions are more loosely coiled. The axis of the first volution in all specimens is at an angle to the axis of the remaining outer volutions and axial sections may appear as a sagittal section for the inner volution (see fig. 5, pl. XX).

The cross section of the tunnel is sub-elliptical and is about one-half as high as wide and a little more than one-half the height of the antetheca. Each side of the tunnel is bordered, except in the last two volutions, by a very asymmetrical ridge, choma, that has a very steep slope next to the tunnel and a very gentle downward slope away from the tunnel. The floor of the tunnel is underlain by the upper layer, tectorium, of the spirotheca. The intersection of the line of the tunnel with axial sections is relatively straight for the genus, and determinations of the tunnel angle give 15 to 20 degrees.

Wedekindellina uniformis seems to be more closely similar to *W. elfina* than to any other described species. *W. uniformis* can be distinguished from that species by its larger form ratio, more uniform profile, thicknesses of the layers of the spirotheca, and the development of its early volutions. *W. uniformis* may be distinguished from *W. minuta* (Henbest) by its larger form ratio, its more sharply pointed poles, and its more numerous volutions; also, the general shape of the shell of these two species is different.

Occurrence.—This species occurs sparingly in a calcareous shale 35 feet below the White Breast coal in the west road-ditch, on the east line of Lucas County, Iowa, near the top of a north-sloping hill, east center SE¼ sec. 1, T. 73 N., R. 20 W. (pl. XX, figs. 4, 5, 14, 23); and very sparingly in the same horizon on the south bank of a small west-flowing creek, 10 feet above the bed of the creek, 75 yards south of County road L, ½ mile west of Lovilia, Monroe County, Iowa, NE¼SW¼ sec. 10, T. 73 N., R. 18 W.

Repository.—State University of Iowa, Catalogue Nos. 969-974 (cotypes); the figured specimens are Nos. 972-974.

Genus Fusulinella Möller

The genus *Fusulinella* was established by Möller[13] in 1877, but it was a year later[14] before any species were referred by name to it; at this later time Möller referred four species to the genus, but he did not designate a genotype. In 1906 Douvillé[15] designated *Fusulinella bocki*, the first species described under the name *Fusulinella*, as the genotype, and it is clear from Möller's original generic diagnosis that this is the type of shell for which he founded the genus. One of the remaining three species referred to this genus by Möller in 1878, *F. sphaerica*, has subsequently been made the type of the genus *Staffella* by Ozawa.[16] This latter genus includes at least one of the two remaining species described under *Fusulinella* by Möller in 1878, *Melonia* (*Borelis*) *sphaeroidea* Ehrenberg; the other one, *F. bradyi* Möller, has been referred by Galloway and Harlton to *Orobias*.

In the Schellwien-Staff monographs, and some others, the name *Fusulinella* is used to refer to forms which are congeneric with *Staffella sphaerica* and quite different from *Fusulinella bocki*. Other paleontologists have used this generic name to designate forms now known to be congeneric with *Fusulina cylindrica*, the type of the genus *Fusulina*. The limits of the genus *Fusulinella* have become clearer since the true nature of *Fusulina cylindrica* Fischer-de-Waldheim, the type of *Fusulina*, has been described by Lee[17] and by Dunbar and Henbest.[18]

The genus *Neofusulinella* was proposed by Deprat[19] in 1912 for an unnamed species of Fusulinidae "dans les calcaires rapportés de Bam-Na-Mat (entre Sam-Neua et Luang-Prabang), par M.

---

13 Möller, V. von, Ueber Fusulinen und ähnliche Foraminiferen-Formen des russischen Kohlenkalkes: *Neues Jahrb. Min. Geol. und Pal.*, Jahrg. 1877, pp. 144-146.

14 Möller, V. von, Die Spiral-Gewundenen Foraminiferen des russischen Kohlenkalks: *Mém. Acad. Imp. Sci. St. Pétersbourg*, ser. 7, vol. 25, no. 9, 1878.

15 Douvillé H., Les calcaires a Fusulines de l'Indo-Chine: *Bull. Soc. Géol. France*, ser. 4, vol. 6, p. 584, 1906.

16 Ozawa, Y., On the Classification of Fusulinidae: *Jour. Coll. Sci., Imp. Univ. Tokyo*, vol. 45, art. 4, p. 24, 1925.

17 Lee, J. S., Fusulinidae of North China: *Palaeontologia Sinica*, ser. B, vol. 4, fasc. 1, pp. 32-35, 1927.

18 Dunbar, C. O., and Henbest, L. G., The fusulinid genera *Fusulina*, *Fusulinella* and *Wedekindella*: *Am. Jour. Sci.*, ser. 5, vol. 20, pp. 357-364, 1930.

19 Deprat, J., Sur deux genres nouveaux de Fusulinidés de l'Asie orientale, intéressants au point de vue phylogénique: *Comptes R. Acad. Sci., Paris*, vol. 154, pp. 1548-1550, 1912.

Mansuy''; in this same publication Deprat stated (page 1550): ''En effet il [the fusulinid species for which he was establishing the new genus] se trouve dans les calcaires permiens à *Doliolina lepida*''. The following year Deprat[20] described the species for which he had originally founded the genus and two other new species which he had encountered since he had established the genus. This was the first time that any named species were referred to this genus. It is clear that Deprat based his genus on a species from the Permian of Bam-na-mat between Sam-neua and Luang-prabang (Laos) that was collected by M. Mansuy. The three species first referred by name to this genus, *Neofusulinella,* in 1913 by Deprat were described in the following order: first, *N. praecursor* Deprat from the base of the Moscovian of Cammon (Laos), second, *N. lantenoisi* Deprat from the Permian of Ban-na-mat (Laos) which was collected by M. Mansuy, and third, *N. schwagerinoides* Deprat from the Moscovian of Cammon. Deprat's original diagnosis of the genus was based on a single species for which he later coined the name *N. lantenoisi,* and it clearly is the genotype of *Neofusulinella.* Galloway and Ryniker[21] have stated that the type of *Neofusulinella* is *N. praecursor* Deprat, the first species to be referrd by name to the genus. It is clear that *N. praecursor* and *N. schwagerinoides* were not included in the original description of the genus, and that *N. lantenoisi* was the only species involved. Therefore, in accordance with Article 30, I, (c), and Opinion 46 of the International Rules of Zoological Nomenclature, *N. lantenoisi* Deprat is the gentoype of *Neofusulinella.* In Deprat's fourth memoir on the family Fusulinidae (*Mém. Service Géol. Indochine,* vol. 4, fasc. 1, 1915) he described three additional species, *N. elongata, N. giraudi* and *N. minima,* from the Permian limestone of Cammon (Laos) under the name *Neofusulinella.* One of these last three species described by Deprat, *N. giraudi,* has been made the type of a new genus *Depratella* by Ozawa.[22] Ozawa stated that his genus can be distinguished from other genera of Fusulinidae by its very small size and *Endothyra*-like asymmetrical early volu-

[20] Deprat, J., Les Fusulinidés des Calcaires Carbonifériens et Permiens du Tonkin, du Laos et du Nord-Annam: *Mém. Service Géol. Indochine,* vol. 2, fasc. 1, pp. 40-44, 1913.

[21] Galloway, J. J., and Ryniker, C., Foraminifera from the Atoka formation of Oklahoma: *Oklahoma Geol. Survey,* Circ. 21, pp. 22-23, 1930.

[22] Ozawa, Y., A new genus, *Depratella,* and its relation to *Endothyra*: *Contr. Cushman Lab. Foram. Research,* vol. 4, pt. 1, no. 55, pp. 9-10, 1928.

tions. It has been stated by Ozawa that the first three species referred to the genus *Neofusulinella* by Deprat have heavy depositional layers [tectoria] on the walls and septa and that they belong to the genus *Fusulinella*, and that this genus *Depratella* Ozawa lacked these deposition layers; this is probably true for *N. praecursor* and *N. schwagerinoides* of the Moscovian, but an examination of Deprat's illustrations and descriptions of *N. lantenoisi*, the genotype of *Neofusulinella*, and *N. giraudi*, the genotype of *Depratella*, leave no doubt that their wall structures as well as other internal features are not materially different, and they are both from the same general stratigraphic horizon. It seems then that we must consider *Depratella* a synonym of *Neofusulinella*.

The species *N. praecursor* and *N. schwagerinoides* are more closely related to the genotype of *Fusulinella* than to any other genotype. The form referred by Deprat to the genus *Fusulinella* in 1913, *F. quadrata*, is clearly more closely related to *Staffella sphaerica*, the genotype of *Staffella*, than to any other recognized genotype. The generic relationships of *N. lantenoisi*, the genotype of *Neofusulinella*, to *Fusulinella bocki*, the genotype of *Fusulinella*, however, are not so clear. Deprat's illustrations of this species (Deprat's pl. 7, figs. 23-25) do not lend themselves to a clear understanding of the internal structures, but they suggest a more highly developed form which lacks the thick tectorium found in *Fusulinella bocki*. This line of evidence suggests very strongly that *N. lantenoisi* (and therefore *N. giraudi*) are congeneric with *Schubertella transitoria* Staff and Wedekind, the genotype of *Schubertella* Staff and Wedekind, which also is not well known.

The illustrations and description of the genotype of *Yangchienia* Lee,[23] *Y. iniqua* Lee of the Chihsia limestone (lower Permian) near Nanking, suggest that it is closely related to *N. lantenoisi* and it may be congeneric with that species. However, the spirotheca of *N. lantenoisi* appears to be thicker than that of *Y. iniqua* due largely to a thicker diaphanotheca in *N. lantenoisi*, also the chomata of these two species are slightly different. The early volutions of *N. lantenoisi* have not been well illustrated but they are probably like those of *Y. iniqua*. The general stratigraphic horizon of these two genotypes is about the same; and the only major difference between

23 This genus was proposed by Lee in 1933 (Lee, J. S., Taxonomic criteria of Fusulinidae with notes on seven new Permian genera: *Mem. Nat. Research Inst. Geol.*, no. 14, p. 14) and with only the genotype referred to it.

the two species appears to be that *Y. iniqua* has a larger chomata and thinner diaphanotheca than *N. lantenoisi.*

From a study of the illustrations and descriptions of the genotype, the descriptions and illustrations of congeneric species, and the specimens available for study, I have drawn up the following generic diagnosis of *Fusulinella*: Shell small, fusiform and short, with an essentially straight axis of coiling. Mature specimens are of ten or less volutions, have a relatively large form ratio, and usually do not exceed 3 mm in length. The septa are composed of an anterior and posterior tectorium, a tectum, and a diaphanotheca. The lower part of the septa are essentially straight to broadly fluted in the polar regions, and are unfluted in the midportion of the shell. The spirotheca is composed of a thick upper tectorium, a tectum, a diaphanotheca, and a relatively thin lower tectorium. The upper tectorium thins slightly poleward from the center of the shell. The tunnel is bordered on either side by an asymmetrical ridge, choma, which has a gentle slope poleward and a relatively steep slope on the tunnel-side.

The name *Fusulinella* has been used to designate a rather large number of American species that are now known to represent at least two genera, *Fusulina* s. s. and *Wedekindellina,* but up to the present it has not been used to designate any American species that are congeneric with *Fusulinella bocki,* the genotype of *Fusulinella.* The following American species seem to be more closely related to *Fusulinella bocki* than to any other recognized genotype and should therefore be referred to the genus *Fusulinella*: *Fusiella primaeva* Skinner and *Fusulina llanoensis* Thomas of the Marble Falls formation (Bend) of Texas, and *Fusulinella iowensis* Thompson of the lower part of the Cherokee of Iowa, described below. It seems probable that *Schubertella transitoria* Galloway and Ryniker (not *S. transitoria* Staff and Wedekind) of the Atoka formation of Oklahoma and *Schubertella gallowayi* Skinner of the Cherokee of Oklahoma are more closely related to *F. bocki* than any other proposed genotype. As can be seen from the above list the genus *Fusulinella* is rather widespread in North America, and it includes some of the oldest known American fusulinids. In America the genus is not known to occur in beds older than the Marble Falls formation nor in beds younger than the middle of the Cherokee, and elsewhere in the world it is generally limited to the Lower Pennsylvanian. However, in 1925 Ozawa[23a] described a form, *F. itoi,* from Japan and stated that it was Upper Permian in age. This species is very similar to *F. bocki* of the Lower Pennsylvanian of Russia and its age needs verification.

Since the true nature of *Fusulina cylindrica* has become clear, some doubt has been expressed as to the validity of the genus *Fusulinella,* and it has been placed in synonymy with *Fusulina* by some paleontologists. In the forms here referred to *Fusulinella* the septa are only very weakly fluted in the polar regions whereas the septa are fluted throughout the length of the shell in typical representatives of *Fusulina* s. s. The chomata of typical representatives of *Fusulinella* are much more strongly developed than are those of *Fusulina.* The spirotheca of representatives of *Fusulina* are usually much thinner, and the shells are usually more elongate. The characters of these two groups of species seem to me to be so very distinctive that there is little reason to believe that all are congeneric, and I am therefore recognizing the validity of both *Fusulina* and *Fusulinella.*

The genus *Wedekindellina* differs from *Fusulinella* particularly in that its representatives are more slender and smaller, they have different developments of the tectoria that fill the chambers in the polar regions, and their septa are essentially unfluted. The relationship of *Fusulinella* to the genus *Schubertella,* as well as to *Neofusulinella, Depratella,* and *Yangchienia,* is not so clearly known, but these forms seem to differ from *Fusulinella* in that their spirotheca does not contain the layers of tectoria which are invariably present in *Fusulinella*; also their early volutions are different from those of *Fusulinella.* The stratigraphic positions of the species on which these four genera were based are quite different from that of known representatives of *Fusulinella,* and it is probable that other generic distinctions can be pointed out after further studies have been made. In general shape *Fusulinella* resembles *Fusiella* somewhat closely, but representatives of these two genera may be readily distinguished for in representatives of *Fusulinella* there are four distinct layers in the spirotheca whereas only three layers can be distinguished in representatives of *Fusiella.* The chomata are very faint in *Fusiella* but the chomata

---

[23a] Ozawa, Y., Paleontological and stratigraphical studies on the Permo-Carboniferous limestone of Nagato: *Jour. Coll. Sci, Imp. Univ. Tokyo,* vol. 45, art. 6, p. 19, pl. 3, figs. 6, 8, 1925.

Genus Fusulina Fischer-de-Waldheim

In 1829 Fischer-de-Waldheim[24] established the genus *Fusulina* for two species from the Upper Carboniferous (Lower Pennsylvanian equivalent) of Miatschkowo, Russia, which he[25] described eight years later as *Fusulina cylindrica* and *F. depressa.* This generic term has been applied to a great variety of fusulinids, but within the last few years the scope of the genus *Fusulina* has been greatly restricted and at present it includes only species which are very closely similar to *F. cylindrica,* the genotype. In America, representatives of this genus in a restricted sense are known to occur only in strata ranging in age from the lower part of the Cherokee to the top of the Des Moines.

In the original description of *F. cylindrica,* the characters which are today used to differentiate fusulinid species and genera are not clearly illustrated or described, but topotypes of this species have subsequently been illustrated and described by a number of paleontologists, among whom may be mentioned Brady[26], Möller[27], Schellwien-Staff[28], Lee[29], and Dunbar and Henbest[30]. Möller interpreted the spirotheca of *F. cylindrica* as being like that of Upper Pennsylvanian and Lower Permian forms, that is, composed of a tectum and a keriotheca with aveoli. Subsequent workers followed Möller in his interpretation of the spirotheca of *F. cylindrica,* and, as the septa of *F. cylindrica* are definitely fluted throughout the length of the shell, they referred to *Fusulina* forms which have this type of septa fluting and spirotheca; these are now placed in the genera *Leeina, Pseudofusulina, Parafusulina,* and *Polydiexodina.*

---

24 Fischer-de-Waldheim, G., Les Céphalopodes fossiles de Moscou et de ses environs: *Bull. Soc. Imp. Natur. Moscou,* vol. 1, p. 330, 1829.

25 Fischer-de-Waldheim, G., Oryctographie du Gouvernement de Moscou 1830-37, pp. 126-127, 1837.

26 Brady, H. B., Notes on a group of Russian fusulinae: *Ann. Mag. Nat. Hist.,* ser. 4, vol. 18, pp. 415-416, pl. 18, figs. 1-4, 1876.

27 Möller, V. von, Die spiral-gewundenen Foraminiferen des russischen Kohlenkalks: *Mém. Acad. Imp. Sci. St. Pétersbourg,* ser. 7, vol. 25, no. 9, pp. 51-54, pl. 1, figs. 2a-2h, pl. 7, figs. 1a-1d, 1878.

28 Schellwien, E., by Staff, H. von, Monographie der Fusulinen, Teil I, Die Fusulinen des russisch-arktischen Meeresgebietes: *Palaeontographica,* vol. 55, pp. 161-163, pl. 13, figs. 1-11 (not figs. 12-13), 1908.

29 Lee, J. S., Fusulinidae of North China: *Palaeontologia Sinica,* ser. B., vol. 4, fasc. 1, pp. 32-35, pl. 4, fig. 8 (not pl. 1, fig. 3, pl. 4, figs. 1-7), 1927.

30 Dunbar, C. O., and Henbest, L. G., The fusulinid genera *Fusulina, Fusulinella* and *Wedekindella*: *Amer. Jour. Sci.,* ser. 5, vol. 20, pp. 357-364, 1930.

When Lee studied topotypes of *Fusulina cylindrica* in 1927, he discovered that in this species the spirotheca has a structure like that of *Fusulinella*, as first described by Möller in 1877, and quite different from the higher Pennsylvanian and Permian forms. In 1930 Dunbar and Henbest also described the spirotheca of *F cylindrica* as being like that of *Fusulinella*, and they restricted the name *Fusulina* to Lower Pennsylvanian forms like those described below.

In 1909 Staff[31] proposed the name *Girtyina* for a subgenus of *Fusulina* and stated that the subgenotype is *G. ventricosa* Meek. Previously, on the same page, he spoke of his subgenus as being represented by *Fusulina* (*Girtyina*) *ventricosa* in Schellwien's manuscript; this manuscript was published by Staff in 1912, and the form described in it as *Girtyina ventricosa*[32] is not at all like the type specimens of *Fusulina ventricosa* Meek and Hayden which represent the genus *Triticites*, but is more nearly like *F. cylindrica* than any other genotype. *G. ventricosa* of Staff (not of Meek and Hayden) has subsequently been named *Fusulinella girtyi* by Dunbar and Condra. Opinion 65 of the International Rules of Zoological Nomenclature states that if an author designates a certain species as genotype it is to be assumed that his determination of the species is correct. If this opinion is to be followed strictly, *Girtyina* is a synonym of *Triticites*, which was established in 1904. However, it seems clear that Staff based his genus *Girtyina* on specimens from Illinois sent to Europe by Meek, who erroneously labeled them *Fusulina ventricosa*; these are now known as *Fusulina girtyi* (Dunbar and Condra). *F. girtyi* has been made the type of a genus *Beedeina* by Galloway[33]. After a detailed study of the illustrations and descriptions of the types of *F. girtyi* and conspecific specimens from Iowa, I am of the opinion that this species is so similar to *F. cylindrica*, the genotype of *Fusulina*, that the two should be regarded as congeneric, and I therefore am suppressing *Beedeina* as a synonym of *Fusulina*.

The following North American species are more nearly similar and presumably more closely related to *Fusulina cylindrica*, the genotype of *Fusulina*, than any other recognized genotype and

---

[31] Staff, H. von, Beiträge zur Kenntnis der Fusuliniden: *Neu. Jahrb. Min. Geol. Pal.*, Beilage-B. 27, p. 490, 1909.

[32] Staff, H. von, Monographie der Fusulinen, Teil III, Die Fusulinen (Schellwienien) Nordamerikas: *Palaeontographica*, vol. 59, pp. 164-165, pl. 18, figs. 2, 5, 7, 1912.

[33] Galloway, J. J., A manual of Foraminifera: p. 401, 1933.

should therefore be referred to the genus *Fusulina*: *Fusulina inconspicua* Girty of the Wewoka of Oklahoma; *Girtyina haworthi* Beede of the lower Fort Scott limestone of Kansas; *Fusulinella girtyi* Dunbar and Condra of the Carbondale formation of Illinois; *Fusulina tregoensis* [= *F. meeki tregoensis*] Roth and Skinner of the Cherokee of Kansas; *F. minutissima* R. and S. and *F. hartvillensis* R. and S. of the Hartville limestone of Wyoming; *F. distenta* R. and S. and *F. rockymontana* R. and S. of the McCoy formation of Colorado; *F. leei* Skinner of the Cherokee of Oklahoma; *F. similis* [= *F. meeki similis*] Galloway and White of the Millsaps formation of Texas; and the forms from the Des Moines series of Iowa described below as *Fusulina? problematica*, *F. pumila*, *F. euryteines*, *F. kayi*, *F. lucasensis*, *F. stookeyi*, *F. megista*, *F. mysticensis*, and *F. eximia*. From the above list it can be seen that the genus *Fusulina* is widespread geographically in North America, and it is known to occur in Europe and Asia and probably in South America. However, its stratigraphic range is limited and it is not known to occur in beds older than the lower part of the Cherokee nor in beds younger than the top of the Des Moines series.

From a study of the descriptions and illustrations of the genotype and conspecific species and all of the numerous specimens available, I have drawn up the following generic diagnosis of the genus *Fusulina*: Shell fusiform to sub-cylindrical, more or less elongate; mature forms vary from about 2.5 to 10 mm in length and from about 1 to 3.5 mm in width. Axis of coiling straight to irregular. External furrows shallow. The spirotheca is composed of an upper tectorium which thins slightly poleward, a tectum, a thin diaphanotheca, and a thin lower tectorium. In some of the more highly developed representatives of the genus the lower tectorium is exceedingly thin or even absent in the mid-length of the chambers beyond the limits of the chomata. The septa are composed of an anterior and posterior tectorium, a tectum, and a diaphanotheca; the tectum and the diaphanotheca are the downward continuations of the tectum and the diaphanotheca of the spirotheca of the preceding chamber. The septa are fluted throughout the length of the shell and the fluting is typically more intense and higher in the polar regions than near the tunnel. The inner volutions are typically symmetrical and fusiform. The tunnel is low and is bordered on either side by deposits, chomata, that form distinct ridges in the inner volutions, but are more or less irregular in the outer volutions.

Representatives of the genus *Fusulina* can be distinguished from those of *Triticites* by the fact that in *Fusulina* the septa are fluted throughout their entire length, whereas in *Triticites* they are essentially straight across the mid-portion of the shell. The spirotheca in *Fusulina* is composed of four layers whereas in *Triticites* it is composed of only two layers, a tectum and a keriotheca—the keriotheca shows an aveoli structure; also the stratigraphic range of the two genera is different. Representatives of *Fusulina* can be distinguished from those of *Fusulinella* by their highly fluted septa throughout the length of the shell and by the less highly developed chomata in *Fusulina*. The spirotheca is typically thinner and the shell is typically more elongate in *Fusulina* than in *Fusulinella*. In *Pseudofusulina* and *Leeina* the structure of the spirotheca and the septa differs from that of *Fusulina*.

The genus *Fusulina* does not constitute as compact a group of species as does *Wedekindellina*, *Fusulinella* and some other genera of primitive fusulinids, for the shape of the shells as well as the intensity of the septal fluting is quite variable in different species. This difference however is more apparent than real for a critical examination of such apparently widely different species as *F. girtyi*, *F. mysticensis*, and *F. kayi* brings out the fact that they differ only in degree and not in structure.

FUSULINA LEEI Skinner

Plate XXI, figures 3, 7, 10, 18

Fusulina leei Skinner, *1931*, Jour. Pal., vol. 5, pp. 257-258, pl. 30, figs. 4, 6.

Shell minute, sub-cylindrical to fusiform, elongate, with bluntly pointed poles, with irregular axis of coiling, and with very faint external furrows. Form ratio of mature specimens is about 1:3.3, and the form ratio is about 1:2.7 in the third volution, 1:2.9 in the fourth volution, 1:3.1 in the fifth volution, and 1:3.3 in the sixth volution. Mature specimens consist of 6½ to 7 volutions, and they are about 4.25 mm in length and 1.25 mm in width. The profile of the mid-portion of the shell is uniform in all volutions, but the extreme polar regions of the last 3 volutions are slightly inflated.

The septa are rather narrowly fluted throughout the length of the shell. The fluting divides the chambers into chamberlets that are shaped like inverted and truncated cones and are separated by fusions of the septa that reach about four-fifths the height of the chambers. The external furrows are relatively straight across the median portion of the shell, but they make broad backward twists in the regions of the poles. The septa are relatively thin and are composed of four distinct layers. The anterior and posterior tectoria are relatively thin. The diaphanotheca is about 7.0 microns thick in the sixth volution about two-thirds the distance from the tunnel to the poles. Where the septa are fused up to near the top of the chambers by points of contact of the fluting, only the diaphanotheca of the posterior chamber seems to be fully developed. The diaphanotheca is recognizable in the outer five volutions and is completely developed in the antetheca of the last chamber. The septal count of two typical specimens is 12 for the first volution, 17 for the second volution, 20 for the third volution, 22 for the fourth volution, 25 for the fifth volution, and 28 for the sixth volution.

The proloculum is spherical, and it is about 85 microns in diameter, and its wall is about 14.5 microns thick. The development of the shell of this species is divisible into an early stage (a "juvenarium") during which the inner three volutions are very tightly coiled, and a later stage during which the chambers of the outer volutions were more highly vaulted.

The spirotheca or wall is relatively thin. The lower tectorium is slightly thicker over the roof of the tunnel than in the region of the poles. The different layers with their respective thicknesses in the sixth volution, about one-half the distance from the center of the tunnel to the poles, are: upper tectorium 7.8 microns, diaphanotheca 7.0 microns, and lower tectorium 11.7 microns—the tectum is so thin that it cannot be measured accurately. The lower tectorium is slightly more dense than the upper tectorium and the diaphanotheca is slightly less dense and more coarsely crystalline than the upper tectorium.

The intersection of the line of the tunnel with axial sections is slightly irregular, and the tunnel angle is about 32 degrees. Both sides of the tunnel are bordered by the chomata which have a broadly rounded upper surface and are about two-thirds as high as the chambers and about one-half as high as broad. The floor of the tunnel is covered by the upper tectorium of the spirotheca which is slightly thicker near the center of the tunnel than near its borders.

The specimens from Iowa which I am referring to *Fusulina leei* present some slight differences from the figured holotype (Skinner's pl. 3, fig. 4), but they seem to agree fairly well with the original description. The Iowa specimens are smaller in all dimensions and the thicknesses of the layers of the spirotheca are not exactly the same as those given by Skinner.

Fusulina leei resembles rather closely *F. kayi*, with which it is found associated, but it can be distinguished from that species particularly by its smaller form ratio, its larger tunnel angle, its more extended polar regions, and its more bluntly pointed poles; also, the fluting of this species is broader than that of *F. kayi*.

Occurrence.—The type specimens of this species came from the Cherokee of Oklahoma, immediately above the Bluejacket sandstone. In Iowa representatives of this species have been obtained from only a calcareous shale 1½ feet below a thin limestone, 35 feet below the White Breast coal, in the west road-ditch, on the east line of Lucas County, Iowa, SE¼ sec. 1, T. 73 N., R. 20 W. (pl. XXI, figs. 3, 7, 10, 18); and from the same horizon in the south bank of a small west-flowing creek, 10 feet above the bed of the creek, 75 yards south of County road L, ½ mile west of Lovilia, SW¼ sec. 10, T. 73 N., R. 18 W., Monroe County, Iowa.

Repository.—State University of Iowa, Catalogue Nos. 854-860 (plesiotypes); the figured specimens are Nos. 857-860.

FUSULINA KAYI Thompson, n. sp.

Plate XXI, figures 1, 2, 4, 5, 8, 12-15, 19, 20

Shell small, uniformly fusiform, slightly elongate, with rather sharply pointed poles, with straight axis of coiling, and with shallow external furrows. Mature specimens of 7 volutions are 3.70 to 4.0 mm in length and about 1.3 mm in width. The rate of increase in size is rather uniform throughout the length of the shell but there is a uniform decrease of form ratio—in the third volution the form ratio is 1:1.9, in the fourth volution 1:2.2, in the fifth volution 1:2.4, in the sixth volution 1:2.6, and in mature specimens 1:2.8.

The septa are relatively thin and are composed of four layers. The two outer layers are thicker in the lower part of the septa where they fuse adjacent septa for about two-thirds the height of the chambers at the points of approach caused by the fluting. The posterior portion of the anterior tectorium is somewhat lighter than the remaining portion but it does not seem to join structurally with the diaphanotheca of the following chamber. The external furrows have an irregular course across the mid-portion of the shell but they are somewhat sinuous in the region of the poles. The septa are very highly fluted throughout the length of the shell and the fluting extends to the top of the septa; however, it is less pronounced in the upper one-third of the chamber. Tangential sections show the flutings to form short elliptical openings or chamberlets; these are located in the lower portion of the chambers and they are about two-thirds as high as the chambers. The septal count for the earlier volutions of the shell is about 17 in the second volution, 19 in the third volution, 24 in the fourth volution, and 28 in the fifth volution. In some specimens the septal count varies as much as four in the fourth volution and three in the fifth volution.

The proloculum is sub-spherical to spherical and has a diameter of 80 to 100 microns. The ontogenetic development of individuals is divisable into an early stage (a "juvenarium") during which the inner two and one-half volutions are tightly coiled and a later stage during which the outer volutions are less tightly coiled.

The spirotheca or wall is relatively thick. The upper tectorium is about 6.0 microns thick in the sixth volution and is composed of rather dense material which is slightly less dense near its lower surface. The diaphanotheca measures 5.9 microns in the sixth volution. The lower tectorium is about 11.7 microns thick over the tunnel in the sixth volution but it thins rapidly toward the poles and is absent in the last volution. The upper tectorium is present on the floors of all chambers but it is not found on the spirotheca of the last volution. The difference in density between the diaphanotheca and the lower part of the upper tectorium is very slight and the line of division would be very difficult to locate if it were not for the presence of the tectum.

The tunnel is rather low and broad and it is about one-third as high as the chamber and about one-fourth as high as wide. The average tunnel angle is about 22 degrees. The floor of the tunnel is covered by a thick layer of tectorium, and either side of the tunnel is bordered by a very high and broadly rounded, more or less symmetrical ridge, the choma, which, in the fifth and sixth volution, is about two-thirds as high as the chambers and is about as broad at the top as it is high—it is only slightly developed in the outer volution.

Two groups of specimens are included under this species which are somewhat doubtfully conspecific but which present certain similarities. The above description is based almost entirely on the first group of these specimens which is represented by figures 2, 5, 8, 14, and 20 on plate XXI—they differ from the second group of specimens represented by figures 1, 4, 12, 13, 15, and 19 on plate XXI particularly in that the septa are more narrowly fluted, the shells are larger, and the form ratios for corresponding volutions are larger. The second group of specimens included under this species resembles *F. inconspicua* Girty in general measurements and outline of the shell. However, the fluting of the septa of *F. inconspicua* is much broader than in these specimens and the tunnel angle is much larger—the tunnel angle of *F. inconspicua* is over 40 degrees.

Among the collections of fusulinids which I am studying from outside the confines of Iowa there is an excellent collection from Girty's type locality of *F. inconspicua* of the Wewoka formation of Oklahoma that was very generously sent me by Mr. R. V. Hollingsworth of the University of Chicago. These topotypes of *F. inconspicua* agree in every detail with Girty's figured cotypes, and they show clearly that *F. inconspicua* is not conspecific with any specimens so far found in Iowa.

Fusulina kayi differs from *F. leei* particularly in that it is shorter, it has a smaller tunnel angle, a larger form ratio, its poles are more sharply pointed, and its septa are more narrowly fluted.

This species is named in honor of Dean George F. Kay, Director of the Iowa Geological Survey, who continually encouraged the writer in his work and who made possible the field work necessary for the preparation of this report.

Occurrence.—This species is known from only one horizon, this is, from a calcareous shale 1½ feet below a thin limestone, 35 feet below the White Breast coal. My collections contain large numbers of specimens from the west road-ditch on the east line of Lucas County, Iowa, near the top of a north-sloping hill, east side SE¼ sec. 1, T. 73 N., R. 20 W. (all figured specimens); and from the south bank of a small west-flowing creek, 10 feet above the bed of the creek, 75 yards south of County road L, ½ mile west of Lovilia, SW¼ sec. 10, T. 73 N., R. 18 W., Monroe County, Iowa.

Repository.—State University of Iowa, Catalogue Nos. 846-853, 861-868 (cotypes); the figured specimens are Nos. 849-853 and 864-868.

FUSULINA? PROBLEMATICA Thompson, n. sp.

Plate XXI, figures 6, 9, 11, 16, 17

Shell minute, short, uniformly fusiform, with rather sharply pointed poles, with straight axis of coiling, and with shallow external furrows. The length of mature specimens is about 2.70 mm and the width is about 1.25 mm. The form ratio is about 1:1.9 in the third volution, 1:2.1 in the fourth volution, 1:2.3 in the fifth volution, and 1:2.2 in mature forms of 6 volutions.

The septa are very thick and are composed of an anterior tectorium, a tectum, a diaphanotheca, and a posterior tectorium. The anterior and posterior tectoria are very thick near the base of the septa and are relatively thin near the top of the chambers. They are the continuations of the tectoria of the spirotheca. The tectum is very thin and dense and is the downward extension of the tectum of the spirotheca of the preceding chamber; however, it is not distinguishable in the lower part of the septa. The diaphanotheca is thin and light and is the downward continuation of the diaphanotheca of the spirotheca of the preceding chamber. The external furrows are essentially straight in the mid-portion of the shell but near the poles they make a slight backward twist. The septa are broadly but rather highly fluted in the polar portions of the shell, but in the median half of the shell they are more broadly fluted. In the polar region the septa are fused at the points of approach of the flutings apparently to the top of the chamber whereas in the median portion of the shell the fusions reach only about three-fourths the height of the chamber. The septal count is about 17 for the second volution, 22 for the third volution, 26 for the fourth volution, and 31 for the fifth volution.

The early stage of development (the "juvenarium") of this species is unusual for this genus in that the proloculum is very minute, about 15 microns in diameter, and the early chambers are added in a slightly involute coil of about two and one-half volutions with its axis of coiling almost at right angles to the axis of coiling of the outer fusulinid coils. The diameter of the proloculum plus these inner two and one-half coils is about 100 microns. In the above measurements of the form ratio and the determination of the septal counts the first volution is taken as the first fusulinid type of coil. The form ratio of these inner two and one-half coils is about 2:1. The inner two and one-half fusulinid volutions are slightly more tightly coiled than the outer volutions.

The spirotheca is very thick. It is composed of an upper tectorium, a tectum, a diaphanotheca, and a lower tectorium. The upper tectorium is very thick and dense. It is about 25 microns thick in the fifth volution beyond the limits of the chomata, and it thickens toward the poles where it, combined with the tectoria of the septa, fills the chambers for about one-fourth the height of the septa. The tectum is very thin and dense. The diaphanotheca is about 5.0 microns thick in the sixth volution, but it is rather indistinct in most sections. The lower tectorium is about 5.0 microns thick over the line of the tunnel, but it rapidly thins poleward to merely a dark line as seen in thin-sections. The lower one-fourth of the upper tectorium of the median part of the shell is of about equal density to the diaphanotheca and the upper three-fourths is about equal in density to the lower tectorium.

The tunnel is narrow and high and its line of intersection with axial sections is very irregular. The tunnel is about one-half the height of the chambers and about one-half as high as wide. Either side of the tunnel is bordered by a vertical wall formed by the inner edge of a ridge, the choma, which has a gentle outer slope, and which in the fifth volution completely fills some of the chambers immediately adjacent to the tunnel. The choma is composed of material similar in density to the upper part of the upper tectorium. The floor of the tunnel is covered by tectorium that is about 23 microns thick in the sixth volution. The tunnel angle is 15 to 22 degrees.

This species is very doubtfully referred to the genus *Fusulina.* The relatively thick upper tectorium and the well developed chomata suggest that its affinities are with *Fusulinella*; but the septa are fluted, though very broadly so, throughout the length of the shell which suggest relationship to *Fusulina* s. s. However, an endothyroid-like coil has not been found in any species previously referred to *Fusulina*—such a coil is known however to occur in the Permian genera *Neofusulinella, Depratella,* and *Yangchienia* and in forms from the lower Pennsylvanian that have been referred to the genus *Schubertella.* Also, Lee has stated that forms from the Orient, which he considered conspecific with the genotype of *Fusulinella, F. bocki,* have such an early development. Lee considers that this is merely a result of dimorphism or even trimorphism and that it is not a generic or even a specific character. A large number of specimens from the type localities of *F. problematica* have been secured and in no case have forms been found with a normal large proloculum and fusiform early volutions which have a spirotheca and chomata structure and septal fluting like *F. problematica.* Furthermore, it does not seem that dimorphism has at all been demonstrated in the fusulinids, and from horizons in which only a single species occurs, such as that from which *Fusulinella iowensis* was obtained, large numbers of sections have in no case given any evidence of dimorphic forms. This is also true of horizons in which a number of species occur. It seems that the early asymmetrical endothyroid-like coils of this species, combined with its other characters, is very probably of generic significance and this species therefore represents an unnamed genus.

The structure of the spirotheca of *F. problematica* is quite different from that of *Schubertella* as originally described by Staff and Wedekind for they state that it is composed of only one layer; also, the original illustrations of *S. transitoria,* the genotype of *Schubertella,* do not show an early endothyroid coil like that of *F. problematica,* though Staff and Wedekind state that the inner whorls are "endothyrisch". The thin diaphanotheca, thick tectoria, and fluted septa of *F. problematica* distinguish it generically from typical representatives of the genera *Neofusulinella, Depratella,* and *Yangchienea. F. problematica* differs generically from the genotype of *Boultonia, B. willsi* Lee, for its spirotheca has four layers whereas *B. willsi* has only two layers. Also, its shell is much shorter and its chomata are better developed.

Occurrence.—My collections from Iowa contain representatives of this species from a thin limestone about 35 feet below the White Breast coal in the bank of a small northeast-flowing creek, 75 yards west of the west edge of Wapello County, NE¼SE¼ sec. 13, T. 72 N., R. 16 W., Monroe County, Iowa (pl. XXI, fig. 17); and from the same horizon in the south bank of a small west-flowing creek, 12 feet above the bed of the creek, 75 yards south of County road L, ½ mile west of Lovilia, SW¼ sec. 10, T. 73 N., R. 18 W., Monroe County; and from a calcareous shale 1½ feet below the limestone mentioned above, in the west road-ditch, on the east line of Lucas County, near the top of a north-sloping hill, SE¼ sec. 1, T. 73 N., R. 20 W. (pl. XXI, figs. 6, 9, 11, 16).

Repository.—State University of Iowa, Catalogue Nos. 869-877 (cotypes); the figured specimens are Nos. 873-877.

FUSULINA LUCASENSIS Thompson, n. sp.
Plate XXII, figures 2, 9, 12, 17, 19

Shell minute, short, uniformly fusiform with bluntly pointed poles, and with straight axis of coiling. Mature specimens of 7 to 7½ volutions are about 3.0 mm in length and 1.25 mm in width, giving a form ratio of 1:2.4. Rarely more gibbous forms are found that give a form ratio of 1:2.1 at maturity. The form ratio is 1:1.9 for the third volution, 1:2.0 for the fourth volution, 1:2.2 for the fifth volution, and 1:2.3 for the sixth volution. The lateral slopes are convex and uniform.

The septa are thick and are composed of two outer thick layers of tectoria, a tectum, and a diaphanotheca. The diaphanotheca measures 11.0 microns in the sixth volution. The septa are 40 microns thick in the sixth volution about midway between the tunnel and the pole. The tectoria are much denser than the diaphanotheca except the posterior one-fifth of the anterior tectorium which is about equal in density to the diaphanotheca. The tectoria of the septa combined with the tectoria of the spirotheca fuse the walls of the chambers in the polar regions where the chambers are very short. The external furrows are straight throughout the length of the shell, but the septa are broadly but highly fluted from pole to pole. The average septal count is about 16 for the second volution, 20 for the third volution, 25 for the fourth volution, 26 for the fifth volution, and 27 for the sixth volution.

The proloculum is sub-spherical and is very small, measuring only 42 to 60 microns in diameter. The entire shell is tightly coiled but the inner two and one-half volutions appear to be more tightly coiled than the outer volutions.

The spirotheca is relatively thick. The diaphanotheca is very thick in comparison with the size of the specimen and measures about 12 microns in the sixth volution. The thickness of the upper tectorium is about five times that of the lower tectorium. In the center of the tunnel of the sixth volution the upper tectorium is 11.5 microns in thickness, whereas, about midway between the tunnel and pole it is 18 microns thick. The lower one-fourth of the upper tectorium is much lighter than the remainder of this layer and is of about the same density as the diaphanotheca on the opposite side of the tectum.

The tunnel is about one-fourth as high as wide and about one-half to one-third as high as the chamber in the sixth volution, and its intersection with axial sections is slightly irregular. Determinations of the tunnel angle based on measurements in the sixth volution give 30 to 35 degrees with an average of about 33 degrees. The tunnel is bordered by ridges, chomata, that are about one-half the height of the chambers in all volutions except the last. In the outer volution the chomata are very low or indistinct.

Fusulina lucasensis seems to be more closely related to *Fusulina kayi*, n. sp., than to any other described species. In *F. lucasensis* the diameter of the proloculum is 42 to 60 microns whereas the diameter of that of *F. kayi* is about 90 microns. The tunnel angle of *F. lucasensis* is larger than the tunnel angle of *F. kayi*. Also *F. lucasensis* differs from *F. kayi* in that it has a much thicker diaphanotheca. *F. lucasensis* can be distinguished from other similar species by its small size, relatively very small proloculum, thick spirotheca, and large tunnel angle.

F. lucasensis resembles in a general way *Fusulina haworthi* White [not *Fusulinella haworthi* Dunbar and Condra] from the top of the Millsaps formation of Texas, but it seems to differ from that species particularly in that the septa of *F. lucasensis* are not so highly fluted as are those of the Texas species; the Iowa specimens are slightly smaller; and the external views of the Texas species show an inflation in the central one-third of the shell which is not found in *F. lucasensis*.

Occurrence.—This species has been found rather abundant at only one horizon and locality in a limestone about 10 feet above a thin coal which apparently is the second coal beneath the Mystic coal. The collections were obtained from the south bank of a small west-flowing creek, about 15 feet above the bed of the creek, SW¼-NE¼ sec. 16, T. 72 N., R. 22 W., Lucas County, Iowa.

Repository.—State University of Iowa, Catalogue Nos. 878-884 (cotypes); the figured specimens are Nos. 881-884.

FUSULINA EURYTEINES Thompson, n. sp.

Plate XXII, figures 4, 13, 14, 18

Fusulinella meeki Dunbar and Condra, *1927*, Nebraska Geol. Survey Bull. 2, ser. 2, pp. 78-80, pl. 15, figs. 4-6, and (?) pl. 2, figs. 12-14. [not *Fusulina ventricosa meeki* Möller, 1879]

(?) *Fusulinella* n. sp. Henbest, *1928,* Jour. Pal., Vol. 2, p. 79, pl. 10, figs. 2, 4.

(?) *Fusulina meeki* White, *1932,* Texas Univ. Bull. 3211, pp. 27-30, pl. 1, figs. 7-12.

Shell small, moderately short, with bluntly pointed poles, and slightly inflated in the central one-half. The shell is constricted near the poles and the extreme ends are slightly inflated in mature forms. The axis of coiling is essentially straight and the external furrows are very shallow. Mature forms of 7 volutions are 4.3 to 4.7 mm in length and 2.0 to 2.1 mm in width, giving a form ratio of about 1:2.2. The form ratio is 1:1.9 in the third volution, 1:2.1 for the fourth volution, 1:2.2 for the fifth volution, and 1:2.1 for the sixth volution.

The septa are rather thick. The diaphanotheca is about 15 microns thick in the sixth volution. The tectoria are more dense than the diaphanotheca and are continuous with the two outer layers, tectoria, of the spirotheca. The posterior one-fifth of the anterior tectorium is about equal in density to the diaphanotheca on the opposite side of the tectum. This lighter portion of the anterior tectorium is very similar in thickness and nature to the lower light part of the upper tectorium of the spirotheca. The external furrows are essentially straight to broadly curved. The lower four-fifths of the septa are broadly fluted near the center of the shell, but they become very narrowly and highly fluted near the poles. There are 25 septa in the third volution, 28 in the fourth volution, and 31 in the fifth volution.

The proloculum is essentially spherical and it is 95 to 125 microns in diameter. The rate of increase of the height of the chambers is essentially uniform throughout the development of the individual.

The spirotheca is thick and is composed of an upper and lower tectorium, a tectum, and a diaphanotheca. The diaphanotheca is about 18 microns thick in the sixth volution. The upper tectorium is about 28 microns thick in the sixth volution beyond the limits of the chomata, and it is three to four times as thick as the lower tectorium in the same position. The lower one-third of the upper tectorium is only slightly denser than the diaphanotheca. The tectoria of the spirotheca and septa tend to fill the chambers in the polar regions of the first four volutions but these layers are relatively thin in the polar zones of the last three volutions.

The line of intersection of the tunnel with axial sections is very irregular and the tunnel angle is 23 to 27 degrees. The tunnel is one-third to one-fourth the height of the chamber and it is about one-fourth as wide as high in the sixth volution. Either side of the tunnel is bordered by a ridge of material, choma, that is very similar in density to the tectoria, and this ridge is one-half to two-thirds the height of the chambers in all volutions except the last one and one-half or two.

Fusulina euryteines is more nearly similar to *F. stookeyi*, n. sp., than any other described species. In general shape and measurements they are very similar, but they can be readily distinguished by their internal structures. The septa of *F. euryteines* are more broadly and less highly fluted than are those of *F. stookeyi*; also the proloculum is smaller and the tectoria and the chomata are better developed in *F. euryteines* than in *F. stookeyi*.

The specimens included under this species are clearly conspecific with the specimens from the Cherokee near Rich Hill, Missouri, described and illustrated by Dunbar and Condra as *Fusulinella meeki*. However, we now know that this form is a representative of the genus *Fusulina* s. s.; therefore, the name *Fusulina meeki* (Dunbar and Condra) becomes a homonym of *Fusulina ventricosa meeki* Möller. There is some question as to the relationship between the specimens from the Millsaps formation of Texas illustrated and described by Dunbar and Condra as *Fusulinella meeki* and by White as *Fusulina meeki* and the Iowa specimens which I am making the types of *Fusulina euryteines*.

Occurrence.—Representatives of this species have been found in Iowa in only one horizon, a thin limestone about 35 feet below the White Breast coal. I have collected specimens from this limestone on the south bank of a small west-flowing creek, 12 feet above the bed of the creek, 75 yards south of County road L, ½ mile west of Lovilia, SW¼ sec. 10, T. 73 N., R. 18 W., Monroe County (pl. XXII, figs. 4, 13, 14, 18); in the west road-ditch, on the east line of Lucas County, near the top of a north-sloping hill, SE¼ sec. 1, T. 73 N., R. 20 W.; in the north road cut of United States highway 34, at the top of a west-sloping hill, SE¼ sec. 13, T. 72 N., R. 16 W., Monroe County; and in the east bank of a small northeast-flowing creek, 75 yards west of the edge of Wapello County, NE¼-SE¼ sec. 13, T. 72 N., R. 16 W., Monroe County. Dunbar and Condra have described conspecific specimens from the Cherokee near Rich Hill, Missouri, and Dunbar and Condra and White have described and illustrated some specimens from the Millsap formation of Texas that may represent it. Also Henbest has briefly described and illustrated a form from the Stonefort limestone of southern Illinois that may be conspecific.

Repository.—State University of Iowa, Catalogue Nos. 885-896 (cotypes); the figured specimens are Nos. 893-896.

FUSULINA PUMILA Thompson, n. sp.
Plate XXII, figures 6, 8, 10, 11

Shell small, short, uniformly fusiform, with bluntly pointed poles, straight external furrows, and straight axis of coiling. The average form ratio as determined by 9 typical axial sections is about 1:2.0 in the third and fourth volutions, and 1:1.8 in the fifth and sixth volutions. Mature forms of 7 volutions are about 3.1 mm in length and 1.8 mm in width.

The septa are relatively thick and are composed of an anterior and posterior tectorium, a diaphanotheca, and a tectum. The diaphanotheca is about 8.0 microns thick in the sixth volution. The posterior side of the anterior tectorium for about one-third its thickness is very similar in density to the diaphanotheca on the opposite side of the tectum. The external furrows are straight and the septa are broadly and highly fluted throughout the length of the shell. The septa are fused at points of approach for about three-fourths the height of the chambers midway between the tunnel and the poles. The septal count is about 21 for the second volution, 23 for the third volution, 26 for the fourth volution, 32 for the fifth volution, and 34 for the sixth volution; these counts may vary from these figures as much as 3 in the fourth and fifth volutions.

The proloculum is small and is between 70 and 110 microns in diameter with an average nearer the smaller figure. The rate of increase of the height of the antetheca is uniform throughout the development of the individual.

The spirotheca is relatively thick. In the sixth volution the upper tectorium is about 30 microns thick midway between the tunnel and pole and about 15 microns thick in the center of the tunnel. In the sixth volution the lower tectorium is 10 microns thick about midway between the tunnel and pole. The diaphanotheca is much less dense than the tectoria, however the lower one-fourth of the upper tectorium is very similar in density to the diaphanotheca. The diaphanotheca is about 7.5 microns thick in the sixth volution.

The tunnel is very high and narrow, and it is about one-half the height of the chambers and one-third as high as wide. The floor of the tunnel is covered by the thick upper tectorium of the spirotheca. Either side of the tunnel is bordered by an asymmetrical ridge, the choma, which is about three-fourths the height of the chambers and which thins rather rapidly poleward. The line of intersection of the tunnel with axial sections is rather irregular and the tunnel angle, as shown by determinations made in the sixth and seventh volutions, is 16 to 19 degrees.

Fusulina pumila is somewhat similar in general shape to *F. girtyi* but it differs from that species particularly in that it is much smaller, its septa are not so highly fluted, and its tectoria are better developed. *F. pumila* differs from *F. euryteines* in that its axis is much shorter, its tunnel angle is smaller, and the septal fluting of the two species is different. *F. pumila* differs from *F. problematica* in that it is larger, its form ratio is larger, its inner volutions are quite different, and its spirotheca is thinner than that of *F. problematica*. *F. pumila* is larger, has a smaller form ratio, smaller tunnel angle, and more numerous septa than *F. tregoensis* Roth and Skinner.

Occurrence.—This species has been found in Iowa in only a thin limestone about 35 feet below the White Breast coal. My collections contain specimens from the north bank of United States highway 34, near the top of a west-sloping hill, SE¼SW¼ sec. 13, T. 72 N., R. 16 W., Monroe County; in the bed of a small northeast-flowing creek, 75 yards west of the Wapello County line, NE¼SE¼ sec. 13, T. 72 N., R. 16 W.; Monroe County (pl. XXII, figs. 6, 8, 10, 11); and from the south bank of a small west-flowing creek, 75 yards south of County road L, 12 feet above the bed of the creek, ½ mile west of Lovilia, SW¼ sec. 10, T. 73 N., R. 18 W., Monroe County.

Repository.—State University of Iowa, Catalogue Nos. 897-905 (cotypes); the figured specimens are Nos. 902-905.

FUSULINA GIRTYI (Dunbar and Condra)

Plate XXII, figures 1, 5, 7, 20

Fusulina ventricosa Meek and Worthen, *1873*, Illinois Geol. Survey, vol. 5, p. 560, pl. 24, figs. 8a and 8b. [not *Fusulina ventricosa* Meek and Hayden, 1858]

Fusulina ventricosa Meek, *1874,* Am. Jour. Sci., ser. 3, vol. 7, p. 484.
Girtyina ventricosa v. Staff, *1912,* Palaeontographica, vol. 59, pp. 164-165, pl. 18, figs. 2, 5, and 7.
Girtyina ventricosa Cady, *1925,* Illinois Geol. Survey, Rept. of Investigation, no. 2, p. 8, text fig. 2, A and B.
Fusulinella girtyi Dunbar and Condra, *1927,* Nebraska Geol. Survey Bull. 2, ser. 2, pp. 76-78, pl. 2, figs. 1-5.
Fusulinella (Girtyina) ventricosa Henbest, *1928,* Jour. Pal., vol. 2, p. 83, pl. 9, figs. 3, 4, 6, and 6a. [not pl. 10, figs. 5, 6, and 7]
Beedeina girtyi Galloway, *1933,* Manual of Foraminifera, p. 401, pl. 36, fig. 17.

The collections from Iowa that I am studying contain a large number of well preserved representatives of this species. However, this species has been adequately described by Dunbar and Condra, and since this publication is readily accessible to most paleontologists it is not necessary to duplicate their work.

The specimens which I am studying agree very closely with the illustrations and descriptions of Dunbar and Condra's cotypes from the roof of Coal No. 6, near Canton, Fulton County, Illinois. The form ratio of the Iowa specimens is about 1:1.6 in the third volution, and 1:1.5 in the remaining outer 6 volutions of mature forms, and mature forms are about 4.3 mm in length and 2.8 mm in width. The tunnel angle is about 14 degrees, and either side of the tunnel is bordered by heavy deposits, the chomata, of dense calcite that are very similar in character to the tectoria. In the earlier volutions these deposits form into asymmetrical ridges that border the tunnel and slope downward toward the poles. In the outer volutions these deposits, chomata, are irregular posterior-anteriorly and do not seem to form into definite ridges from one chamber to the next; however, in many of the chambers immediately adjacent to the tunnel there is only a small circular opening left near the top of the chamber. The septal count of the Iowa forms agrees very closely with that of the Illinois specimens in the third and fourth volutions, but some of the Iowa specimens have as high as 45 septa in the fifth volution and 54 septa in the sixth volution—the average is much nearer the figures given by Dunbar and Condra, 38 and 41 respectively. The proloculum of the Iowa specimens is about 140 microns in diameter with an average a little less than this figure.

Fusulina girtyi externally seems more nearly similar to *Fusulina* *pumila*, n. sp., than to any other described species. It differs from this species in that it is much larger, it contains more numerous volutions, its walls are relatively thinner, its septal fluting is different, its proloculum is much larger, and its tunnel angle is smaller. *F. girtyi* occurs associated with *Fusulina stookeyi*, n. sp., from which it may be distinguished by the difference in the shape of the shell, the shortness of *F. girtyi* as compared with *F. stookeyi*, the difference in the nature of the septal fluting, the difference of the development of the spirotheca, and the difference in the tunnel angle. The close association of these two species, *F. girtyi* and *F. stookeyi*, would suggest that they may be merely dimorphic expressions of the same species. However, the fact that in one place at least *F. stookeyi* is extremely abundant and *F. girtyi* is very rare seems to support my conclusion that they represent distinct species.

Occurrence.—*Fusulina girtyi* is known to occur in Iowa in only the so-called "eighteen-foot limestone" [18 feet above the Mystic coal]. It has been found at five different localities, which are as follows: ten feet above the bed of a small north-flowing creek, near an old mine drift, NE¼ sec. 1, T. 70 N., R. 17 W., Appanoose County (pl. XXII, figs. 1, 5, 7, 20); in the bed of a creek 50 yards north of County road S, 2 miles northeast of Moravia, NW¼ sec. 35, T. 71 N., R. 17 W., Monroe County; on the south bank of Fish Branch, NE¼ sec. 28, T. 70 N., R. 19 W., Appanoose County; on the south bank of Chariton River, east bank Iowa highway 60, NW¼SW¼ sec. 7, T. 69 N., R. 17 W., Appanoose County; and in the bed of County road G, ¼ mile west of Brazil, SW¼ sec. 20, T. 69 N., R. 18 W., Appanoose County. Representatives of this species have been found in the "roof rock" of Coal No. 6 of the Carbondale formation of Illinois and in the Fort Scott limestone at Oswego, Kansas.

Repository.—State University of Iowa, Catalogue Nos. 919-927 (plesiotypes); the figured specimens are Nos. 924-927.

FUSULINA STOOKEYI Thompson, n. sp.

Plate XXII, figures 3, 15, 16, 21

Shell small, short, fusiform, with bluntly pointed poles; the central one-half is inflated. The axis of coiling is slightly irregular. Approximately one-fifth the distance from the poles the shell is slightly constricted and the lateral slopes are slightly concave. The external furrows are shallow. Mature forms consist of 7 to 7½ volutions and are 5.1 to 5.5 mm in length and 2.5 to 2.8 mm in width. The form ratio is 1:1.8 to 1:2.4 in the third volution, 1:1.8 to 1:2.3 in the fourth volution, 1:1.9 to 1:2.2 in the fifth volution, and 1:1.9 to 1:2.2 in the sixth volution: the average form ratios for these volutions are 1:1.9, 1:1.9, 1:2.0, and 1:2.1 respectively. In some of the more elongate forms the poles are sharply pointed and are drawn out in the third, fourth, and fifth volutions; this, of course, results in abnormally small form ratios for these volutions.

The septa are very narrowly and highly fluted throughout the length of the shell and the chambers are divided into chamberlets which reach approximately four-fifths the height of the chambers. The fusions between the chamberlets do not seem to extend to the base of the septa due to a slight reversal of the fluting before reaching the spirotheca of the preceding volution. There are 21 septa in the second volution, 24 in the third volution, 28 in the fourth volution, 32 in the fifth volution, 39 in the sixth volution, and 44 in the seventh volution. The septa are very thin in the polar one-fourth of the shell and have very thin tectoria. In the central one-half the septa are coated with upward extensions of the chomata that decrease in thickness very rapidly from the tunnel poleward.

The proloculum is of medium size and measures about 140 microns in diameter. The inner two and one-half to three volutions of this species are tightly coiled and the outer volutions are more loosely coiled.

The spirotheca or wall is relatively thin. The diaphanotheca is very light and translucent, and it increases in thickness from a very thin layer in the first volution to about 22 microns near the tunnel in the seventh volution. The upper tectorium is about 14 microns thick near the tunnel of the sixth volution, and it decreases to a very thin layer near the poles. The lower tectorium is well developed over the line of the tunnel but it decreases rapidly in thickness poleward and in the polar regions it cannot be discerned. The lower part of the upper tectorium of the spirotheca as well as the posterior part of the anterior tectorium of the septa are about equal in density to the diaphanotheca on the opposite side of the tectum.

The tunnel is broad and low and is about one-third the height of the chambers and about one-fifth as high as broad in the seventh volution. The tunnel angle as determined in the sixth volution is 20 to 28 degrees with an average of about 24 degrees. The chomata are in the form of high, narrow, broadly rounded ridges which flank either side of the tunnel in the earlier volutions, but in the outer three volutions they are more irregular and do not form continuous uniform ridges. In these outer volutions the upper part of the spirotheca and the lower part of the septa are coated with dense granular calcite near the tunnel; this thins rapidly poleward.

Fusulina stookeyi externally is very similar to *Fusulina euryteines*. These two species agree very closely in size and measurements but their internal structures are very different. The fluting of *F. stookeyi* is very narrow and high whereas that of *F. euryteines* is relatively broad and low—these characters alone are sufficient to distinguish the two species. The proloculum of *F. euryteines* is smaller than that of *F. stookeyi*, the chomata are better developed in *F. euryteines*, and the tectoria of the two species are different. *F. stookeyi* differs from *Fusulina similis* Galloway and White in that it is larger than that species, its proloculum is larger, its septal fluting is different, and the general shape and form ratios of the shells are quite different.

This species is named in honor of Mr. Donald G. Stookey, who is studying the Pennsylvanian rocks of Iowa and who was the writer's field companion when the specimens on which this report is based were collected.

Occurrence.—This species occurs very abundantly in the so-called "eighteen-foot limestone" [18 feet above the Mystic coal] but it is confined to that horizon. I have found it in the south bank of Chariton River, east side of Iowa highway 60, SE¼ sec. 7, T. 69 N., R. 17 W., Appanoose County, Iowa; on the west bank of a small north-flowing creek, NE¼ sec. 1, T. 70 N., R. 17 W., Appanoose County, Iowa (pl. XXII, fig. 15); in the bed of County road G, ¼ mile west of Brazil, north side SW¼ sec. 20, T. 69 N., R. 18 W., Appanoose County, Iowa; in the east cut-bank of County road K, eighteen feet above the bed of the road, SW¼SW¼ sec. 16, T. 67 N., R. 16 W., Appanoose County, Iowa; and in the bed of a small creek, fifty yards north of County road S, 2 miles northeast of Moravia, NW¼ sec. 35, T. 71 N., R. 17 W., Monroe County, Iowa (pl. XXII, figs. 3, 16, 21).

Repository.—State University of Iowa, Catalogue Nos. 906-918 (cotypes); the figured specimens are Nos. 915-918.

FUSULINA MYSTICENSIS Thompson, n. sp.
Plate XXIII, figures 1-3

Shell large, elongate, fusiform to sub-cylindrical, with bluntly pointed poles. In profile representatives of this species are variable, but sub-cylindrical forms with very bluntly pointed poles are the more common. Mature forms consist of 8½ to 9 volutions and they are 8.5 to 10.2 mm in length and 2.6 to 3.0 mm in width. The form ratio of mature specimens is 1:4.0 to 1:3.0, with an average closer to the larger ratio. The average form ratio of 14 specimens is 1:2.5 for the third volution, 1:2.7 for the fourth volution, 1:3.0 for the fifth volution, 1:3.3 for the sixth volution, and 1:3.2 for the seventh volution. The shell is fusiform in the inner six volutions and the poles are sharply pointed, but in the outer volutions the poles become very bluntly rounded and the lateral slopes are very gentle.

The septa are thin. The tectoria are very thin near the poles but they appear to be relatively thick near the tunnel; this increase in thickness near the tunnel is due to the addition of material probably from the chomata. The diaphanotheca is less dense than the tectoria in the upper part of the septa but in the lower part of the septa it appears more dense and is not distinguishable from the tectoria. The external furrows are essentially straight. The septa are very narrowly and highly fluted throughout the length of the shell, but in the mid-portion of the shell the fluting is slightly broader than it is near the poles. The septal count varies considerably for different individuals. The average septal count for 7 sagittal sections is 23 for the second volution, 28 for the third volution, 30 for the fourth volution, 35 for the fifth volution, 39 for the sixth volution, and 43 for the seventh volution. The variations for these different volutions are 18 to 28, 25 to 31, 29 to 33, 31 to 37, 35 to 45, and 40 to 53, respectively.

The proloculum is sub-spherical and is 130 to 175 microns in diameter. The inner two volutions are very tightly coiled about the proloculum, in the third volution the coiling is somewhat less tight and beyond the third volution the chambers become noticeably higher.

The spirotheca is of medium thickness for the genus. The tectoria are thin, they are of about equal thicknesses, and they are composed of rather dense calcite. In the seventh volution beyond the limits of the chomata they are about 5 microns thick. The diaphanotheca is of translucent calcite and it is about 18.7 microns thick in the seventh volution near the tunnel.

The tunnel is one-third to one-half the height of the chamber and about one-fifth as high as wide in the seventh volution. The tunnel angle is 21 to 32 degrees in the seventh volution, with an average of about 26 degrees. The chomata are in the form of very asymmetrical ridges in the inner five volutions, but in the outer volutions the deposits are rather irregular and they cover the upper part of the spirotheca and the septa with rapidly decreasing thicknesses for about one-fourth the distance from the tunnel to the poles.

Fusulina mysticensis is more nearly similar to *Fusulina megista*, n. sp., than any other described species, but it may be distinguished from that species by its smaller form ratio, more elongate shell, and larger tunnel angle. *F. mysticensis* and *F. megista* are associated together in the same limestone and gradational forms more or less intermediate between the types here figured are found, and it is possible that *F. megista* is merely a variety of *F. mysticensis*.

Occurrence.—This species is found rather abundantly in the so-called "fifty-foot limestone" [50 feet above the Mystic coal] of Appanoose County, Iowa; I have found representatives of it in the east valley wall of Shoal Creek, 3¼ miles east of Cincinnati, in the south ditch of County road C, SW¼ sec. 6, T. 67 N., R. 17 W. (pl. XXIII, figs. 1-3); in the south edge of the town of Mystic, fifty feet above Walnut Creek, SW¼ sec. 16, T. 69 N., R. 18 W.; beneath the bridge of County road P, Chariton River, SE¼ sec. 9, T. 70 N., R. 19 W.; in the south ditch of Iowa highway 3, 1½ miles west of Sunshine, NE¼NW¼ sec. 32, T. 69 N., R. 18 W.; and ¼ mile south of Iowa highway 3, east edge NW¼ sec. 34, T. 69 N., R. 19 W.

Repository.—State University of Iowa, Catalogue Nos. 943-953 (cotypes); the figured specimens are Nos. 951-953.

FUSULINA MEGISTA Thompson, n. sp.

Plate XXIII, figures 4-6

(?) *Fusulinella meeki robusta* Dunbar and Condra, *1927*, Nebraska Geol. Survey Bull. 2, ser. 2, pp. 80-82, pl. 15, figs. 7, 8.

Shell large, somewhat elongate and robust, with bluntly pointed poles, with straight axis of coiling, and with shallow external furrows. Mature specimens of 9 to 9½ volutions are 6.4 to 8.5 mm in length and 3.2 to 3.5 mm in width. The form ratio is about 1:2.0 in the third volution, 1:2.1 in the fourth volution, and 1:2.3 in the fifth, sixth and seventh volutions. Mature specimens have a form ratio of 1:2.5 to 1:2.0 with an average nearer the smaller ratio. The profile of this species is rather uniform throughout the growth of the individual and the lateral slopes are slightly convex in most of the specimens, but some specimens have been found that have slightly concave lateral slopes near the poles.

The septa are relatively thick and are composed of an anterior and posterior tectorium, a tectum, and a diaphanotheca. The diaphanotheca and tectum are of about the same thicknesses as the tectum and diaphanotheca of the spirotheca. The tectoria of the septa are well developed in the region of the tunnel but they rapidly thin poleward. There are about 23 septa in the second volution, 26 in the third volution, 32 in the fourth volution, 39 in the fifth volution, 45 in the sixth volution, and 48 in the seventh volution. The external furrows are essentially straight from pole to pole. The septa are very narrowly and highly fluted throughout the length of the shell, and the fluting divides the chambers into chamberlets. The fusions of the septa that separate the chamberlets reach to about four-fifths the height of the chambers, and in many cases the fusions do not reach completely to the floor of the chambers.

The proloculum is spherical to sub-spherical and is 140 to 200 microns in diameter, with an average of about 170 microns. The inner three to three and one-half volutions are very tightly coiled about the proloculum but the outer volutions have higher septa. This change in manner of coiling takes place through about one-half volution.

The spirotheca is of moderate thickness for the genus. The upper tectorium is about 15 microns thick in the center of the tunnel of the sixth volution, it becomes somewhat thicker immediately on either side of the tunnel, but it is extremely thin in the polar regions. The lower tectorium is best developed immediately over the tunnel where it is 8 to 10 microns thick in the sixth volution and it is very thin or even absent toward the poles of the outer four volutions. The diaphanotheca increases in thickness uniformly from a very thin layer in the first volution to about 19 microns in the seventh volution near the line of the tunnel. The different layers of the spirotheca, in the order of their densities, are tectum, tectoria, and diaphanotheca. However, the lower part of the upper tectorium of the spirotheca as well as the posterior side of the anterior tectorium of the septa are of about the same density as the diaphanotheca.

The tunnel is of moderate height and it is relatively narrow. The line of intersection of the tunnel with axial sections is very irregular and the tunnel angle, as determined in the eighth volution, is 15 to 18 degrees. The tunnel is bordered on either side by deposits, the chomata, that form asymmetrical ridges in the inner volution, but they become more irregular in the outer volutions and do not form definite ridges. These deposits show in axial sections of the outer four volutions as more dense portions of the shell, due to the abnormal thickness of the septa and the upper part of the spirotheca immediately adjacent to the tunnel.

Fusulina megista is more nearly similar to *F. mysticensis*, n. sp., than any other described species but it can be distinguished from that species by its shorter and thicker shell, its more nearly uniform profile in mature specimens, and its smaller tunnel angle.

Fusulina megista very closely resembles the forms from the Pawnee limestone of Kansas described by Dunbar and Condra as *Fusulinella meeki robusta*, and these specimens are probably conspecific with the Iowa specimens. However, since it is now known that *Fusulinella robusta* Dunbar and Condra is more closely related to *Fusulina cylindrica*, the genotype of *Fusulina*, than any other genotype the name *Fusulina robusta* (Dunbar and Condra) becomes a homonym of *Fusulina robusta* Meek, and hence the name *robusta* cannot be used for this species.

Occurrence.—This species has been found in only the so-called "fifty-foot limestone" [50 feet above the Mystic coal], from five different localities in Appanoose County, Iowa. These localities are: beneath the bridge over Chariton River of County road P, SE¼ sec. 9, T. 70 N., R. 19 W.; in the south ditch of Iowa highway 3, 1½ miles west of Sunshine, NE¼SW¼ sec. 32, T. 69 N., R. 18 W. (pl. XXIII, fig. 6); the south ditch of County road C, near the center SW¼ sec. 6, T. 67 N., R. 17 W. (pl. XXIII, figs. 4-5); and ¼ mile south of Iowa highway 3, east side NW¼ sec. 34, T. 69 N., R. 19 W. The specimens described by Dunbar and Condra as

"*Fusulinella meeki robusta*", which I believe are probably conspecific with the cotypes of *Fusulina megista*, came from the Pawnee limestone near Pawnee, Kansas.

Repository.—State University of Iowa, Catalogue Nos. 928-942 (cotypes); the figured specimens are Nos. 940-942.

FUSULINA EXIMIA Thompson, n. sp.
Plate XXIII, figures 7-10

Shell rather large for this genus, very elongate, and cylindrical, with bluntly rounded poles. The axis of coiling is irregular and the lateral slopes are irregular. The external furrows are very distinct though shallow. The form ratios of the inner four volutions vary considerably among the different specimens, but in the outer volutions the profiles are, though very irregular, somewhat similar. The inner four to four and one-half volutions are irregularly fusiform with sharply pointed poles, but the outer volutions are cylindrical to subcylindrical and the poles become more blunt. Mature forms of 8 to 8½ volutions are about 7.4 mm in length and 1.7 to 2.1 mm in width. The average form ratio of seven typical specimens is 1:2.8 for the third volution, 1:3.1 for the fourth volution, 1:3.6 for the fifth volution, 1:4.1 for the sixth volution, and 1:4.3 for the seventh volution. The form ratio of mature specimens is 1:3.5 to 1:4.4.

The septa of this species are very thin and are composed of only a tectum and diaphanotheca; however, both sides of the septa are partially covered by very thin discontinuous layers of rather dense granular calcite that probably correspond to the tectoria of other members of this genus. The tectum and the diaphanotheca of the septa are the downward continuations of the tectum and diaphanotheca of the spirotheca of the preceding volution. The tectum is very dense and thin, and the diaphanotheca is translucent and is only slightly thinner than the diaphanotheca of the spirotheca. The septa are covered above and on both sides of the tunnel by heavy layers of dense calcite which was probably secreted at the same time the chomata was formed. The line of the external furrow is broadly sinuous to straight. The lower portions of the septa are fluted throughout the length of the shell, but near the tunnel the fluting is very broad and the fusions of the septa are low. In the regions of the poles the fluting becomes narrow and high. Five typical sagittal sections give a septal count of 20 to 23 for the second volution, 23 to 26 for the third volution, 25 to 30 for the fourth volution, 28 to 36 for the fifth volution, 32 to 37 for the sixth volution, and 35 to 37 for the seventh volution. The averages for these same volutions are 21, 25, 28, 31, 34, and 36, respectively.

The proloculum is spherical to sub-ellipsoidal and is 100 to 155 microns in diameter. The inner two and one-half to three volutions are tightly coiled about the proloculum, but the rest of the shell is less tightly coiled.

The spirotheca is thin. The diaphanotheca is composed of relatively clear calcite and it increases in thickness from a very thin layer in the first volution to 15 microns near the tunnel of the seventh volution. The diaphanotheca is overlain by a thin layer, the tectum, of dense granular calcite. The tectum is overlain in places by a thin layer of lighter calcite that is not everywhere present but is found in the earlier volutions near the center of the shell. The diaphanotheca is underlain by a thin layer of dense calcite near the line of the tunnel that was probably secreted at the same time the chomata was formed.

The tunnel is very low and broad. It is about three-sevenths the height of the chambers and one-seventh to one-tenth as high as wide in the seventh volution. The intersection of the tunnel with axial sections forms a slightly irregular path. The tunnel angle is 28 to 52 degrees. The tunnel is bordered by well developed ridges, the chomata, which are essentially symmetrical and that are about one-third the height of the chamber and one-half as high as broad.

In general external appearances *Fusulina eximia* somewhat resembles *Fusulina mysticensis,* n. sp.; however, it differs from that species especially in that it is more elongate and smaller, its septa are very differently fluted, its spirotheca is thinner, and its tunnel angle is much larger. *F. eximia* is larger, more elongate, and quite different in shape from *Fusulina haworthi* White of the Millsaps formation of Texas.

Fusulina eximia is very similar to *Fusulinella haworthi* Dunbar and Condra from just below the Lonsdale limestone of Illinois, and it may be conspecific with that species; however, the Iowa specimens are more elongate and more nearly cylindrical, and the septa are apparently less highly fluted. It is possible that the specimens here described as *F. eximia* are conspecific with *Fusulina haworthi* (Beede) of the lower Fort Scott limestone at Fort Scott, Kansas. However, Beede's brief description of that species was not accompanied by an illustration and his types have apparently been misplaced. As there is some disagreement among paleontologists as to the exact nature of *F. haworthi* it seems that until the cotypes of that species are found or until good topotypes are illustrated and described it will be best to consider *F. eximia* as a distinct species.

The spirotheca of *F. eximia* differs from the more primitive representatives of *Fusulina* s. s., here described, primarily in that the layers of spirotheca are much thinner and the septal fluting is less highly developed across the median portion of the shell. The diaphanotheca is well developed, but no traces of aveoli are discernable. *F. eximia* seems to be somewhat intermediate between typical representatives of *Fusulina* and typical *Triticites,* but its septal fluting and spirotheca structure show its affinities to be closer to the genus *Fusulina.*

Occurrence.—Fusulina eximia has been found only in the upper one foot of calcareous shale immediately beneath the so-called "floating-rock" [about 80 feet above the Mystic coal], 1/8 mile north of Iowa highway 3, 1/8 mile west of the large creek, at the water-fall of a small east-flowing creek, 1 mile west by north of Centerville courthouse, SE1/4 sec. 26, T. 69 N., R. 18 W., Appanoose County, Iowa (pl. XXIII, figs. 7-10); and in the same horizon on the east bank of Iowa highway 60, in the northeast corner of the town of Centerville.

Repository.—State University of Iowa, Catalogue Nos. 954-961 (cotypes); the figured specimens are Nos. 958-961.

PLATE XX

All the specimens figured on this plate came from the middle and lower portion of the Cherokee of Southeastern Iowa.

Page

Figs. 1,2,7,9,12,13,17,22,24-27—*Wedekindellina euthysepta* (Henbest)? 282

1,2,12,13—Axial sections, x20; 17, 22,24-26—external views, x10; 7—tangential section, x20; 9,27—sagittal section, x20.

3,6,15,16,20,21—*Wedekindellina dunbari* Thompson, n. sp. 285

3—Tangential section showing unfluted septa, x20; 6—axial section, x20; 15,20—external views of slightly weathered specimens, x10; 16—external view showing unfluted antetheca, x20; 21—sagittal section, x20.

4,5,14,23—*Wedekindellina uniformis* Thompson, n. sp. 289

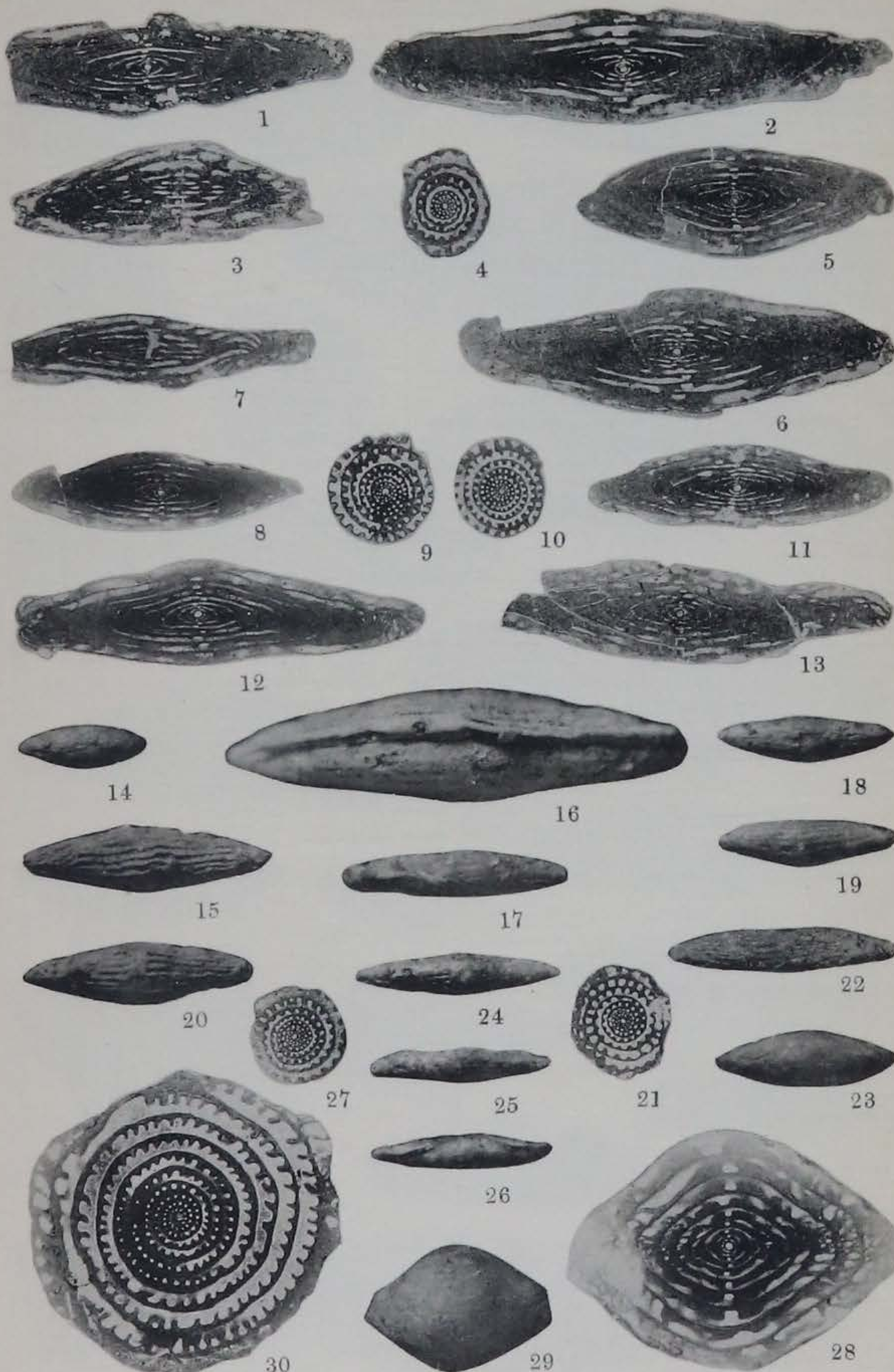
5—Axial section, x20; 14,23—external views of mature and sub-mature specimens, x10; 4—sagittal section, x20.

8,10,11,18,19—*Wedekindellina elfina* Thompson, n. sp. 287

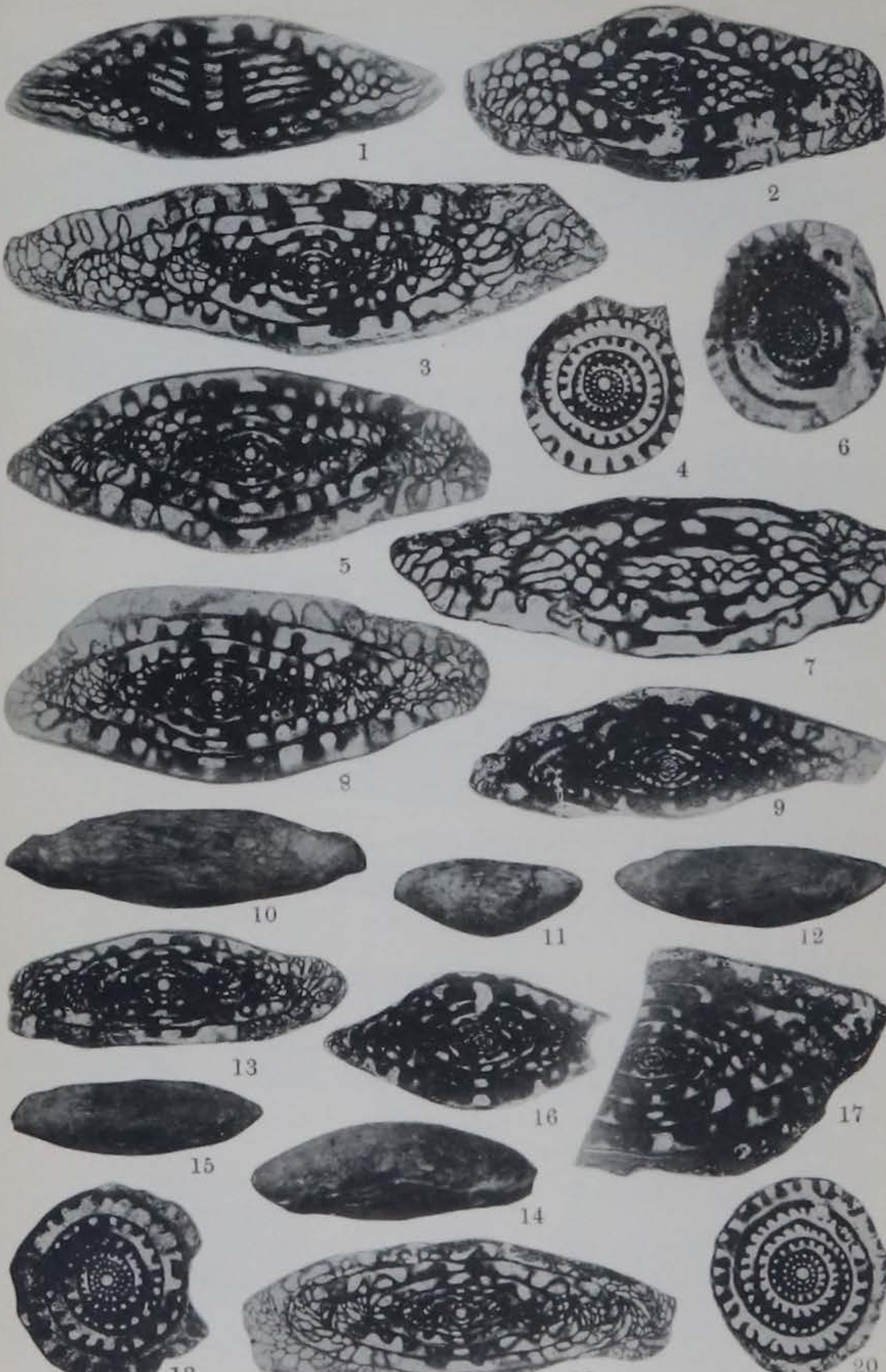
8,11—Axial sections, x20; 18,19—external views, x10; 10—sagittal section, x20.

28-30—*Fusulinella iowensis* Thompson, n. sp. 296

28—Axial section, x20; 29—external view, x10; 30—sagittal section, x20.



Thompson, Des Moines Fusulinids



Thompson, Des Moines Fusulinids

PLATE XXI

All of the specimens illustrated on this plate came from the middle of the Cherokee of Lucas and Monroe counties, Iowa. All illustrations are unretouched photographs.

Page

Figs. 3,7,10,18—*Fusulina leei* Skinner 301

3—Axial section, x20; 7—tangential section, x20; 18—sagittal section, x20; 10—external view, x10.

1,2,4,5,8,12-15,19,20—*Fuslina kayi* Thompson, n. sp. 303

5,8,13,19—Axial sections; x20; 1,2—tangential sections showing septal fluting, x20; 4,20—sagittal sections, x20; 12,14,15—external views, x10.

6,9,11,16,17—*Fusulina? problematica* Thompson, n. sp. 306

16,17—Axial sections showing innermost volutions and proloculum, x20; 19—sagittal section, x20; 20—external view, x10.

PLATE XXII

All of the specimens illustrated on this plate came from the middle and upper portions of the Des Moines series of south-central Iowa. All illustrations are unretouched photographs.

Page

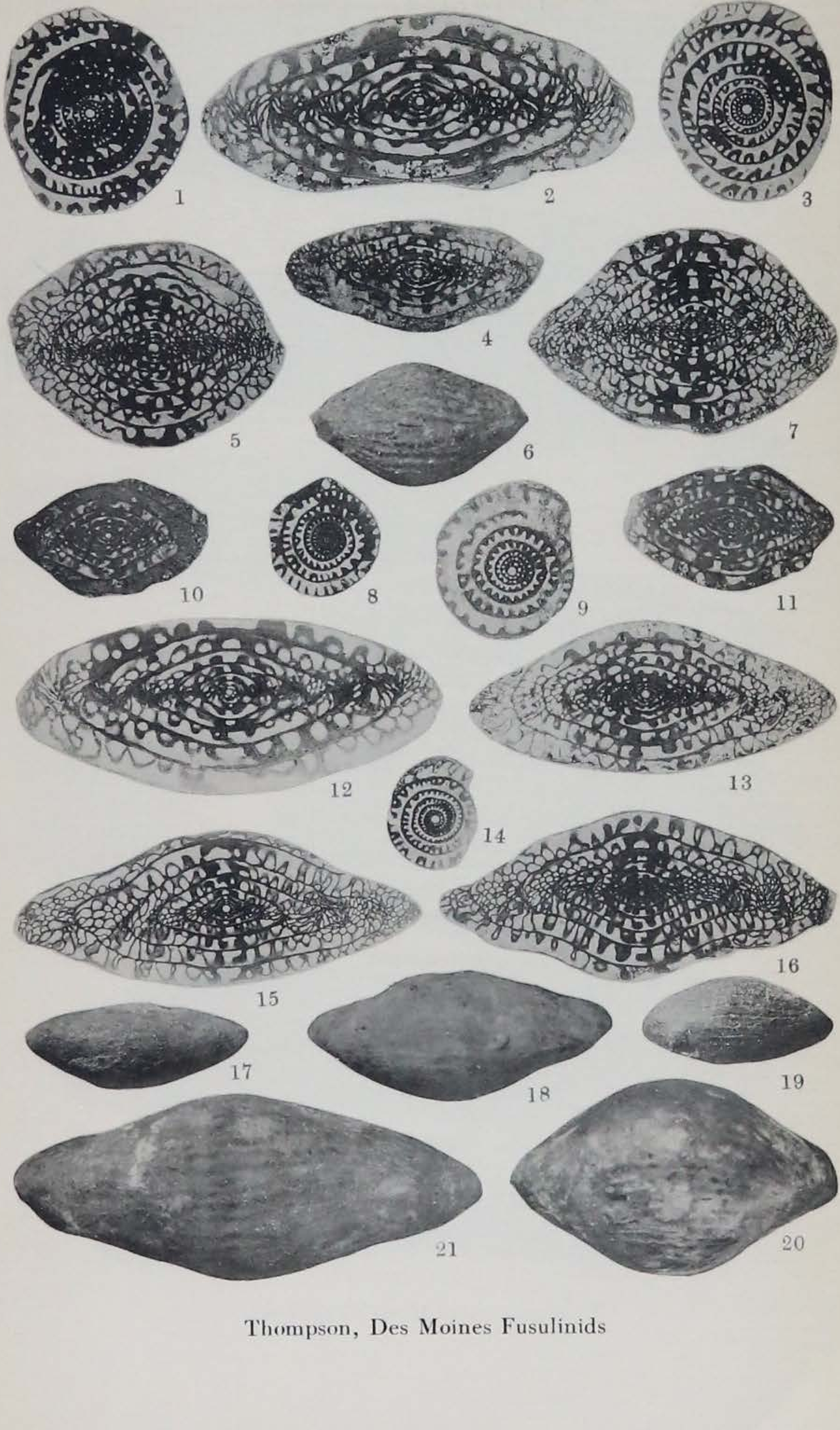
Figs. 2,9,12,17,19—*Fusulina lucasensis* Thompson, n. sp. 309
2,12—Axial sections, x20; 9—sagittal section, x20; 17,19—external views, x10.

4,13,14,18—*Fusulina euryteines* Thompson, n. sp. 310
4,13—Axial sections, x10; 14—sagittal section, x10; 18—external view, x10.

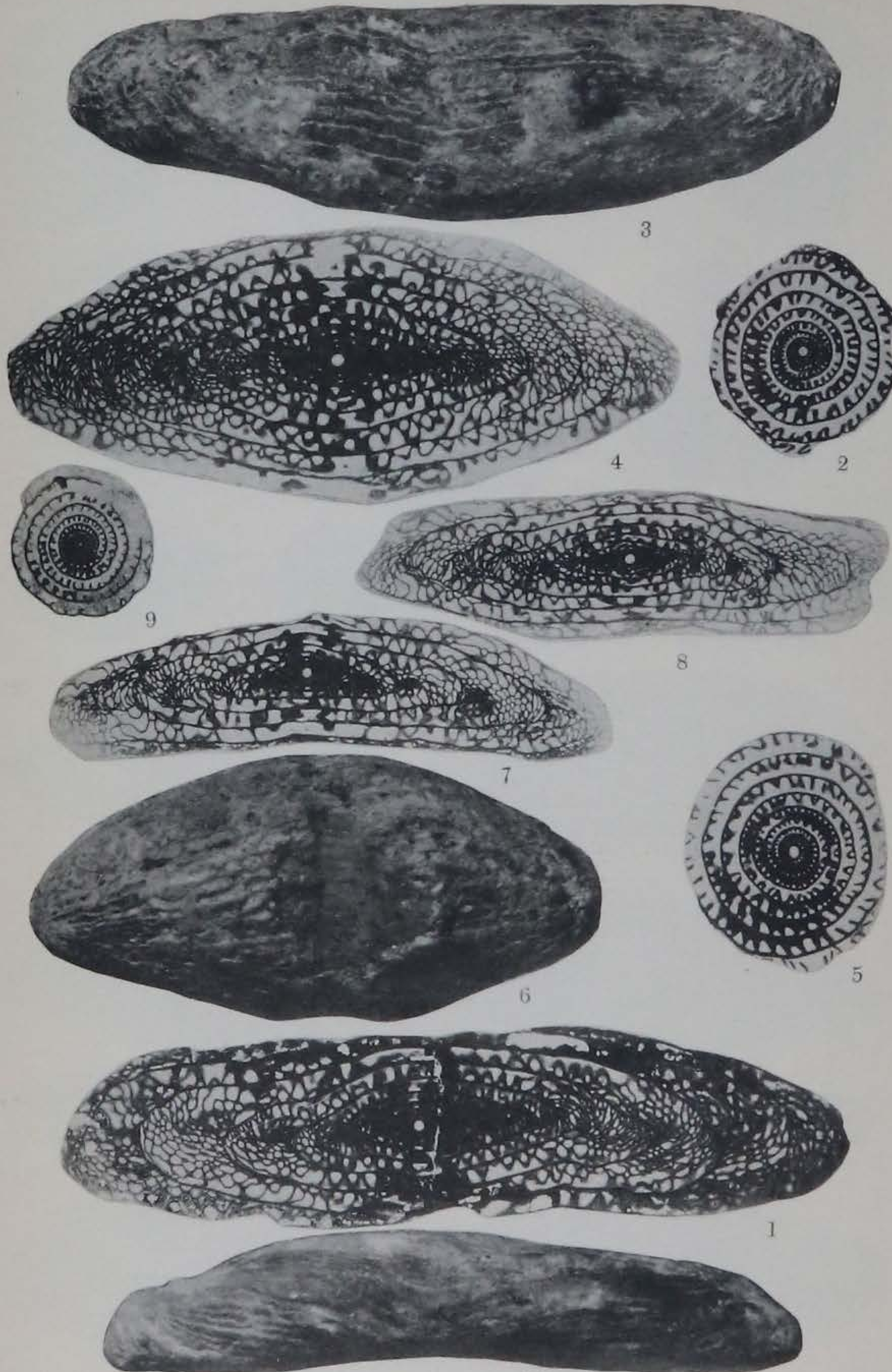
6,8,10,11—*Fusulina pumila* Thompson, n. sp. 313
10,11—Axial sections, x10; 8—sagittal section, x10; 6—external view, x10.

1,5,7,20—*Fusulina girtyi* (Dunbar and Condra) 314
5,7—Axial sections, x10; 1—sagittal section, x10; 20—external view, x10.

3,15,16,21—*Fusulina stookeyi* Thompson, n. sp. 316
15,16—Axial sections, x10; 3—sagittal section, x10; 21—external view, x10.



Thompson, Des Moines Fusulinids



Thompson, Des Moines Fusulinids

PLATE XXIII

All of the specimens illustrated on this plate came from the upper portion of the Des Moines series of south-central Iowa. All illustrations are unretouched photographs.

Page

Figs. 1-3—*Fusulina mysticensis* Thompson, n. sp. 319
1—Axial section, x10; 2—sagittal section, x10; 3—external view, x10.

4-6—*Fusulina megista* Thompson, n. sp. 320
4—Axial section, x10; 5—sagittal section, x10; 6—external view, x10.

7-10—*Fusulina eximia* Thompson, n. sp. 323
7-8—Axial sections, x10; 9—sagittal section, x10; 10—external view, x10.

INDEX