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Lower and Middle Pennsylvanian Fusulinids from the Bird Spring Formation near Mountain Springs Pass, Clark County, Nevada*

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ABSTRACT.—The lower 1200 feet of the Bird Spring Formation at Mountain Springs Pass, Clark County, Nevada, contain fusulinids belonging to the Zone of *Millerella,* Zone of *Profusulinella,* Zone of *Fusulinella,* and Zone of *Fusulina.* Strata referred to the above zones are 673 feet thick, 112 feet thick, 71 feet thick, and 344 feet thick, respectively.

The fusulinid fauna present includes representatives of the genera *Millerella, Paramillerella, Staffella, Eoschubertella, Pseudostaffella, Profusulinella, Fusulinella, Wedekindellina, Fusulina,* and the new genera *Schubertina* and *Pseudoschubertella.* New species and subspecies include *Millerella marblensis robusta, M. springensis, M. extensa, Schubertina circuli, S. circuli compacta, S. circuli minuta, S. extensa, Pseudoschubertella fusiforma, Profusulinella springensis, Fusulinella submatura* and *F. euryangulata.* Noteworthy is the particularly high stratigraphic occurrence of the genus *Fusulinella.*

On the basis of the stratigraphic distribution of fusulinid species in this section, descriptive and informal zones are suggested for local application to the correlation of beds within the central Spring Mountains. Each zone is characterized by its unique fusulinid content. They are designated zones A, B, C, D, E, F, G, H, I, and J. Included also are subzones designated E1, E2, E1a, I1 and I2.

Among the described species in the Mountain Springs Pass fauna, few phylogenetic interrelationships can be demonstrated. This is explained on the basis of the cyclic nature of sedimentation which prevailed in southern Nevada during Pennsylvanian Period.

Morrowan and Derryan portions of this fauna are difficult to relate to other faunas of this age elsewhere; but they have some elements which are geographically widespread from the Great Basin to the midcontinent. The Desmoinesian portion of this fauna has elements which are more restricted to the Great Basin and Rocky Mountains on the one hand and to the midcontinent and southwestern United States on the other hand. Thus there is indicated a higher degree of provincialization of fusulinid faunas in Desmoinesian Epoch than in earlier epochs. Other than the high stratigraphic occurrence of the genus *Fusulinella,* there is very little to tie Lower and Middle Pennsylvanian faunas to Asian faunas.

Significant information concerning the ranges of fusulinid species based on bed-by-bed analyses of fusulinid distribution from many local sections will form the basis for refined hronostratigraphic zonation of Lower and Middle Pennsylvanian strata of Great Basin nd elsewhere.

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*A dissertation submitted to the faculty of the Department of Geology, Brigham Young University in partial fulfillment of the requirements for the degree Doctor of Philosophy.

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INTRODUCTION

Previous Work

Rocks of Lower and Middle Pennsylvanian age in southern Nevada have been recognized formally since 1931 when Hewett (1931) mapped the area and gave the name Bird Spring Formation to a body of dominantly carbonate rock ranging in age from latest Mississippian through Middle Permian. Longwell and Dunbar (1936a, b) recognized and discussed the importance of fusulinids present in the formation. Their work and the work of others on the stratigraphy of this formation in the Spring Mountains and elsewhere is summarized in Rich (1961) and Cassity and Langenheim (1966) and need not be repeated here. The most significant publications concerning the fusulinids from the Bird Spring Formation of recent time are those by Rich (1961), Coogan (1964) and Cassity and Langenheim (1966). Rich (1961) summarized the fusulinid zones recognizable in the Lee Canyon section and illustrated representative fusulinids collected from each zone and their distribution but presented no systematics. Cassity and Langenheim (1966) reported on fusulinids from the northern part of the Arrow Canyon Range and accompanied their summary of fusulinid distribution and zones recognized with a section on systematics, which is the first published work on fusulinid systematics for southern Nevada. Both these papers recognized a complete set of fusulinid zones, including the following pertinent to the present study: Zone of *Millerella,* Zone of *Profusulinella,* Zone of *Fusulinella,* and Zone of *Fusulina.*

Coogan (1964) covered the area from the Arrow Canyon Range north to the Ely area and was restricted to Chesterian through Derryan age rocks. The series represented here were further subdivided into smaller units on the basis of assemblages of fusulinid species and macrofossils (see his figure 2, p. 490-491; also Cassity and Langenheim, 1966, p. 940, fig. 6). Bissell (1962, p. 17-18) also presents a refined zonal scheme on the basis of assemblages of fusulinid species (see Cassity and Langenheim, 1966, p. 940, fig. 6 for a comparison of the various zonal schemes mentioned). In another important publication on the Pennsylvanian and Permian strata of eastern Nevada and western Utah, Bissell (1964) illustrated with thirteen stratigraphic columns the distribution of some significant fusulinids in the Ely and Hogan formations (see fig. 4, p. 580; fig. 5, p. 582 and fig. 6, p. 583. A zonal scheme somewhat different from that suggested in 1962 is also shown (see p. 574, fig. 2). Fusulinid systematics were not included.

Purpose and Scope

Aside from the above mentioned works, which have proved very useful, nothing has been published at this time concerning the detailed bed-by-bed distribution of fusulinid species in Lower and Middle Pennsylvanian rocks of the southern portion of the Great Basin. Very little attention has been paid to the description of small fusulinids, particularly in beds younger than Early Derryan. Finally, no attempt has been made to recognize local fusulinid zones and test these with various sections within a mountain range.

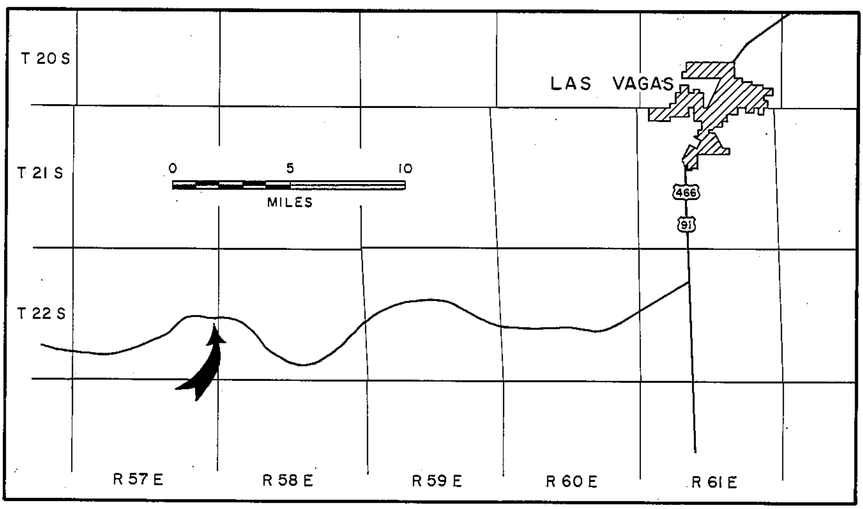
The purpose of this report is to: (1) Extend knowledge of some of the details of fusulinid distribution further south into the central Spring Mountains; (2) Initiate detailed description and show distribution of some of the smaller fusulinid species; and (3) Suggest an informal and tentative zonal scheme of fusulinids applicable to the local synchronization of Lower and Middle Pennsylvanian rocks in the central Spring Mountains.

Location

Although several stratigraphic sections were measured and collected in detail, time permitted the study of only one of these. This one is located about one mile west of Mountain Springs Pass in the Mountain Springs, Nevada, Quadrangle, in the S$\frac{1}{2}$, NW$\frac{1}{4}$, sec. 19, T. 22 S., R. 58 E., and SE$\frac{1}{4}$, NE$\frac{1}{4}$, sec. 24, T. 22 S., R. 57 E. Measurements and collections were made on the first east-west trending ridge south of the Las Vegas-Pahrump Road (Text-fig. 1). Sample localities are indicated at the outcrop by a spot of yellow paint on the location which is accompanied by a sample number, *e.g.*, FCM 211.

Acknowledgments

The writer wishes to express his sincere gratitude to several members of the Geology Department of Brigham Young University whose aid was essential to the completion of this project. His major professor, Dr. Harold Bissell, gave



TEXT-FIGURE 1.—Index map showing location of Mountain Springs Pass section.

important field assistance as well as valuable advice and encouragement throughout the project. Dr. Jess Bushman and Dr. Morris Peterson kindly consented to read and criticize the manuscript. The writer also benefited from discussions with Dr. J. Keith Rigby, Dr. Kenneth Hamblin, Lee Braithwaite, Dr. Robert Kleinpell and Dr. William B. N. Berry, the latter two of the University of California, Berkeley. Gary Lawyer generously donated considerable time and effort to the completion of the plates and text-figures in this report. Dr. D. T. Secor of the University of South Carolina kindly gave him a copy of his geologic map of the central Spring Mountains which provided much useful information. Finally, special acknowledgment with much gratitude must be made to the unselfish effort put forth by his wife, Susan, who did the typing, assisted in much of the photographic work and the recording of data, and whose continual encouragement—and occasional pushings—were helpful with the completion of this project.

GENERAL LITHOLOGY

The lithology of this section in general is fairly typical of the Bird Spring Formation described elsewhere in the Spring Mountains (Rich, 1961; 1963; Welsh, 1959; Secor, 1962; Heath, Lumsden and Carozzi, 1967). The basal 64 feet (units 2-4) is marked by orthoquarzite, shale and a few limestone beds and is underlain by the limestone beds of the Monte Cristo Formation. The orthoquartzite grades quickly upward into 492 feet of dominantly coarsely calcarenitic, crinoidal, fragmental, and skeletal limestones which are mostly medium- to thick-bedded, dark-colored, and with only minor amounts of chert, micritic limestones and calcisiltite (units 5-17). Chert becomes more abundant in the upper portion of this sequence. Overlying these beds are 224 feet of dominantly micritic and calcisiltitic, medium-bedded limestones alternating with covered intervals presumably represented by siltier or shalier beds (units 18-51). Also present are minor amounts of calcarenitic, skeletal and dolomitic limestones. Chert is fairly common as nodules and beds in a few units. Overlying this sequence are 138 feet of dominantly medium-grained, thin-to-thick-bedded calcarenitic and pelletal limestones alternating with covered intervals presumably representing siltier or shalier strata (units 52-73). Also present are minor amounts of skeletal, fusulinal, fragmental and micritic limestones. Beds and nodules of chert are occasionally common. Above these beds are 347 feet of dominantly micritic, calcisiltitic, thin-to thick-bedded limestones alternating with covered intervals presumably representing siltier or shalier strata (units 74-120). Also present are pelletal, fusulinal, fragmental, and dolomitic limestones in lesser amounts. Chert is fairly common in the lower half of this sequence but more rare in the upper half. The section under study in this report is topped by 51 feet of calcareous, cross-bedded, medium-grained, platy- to blocky-weathering sandstones (unit 121). This unit is a fairly good marker bed within this formation and is about 70 feet above the top of the Desmoinesian portion of the Bird Spring Formation. Above this unit continues the Upper Pennsylvanian portion of this formation.

METHODS OF PREPARATION AND RESEARCH

Each sample was sawed into slices about one-half to one centimeter thick. Each of the flat surfaces so produced was smoothed off with 600 mesh grinding powder and then examined under a binocular microscope for potentially good sections of both large and small fusulinids. A small amount of dilute hydrochloric acid dropped on the surface of the slice helped to reveal the presence of fusulinids not otherwise visible. This method is also quite useful in the field, for a drop on a freshly broken surface will not only reveal the presence of fusulinids not otherwise visible, but will also reveal the internal petrographic structures and texture of a limestone sample and hence greatly facilitate accurate field description of beds. Individual fusulinids discovered on the slice surface were circled in pencil, sawed out with excess rock matter trimmed away, ground to the proloculus, and mounted on a glass slide. Since individually sawed out specimens were fairly small, it was possible to mount several individual specimens on a single glass slide. Excess rock material was cut away with a Ward-Ingram cut-off saw and the mounted specimens were ground to nearly the appropriate thinness on a Ward-Ingram grinder. The Ward-Ingram machines are recommended since they greatly reduce the time necessary to process the thin sections. Final grinding was done with 600 and 1000 mesh grinding powder and a glass lap.

Each specimen was photographed on 35 millimeter film which is fairly inexpensive and rapid. Using kodabromide paper, each photo was enlarged to a convenient magnification (25X for the larger specimens and 100X for the smaller specimens). Each print was mounted on a five by eight inch index card and measurements were made on the enlarged print and recorded on the index card.

In order to facilitate the comparison of these fusulinids with species described in the literature, a chart of all described American species of *Eoschubertella, Profusulinella, Fusulinella, Fusulina,* and *Wedekindellina* was prepared. The name, statistical data and pertinent description of each species were placed on a thin strip of paper. The strips were then taped together according to increasing form ratios and sizes. Thus, in studying the southern Nevada specimens, the closely similar species could be quickly ascertained and identifications were thereby facilitated.

THE NATURE OF THE FUSULINID FAUNAS

The superfamily Fusulinacea is well represented by an abundant and varied fauna in the lower portion of the Bird Spring Formation. Present here are representatives of the families Ozawainellidae, Staffellidae, and Fusulinidae as well as the subfamilies Schubertellinae and Fusulininae. The family Ozawainellidae is adequately represented by members of the genus *Millerella* including the widespread *M. marblensis* Thompson and a new subspecies, *M. marblensis robusta* n. subsp., *M. pressa* Thompson and several newly described species, including *M. springensis* n. sp., *M. extensa* n. sp., *M.* spp. A, B, C, and D. Most of these species are, in the context of this particular stratigraphic section, restricted in their vertical ranges. Further detailed study may show them to be useful in correlation, particularly when used in conjunction with other fusulinid species. The genus *Paramillerella* is present throughout the section but is not well represented, only one possible new species being described, *P.* sp. A.

The family Staffellidae is represented by abundant specimens referable to the genus *Staffella.* Some of these might also be referable to the genus *Nankinella,* but since most specimens are more or less badly altered by recrystallization, these determinations were not attempted.

The family Fusulinidae is well represented by members of the subfamilies Schubertellinae and Fusulininae. Among the Schubertellinae are several representatives of the genus *Eoschubertella,* including *E. bluensis* Ross and Sabins and subspecies A and B; *E.* sp. aff. *E. texana* Thompson; *E.* sp. aff. *E. mexicana* Thompson; and the new forms *E.* sp. A and *E.* sp. B. Along with *Eoschubertella* are representatives of two newly described genera, *Schubertina* and *Pseudoschubertella.* These are minute forms, the more spherical ones belonging to the genus *Schubertina,* which is represented by *S. circuli* n. sp., *S. circuli compacta* n. subsp., *S. circuli minuta* n. subsp., and *S. extensa* n. sp. The fusiform specimens belong to the genus *Pseudoschubertella,* which is represented by *P. fusiforma* n. sp. and *P.* sp. A. These minute forms, especially *Schubertina,* are abundant in some beds in the upper portion of this section.

The subfamily Fusulininae is represented by members of the genera *Pseudostaffella, Profusulinella, Fusulinella, Wedekindellina,* and *Fusulina. Pseudostaffella* ranges through the lower and middle portion of the section but is more common in the lower portion where it is represented by *P. needhami* Thompson, *P.* sp. A and *P.* sp. A var. A. Higher, there is a large nearly globose specimen resembling, in some respects, *Eoschubertella* which is described as *P.* (?) sp. A. *Profusulinella* is present but not represented by any of the well-developed forms described by Thompson from New Mexico (Thompson, 1948) and reported from other Great Basin faunas by Thompson and Zeller (1956), Coogan (1964), Rich (1961), Cassity and Langenheim (1961), and Bissell (1964). Present instead are the rather small primitive-looking forms *P.* sp. aff. *P. walnutensis* Ross and Sabins and *P. springensis* n. sp.

The genus *Fusulinella* is represented by the species *F. lounsberyi* Thompson, *F. submatura* n. sp. and *F. euryangulata* n. sp. *F. lounsberyi* is a small upper Derryan species described by Thompson from the Uinta Mountains (Thompson, 1945) which resembles closely the immature stages of *F. devexa* Thompson and may be closely related to it. *F. submatura* n. sp. resembles *Wedekindellina* in some respects, particularly in its plane septa. *F. euryangulata* is remarkable for its high stratigraphic occurrence in association with fairly advanced forms of *Fusulina.* Verville, Thompson and Lokke (1956) described the occurrence of *Fusulinella alta* Verville, Thompson and Lokke and *F. nevadensis* Verville, Thompson and Lokke with *Fusulina weintzi* Verville, Thompson and Lokke from the eastern Great Basin. *F. weintzi* is a fairly advanced *Fusulina* and was considered by them to indicate a Medial Desmoinesian age. Bissell (1964), in his stratigraphic columns of the Hogan Formation in the eastern Great Basin, showed the distribution of *Fusulinella alta, F. nevadensis, Fusulina weintzi* and *F. retusa* Thompson and Thomas. Interestingly, in the thirteen stratigraphic columns illustrated, *Fusulinella alta* and/or *F. nevadensis* are always shown occurring below *Fusulina weintzi* and/or *F. retusa.* In the Mountain Springs Pass section, *Fusulinella euryangulata* occurs in the same samples with *Fusulina* sp. aff. *F. weintzi* and *F.* sp. aff. *F. retusa.* Furthermore, other undescribed species of typical *Fusulinella* are present in the samples above this occurrence, even in the highest fusulinid-bearing strata referable to the Desmoinesian Series. These latter strata are below the first occurrence of *Triticites* but above the highest occurrence of *Fusulina.* To date, then, these southern Nevada forms probably represent the highest reported occurrence in North America of the genus *Fusulinella.*

Representatives of the genus *Wedekindellina* are scantily present throughout the Desmoinesian portion of the section except for *W.* sp. aff. *W. pseudomatura* Ross and Sabins, which is fairly common in the Lower Desmoinesian portion of the section in samples 293 and 294 and a fairly large number of badly abraided specimens present in sample 291. Some of these latter suggest the type similar to

W. euthysepta (Henbest). *Fusulina* is represented by the relatively primitive forms *F. rockymontana* Roth and Skinner and *F.* sp. aff. *F. pattoni* Needham as well as the more advanced forms *F.* sp. aff. *F. retusa, F.* sp. aff. *F. weintzi,* and the fairly widespread form *F. novamexicana* Needham.

FUSULINID BIOSTRATIGRAPHY

The Lower and Middle Pennsylvanian portions of the Bird Spring Formation comprise the following major fusulinid zones: the Zone of *Millerella,* the Zone of *Profusulinella,* the Zone of *Fusulinella,* and the Zone of *Fusulina.* The Zone of *Triticites* immediately overlies the section under consideration in this report.

The Zone of *Millerella* extends approximately to unit 38 and is about 673 feet thick. It includes rocks assigned to the Chesterian and Morrowan Series. This same Zone is about 1100 feet thick to the north in Lee Canyon (Rich 1961, taken from text-fig. 4, p. 1167) and about 1700 feet thick further north in Arrow Canyon (Cassity and Langenheim, 1966, taken from text-figs. 2-4, p. 934-936).

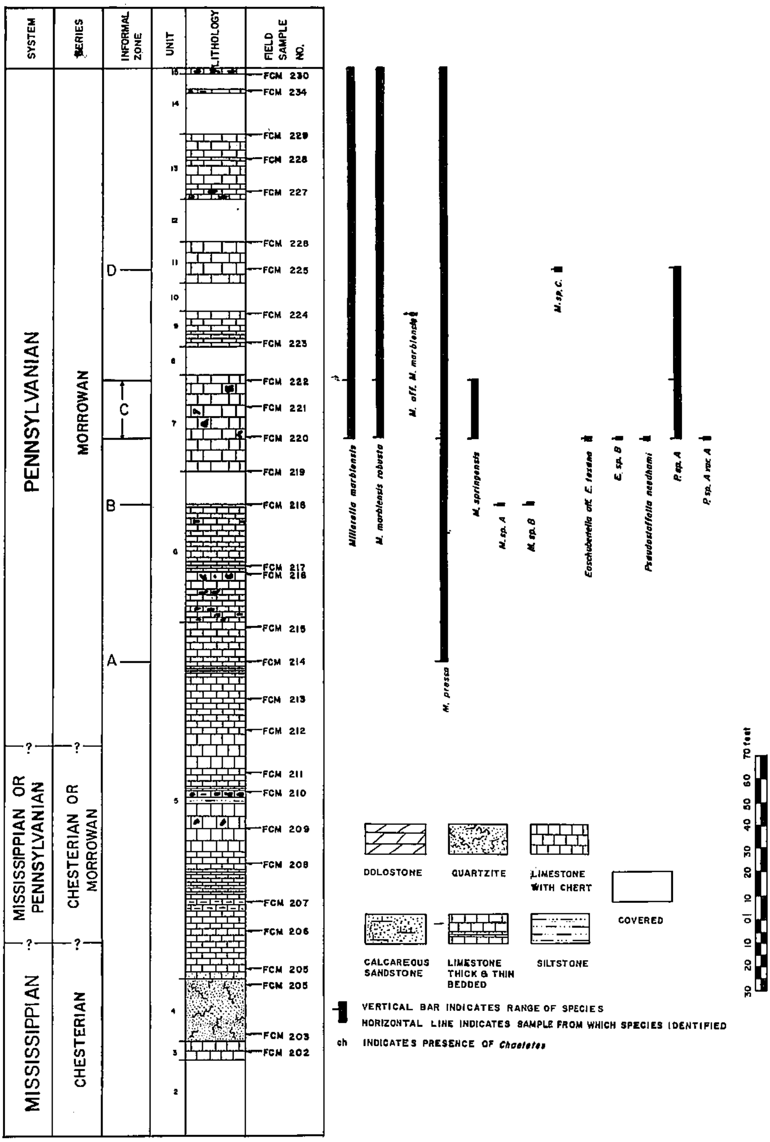
The Zone of *Profusulinella* extends from unit 39 to about unit 52 and is only about 112 feet thick. In Lee Canyon, Rich (1961) shows about 225 feet of this Zone and in Arrow Canyon, Cassity and Langenheim (1966) show about 140 feet. Rocks included in this Zone are assigned to the lower part of the Derryan Series.

The Zone of *Fusulinella* extends from unit 53 to unit 64 and is approximately 71 feet thick at Mountain Springs Pass, while at Lee Canyon, Rich (1961) shows about 250 feet and at Arrow Canyon, Cassity and Langenheim (1966) show a thickness of about 280 feet. Rocks in this Zone are assigned to the upper portion of the Derryan Series.

The Zone of *Fusulina* at Mountain Springs Pass is present from unit 65 to unit 120 and is about 340 feet thick. Rich (1961) shows about 275 feet of this Zone at Lee Canyon and Cassity and Langenheim (1966) show about 440 feet of this Zone. Strata within this Zone are assigned to the Desmoinesian Series.

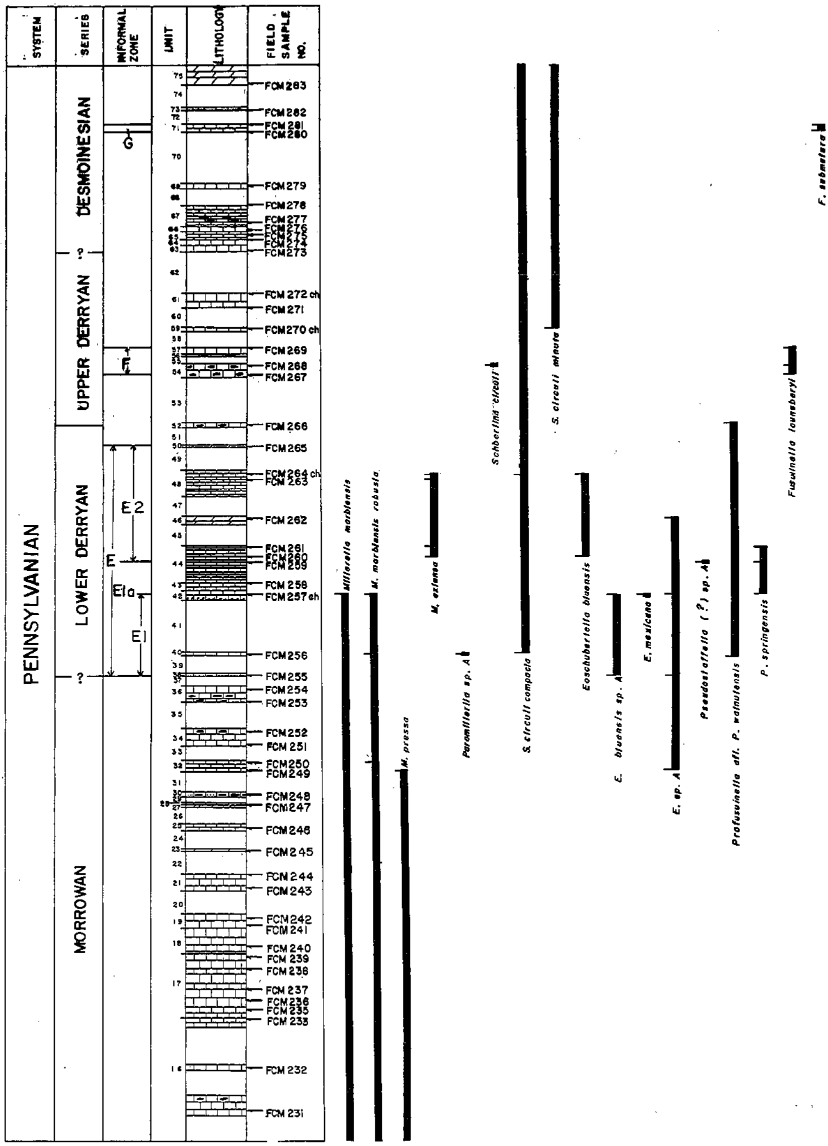
Within the stratigraphic limits of each of these major fusulinid zones are restricted intervals and horizons, each of whose fusulinid content is unique. The writer suggests the designation of these units as purely descriptive, informal zones applicable to the local correlation of the lower portion of the Bird Spring Formation within the central Spring Mountains. To emphasize the informal nature of these zones, they are designated with capital letters rather than species names, and the word "zone" is not capitalized. These zones are summarized in table 41 and text-figs. 2-4.

Within the Zone of *Millerella,* there are four of these zones. The lowest of these, here designated as zone A, is a single horizon 202 feet above the base of the Bird Spring Formation. Sample number FCM 214 was collected here. Zone A is characterized by the presence of abundant specimens of *Millerella pressa* Thompson. Zone B is a single horizon 269 feet above the base of the formation (sample number FCM 218), and is characterized by the presence of *M.* sp. A and *M.* sp. B. Zone C is a 24 foot interval, the base of which is 299 feet above the base of the formation (sample numbers FCM 220 and 222). Appearing for the first time in this zone are *M. marblensis* Thompson and *M. marblensis robusta* n. subsp. Restricted to this zone are *M. springensis* n. sp.,



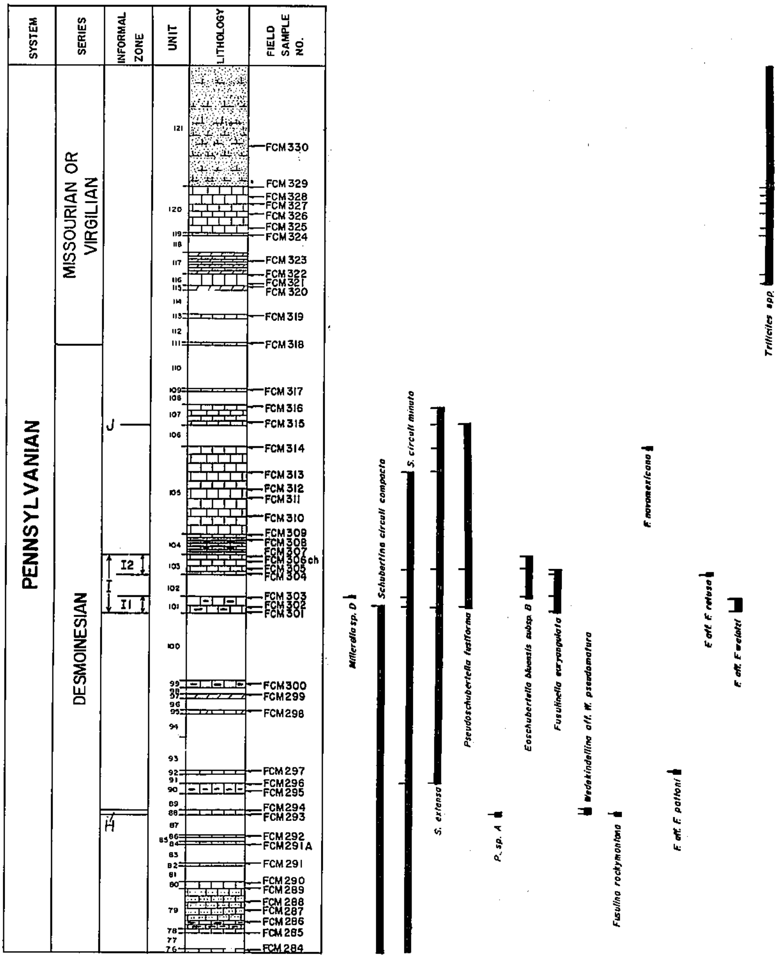
TEXT-FIGURE 2.—Columnar section and fusulinid range chart, unit 2 through unit 15.

Pseudostaffella needhami Thompson, *P.* sp. A., *P.* sp. A var. A, *Eoschubertella* sp. aff. *E. texana* Thompson and *E.* sp. B. The highest of these zones within the Zone of *Millerella,* here designated zone D, is a single horizon 371 feet above the base of the formation (FCM 225) characterized by the presence of *M.* sp. C and the highest occurrence of *Pseudostaffella* sp. A.



TEXT-FIGURE 3.—Columnar section and fusulinid range chart, unit 16 through unit 75.

Within the limits of the Zone of *Profusulinella* is just one of these local zones, here designated zone E. Zone E is an interval 108 feet thick whose base is 674 feet above the base of the formation (FCM 255-266). Appearing for the last time within this zone are *Millerella marblensis, M. marblensis robusta, M. extensa* n. sp. and *Eoschubertella* sp. A. Restricted to this zone are *Paramillerella*



TEXT-FIGURE 4.—Columnar section and fusulinid range chart, unit 76 through unit 121.

sp. A, *Eoschubertella bluensis* Ross and Sabins, *E. bluensis* subsp. A, *E.* sp. aff. *E. mexicana* Thompson, *Pseudostaffella* (?) sp. A, *Profusulinella* sp. aff. *P. walnutensis* Ross and Sabins, and *P. springensis* n. sp. Within the limits of zone E, two subzones can be distinguished, here designated zones E1 and E2. Zone E1 is an interval 35 feet thick (FCM 255 to 257) whose base is at the base of zone E and is characterized by the restriction to the zone of *Paramillerella* sp. A, *Eoschubertella bluensis* subsp. A, and *E.* sp. aff. *E. mexicana;* the first appearance within the Zone of *Profusulinella* sp. aff. *P. walnutensis,* and *P. springensis;* and the highest occurence within the zone of *M. marblensis* and *M. marblensis robusta.* Zones E1 and E2 are separated by a thirteen foot interval devoid of significant fusulinids. Zone E2 is an interval 60 feet thick (FCM 259-266) whose base is 48 feet above the base of zone E. Zone E2 is characterized by the restriction to it of *Eoschubertella bluensis* and *Pseudostaffella*

(?) sp. A; and the highest occurrence within the zone of *Millerella extensa, Eoschubertella* sp. A, *Profusulinella* sp. aff. *P. walnutensis* and *P. springensis.* Furthermore, at the top of zone E1 a single horizon can be recognized which is here designated zone E1a and is marked by the association of *Millerella marblensis, M. marblensis robusta, Eoschubertella bluensis* subsp. A, *E.* sp. aff. *E. mexicana, E.* sp. A and *Profusulinella springensis.* Also noteworthy in this zone is the first occurrence of the tabulate coral *Chaetetes.*

Within the limits of the Zone of *Fusulinella* is only one zone, here designated zone F. Zone F is an interval twelve feet thick (FCM 267-269) whose base is 803 feet above the base of the formation. It is characterized by the restricted occurrence of *Fusulinella lounsberyi* Thompson and *Schubertina circuli* n. sp.

The zone of *Fusulina* contains four local zones. The lowest of these, here designated zone G, is an interval four feet thick (FCM 280, 281), 907 feet above the base of the formation and characterized by the restricted occurrence of *Fusulinella submatura* n. sp. The placement of Zone G within the Zone of *Fusulina* was made because specimens of the genus *Wedekindellina* occur somewhat lower in the formation. Zone H is an interval two feet thick (FCM 293, 294), the base of which is 996 feet above the base of the formation. Zone H is characterized by the restricted occurrence of *Fusulina rockymontana* Roth and Skinner, *Wedekindellina* sp. aff. *W. pseudomatura* Ross and Sabins and *Pseudoschubertella* sp. A. Zone I is an interval 25 feet thick (FCM 301-307) whose base is 1083 feet above the base of the formation. It is characterized by the restricted occurrence of *Fusulinella euryangulata* n. sp., *Fusulina* sp. aff. *F. retusa* Thompson and Thomas, *F.* sp. aff. *F. weintzi* Verville, Thompson and Lokke, *Millerella* sp. D, *Pseudoschubertella fusiforma* n. sp. and *Eoschubertella bluensis* subsp. B; and by the highest occurrence of *Schubertina circuli compacta* n. subsp. Within the limits of zone I, two subzones can be recognized, here designated zones I1 and I2. Zone I1 is an interval seven feet thick (FCM 301-303) whose base is at the base of zone I. It is marked by the restricted occurrence of *Fusulina* sp. aff. *F. weintzi* and *Millerella* sp. D; by the lowest occurrence of *Pseudoschubertella fusiforma, Eoschubertella bluensis* subsp. B, and *Fusulinella euryangulata;* and by the highest occurrence of *Schubertina circuli compacta.* Zones I1 and I2 are separated by a covered interval of nine feet. Zone I2 is an interval nine feet thick whose base is sixteen feet above the base of zone I. It is characterized by restricted occurrence of *Fusulina* sp. aff. *F. retusa;* and by the highest occurence of *Pseudoschubertella fusiforma, Eoschubertella bluensis* subsp. B and *Fusulinella euryangulata.* Noteworthy is the highest occurrence within this zone of *Chaetetes.* Zone J is the highest of the local zones described here. It is a single horizon (FCM 314) 1139 feet above the base of the formation and is characterized by the restricted occurrence of *Fusulina novamexicana.*

CONCLUSIONS: SIGNIFICANCE OF THE FAUNA

Phylogenetic Significance

Most conclusions of phylogenetic significance are included under "Nature of the Fauna" and in specific discussions of species under "Systematic Paleontology." Therefore, comments here will be restricted to interrelationships among the various species and subspecies within the Mountain Springs Pass fauna itself.

A critical examination of the comparative morphology of the different species described here indicates that, with a few exceptions mentioned below, they are not closely related. There are few "evolutionary series" represented, either from a strictly descriptive morphological standpoint or from an interpretive phylogenetic standpoint. Therefore, it is believed that most of the elements of this fauna are cryptogenetic, *i.e.,* they migrated into the area from external sources.

One possible explanation of this phenomenon combines both the interpreted mode of life of fusulinds and the environmental conditions under which the Bird Spring Formation was interpreted to have formed. Fusulinids are generally considered to have a benthonic mode of life, which implies a sensitive response to ecologic changes; therefore they are very likely facies-controlled. The conditions of sedimentation of the Bird Spring Formation have been discussed at some length by Rich (1963) and Heath, Lumsden, and Carozzi (1967). These writers describe the petrographic nature of the Bird Spring Formation as cyclic and as reflecting cyclic conditions of sedimentation, including energy, depth, and supply of terrigenous matter. Under such rapidly changing bottom conditions, relatively favorable environments for the establishment and maintenance of a developing population of relatively stenopic fusulinids did not persist over a sufficient period of time to allow a phylogenetic succession of fusulinids to be preserved in this one area. It should be pointed out, however, that numerous fusulinids were present in many beds which were not abundant or sufficiently preserved for specific description. Perhaps more intensive work on these might reveal some phylogenetically significant sequences not recognized at this time.

Some of the minute forms described here do seem to represent morphologic sequences of phylogenetic significance. The species *Millerella* sp. A, *M.* sp. B, *M. marblensis* Thompson and *M. marblensis robusta* n. subsp. are interpreted to be closely related. Indeed, *M.* sp. A and *M.* sp. B may be slightly dwarfed forms of *M. marblensis* and *M. marblensis robusta,* respectively. Since the former occurs below the latter, it seems reasonable to suggest that the former may be the ancestors, or at least closely related to the ancestors. In a second case, *Eoschubertella bluensis* subsp. A, *E. bluensis* Ross and Sabins and *E. bluensis* subsp. B also are likely closely related, differing only in size, which increases in the order mentioned. *E. bluensis* B, however, is somewhat higher stratigraphically than the other two and possibly is not involved in the same series. Another group of interpreted closely related forms is *Schubertina circuli compacta* n. subsp., *S. circuli* n. sp., and *S. circuli minuta* n. subsp. In this case, *S. circuli compacta* likely was the basic stock which gave rise to *S. circuli* by evolving forms more loosely coiled in the inner volutions, and later gave rise to *S. circula minuta* by evolving forms with an overall decrease in size. The three above-mentioned examples are the only sequences of interpreted phylogenetic significance discovered in the Mountain Springs Pass fauna.

Paleozoogeographic Significance

The Mountain Springs Pass fauna is closely related to other faunas previously reported from the Great Basin, both in Clark County (Rich, 1961; Cassity and Langenheim, 1966; Wright, 1952; and Steele, 1959) and to the north in east-central and eastern Nevada and western Utah (Steele, 1959; Slade, 1961; Bissell, 1964; Coogan, 1964; Thompson, Verville and Bissell, 1950; and Verville, Thompson and Lokke, 1956). Elements of parts of this fauna are also present in parts of the Rocky Mountains (Thompson and Thomas, 1953; Roth and Skinner, 1930; and Thompson, 1945a), the Black Hills (Thompson, 1936a), New Mexico and southwest Texas (Thompson, 1948, and Needham, 1937), central Texas (Thompson, 1947), southeastern Arizona (Ross and Sabins, 1965, and Ross and Tyrell, 1965), the midwest (Dunbar and Henbest, 1942) and Arkansas (Thompson, 1944).

Elements of the Zone of *Millerella* and Zone of *Profusulinella* portions of the Mountain Springs Pass fauna are not easy to evaluate because relatively few detailed studies have been made on the smaller fusulinids, especially the millerellids, pseudostaffellids and eoschubertellids. Furthermore, the profusulinellas found at Mountain Springs Pass are very primitive and have not been described elsewhere (with the exception of *P. walnutensis* Ross and Sabins from southeastern Arizona). Within these two major zones, the elements that are of interest to this discussion come from zones designated A, C, and E, and are *Millerella pressa* Thompson, *M. marblensis* Thompson, *Pseudostaffella needhami* Thompson, *Eoschubertella mexicana* Thompson, *E. bluensis* Ross and Sabins, *E. texana* Thompson, and *Profusulinella walnutensis* Ross and Sabins, 1965. Of these, *M. marblensis* has been reported in most areas where the Zone of *Millerella* is present, from Arkansas to the Great Basin (Thompson, 1944, 1945a, 1947, 1948; Rich, 1961; Ross and Sabins, 1965; Ross and Tyrell, 1965; Bissell, 1964; Cassity and Langenheim, 1966; Slade, 1964; and Coogan, 1964). *M. pressa* is known from western Kansas (Thompson, 1944), the Uinta Mountains (Thompson, 1945), and the Great Basin (Bissell, 1964). The other species are known principally from the southwestern United States, from southwest Texas to the Great Basin (Thompson, 1947, 1948; Ross and Sabins, 1965; and Rich, 1961).

At this time only tentative conclusions can be advanced concerning the regional significance of that part of the Mountain Springs Pass fauna from the Zone of *Millerella* and the Zone of *Profusulinella*. Some elements are geographically widespread, and there is not sufficient information to indicate whether provincialization has taken place. Further detailed studies on the taxonomy and distribution of these elements may change this picture. For example, although *Millerella marblensis* seems to be geographically widespread, a number of forms have admittedly been referred to it which may not be conspecific with the types from the Marble Falls Limestone. A critical evaluation of abundant topotype material and a careful comparison of forms referred to this species with the types may confirm the apparent widespread distribution of *M. marblensis;* or it may reveal that *M. marblensis* is not so widespread and that there is more provincialization of fusulinid faunas of this age than appears to be the case now.

The Zone of *Fusulinella* at Mountain Springs Pass contains only one previously described species, *Fusulinella lounsberyi* Thompson, which is present in zone F. This species has been described by Thompson (1945) from the Uinta Mountains. As previously mentioned, this species bears close resemblance to *F. devexa* Thompson (immature stages), which is widespread throughout the Great Basin and the southwestern United States, including New Mexico and southeastern Arizona (Thompson, 1948; Ross and Sabins, 1965; Steele, 1959; Bissell, 1964; Coogan, 1964; Slade, 1961; and Cassity and Langenheim, 1966).

If these two prove to be closely related, as is suggested here, then this portion of the Mountain Springs Pass fauna is also geographically widespread throughout the western United States where the Zone of *Fusulinella* occurs. The lack of other species of *Fusulinella* in this part of the Mountain Springs Pass fauna, species which have been reported to the north in other parts of the Great Basin, can be ascribed to either ecologic facies control, or tectonic facies control, resulting in the nondeposition of sediments in which these other species would be preserved, or some combination of both. In this connection, neither Rich (1691) or Cassity and Langenheim (1966) have reported from the Zone of *Fusulinella* in Clark County species of *Fusulinella* other than *F. devexa.*

The Zone of *Fusulina* is better represented in the Mountain Springs Pass fauna by previously described species and provincial relationships are more complex. The lower two zones, G and H, contain *Fusulinella submatura* n. sp., *Fusulina rockymontana* Roth and Skinner, and *Wedekindellina* sp. aff. *W. pseudomatura* Ross and Sabins. *F. rockymontana* is widely distributed from the Great Basin eastward into the Great Plains and southeastward into southeastern Arizona (Thompson, Verville and Bissell, 1950; Roth and Skinner, 1930; Thompson, 1936a; Ross and Tyrell, 1965). If it proves that *Fusulinella submatura* is closely related to *W. matura,* another widespread element would be present in this part of the fauna. None of these elements have so far been reported in midcontinent fusulinid faunas of this approximate age, so that some provincial separation appears to have taken place at this time. Higher in the Mountain Springs Pass fauna, in zone I, there is evidence of further provincialism, taking into consideration the elements *Fusulina* sp. aff. *F. weintzi* Verville, Thompson, and Lokke and *F.* sp, aff. *F. retusa* Thompson and Thomas. At the present time, these species, singly or together, are known exclusively from Wyoming (Thompson and Thomas, 1953), and the Great Basin (Verville, Thompson, and Lokke, 1956; Steele, 1959; Bissell, 1964; and Cassity and Langenheim, 1966). They are not known from southeastern Arizona, New Mexico, or from the midcontinent. On the other hand, *F. novamexicana* Needham from zone J is known from the midcontinent (Dunbar and Henbest, 1942; Alexander, 1954), New Mexico (Needham, 1937), and southeastern Arizona (Ross and Sabins, 1965; Ross and Tyrrell, 1965), but not from more northerly areas of the Great Basin, nor from the Central Rockies. If this distributional picture is valid, it would appear that the Mountain Springs Pass fauna was receiving elements from the midcontinent through a southeasterly passageway at one time, and also from the Central Rockies through more northerly areas of the Great Basin at a somewhat earlier time.

A further interesting feature of this part of the Mountain Springs Pass fauna is the unusually high occurrence of specimens clearly referable to the genus *Fusulinella,* which was mentioned earlier in this report. This phenomenon may occur in other parts of the Great Basin (see Verville, Thompson and Lokke, 1956), but this has not been definitely established. It has never been reported in other parts of North America. This does, however, occur in Asia, especially in Japan (see Toriyama, 1967, p. 79-80) where species of *Fusulinella* occur along with the highest known species of *Fusulina.* Two possible solutions are suggested as an explanation of this phenomenon. Either the Mountain Springs Pass area was a sanctuary where species of the genus *Fusulinella* could continue to live and evolve, or species having an ultimate Asian origin were fed into the area from time to time through the Pacific Northwest. The former hypothesis seems less likely than the latter, since no phylogenetic sequences can be interpreted in the fusulinellas of the Mountain Springs Pass fauna at this time. Detailed studies of the Middle Pennsylvanian fusulinid faunas in the Pacific Northwest and Alaska would shed some interesting light on this subject.

Other than the phenomenon just mentioned, there is little to relate Asian and American faunas of this age. Toriyama (1967, p. 37-80), in his comprehensive summary of Japanese fusulinacean zones lists a few species common to the two areas, among which are *Millerella marblensis* Thompson, *M. inflecta* Thompson, *Staffella powwowensis* Thompson, *Nankinella plummeri* Thompson, *Fusulinella acuminata* Thompson, *F. furnishi* Thompson, *F. prolifica* Thompson, and *Fusulina girtyi* (Dunbar and Condra). This represents a very small proportion of the fauna of either area, but if these identifications prove valid under critical examination, it will be a very interesting problem to determine how these forms managed to become common to both areas ,*i.e.,* in which direction they migrated and when the migration occurred, particularly since some of these forms are not yet known from the Great Basin.

Chronostratigraphic Significance

The chronostratigraphic significance of the major fusulinid zones is well known, so remarks here will be restricted to the significance of the fauna with respect to the informal zones designated earlier in this report. These zones, based on the analysis of the distribution of facies-controlled fusulinids from a single stratigraphic section, cannot at this time be considered to have widespread chronostratigraphic significance. They do, however, represent a superpositional sequence of fusulinid-bearing strata. If the identity and superpositional relations of these zones stand the test of critical analysis of other sections within the Spring Mountains, they will be shown to have at least local significance in the synchronization of strata from place to place in the central Spring Mountains in much the same sense as a "key" or "marker" bed would.

Although it is not expected that any of these zones are necessarily recognizable outside of the central Spring Mountains, it is interesting to note that two of the diagnostic species for zone I, *Fusulina* sp. aff. *F. retusa* Thompson and Thomas and *F.* sp. aff. *F. weintzi* Verville, Thompson and Lokke have been recognized singly or together at several other places in the Great Basin (see Bissell, 1964; Steele, 1959; Cassity and Langenheim, 1966) at about the same stratigraphic horizon. Other zones cannot be recognized outside of the central Spring Mountains at this time.

It is the writer's opinion that detailed bed-by-bed analyses of the distribution of both large and small fusulinids from many sections in the Great Basin will bring to light information concerning the ranges of species which can then be synthesized into zones which are of at least provincial extent and of true chronostratigraphic significance. In this manner only can the series of the Lower and Middle Pennsylvanian be subdivided into stages and zones which would truly facilitate a regional understanding of the refined details of Early and Medial Pennsylvanian history in the Great Basin and elsewhere.

Two other matters of chronostratigraphic significance should be briefly considered. First is the problem of the Mississippian-Pennsylvanian boundary. This boundary has normally been placed within the lower part of the Bird Spring Formation on the basis of brachiopods, cephalopods and corals (Rich, 1961, p. 1163-1167; Coogan, 1964, p. 490-491). The Mountain Springs Pass fusulinid fauna does not shed much light on this problem since fusulinids are scarce in the lower 200 feet of this section. At this time, it appears that the placement of this boundary is still best made on the basis of macrofossils, such as ammonoids, and certain types of microfossils, such as conodonts.

Another matter of chronostratigraphic importance is the presence of the tabulate coral *Chaetetes*. This has been mentioned in several publications on Great Basin stratigraphy and biostratigraphy, notably those by Dott (1954, 1955), Rich (1960), and Wilson (1963). The presence of *Chaetetes*, in conjunction with other fossils, notably *Profusulinella* as suggested by Dott, or the tabulate coral *Multithecopora* as suggested by Wilson, has been established as a guide to Lower Derryan rocks of the Great Basin. In the Mountain Springs Pass section, *Chaetetes* occurs at five different horizons from within the Zone of *Profusulinella* to well within the Zone of *Fusulina*, *i.e.*, from zones E to I (Text-figs. 3 and 4). The writer confirms the warning put forth by others that the presence of *Chaetetes* by itself is not reliable for the recognition of the Derryan Series, but must be used in conjunction with other fossils as suggested above.

SYSTEMATIC PALEONTOLOGY

The specimens described here are deposited in the Brigham Young University Paleontology Repository.

Suborder FUSULININA Wedekind, 1937

Superfamily FUSULINACEA Möller, 1878

Family OZAWAINELLIDAE Thompson and Foster, 1937

Genus MILLERELLA Thompson, 1942b

MILLERELLA MARBLENSIS Thompson, 1942

Pl. 1, figs. 1-5

Millerella marblensis THOMPSON, 1942b, p. 405-407, pl. 1, figs. 3-14.

Description.—Shell discoidal, of from four and one-half to five and one-half volutions. Width of test ranges from 0.642 mm to 0.735 mm in the five best preserved and oriented specimens of five to five and one-half volutions. The axial length in these specimens ranges from 0.111 mm to 0.130 mm and the form ratio ranges from 0.164 to 0.199. Whorl sides are convex, and the periphery of the final whorl is round to subround. The periphery of the inner whorls is round to subround. Final volution slightly inflated, the maximum transverse dimension measuring from 0.172 mm to 0.210 mm in the above-mentioned specimens. The inner three whorls are involute, the fourth may be slightly evolute and the fifth is even more evolute normally overlapping the flanks of the preceding whorl to a position between the crests of the preceding two to three volutions. Volution heights increase slowly to moderately for the first three to four volutions but rapidly for succeeding volutions. Spirotheca thin, composed of tectum, diaphanotheca and outer tectorium. Chomata discontinuous, showing only where the thin section passes near the plane of a septum, in which case they are low and not conspicuous. Measurements of the principal taxonomic characters are shown in table 1.

Remarks.—The specimens described herein agree in all respects quite closely to the holotype of the species described by Thompson. *M. marblensis* resembles *M. pressa* Thompson in general form. However, *M. marblensis* has a shorter axial length, smaller form ratio, greater volution heights for corresponding volutions, and is more evolute than *M. pressa*.

Occurrence.—Specimens of *Millerella marblensis* Thompson were obtained from collections FCM 220, 222, and 257.

TABLE 1
Millerella marblensis Thompson

Spec. No.	No. of vol.	Half-length 1	2	3	4	5	6	Radius Vector 1	2	3	4	5	6
220-11B	5	.025	.036	.049	.064	.064	----	.049	.090	.148	.230	.356	----
220-22C	5	.024	.089	.052	.065	.065	----	.041	.080	.131	.206	.358	----
222-12C	5 1/2	.014	.024	.035	.050	.059	.059	.035	.056	.090	.151	.250	.380
222-6A	5 1/2	.018	.030	.044	.070	.070	.070	.050	.076	.127	.190	.290	.390
220-8G	5 1/2	.020	.027	.040	.058	.058	.058	.031	.059	.096	.157	.260	.301

Spec. No.	Radius Vector Ratio 1	2	3	4	5	6	Height of Volution 1	2	3	4	5	6
220-11B	.510	.400	.331	.278	.180	----	.023	.040	.059	.081	.131	----
220-22C	.586	.488	.397	.316	.182	----	.022	.039	.051	.076	.152	----
222-12C	.400	.429	.389	.331	.236	.155	.020	.020	.033	.064	.099	.132
222-6A	.360	.394	.347	.368	.242	.180	.030	.030	.050	.067	.100	.100
220-8G	.645	.458	.417	.370	.223	.152	.013	.027	.037	.061	.101	.120

Spec. No.	Width	Length	Form Ratio	Diam. Pro.	Max. Diam. Last Vol.
220-11B	.655	.130	.199	.041	.185
220-22C	.642	.127	.198	.040	.196
222-12C	.645	.130	.190	.034	.204
222-6A	.735	.135	.184	.032	.210
220-8G	.675	.111	.164	.035	.172

MILLERELLA MARBLENSIS ROBUSTA n. subsp.

Pl. 1, figs. 6-13

Description.—Shell discoidal, from four and one-half to five and one-half volutions. Width of test ranges from 0.607 mm to 0.700 mm in the eight best preserved and oriented specimens of four and one-half to five and one-half volutions. The axial length in these specimens ranges from 0.135 mm to 0.161 mm and the form ratio ranges from 0.216 to 0.253. Volution sides convex and the periphery of the final volution is round to subround while those of the inner volutions are round to subangular. The final volution inflated, the maximum transverse dimension measuring from 0.197 mm to 0.247 mm in the above-mentioned specimens. The inner three volutions are involute, the fourth may be slightly evolute, and the fifth is even more evolute, overlapping the flanks of the preceding volution at a point corresponding to a position between the crests of the preceding two to three volutions. Volution height increases moderately for the first three to four volutions and rapidly for succeeding volutions. Spirotheca thin, composed of tectum, diaphanotheca and outer tectorium. Chomata discontinuous, showing only where the thin section passes near the plane of a septum, in which case they are not conspicuous. Measurements of principal taxonomic characters are shown in table 2.

Remarks.—This form closely resembles both *Millerella marblensis* Thompson and *Millerella pressa* Thompson. In general shape and size, it resembles *M. pressa* very closely, but *M. pressa* is more parallel-sided, less evolute, less deeply umbilicate, and has a smaller proloculus. *M. marblensis robusta* differs from *M. marblensis* in having a greater axial length, form ratio, and more inflated whorls.

Holotype.—FCM 220-6A.
Occurrence.—Specimens of *M. marblensis robusta* were obtained from collections FCM 220, 222, 250, 256 and 257.

MILLERELLA sp. aff. M. MARBLENSIS Thompson, 1942

Pl. 1, fig. 14

M. aff. *Millerella marblensis* THOMPSON, 1942b, p. 405-407, pl. 1, figs. 3-14.

Description.—Shell discoidal of three and one-half to four volutions. Width of test is 0.438 mm in the best oriented specimen of three and one-half volutions. The axial length

TABLE 2

Millerella marblensis robusta n. subsp.

Spec. No.	No. of vol.	Half-length						Radius Vector					
		1	2	3	4	5	6	1	2	3	4	5	6
222-4F	5 1/2	.025	.031	.039	.055	.079	.079	.038	.067	.109	.175	.258	.390
220-17E	5	.025	.040	.054	.020	.080	----	.056	.090	.146	.230	.361	----
220-18D	5	.027	.049	.065	.078	.078	----	.047	.085	.135	.237	.342	----
220-17C	5	.020	.031	.050	.069	.069	----	.045	.085	.142	.240	.380	----
222-9B	5	.025	.033	.048	.063	.063	----	.045	.086	.143	.229	.340	----
220-16G	5	.021	.031	.051	.072	.072	----	.046	.072	.146	.231	.360	----
220-6A	5	.033	.040	.064	.070	.070	----	.050	.089	.137	.220	.320	----
220-13B	4 1/2	.024	.038	.058	.072	.072	----	.041	.082	.133	.228	.344	----

Spec. No.	Radius Vector Ratio						Height of Volution					
	1	2	3	4	5	6	1	2	3	4	5	6
222-4F	.658	.463	.358	.314	.306	.202	.018	.027	.043	.068	.084	.136
220-17E	.446	.445	.370	.348	.220	----	.032	.035	.045	.093	.136	----
220-18D	.575	.576	.481	.330	.238	----	.026	.040	.050	.100	.106	----
220-17C	.445	.365	.352	.288	.182	----	.027	.040	.060	.097	.138	----
222-9B	.511	.384	.336	.275	.185	----	.028	.043	.059	.085	.107	----
220-16G	.456	.431	.349	.312	.200	----	.031	.037	.065	.085	.130	----
220-6A	.660	.450	.468	.318	.219	----	.027	.039	.049	.081	.100	----
220-13B	.586	.462	.436	.316	.209	----	.019	.040	.051	.091	.112	----

Spec. No.	Width	Length	Form Ratio	Diam. Pro.	Max. Diam. Last Vol.
222-4F	.700	.161	.230	.039	.245
220-17E	.683	.150	.220	.043	.220
220-18D	.630	.159	.253	.042	.197
220-17C	.678	.150	.221	.030	.230
222-9B	.635	.137	.216	.037	.240
220-16G	.644	.151	.236	.036	.221
220-6A	.607	.139	.229	.045	.240
220-13B	.609	.139	.222	.045	.201

of this test is 0.110 and the form ratio is 0.251. The sides of the volutions are convex and the periphery in all volutions is round to subround. The final volution is slightly inflated, the maximum transverse dimension of the final volution measuring 0.135 mm. The inner volutions are involute and the final volution is only slightly evolute. Volution height increases slowly for the first three volutions and only moderately for succeeding volutions. The spirotheca is thin, composed of tectum, diaphanotheca, and outer tectorium. Chomata low, not conspicuous. Measurements of principal taxonomic characters are shown on table 3.

TABLE 3

Millerella sp. aff. *M. marblensis* Thompson

Spec. No.	No. of vol.	Half-length				Radius Vector				Radius Vector Ratio			
		1	2	3	4	1	2	3	4	1	2	3	4
224-3B	3 1/2	.036	.042	.055	.055	.051	.080	.162	.241	.510	.526	.340	.228

Spec. No.	Height of Volution				Width	Length	Form Ratio	Diam. Pro.	Max. Diam. Last Vol.
	1	2	3	4					
224-3B	.029	.039	.072	.080	.438	.110	.251	.050	.135

Remarks.—The specimen described herein agrees closely in size and shape with inner portions of the shell of *M. marblensis* Thompson and it may be an immature form of the latter. Insufficient specimens are present for definite specific determination.

Occurrence.—Specimens of *M.* aff. *M. marblensis* are present in collection FCM 224.

MILLERELLA PRESSA Thompson, 1944

Pl. 1, figs. 15-19

Millerella pressa THOMPSON, 1944, p. 423-425, pl. 2, figs. 16-23.

Description.—Shell minute, discoidal. Width of test in six best preserved and oriented specimens of four and one-half to five and one-half volutions ranges from 0.510 mm to 0.668 mm. Axial length in these specimens ranges from 0.135 mm to 0.169 mm and the form ratio ranges from 0.202 to 0.295. The sides of the whorls are parallel to slightly convex in outline and the periphery is round to subround. The inner two to three volutions are involute while the fourth and fifth volutions are silghtly evolute. The volution height increases moderately in the inner portion of the shell but increases rapidly in the fifth volution and sometimes in the fourth and fifth volution. The spirotheca is thin, composed of three layers—the tectum, diaphanotheca, and outer tectorium. Chomata low and discontinuous. Measurements of principal taxonomic characters are presented in table 4.

Remarks.—The specimens described herein agree quite closely in all respects to the holotype of this species described by Thompson. They resemble *M. marblensis* Thompson in general form. However, the axial length and form ratio of *M. pressa* is greater, the volution height is less for corresponding whorls, and the last whorl of *M. pressa* overlaps previous whorls to a greater degree than in *M. marblensis.*

Occurrence.—Specimens referred to the species were obtained from collections FCM 214, 220 and 249.

TABLE 4

Millerella pressa Thompson

Spec. No.	No. of vol.	Half-length						Radius Vector					
		1	2	3	4	5	6	1	2	3	4	5	6
214-1D	5 1/2	.013	.024	.038	.055	.070	.070	.046	.077	.108	.183	.255	.375
214-1E	5	.020	.031	.061	.074	.074	----	.040	.080	.138	.209	.344	----
249-6E	4 1/2	.067	.030	.053	.079	.079	----	.031	.052	.104	.199	.295	----
214-3B	4 1/2	.020	.033	.051	.069	.074	----	.035	.071	.121	.213	.312	----
214-6E	4 1/2	.014	.020	.027	.055	.055	----	.033	.060	.106	.180	.263	----

Spec. No.	Radius Vector Ratio						Height of Volution					
	1	2	3	4	5	6	1	2	3	4	5	6
214-1D	.283	.012	.352	.301	.275	.187	.027	.030	.031	.075	.072	.120
214-1E	.500	.388	.442	.354	.215	----	.021	.040	.060	.070	.140	----
249-6E	.548	.577	.500	.397	.268	----	.012	.023	.050	.090	.091	----
214-3B	.512	.450	.421	.324	.238	----	.018	.036	.050	.090	.120	----
214-6E	.424	.333	.255	.306	.209	----	.020	.030	.040	.080	.083	----

Spec. No.	Width	Length	Form Ratio	Diam. Pro.	Max. Diam. Last Vol.
214-1D	.668	.135	.202	.034	.151
214-1E	.605	.150	.248	.028	.176
249-6E	.510	.150	.295	.034	.165
214-3B	.589	.169	.287	.040	.186
214-6E	.475	.134	.282	.032	.144

MILLERELLA SPRINGENSIS n. sp.

Pl. 1, figs. 20-24

Description.—Shell thickly discoidal, from four and one-half to five and one-half volutions. Width of test ranges from 0.450 mm to 0.630 mm in the five best preserved and oriented specimens. The axial length in these specimens ranges from 0.145 mm to 0.197 mm and the form ratio ranges from 0.252 to 0.367. Volution sides are convex. The periphery of the final volution is broadly rounded while the periphery of the inner volution is round. The final volution is inflated, the maximum transverse dimension measuring from 0.192 mm to 0.262 mm in the above-mentioned specimens. The inner three to four volutions are involute. The outer one or two volutions are slightly evolute, overlapping the sides of the preceding whorl to a point not far from the axis of coiling. Volution height increases slowly for the inner three to four volutions and moderately for succeeding volutions. The spirotheca is thin, composed of tectum, diaphanotheca and outer tectorium. Chomata discontinuous, low, and inconspicuous, showing only where the thin section passes near the plane of a septum. Measurements of principal taxonomic characters are listed in table 5.

Remarks.—*Millerella springensis* n. sp. closely resembles *Paramillerella pingius* (Thompson) in general dimensions. The former species, however, is partially evolute, has a more broadly rounded whorl periphery, and poorly developed chomata. *M. springensis* also resembles *M. inflecta* Thompson but is larger, has a smaller form ratio, and does not have the well-developed chomata present in the latter.

Holotype.—FCM 222-14E.
Occurrence.—Specimens of this species were collected from samples FCM 220 and 222.

TABLE 5
Millerella springensis n. sp.

Spec. No.	No. of vol.	Half-length						Radius Vector					
		1	2	3	4	5	6	1	2	3	4	5	6
222-6C	5 1/2	.016	.029	.050	.073	.105	.105	.036	.061	.100	.145	.236	.322
222-14E	5 1/2	.016	.029	.045	.067	.079	.079	.030	.060	.100	.179	.225	.312
222-14A	5	.020	.028	.045	.072	.100	----	.045	.080	.124	.200	.309	----
220-1B	5	.022	.038	.050	.076	.076	----	.032	.061	.111	.180	.260	----
222-14D	4 1/2	.022	.035	.054	.075	.075	----	.039	.061	.100	.155	.250	----

Spec. No.	Radius Vector Ratio						Height of Volution					
	1	2	3	4	5	6	1	2	3	4	5	6
222-6C	.445	.476	.500	.539	.445	.328	.025	.026	.038	.049	.091	.091
222-14E	.534	.483	.450	.374	.352	.253	.018	.030	.040	.080	.049	.087
222-14A	.445	.350	.363	.360	.324	----	.030	.031	.045	.080	.110	----
220-1B	.688	.623	.454	.423	.292	----	.020	.029	.048	.070	.080	----
222-14D	.564	.574	.540	.484	.300	----	.025	.025	.039	.056	.095	----

Spec. No.	Width	Length	Form Ratio	Diam. Pro.	Max. Diam. Last Vol.
222-6C	.630	.197	.312	.025	.262
222-14E	.600	.151	.252	.025	.259
222-14A	.570	.188	.330	.034	.235
220-1B	.502	.145	.288	.032	.192
222-14D	.450	.165	.367	.035	.192

MILLERELLA EXTENSA n. sp.

Pl. 1, figs. 25-27

Description.—Shell discoidal, of three and one-half to four and one-half volutions. Width of the test ranges from 0.360 mm to 0.465 mm in the three most well-preserved and best-oriented specimens of four to four and one-half volutions which are not uncoiled. The axial length ranges from 0.056 mm to 0.085 mm in these specimens and the form ratio ranges from 0.156 to 0.211. In two other specimens of three and one-half volutions which are uncoiled, the widths are 0.342 mm and 0.366 mm in the coiled portion and 0.522 mm and 0.525 mm respectively including the uncoiled portion of the test exposed in the thin section. The axial lengths of these specimens are 0.090 mm and 0.086 mm respectively, and the form ratios are 0.263 and 0.265 respectively, in the coiled portion of the test and 0.173 and 0.164 respectively, including the uncoiled part of the test shown in the thin sections. Volution sides are convex and the periphery of all volutions is subround to subangular. The final volution is slightly inflated, the maximum transverse dimension measuring from 0.093 mm to 0.111 mm in the five above-mentioned specimens. There is considerable variation in the degree to which these specimens are involute. In some, the second volution may be slightly evolute and in others, even when uncoiled, the first three volutions are involute and the fourth may be only slightly evolute at first, and then starts uncoiling without completing a fifth volution. Volution heights increase slowly to moderately in the first three volutions and rapidly for succeeding volutions. The spirotheca is thin, composed of tectum, diaphanotheca, and outer tectorium. Chomata low, not conspicuous and discontinuous, showing only where thin section passes near plane of septum. Measurements of principal taxonomic characters listed in table 6.

Remarks.—*Millerella extensa* resembles no previously described species very closely. In shape, it resembles *Millerella marblensis* Thompson but is smaller and more loosely coiled. The uncoiled forms from the Big Saline Limestone of Texas described by Moore (1946) as *M. marblensis* are much larger than *M. extensa.*

Holotype.—FCM 264-13A.

Occurrence.—Specimens of this species were collected from samples FCM 260, 261, 263, and 264.

TABLE 6

Millerella extensa n. sp.

Spec. No.	No. of vol.	Half-length					Radius Vector					Radius Vector Ratio				
		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
264-13A	4 1/2	.016	.022	.030	.041	.041	.030	.050	.080	.130	.273	.534	.440	.375	.316	.150
264-3B	4	.017	.024	.024	.024	----	.039	.066	.111	.192	----	.436	.364	.216	.125	----
264-13F	4	.015	.020	.035	.035	----	.040	.064	.118	.195	----	.375	.312	.296	.180	----

Spec. No.	Height of Volution					Width	Length	Form Ratio	Diam. Pro.	Max. Diam. Last Vol.
	1	2	3	4	5					
264-13	.018	.020	.021	.050	.141	.465	.085	.183	.026	.106
264-3B	.021	.029	.048	.081	----	.360	.056	.156	.030	.093
264-13F	.022	.029	.051	.072	----	.369	.078	.211	.030	.110

MILLERELLA sp. A

Pl. 1, figs. 28, 29

Description.—Shell minute, discoidal. Width of test 0.343 mm and 0.441 mm in the two best-oriented and preserved specimens of four and five volutions, respectively. The axial length in these specimens is 0.077 mm and 0.075 mm, respectively, and the form ratio is 0.225 and 0.170, respectively. The sides of the volutions are convex and the periphery of all volutions is round to subround. The final volution is inflated, the maximum transverse dimension measuring 0.121 mm and 0.136 mm respectively, in the above-mentioned specimens. The first two or three volutions are involute, the fourth and fifth volutions are somewhat evolute, overlapping the flanks of the preceding whorls at a point corresponding to a position between the crests of the preceding two to three volutions. Volution heights increase clowly to moderately throughout the shell. The spirotheca is thin, composed of tectum, diaphanotheca and outer tectorium. Chomata low and discontinuous, showing only where the thin section passes near the plane of a septum. Measurements of principal taxonomic features are presented in table 7.

Remarks.—*Millerella* sp. A resembles *Millerella extensa* in size and shape but has more volutions, has a more inflated final volution and is more tightly coiled. *M* sp. A is smaller than *Millerella marblensis* Thompson.

Occurrence.—Specimens of this species were collected from sample FCM 218.

TABLE 7

Millerella sp. A

Spec. No.	No. of vol.	Half-length					Radius Vector					Radius Vector Ratio				
		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
218-2D	5	.012	.022	.039	.039	.039	.037	.063	.110	.057	.220	.324	.350	.354	.248	.177
218-3B	4	.018	.022	.040	.040	----	.033	.070	.115	.192	----	.474	.386	.348	.208	----

Spec. No.	Height of Volution					Width	Length	Form Ratio	Diam. Pro.	Max. Diam. Last Vol.
	1	2	3	4	5					
218-2D	.020	.030	.045	.040	.067	.441	.075	.170	.025	.136
218-3B	.021	.032	.042	.078	----	.343	.077	.225	.030	.121

MILLERELLA sp. B.

Pl. 1, figs. 30, 31

Description.—Shell minute, discoidal. Width of test is 0.475 mm and 0.491 mm in the two specimens of from four and one-half to five volutions representing this form. The axial length is 0.128 mm and 0.120 mm, respectively, and the form ratio is 0.270 and 0.244, respectively. Volution sides are convex and the periphery of all volutions is round to subround. The final volutions are inflated, the maximum transverse dimension measuring 0.168 mm and 0.169 mm, respectively, in the above-mentioned specimens. The inner three volutions are involute, the fourth may be slightly evolute. The fifth is even more evolute, overlapping the sides of the previous volution at a point corresponding to a position between the crests of the preceding two to three volutions. Volution heights increase slowly to moderately for the first two to three volutions and more rapidly for succeeding volutions. The spirotheca is thin, composed of tectum, diaphanotheca and outer tectorium. Chomata low and discontinuous, showing only where the thin section passes near the plane of a septum. Measurements of principal taxonomic characters are presented on table 8.

Remarks.—*Millerella* sp. B has a smaller axial length and more poorly developed chomata than *Millerella inflecta* Thompson. It is smaller than *M. marblensis* Thompson and *M.*

EXPLANATION OF PLATE 1

FIGS. 1-5.—*Millerella marblensis* Thompson
Axial sections, X35.75, FCM 220-11B, 222-12C, 222-6A, 220-8G, 220-22C.

FIGS. 6-13.—*Millerella marblensis robusta* n. subsp.
Axial sections, X35.75, FCM 222-4F, 220-17C, 222-9B, 220-16G, 220-1E, 220-6A (holotype), 220-13B, 220-18D.

FIG. 14.—*Millerella* sp. aff. *M. marblensis* Thompson
Axial section, X35.75, FCM 224-3B.

FIGS. 15-19.—*Millerella pressa* Thompson
Axial sections, X35.75, FCM 214-1D, 214-1E, 214-3B, 249-6E, 214-6E.

FIGS. 20-24.—*Millerella springensis* n. sp.
Axial sections, X35.75, FCM 222-6C, 222-14E (holotype), 222-14A, 222-14D, 220-1B.

FIGS. 25-27.—*Millerella extensa* n. sp.
Axial sections, X35.75, FCM 264-13A (holotype), 264-13F, 264-3B.

FIGS. 28, 29.—*Millerella* sp. A
Axial sections, X35.75, FCM 218-2D, 218-3B.

FIGS. 30, 31.—*Millerella* sp. B
Axial sections, X-35.75, FCM 218-3C, 218-2E.

FIGS. 32-34.—*Millerella* sp. C
Axial sections, X35.75, FCM 225-8H, 225-2B, 225-1C.

FIG. 35.—*Millerella* sp. D
Axial section, X35.75, FCM 303-8G.

FIGS. 36, 37.—*Paramillerella* sp. A
Axial sections, X35.75, FCM 256-5C, 256-9C.

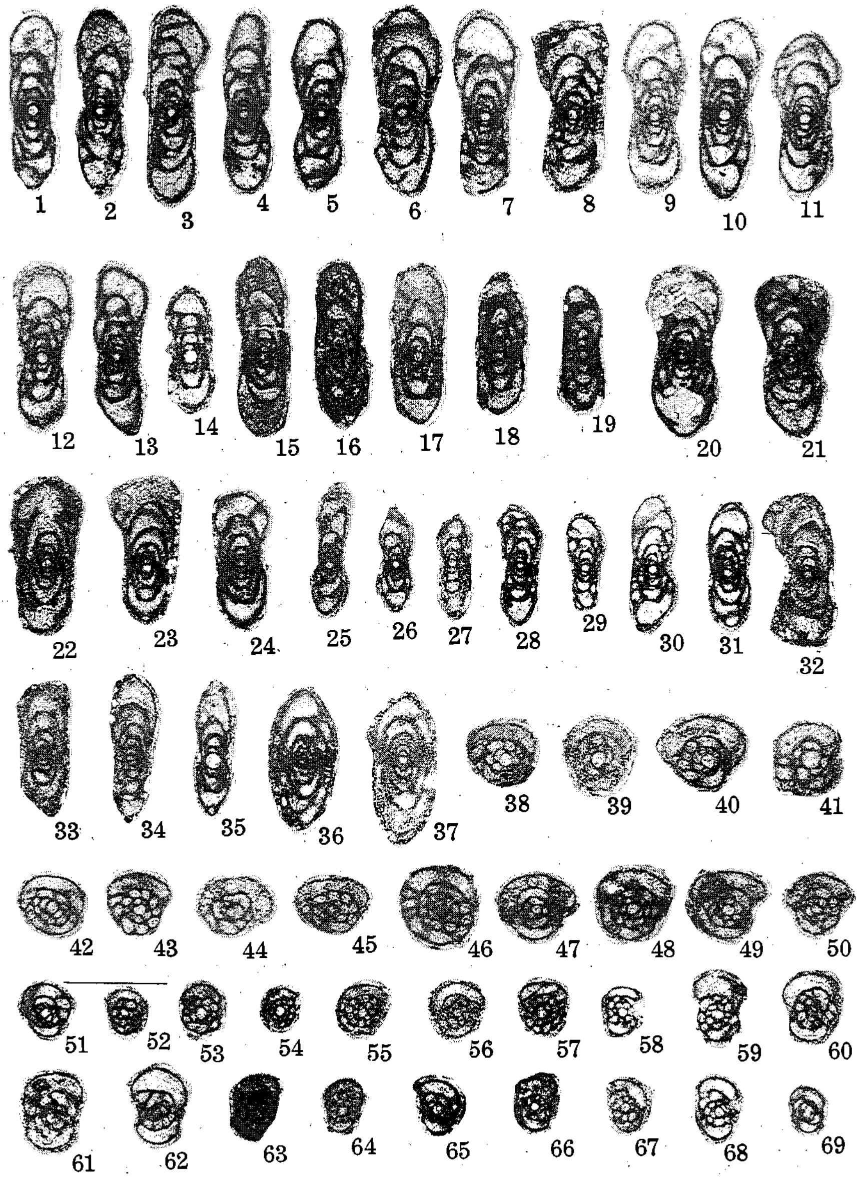
FIGS. 38-41.—*Schubertina circuli* n. gen., n. sp.
Axial sections, X35.75, FCM 268-9L, 268-12E (holotype), 268-3H, 268-6D.

FIGS. 42-50.—*Schubertina circuli compacta* n. gen., n. sp., n. subsp.
Axial sections, X35.75, FCM 302-9A, 302-10K, 302-11K, 302-1C, 302-2F, 302-2J, 302-11D (holotype), 264-11D, 302-9F.

FIGS. 51-58.—*Schubertina circuli minuta* n. gen., n. sp., n. subsp.
Axial sections, X35.75, FCM 305-1J, 302-3J, 305-3H, 303-2B, 305-5C, 313-1B, 303-4D, 296-2F (holotype).

FIGS. 59-69.—*Schubertina extensa* n. gen., n. sp.
Axial sections, X35.75, FCM 296-6B (holotype), 313-2A, 316-5D, 315-4K, 302-2G, 302-7B, 296-8I, 296-1X, 313-2D, 296-1C, 302-1I.

PLATE 1


1 2 3 4 5 6 7 8 9 10 11
12 13 14 15 16 17 18 19 20 21
22 23 24 25 26 27 28 29 30 31 32
33 34 35 36 37 38 39 40 41
42 43 44 45 46 47 48 49 50
51 52 53 54 55 56 57 58 59 60
61 62 63 64 65 66 67 68 69

marblensis robusta n. subsp. and has a greater axial length than *M.* sp. A and *M. extensa* n. sp.

Occurrence.—*M.* sp. B was collected from sample FCM 218.

TABLE 8

Millerella sp. B

Spec. No.	No. of vol.	Half-length					Radius Vector					Radius Vector Ratio				
		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
218-3C	4 1/2	.015	.022	.038	.050	.050	.023	.055	.098	.161	.270	.652	.400	.409	.311	.185
218-2E	4	.027	.050	.067	.067	----	.060	.105	.168	.270	----	.450	.476	.399	.248	----

Spec. No.	Height of Volution					Width	Length	Form Ratio	Diam. Pro.	Max. Diam. Last Vol.
	1	2	3	4	5					
218-3C	.019	.020	.038	.068	.108	.491	.120	.244	.036	.169
218-2E	.040	.045	.061	.101	----	.475	.128	.270	.030	.168

MILLERELLA sp. C
Pl. 1, figs. 32-34

Description.—Shell minute, discoidal, saggital plane sometimes bent. Width of test ranges from 0.465 mm to 0.560 mm in the three most well-preserved and best-oriented specimens of four and one-half to five volutions. The axial length in these specimens ranges from 0.125 mm to 0.136 mm and the form ratio ranges from 0.241 to 0.292. Volution sides are convex and the periphery of all volutions is round to subround. The final volution is inflated, the maximum transverse dimension measuring 0.151 mm to 0.200 mm in the above-mentioned specimens. The inner three volutions are involute, the fourth may be slightly evolute and the fifth is even more evolute, overlapping the preceding volution at a point corresponding to a position between the crests of the preceding two to three volutions. Volution height increases slowly to moderately for the first three volutions and more rapidly for succeeding volutions. The spirotheca is thin, not well preserved. The chomata are low and discontinuous, showing where the thin section passes near the plane of a septum. Measurements of principal taxonomic characters listed in table 9.

Remarks.—*Millerella* sp. C is a smaller form and has a larger form ratio than *Millerella marblensis* Thompson or *Millerella marblensis robusta,* n. subsp. It is more highly evolute than *M. pressa* Thompson. The curved saggital plane in some of the specimens distinguish this form from other described species of the genus. However, these specimens are not well preserved and the curved saggital plane may be in part a consequence of the orientation of the section as well as manner of growth.

Occurrence.—*M* sp. C was collected from sample FCM 225.

TABLE 9

Millerella sp. C

Spec. No.	No. of vol.	Half-length					Radius Vector					Radius Vector Ratio				
		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
225-8H	4 1/2	.022	.038	.050	.070	.070	.037	.069	.109	.180	.295	.595	.552	.459	.389	.237
225-1C	5	.021	.042	.065	.065	.065	.044	.076	.126	.197	.282	.478	.552	.516	.330	.231
225-2B	4 1/2	.017	.022	.038	.056	.056	.039	.064	.105	.168	.269	.436	.344	.362	.334	.208

Spec. No.	Height of Volution					Width	Length	Form Ratio	Diam. Pro.	Max. Diam Last Vol.
	1	2	3	4	5					
225-8H	.020	.031	.040	.072	.118	.560	.135	.241	.030	.200
225-1C	----	.032	.049	.072	.082	.513	.125	.244	----	.151
225-2B	.028	.027	.040	.065	.100	.465	.136	.292	.021	.180

MILLERELLA sp. D
Pl. 1, fig. 35

Description.—Shell minute, discoidal. Width of test 0.502 mm in the single most well-preserved and best-oriented specimen of three and one-half volutions. The axial length of this specimen is 0.100 mm and the form ratio is 0.198. Volution sides are slightly convex, sloping away from a subangular periphery in the final volution. The periphery of inner volutions is subround to round. The final volution is slightly inflated, the maximum transverse dimension measuring 0.135 mm. The inner three volutions are involute, the fourth is evolute, overlapping the sides of the previous volution at a point corresponding to a position between the crests of the preceding two to three volutions. Volution heights increase moderately for the inner three volutions and rapidly for succeeding volutions. The spirotheca is thin, composed of tectum, diaphanotheca and outer tectorium. Chomata low, discontinuous and not conspicuous, showing only where the thin section passes near the plane of a septum. Measurments of principal taxonomic characters are listed in Table 10.

Remarks.—The specimen described here is unique in having a subangular whorl periphery in the final volution. It has a larger proloculus and has higher volutions than other described species.

Occurrence.—*M.* sp. D was collected from sample FCM 303.

TABLE 10
Millerella sp. D

Spec. No.	No. of vol.	Half-length				Radius Vector				Radius Vector Ratio				Height of Volution			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
303-8C	3 1/2	.032	.042	.052	.052	.057	.110	.171	.274	.562	.382	.304	.190	.025	.054	.063	.115

Spec. No.	Width	Length	Form Ratio	Diam. Pro.	Max. Diam. Last Vol.
303-8C	.502	.100	.198	.061	.135

MILLERELLA spp.

Along with the forms above described, there occurs a fairly large number of specimens which, because of immature stage of shell, or poor preservation, or poor orientation, or some combination of these factors, are not assignable to known or described species and are not described individually in this report.

Genus PARAMILLERELLA Thompson, 1951
PARAMILLERELLA sp. A
Pl. 1, figs. 36, 37

Description.—Test minute, lenticular. The width of two well-preserved and oriented specimens of four and one-half volutions measures 0.440 mm and 0.518 mm. The axial length in these specimens measures 0.205 mm and 0.205 mm and the form ratio is 0.466 and 0.483. Volution sides taper outward from a subangular periphery down to the axis of coiling. The periphery of inner volutions is round to subangular. The test is completely involute. Volution height increases slowly for the first two whorls and moderately for succeeding whorls. The spirotheca is thin, composed of tectum, diaphanotheca and outer tectorium. Chomata low, discontinuous and inconspicuous, showing only where section passes near plane of septum. Measurements of principal taxonomic characters are listed in table 11.

Remarks.—*Paramillerella* sp. A differs from *P. circuli* (Thompson) in having a more angular whorl periphery and in being somewhat smaller. *P.* sp. A closely resembles *P. advena ampla* Thompson and may be a variety of it if not actually conspecific. However *P.* sp. A has a shorter axial length and consequently a smaller form ratio.

Occurrence.—*P.* sp. A was collected from sample FCM 256.

TABLE 11
Paramillerella sp. A

Spec. No.	No. of vol.	Half-length					Radius Vector					Radius Vector Ratio				
		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
256-5C	4 1/2	.025	.042	.059	.085	.122	.029	.054	.098	.168	.279	.863	.778	.602	.506	.438
256-9C	4 1/2	.021	.032	.050	.080	.101	.037	.058	.105	.163	.237	.568	.552	.476	.490	.426

Spec. No.	Height of Volution					Width	Length	Form Ratio	Diam. Pro.
	1	2	3	4	5				
256-5C	.018	.027	.044	.071	.105	.518	.250	.483	.030
256-9C	.020	.020	.045	.057	.078	.440	.205	.466	.035

PARAMILLERELLA spp.

Discussion.—A number of specimens of *Paramillerella* occur throughout the samples which are too poorly preserved to merit species identification or description.

Family STAFFELLIDAE Miklukho-Maklay, 1949
Genus STAFFELLA Ozawa, 1925
STAFFELLA spp.

Discussion.—A number of thickly discoidal specimens whose shells have been partly or wholly destroyed by recrystallization occur throughout the section.

Family FUSULINIDAE Möller, 1878
Subfamily SCHUBERTELLINAE Skinner, 1931
Genus SCHUBERTINA n. gen.

Genotype: *Schubertina circuli* n. sp.

Description.—Shell minute, spherical to discoidal. The largest dimension measured in any of the specimens is 0.29 mm. Mature forms possess two and one-half to three volutions. Form ratios range from slightly greater than unity to considerably less. In all forms described under this genus, the orientation of the coil axis shifts markedly from inner to outer volutions. The spirotheca is thin, granular, with a somewhat obscure structure, apparently composed of two or three layers, possibly homologous with tectum and diaphanotheca or tectum, diaphanotheca and outer tectorium, respectively. Aperture not apparent; chomata not apparent.

Discussion.—These are the smallest fusulinids yet described in North America, if indeed they are fusulinids. They have little in common with typical large fusulinids, but fit within the broad range of descriptions for the subfamily Schubertellinae. These forms tend to mimic, in miniature fashion, the shapes and plan of growth of some species of *Pseudostaffella* and *Eoschubertella.* Outside of this comparison these forms are not closely similar to any other fusulinid.

Occurrence.—The described forms are from the Upper Derryan and Desmoinesian portion of the Bird Spring Formation, Clark County, Nevada.

SCHUBERTINA CIRCULI n. sp.

Pl. 1, figs. 38-41

Description.—Test minute, nearly spherical, involute. Width of test in the four best preserved and oriented specimens of two to two and one-half volutions ranges from 0.23 mm to 0.27 mm. The axial length of these specimens ranges from 0.25 mm to 0.31 mm and the form ratio ranges from 0.962 to 1.149. The axis of coiling in these specimens changes orientation, being approximately perpendicular to the plane of the section in the inner one and one-half volutions but approximately parallel to this plane in the final volution. Volution height is uniform or increases only slowly. Spirotheca thin, granular, composed possibly of two, perhaps three layers. Measurements of principal taxonomic characters may be found in table 12.

Remarks.—The unique features of this species are its small size, spherical shape and shifting coil axis. It differs from *Schubertina circuli compacta* n. subsp. only in having

TABLE 12

Schubertina circuli n. gen., n. sp.

Spec. No.	No. of vol.	Radius Vector			Height of Volution			Width	Length	Form Ratio	Diam. Pro.
		1	2	3	1	2	3				
268-12E	2 1/2	.07	.12	.15	.03	.05	.05	..27	.26	0.96	.06
268-3H	2 1/2	.05	.10	.16	.02	.05	.07	.27	.31	1.15	.06
268-9L	2 1/2	.04	.09	.15	.02	.05	.06	.23	.25	1.09	.05
268-6D	2	.07	.14	---	.04	.06	---	.25	.28	1.12	.08

a larger proloculus and greater volution height. From *S. Circuli minuta* n. subsp., it differs only in being larger. From *S. extensa* n. sp. it differs in having a larger form ratio.

Occurrence.—Specimens of this form were collected from samples FCM 268.

Holotype.—FCM 268-12E.

SCHUBERTINA CIRCULI COMPACTA n. subsp.

Pl. 1, figs. 42-50

Description.—Test minute, nearly spherical, involute. Width of test in the nine best preserved and oriented sections two to three volutions ranges from 0.21 mm to 0.29 mm. The axial length of these specimens ranges from 0.23 mm to 0.20 mm and the form ratio ranges from 0.930 to 1.300. The axis of coiling in these specimens changes orientation, being approximately perpendicular to the plane of the section in the inner one and one-half to two volutions, but approximately parallel to this plane in the final volution. Volution height is uniform or increases only slowly. Spirotheca thin, granular, composed of two, perhaps three layers. Measurements of principal taxonomic characters may be found in table 13.
Remarks.—This subspecies differs from the typical form in having a somewhat smaller proloculus and in having one-half more volution for similar test width, hence it is also more tightly coiled. It differs from *Schubertina circuli minuta* n. subsp. in being larger.

Holotype.—FCM 302-11D.

Occurrence.—Specimens of this form were collected from samples FCM256, 264, and 302.

TABLE 13

Schubertina circuli compacta n. gen., n. sp., n. subsp.

Spec. No.	No. of vol.	Radius Vector 1	2	3	Height of Volution 1	2	3	Width	Length	Form Ratio	Diam. Pro.
302-11D	3	.05	.09	.15	.02	.04	.06	.26	.27	1.04	.05
264-11D	3	.04	.08	.15	.03	.04	.06	.25	.29	1.16	.05
302-2J	3	.05	.09	.13	.03	.04	.04	.24	.29	1.21	.04
302-9A	3	.05	.06	.11	.03	.03	.05	.22	.23	1.05	.05
302-10K	2 1/2	.05	.09	.13	.03	.04	.05	.23	.23	1.00	.05
302-9F	2 1/2	.05	.08	.13	.03	.04	.05	.22	.24	1.09	.04
302-11K	2 1/2	.04	.09	.13	.02	.05	.06	.22	.27	1.23	.04
302-2F	3	.04	.07	.14	.02	.02	.06	.29	.27	0.93	.03
302-1C	2	.06	.11	---	.04	.05	---	.20	.26	1.30	.04

SCHUBERTINA CIRCULI MINUTA n. subsp.

Pl. 1, figs. 51-58

Description.—Test minute, nearly spherical, involute. Width of test in the eight best-preserved and oriented specimens of two to three volutions ranges from 0.15 mm to 0.20 mm. The axial length of these specimens ranges from 0.12 mm to 0.21 mm and the form ratio ranges from 0.667 to 1.050. The axis of coiling in these specimens changes orientation, being approximately perpendicular to the plane of the section in the inner one and one-half to two volutions, but approximately parallel to this plane in the final volution. Volution height nearly uniform. Spirotheca thin, granular, composed of two, perhaps three layers. Measurements of principal taxonomic characters may be found in table 14.

Remarks.—This subspecies differs from *Schubertina circuli* n. sp. and *Schubertina circuli compacta* n. subsp. in having smaller dimensions and a generally smaller form ratio.

Holotype.—FCM 296-2F.

Occurrence.—Specimens referred to this form were collected from samples FCM 270, 296, 302, 303, 305, and 313.

TABLE 14

Schubertina circuli minuta n. gen n. sp., n. subsp.

Spec. No.	No. of vol.	Radius Vector 1	2	3	Height of Volution 1	2	3	Width	Length	Form Ratio	Diam. Pro.
296-2F	2 1/2	.05	.08	.09	.03	.03	.03	.18	.12	0.67	.04
303-2B	2	.04	.09	---	.03	.03	---	.15	.15	1.00	.04
305-3H	2	.05	.11	---	.03	.05	---	.18	.14	0.78	.05
305-5C	3	.04	.07	.10	.02	.03	.03	.19	.17	0.90	.03
303-4D	2 1/2	.05	.08	.11	.03	.03	.04	.19	.17	0.90	.04
313-1B	2 1/2	.05	.09	.11	.04	.03	.04	.20	.21	1.05	.03
302-3J	2	.05	.09	---	.04	.03	---	.16	.16	1.00	.03
305-1J	3	.03	.06	.10	.02	.03	.04	.19	.19	1.00	.03

SCHUBERTINA EXTENSA n. sp.

Pl. 1, figs. 59-69

Description.—Test minute, thickly discoidal. Width of test in the eleven best-preserved and oriented specimens of two to three volutions ranges from 0.18 mm to 0.29 mm. The axial length of these specimens ranges from 0.12 mm to 0.10 mm and the form ratio ranges from 0.526 to 0.760. The axis of coiling in these specimens changes orientation, being approximately perpendicular to the plane of the section for the inner one and one-half to two volutions, but approximately parallel to this plane in the final volution. Volution height remains uniform in the first two volutions but is somewhat larger in some specimens in the final volution. The spirotheca is thin, granular, composed of two, possibly three layers. Measurements of principal taxonomic features may be found in table 15.

Remarks.—This form differs from *Schubertina circuli* n. sp. in its shape, being thickly discoidal rather than spherical and in not having uniform volution height throughout.

Holotype.—FCM 296-6B.

Occurrence.—Specimens of this form were collected from samples FCM 296, 302, 305, 313, 314, 315, and 316.

TABLE 15

Schubertina extensa n. gen., n. sp.

Spec. No.	No. of vol.	Radius Vector 1	2	3	Height of Volution 1	2	3	Width	Length	Form Ratio	Diam. Pro.
296-6B	3	.04	.08	.15	.03	.03	.07	.25	.15	0.60	.04
313-2A	2 1/2	.07	.11	.15	.05	.04	.05	.25	.19	0.76	.04
315-4K	3	.06	.09	.16	.04	.04	.08	.28	.15	0.54	.04
316-5D	3	.06	.10	.12	.03	.05	.06	.29	.18	0.62	.05
302-1I	3	.04	.07	.09	.02	.03	.04	.18	.12	0.67	.04
296-8I	3	.04	.07	.10	.02	.03	.04	.20	.13	0.65	.04
296-1C	2 1/2	.06	.10	.13	.04	.04	.05	.22	.13	0.59	.04
296-1X	2	.05	.12	---	.03	.08	---	.21	.13	0.62	.03
313-2D	2	.04	.10	---	.02	.06	---	.19	.13	0.69	.04
302-7B	2 1/2	.04	.07	.12	.13	.13	.14	.20	.12	0.60	.03
302-2G	3	.05	.08	.13	.03	.03	.05	.25	.15	0.60	.04

Genus PSEUDOSCHUBERTELLA n. gen.

Genotype.—*Pseudoschubertella fusiforma* n. sp.

Description.—Test minute, fusiform with pointed to bluntly rounded poles. Maximum axial length is 0.37 mm; maximum width is 0.27 mm and the form ratio ranges from 1.285 to 1.530. Orientation of coil axis shifts markedly from inner to outer volutions in all specimens referred to species of this genus. Spirotheca thin, granular, composed of two, possibly three layers, homologous with tectum and diaphanotheca, or tectum, diaphanotheca and outer tectorium. Chomata inconspicuous or absent.

Remarks.—The diagnostic features of this genus are the small size, fusiform shape and shifting coil axis. In these respects it resembles miniature forms of *Eoschubertella.*

Occurrence.—The described forms are from Desmoinesian portion of the Bird Spring Formation, Clark County, Nevada.

PSEUDOSCHUBERTELLA FUSIFORMA n. sp.

Pl. 2, figs. 1-6

Description.—Test minute, fusiform. Width of test in the six best-oriented and preserved specimens of two and one-half to three volutions ranges from 0.17 mm to 0.25 mm. The axial length in these specimens ranges from 0.26 mm to 0.37 mm and the form ratio ranges from 1.285 to 1.530. Volution height uniform or increases slightly. Coil axis changes orientation in the inner volutions, but is approximately parallel to the plane of the section in the final one and one-half volutions. Spirotheca thin, granular, composed of two, possibly three, layers. Measurements of principal taxonomic characters may be found in table 16.

Remarks.—The fusiform shape and shifting coil axis are features which relate this form to some species of *Eoschubertella,* but it is smaller than any of the described forms of the latter. It has more pointed poles than *Pseudoschubertella* sp. A.

Occurrence.—Specimens of this form were collected from samples FCM 302, 305, and 315.

Holotype.—FCM 302-1H.

TABLE 16

Pseudoschubertella fusiforma n. gen., n. sp.

Spec. No.	No. of vol.	Radius Vector			Height of Volution			Width	Length	Form Ratio	Diam. Pro.
		1	2	3	1	2	3				
302-1H	3	.06	.09	.15	.03	.04	.07	.25	.37	1.48	.06
302-8J	3	.05	.08	.12	.02	.03	.05	.23	.31	1.35	.06
302-8C	3	.04	.07	.12	.03	.04	.05	.21	.27	1.29	.03
302-5G	3	---	.07	.11	---	---	.04	.21	.32	1.53	---
315-5F	2 1/2	.04	.07	.10	.02	.03	.04	.17	.26	1.53	.04
305-7B	3	.05	.09	.14	.03	.05	.05	.24	.33	1.38	.05

PSEUDOSCHUBERTELLA sp. A

Pl. 2, fig. 7

Description.—Test minute, thickly fusiform, represented by one specimen of three volutions. Width of test is 0.27 mm. Length of the test is 0.35 mm and the form ratio is 1.297. The coil axis is oriented perpendicular to the section in the inner one and one-half volutions, but is parallel to the section in the final one and one-half volutions. The poles of the test blunt. Volution height uniform for inner two volutions, but increases slightly in the final volution. Spirotheca thin, granular, composed of two, possibly three layers. Measurements of principal taxonomic characters may be found in table 17.

Remarks.—Pseudoschubertella sp. A differs from *Pseudoschubertella fusiforma* n. sp. in having smaller form ratio, blunted poles and in having the coil axis change orientation in a more regular manner.

TABLE 17

Pseudoschubertella sp. A

Spec. No.	No. of vol.	Radius Vector			Height of Volution			Width	Length	Form Ratio	Diam. Pro.
		1	2	3	1	2	3				
293-3B	3	.06	.10	.15	.04	.04	.05	.27	.35	1.30	.04

Occurrence.—The single specimen of this form was collected from FCM 293.

Genus EOSCHUBERTELLA Thompson, 1937
EOSCHUBERTELLA BLUENSIS Ross and Sabins, 1965
Pl. 2, figs. 8, 9

Eoschubertella bluensis ROSS AND SABINS, 1965, p. 184, pl. 21, figs. 28, 29.

Description.—Test minute, subspherical, globose. Width of test in the two best-oriented and preserved specimens of two and one-half and three volutions is 0.31 mm and 0.32 mm respectively. Axial length in these specimens is 0.30 mm and 0.26 mm respectively and the form ratios are 0.969 and 0.813 respectively. Shape of early whorls discoidal, later whorls globose. Maximum axial dimension of final one-half whorl in these specimens 0.37 mm and 0.32 mm respectively. Coil axis changes orientation from early to later whorls. Volution height increases slowly, uniformly. Spirotheca thin, composed of three layers—tectum, diaphanotheca and upper tectorium. Chomata inconspicuous and not uniformly developed in different specimens. Measurements of principal taxonomic characters presented on table 18.

TABLE 18
Eoschubertella bluensis Ross and Sabins

Spec. No.	No. of vol.	Half-length			Radius Vector			Radius Vector Ratio			Height of Volution			Tunnel Angle (Degrees)		
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
261-7D	3	---	---	.15	.06	.12	.18	----	----	0.83	.04	.05	.07	--	--	--
264-11B	2 1/2	---	.13	.18	.07	.13	.18	----	1.00	1.00	.03	.06	.07	--	--	25

Spec. No.	Width	Length	Form Ratio	Diam. Pro.
261-7D	.32	.26	0.81	.06
264-11B	.31	.30	0.97	.07

EXPLANATION OF PLATE 2

FIGS. 1-6.—*Pseudoschubertella fusiforma* n. gen., n. sp.
Axial sections, X35.75, FCM 302-1H (holotype), 302-5G, 302-8J, 302-8C, 315-5F, 305-7B.

FIG. 7.—*Pseudoschubertella* sp. A
Axial section, X35.75, FCM 293-3B.

FIGS. 8, 9.—*Eoschubertella bluensis* Ross and Sabins
Axial sections, X35.75, FCM 261-7D, 264-11B.

FIGS. 10-13.—*Eoschubertella bluensis* subsp. A
Axial sections, X35.75, FCM 257-12C, 257-9C, 255-7I, 257-8E.

FIGS. 14-17.—*Eoschubertella bluensis* subsp. B
Axial sections, X35.75, FCM 305-4I, 303-1H, 307-3A, 303-3D.

FIG. 18.—*Eoschubertella* sp. aff. *E. mexicana* Thompson
Axial section, X35.75, FCM 257-2B.

FIGS. 19, 20.—*Eoschubertella* sp. aff. *E. texana* Thompson
Axial sections, X35.75, FCM 220-8B, 220-6J.

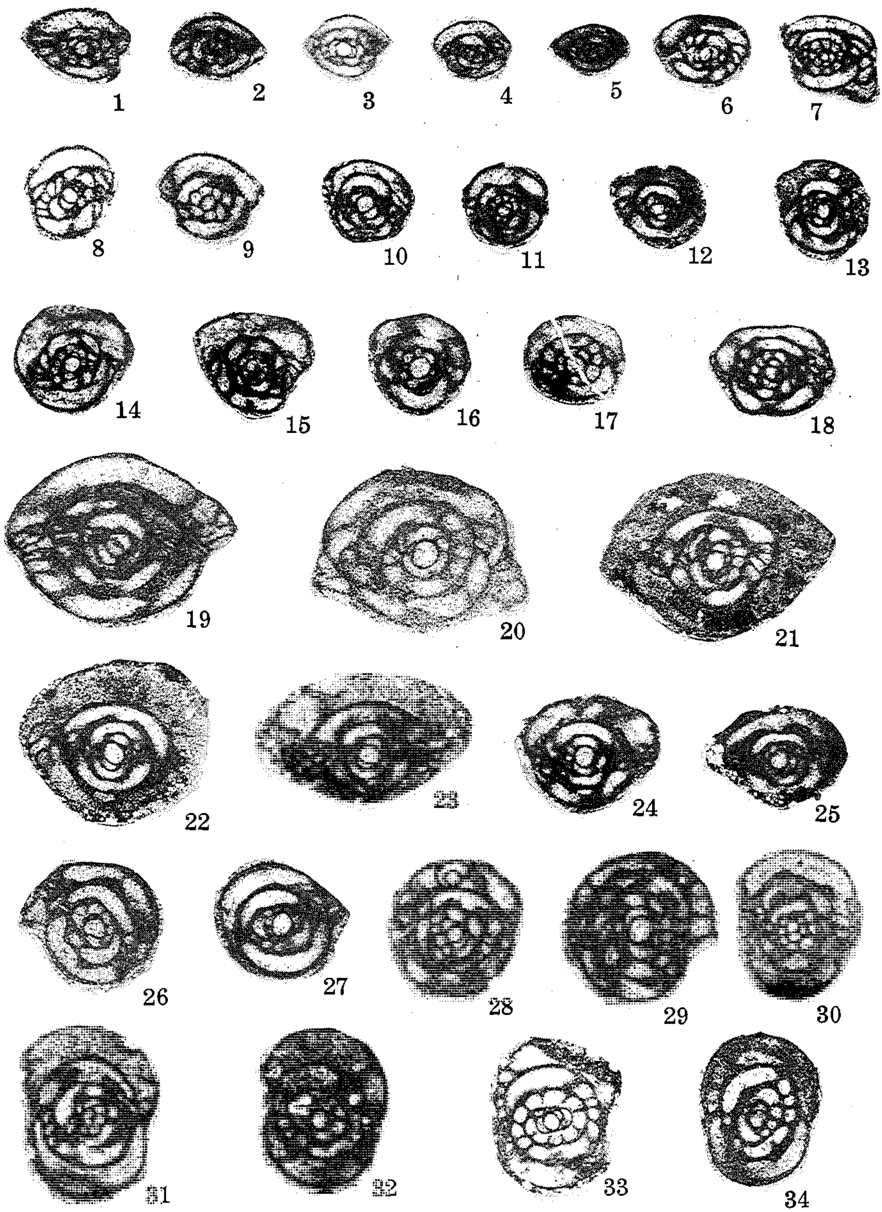
FIGS. 21-25.—*Eoschubertella* sp. A
Axial sections, X35.75, FCM 249-10B, 255-2A, 255-13E, 257-11A, 255-9E.

FIGS. 26, 27.—*Eoschubertella* sp. B
Axial sections, X35.75, FCM 220-18G, 220-2C.

FIGS. 28, 29.—*Pseudostaffella needhami* Thompson
Axial sections, X35.75, FCM 220-4A, 220-3F.

FIGS. 30-34.—*Pseudostaffella* sp. A
Axial sections, X35.75, FCM 220-5E, 222-11D, 220-11C, 225-7A, 220-4G.

PLATE 2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Remarks.—In general dimensions and shape, these specimens agree closely with the type specimens described by Ross and Sabins from southeastern Arizona. *E. bluensis* Ross and Sabins has larger volution height and hence is less tightly coiled than *E. bluensis* subsp. A and is smaller than *E. bluensis* subsp. B.

Occurrence.—Specimens referred to this species were obtained from samples FCM 261 and 264.

EOSCHUBERTELLA BLUENSIS subsp. A

Pl. 2, figs. 10-13

Description.—Test minute, spherical, subglobose. Width of test in the four best-oriented and preserved specimens of three to three and one-half volutions ranges from 0.28 mm to 0.34 mm. Axial length in these specimens ranges from 0.29 mm to 0.32 mm and the form ratio ranges from 0.940 to 1.143. Shape of early whorls thickly discoidal, later whorls subglobose. Maximum axial dimension of final half volution of these specimens ranges from 0.31 mm to 0.32 mm. Whorls broadly rounded. Coil axis changes orientation from earlier to later whorls. Pattern of changes not uniform in different specimens. Volution height uniform or increases slightly in final volution. Spirotheca thin, composed of tectum, diaphanotheca and outer tectorium. Chomata small, low, asymmetrical; tunnel broad. Measurements of principal taxonomic characters presented on table 19.

Remarks.—*Eoschubertella bluensis* supsp. A differs from the typical form in being less globose, more tightly coiled and in having more uniformly developed chomata.

Occurrence.—Specimens referred to this species were obtained from samples FCM 255 and 257.

TABLE 19

Eoschubertella bluensis subsp. A

Spec. No.	No. of vol.	Half-length 1	2	3	4	Radius Vector 1	2	3	4	Radius Vector Ratio 1	2	3	4	Height of Volution 1	2	3	4
257-12C	3	.04	.09	.12	---	.07	.11	.16	---	0.57	0.82	0.75	----	.04	.05	.04	---
257-9C	3 1/2	---	.09	.12	.17	.04	.07	.12	.17	----	1.29	1.00	1.00	.02	.03	.05	.07
257-8E	3 1/2	.04	.07	.12	.16	.06	.09	.15	.19	0.67	0.78	0.80	0.84	.03	.04	.06	.07
255-7I	3	.05	.08	.15	---	.06	.10	.16	---	0.83	0.80	0.94	----	.04	.04	.06	---

Spec. No.	Tunnel Angle (Degrees) 1	2	3	4	Width	Length	Form Ratio	Diam. Pro.
257-12C	--	--	32	--	.29	.29	1.00	.06
257-9C	--	--	27	36	.30	.29	0.97	.05
257-8E	--	25	22	--	.34	.32	0.94	.05
255-7I	--	--	32	--	.28	.32	1.14	.04

EOSCHUBERTELLA BLUENSIS subsp. B

Pl. 2, figs. 14-17

Description.—Test minute, subspherical, globose. Width of test in the four best-oriented and preserved specimens of three and one-half to four and one-half volutions ranges from 0.32 mm to 0.39 mm. Axial length in these specimens ranges from 0.31 mm to 0.36 mm and the form ratio ranges from 0.915 to 0.970. Final whorl globose, extending beyond end of coil axis; maximum axial dimension of final half volution ranges from 0.35 mm to 0.42 mm. Volution outline broadly rounded. Coil axis changes orientation from inner to outer volutions. Volution height increases from inner to outer volutions. Spirotheca thin, composed of tectum, diaphanotheca and outer tectorium. Chomata not discernible. Measurements of principal taxonomic characters presented on table 20.

Remarks.—This subspecies differs from the typical form in being larger in most dimensions, having practically no chomata and in having a slightly thinner wall. It is smaller than other described species of the genus. A morphological series beginning with *E. bluensis* A leading through *E. bluensis* to *E. bluensis* B exists in which there is an increase in size and volution height and a reduction of chomata.

Occurrence.—Specimens referred to this form were collected from samples FCM 303, 305 and 307.

TABLE 20
Eoschubertella bluensis subsp. B

Spec. No.	No. of vol.	Half-length 1	2	3	4	Radius Vector 1	2	3	4	Radius Vector Ratio 1	2	3	4	Height of Volution 1	2	3	4
305-4I	3 1/2	.05	.09	.15	.19	.06	.10	.18	.21	0.84	0.90	0.84	0.91	.03	.04	.07	.09
303-1H	3	.06	.11	.16	---	.06	.10	.20	---	1.00	1.10	0.80	----	.02	.04	.09	---
307-3A	2 1/2	---	.08	.15	---	.09	.15	.20	---	----	0.53	0.80	----	.05	.06	.08	---
303-3D	2 1/2	---	.11	.16	---	.07	.13	.19	---	----	0.85	0.84	----	.03	.06	.07	---

Spec. No.	Width	Length	Form Ratio	Diam. Pro.
305-4I	.39	.36	0.92	.05
303-1H	.37	.35	0.95	.06
307-3A	.35	.32	0.92	.08
303-3D	.32	.31	0.97	.08

EOSCHUBERTELLA sp. aff. E. TEXANA Thompson, 1947

Pl. 2, figs. 19, 20

E. aff.*Eoschubertella texana* THOMPSON, 1947, p. 161-162, pl. 31, figs. 1-8.

Description.—Test minute, thickly fusiform to subglobose with rounded poles. Width of test in the two best-preserved and oriented specimens of three volutions is 0.63 mm. Axial length in these specimens is 0.70 mm and 0.77 mm and the form ratio is 1.11 and 1.22, respectively. Volution height increases slowly from inner to outer volutions. Orientation of coil axis shifts slightly from inner to outer volutions. Spirotheca thin, composed of tectum, diaphanotheca and upper tectorium. Chomata inconspicuous. Measurement of principal taxonomic characters presented on table 21.

Remarks.—In shape, size and nature of chomata, these specimens compare more closely with *E. texana* Thompson than with any other described American species. However, they are somewhat larger than the forms described by Thompson and somewhat more loosely coiled. These forms are also quite similar to *E. gallowayi* (Skinner), but are smaller and lack the well-developed chomata present in the forms described by Skinner (1931, p. 256-257).

Occurrence.—Specimens referred to this species were collected from sample FCM 220.

TABLE 21
Eoschubertella sp. aff. *E. texana* Thompson

Spec. No.	No. of vol.	Half-length 1	2	3	4	Radius Vector 1	2	3	4	Radius Vector Ratio 1	2	3	4	Height of Volution 1	2	3	4
220-6J	3	---	.26	.34	---	.11	.21	.33	---	----	1.24	1.03	----	.06	.10	.12	---
220-8B	4	---	.13	.24	.33	---	.12	.21	.35	----	1.08	1.14	0.95	---	---	.08	.13

Spec. No.	Tunnel Angle 1	2	3	4	Width	Length	Form Ratio	Diam. Pro.
220-6J	--	--	53	--	.63	.70	1.11	.10
220-8B	--	25	26	--	.63	.77	1.22	---

EOSCHUBERTELLA sp. aff. E. MEXICANA Thompson, 1948

Pl. 2, fig. 18

E. aff. *Eoschubertella mexicana* THOMPSON, 1948, p. 79, pl. 28, figs. 1-8.

Description.—The single specimen figured is minute, subspherical with rounded poles. Width of test of three and one-half volutions is 0.32 mm. Axial length of this specimen is 0.45 mm and the form ratio is 1.408. Volution height increases slowly in the first three volutions then decreases slightly in the fourth volution. Orientation of coil axis more or less consistent throughout the test. Spirotheca thin, composed of tectum, diaphanotheca and upper tectorium. Chomata low, narrow. Tunnel angle moderate, ranging from 30° to 24° from the second to the fourth volutions, the angle actually decreasing somewhat. Measurements of principal taxonomic characters are presented on table 22.

TABLE 22

Eoschubertella sp. aff. *E. mexicana* Thompson

Spec. No.	No. of vol.	Radius Vector				Height of Volution				Tunnel Angle				Width	Length	Form Ratio	Diam. Pro.
		1	2	3	4	1	2	3	4	1	2	3	4				
257-2B	3 1/2	.07	.10	.15	.17	.03	.03	.05	.04	--	30	27	24	.32	.45	1.41	.05

Remarks.—This specimen closely resembles those described by Thompson except that it has a slightly larger form ratio, does not have a shifting coil axis, and decreases in volution height in its last volution.

Occurrence.—The single specimen referred to this species was obtained from FCM 257.

EOSCHUBERTELLA sp. A

Pl. 2, figs. 21-25

Description.—Test minute, subglobose to thickly fusiform with subrounded to bluntly pointed poles. Width test in the five best-oriented and preserved specimens of three to four volutions ranges from 0.35 mm to 0.60 mm. Axial length in these specimens ranges from 0.43 mm to 0.81 mm and the form ratio ranges from 1.259-1.400. Volution height increases slowly in first three volutions, then more rapidly in the fourth volution. Orientation of coil axis shifts slightly from inner to outer volutions. Spirotheca thin, composed of tectum, diaphanotheca and upper tectorium. Chomata present in second and third volutions, low and broad. Tunnel angle moderate, ranging from 21° to 32°. Principal taxonomic characters presented on table 23.

Remarks.—*E.* sp. A most closely resembles *E. gallowayi* (Skinner) and *E. texana* Thompson. It differs from them both by having subround to bluntly pointed poles. *E.* sp. A is somewhat smaller than *E. gallowayi* and has a larger tunnel angle. *E.* sp. A has better developed chomata than *E. texana* and a larger form ratio.

Occurrence.—Forms referred to this species were obtained from samples FCM 249, 255, 257, and 261.

TABLE 23

Eoschubertella sp. A

Spec. No.	No. of vol.	Half-length				Radius Vector				Radius Vector Ratio				Height of Volution			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
249-10B	4	.06	.15	.25	.40	.07	.13	.19	.32	0.86	1.16	1.31	1.25	.03	.06	.06	.14
257-11A	3	.07	.15	.27	---	.08	.14	.21	---	0.88	1.07	1.29	----	.04	.05	.08	---
255-2A	4	.06	.14	.23	---	.08	.13	.20	---	0.75	1.08	1.15	----	.04	.04	.07	.16
255-13E	3	.07	.15	.23	---	.07	.12	.19	---	1.00	1.25	1.21	----	.03	.05	.07	---
255-9E	3	.07	.11	.21	---	.07	.11	.18	---	1.00	1.00	1.17	----	.03	.04	.07	---

Spec. No.	Tunnel Angle				Width	Length	Form Ratio	Diam. Pro.
	1	2	3	4				
249-10B	--	--	32	--	.60	.81	1.35	.08
257-11A	--	27	31	--	.40	.51	1.28	.08
255-2A	--	--	21	27	---	---	----	.08
255-13E	--	30	26	--	.35	.49	1.40	.08
255-9E	--	--	30	--	.34	.43	1.27	.07

EOSCHUBERTELLA sp. B

Pl. 2, figs. 26, 27

Description.—Test minute, spherical. Width of test in two specimens of three and three and one-half volutions is 0.44 mm. Axial length in these specimens is 0.43 mm and 0.39 mm, respectively, and the form ratio is 0.978 and 0.886, respectively. Volution height uniform or increases only slowly. Volution outline round with round poles. Orientation of coil axis shifts considerably from inner to outer volutions. Spirotheca thin, composed of tectum, diaphanotheca, and upper tectorium. Chomata inconspicuous. Measurements of principal taxonomic features are presented on table 24.

Remarks.—These specimens resemble *E. bluensis* subsp. B more than any other described species. In *E.* sp. B, the volution height is more uniform, the test is somewhat larger, the shape, although spherical, is not so globose. *E.* sp. B has a smaller form ratio than *E. mexicana* Thompson and does not have well-developed chomata. *E.* sp. B is considerably smaller than other described species of the genus.

Occurrence.—Specimens referred to this form were obtained from sample FCM 220.

TABLE 24

Eoschubertella sp. B

Spec. No.	No. of vol.	Half-length 1	2	3	4	Radius Vector 1	2	3	4	Radius Vector Ratio 1	2	3	4	Height of Volution 1	2	3	4
220-2C	3 1/2	.05	.09	.16	.22	.08	.12	.20	.23	0.63	0.75	0.80	0.96	.04	.06	.08	.09
220-18G	3	.06	.08	.22	---	.09	.16	.23	---	0.67	0.50	0.96	----	.07	.07	.07	---

Spec. No.	Tunnel Angle 1	2	3	4	Width	Length	Form Ratio	Diam. Pro.
220-2C	--	--	--	--	.44	.39	0.89	.09
220-18G	--	--	25	--	.44	.43	0.98	.09

EOSCHUBERTELLA spp.

Among the specimens collected and sectioned are a number belonging to the genus *Eoschubertella* but are too poorly preserved or oriented to warrant specific description.

Subfamily FUSULININAE von Möller, 1878
Genus PSEUDOSTAFFELLA Thompson, 1942
PSEUDOSTAFFELLA NEEDHAMI Thompson, 1942

Pl. 2, figs. 28, 29

Pseudostaffella needhami THOMPSON, 1942b, p. 411-413, pl. 1, figs. 15-20, pl. 3, figs. 10-14; 1948, p. 80, pl. 25, figs. 17-25.

Description.—Test minute, subspherical. Width of test in the two best-preserved and oriented specimens of three and one-half to four volutions is 0.50 mm and 0.55 mm. Axial length in these specimens is 0.45 mm and 0.50 mm., respectively, and the overall form ratio is 0.900, and 1.000, respectively. The periphery of the whorls is broadly rounded and the umbilical region is even or only slightly depressed. Volution height is uniform or increases only gradually. Orientation of coil axis shifts irregularly from inner to outer volutions. Spirotheca is thin, composed of three layers—tectum, upper tectorium and diaphanotheca. Chomata not uniformly developed or conspicuous, showing best near base of septa. Measurements of principal taxonomic features are presented in table 25.

TABLE 25

Psudostaffella needhami Thompson

Spec. No.	No. of vol.	Half-length 1	2	3	4	Radius Vector 1	2	3	4	Radius Vector Ratio 1	2	3	4	Height of Volution 1	2	3	4
220-4A	4	.03	.09	.14	.23	.07	.11	.18	.28	0.43	0.82	0.78	0.82	.04	.04	.08	.10
220-3F	3 1/2	.10	---	---	---	.11	.19	.26	.28	0.91	----	----	----	.06	.08	.07	.06

Spec. No.	Tunnel Angle 1	2	3	4	Width	Length	Form Ratio	Diam. Pro.
220-4A	—	--	26	--	.50	.45	0.90	.06
220-3F	--	28	22	--	.55	.55	1.00	.10

Remarks.—These specimens agree closely in general dimensions and shape to the holotype of the species although some of the paratypes are quite different in shape and may belong to different species. Chomata are not as conspicuous as in holotype or paratypes. This is not considered sufficient distinction to separate species. *P. needhami* differs from *P.* sp. A and *P.* sp. A var. A in having a larger form ratio and more broadly rounded periphery. *P. needhami* resembles *P. keytei* var. *maccoyensis* (Thompson) in size and shape but has fewer whorls and less conspciuous chomata.

Occurrence.—Specimens referred to this species were collected from sample FCM 220.

PSEUDOSTAFFELLA sp. A

Pl. 2, figs. 30-34

Description.—Shell minute, nautiliform. Width of test in the five best-preserved and oriented specimens of three and one-half to four and one-half volutions ranges from 0.52 mm to 0.65 mm. Axial length in these specimens ranges from 0.38 mm to 0.42 mm and the form ratio ranges from 0.647 to 0.730. Periphery is broadly rounded and umbilical region is slightly depressed. Volution height increases gradually and uniformly. Orientation of coil axis shifts from inner to outer volutions, although in the outer one and one-half to two volutions, the axis remains more or less in the plane of the section. Spirotheca thin, composed of three layers, *i.e.*, tectum, diaphanotheca and upper tectorium, although a fourth layer, the lower tectorium can be seen in the penultimate volutions of some specimens. Chomata inconspicuous, showing only near base of septa. Measurements of principal taxonomic characters are shown in table 26.

Remarks.—P. sp. A resembles *P. hollingsworthi* (Thompson) in size and shape but has larger axial length, form ratio and has much less conspicuous chomata. *P.* sp. A differs from *P. atokensis* (Thompson) for the same reasons and, in addition, has a more broadly rounded periphery. *P.* sp. A differs from *P. needhami* Thompson in having a smaller form ratio.

Occurrence.—Specimens referred to this species were collected from samples FCM 220 and 225.

TABLE 26

Pseudostaffella **sp. A**

Spec. No.	No. of vol.	Half-length					Radius Vector					Radius Vector Ratio				
		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
220-11C	3 1/2	.05	.12	.19	.21	---	.09	.14	.24	.33	---	0.56	0.86	0.79	0.64	----
222-11D	4	---	.12	.18	.22	---	.07	.13	.22	.35	---	----	0.92	0.82	0.63	----
225-7A	4 1/2	.03	.14	.18	.21	.21	.06	.10	.17	.26	.30	0.50	1.40	1.06	0.81	0.70
220-4G	3 1/2	.07	.09	.14	.19	---	.10	.15	.25	.33	---	0.70	0.60	0.56	0.58	----
220-5E	4	---	.09	.14	.17	---	.05	.11	.19	.28	---	----	0.82	0.74	0.61	----

Spec. No.	Height of Volution					Tunnel Angle					Width	Length	Form Ratio	Diam. Pro.
	1	2	3	4	5	1	2	3	4	5				
220-11C	.05	.05	.10	.14	---	--	28	41	--	--	.57	.40	0.70	.07
222-11D	.04	.06	.09	.12	---	--	37	35	--	--	.65	.42	0.65	.06
225-7A	.03	.05	.07	.09	.09	--	--	--	--	--	.56	.39	0.70	.06
220-4G	.06	.05	.09	.12	---	--	--	29	33	--	.58	.38	0.66	.07
220-5E	.03	.06	.08	.10	---	--	--	31	40	--	.52	.38	0.73	.04

PSEUDOSTAFFELLA sp. A, var. A

Pl. 3, figs. 1-3

Description.—Shell minute, nautiliform. Width of test in the three best-preserved and oriented specimens of three to four volutions ranges from 0.53 mm to 0.63 mm. Length of test in these specimens ranges from 0.33 mm to 0.37 mm and the form ratio ranges from 0.588 to 0.627. Periphery is rounded and the umbilicus is slightly depressed. Volution height increases gradually and uniformly. Orientation of coil axis shifts irregularly although it is more or less parallel to the section in the final one and one-half to two volutions. Spirotheca thin, composed of three layers—upper tectorium, tectum, and diaphanotheca, although a fourth layer, the lower tectorium, appears irregularly in some specimens. Chomata inconspicuous, showing only near base of septa. Measurements of principal taxonomic characters are presented in table 27.

Remarks.—*P.* sp. A var. A resembles the typical form very closely except that it has a shorter axial length, a smaller form ratio, and a more narrow periphery. In these respects it more nearly resembles *P. hollingsworthi* and *P. atokensis* than does the typical form. *P.* sp. A var. A differs from these in having inconspicuous chomata and in having a less consistent orientation of the coil axis.

Occurrence.—Specimens referred to this species were collected from sample FCM 220.

TABLE 27

Pseudostaffella sp. A var. A

Spec. No.	No. of vol.	Half-length				Radius Vector				Radius Vector Ratio				Height of Volution			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
220-10E	3	----	.12	.20	---	.16	.25	.37	---	----	0.48	0.54	----	---	.09	.13	---
220-2E	4	.04	.10	.16	.17	.06	.11	.18	.28	0.67	0.91	0.89	0.61	.03	---	.07	.10
220-20C	3 1/2	---	---	---	.20	.10	.18	.27	.33	----	----	----	0.61	.06	.07	.09	.11

Spec. No.	Tunnel Angle				Width	Length	Form Ratio	Diam. Pro.
	1	2	3	4				
220-10E	--	25	38	--	.63	.37	0.59	.08
220-2E	--	--	23	29	.53	.33	0.62	---
220-20C	--	--	33	29	.59	.37	0.63	.09

PSEUDOSTAFFELLA spp.

A number of specimens in the writer's collection are referable to *Pseudostaffella* but are not suitable for species identification or description because they are either too few in number or they are not well preserved or oriented for adequate study.

PSEUDOSTAFFELLA (?) sp. A

Pl. 3, fig. 4

Description.—Test minute, subspherical, umbilicate. Width of test in the one best-preserved and oriented specimen of three and one-half volutions is 0.45 mm. The axial length is 0.40 mm and the form ratio is 0.890. Umbilicus depressed; the maximum axial dimension of the final one-half whorl is 0.47 mm, resulting in a globose cross-sectional shape for the final whorls. Whorl periphery broadly rounded. Volution height increases gradually. Orientation of coil axis shifts irregularly, but is approximately parallel to plane of section in final two and one-half volutions. Spirotheca thin, composed of three layers, tectum, diaphanotheca and upper tectorium. Chomata inconspicuous. Measurements of principal taxonomic features are presented in table 28.

TABLE 28

Pseudostaffella (?) sp. A

Spec. No.	No. of vol.	Half-length				Radius Vector				Radius Vector Ratio				Height of Volution			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
259-8E	3 1/2	---	.07	.11	.17	.07	.12	.19	.25	----	0.58	0.58	0.68	.03	.05	.07	.09

Spec. No.	Tunnel Angle				Width	Length	Form Ratio	Diam. Pro.
	1	2	3	4				
259-8E	--	--	26	--	.45	.40	0.89	.09

Remarks.—This specimen and others referred to the same form, are distinct from other pseudostaffellas in having a distinctly depressed umbilical area and a consequent globose whorl outline, in which respect it resembles *Eoschubertella.* With regard to overall dimension and shape, it is still allied to *Pseudostaffella.*

Occurrence.—Specimens referred to this form were collected from sample FCM 259.

Genus PROFUSULINELLA Rauzer-Chernousova and Belyaev, 1936

PROFUSULINELLA sp. aff. P. WALNUTENSIS Ross and Sabins, 1965

Pl. 3, figs. 5-7

P. aff. *Profusulinella walnutensis* ROSS AND SABINS, 1965, p. 185, pl. 21, figs. 9-13.

Description.—Test minute, thickly fusiform, with subrounded poles. Width of test in the three best-oriented and preserved specimens of two and one-half to three volutions ranges from 0.38 mm to 0.44 mm. Axial length in these specimens ranges from 0.66 mm to 0.72 mm and the form ratio ranges from 1.580 to 1.639. Volution height increases uniformly and moderately from inner to outer volutions. Lateral slopes of volutions broadly convex. Orientation of coil axis consistent in two of these specimens and shifts considerably in the third. Spirotheca thin, composed of tectum, diaphanotheca, and upper tectorium. Chomata indistinct in early volutions, moderately high and broad in outer volutions. Tunnel angle moderate, ranging from 27° to 35°. Measurements of principal taxonomic characters are presented on table 29.

Remarks.—These specimens agree closely in size and shape with those described by Ross and Sabins. Some differences are that these specimens have more rounded poles, less conspicuous chomata, and fewer volutions than those described by Ross and Sabins. They are, in some respects, closely allied with *Eoschubertella* in that they are more or less loosely coiled, have fairly rounded poles, and inconsistently developed chomata. It is also possible that the forms from sample number 266 are juvenile stages of larger fusulinids such as *Fusulinella* since easily recognizable fusulinellas appear for the first time just a few feet higher in the section.

Occurrence.—Specimens referred to this form were obtained from samples FCM 256 and 266.

TABLE 29

Profusulinella sp. aff. *P. walnutensis* Ross and Sabins

Spec. No.	No. of Vol.	Half-length			Radius Vector			Radius Vector Ratio			Height of Volution			Tunnel Angle		
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
266-4D	3	.10	.19	.39	.07	.13	.24	1.43	1.46	1.63	.03	.05	.11	--	24	29
266-1E	2 1/2	.11	.26	.31	.08	.16	.22	1.38	1.63	1.41	.04	.08	.09	27	30	35
256-3E	3	.08	.16	.29	.08	.13	.21	1.00	1.23	1.38	.04	.05	.07	--	--	27

Spec. No.	Width	Length	Form Ratio	Diam. Pro.
266-4D	.44	.72	1.64	.09
266-1E	.38	.61	1.60	.10
256-3E	.38	.60	1.58	.07

PROFUSULINELLA SPRINGENSIS n. sp.

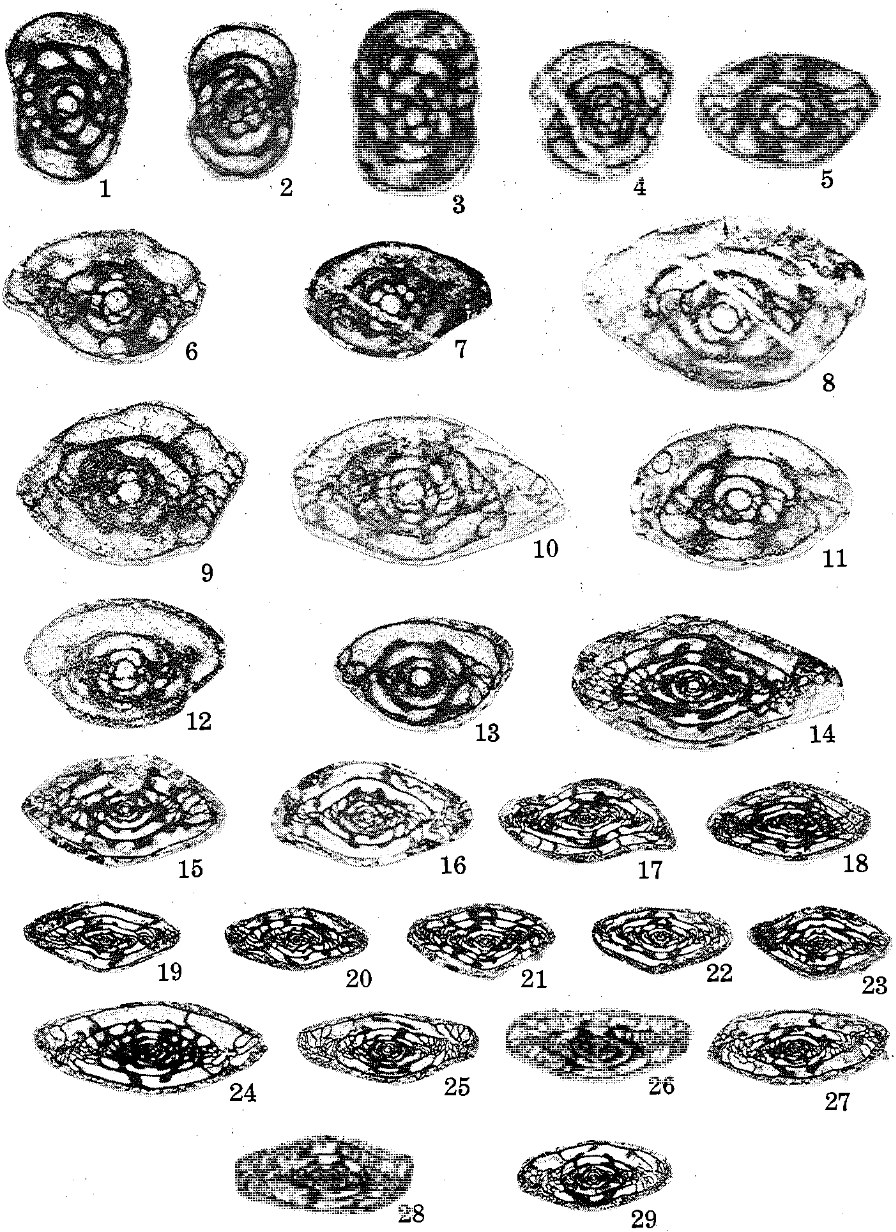
Pl. 3, figs. 8-13

Description.—Test minute, fusiform, with subrounded, bluntly pointed or truncated poles. Width of test in the six best-preserved and oriented specimens of three to four volutions

EXPLANATION OF PLATE 3

FIGS. 1-3.—*Pseudostaffella* sp. A var. A
Axial sections, X35.75, FCM 220-20C, 220-2E, 220-10E.
FIG. 4.—*Pseudostaffella* (?) sp. A
Axial section, X35.75, FCM 259-8E.
FIGS. 5-7.—*Profusulinella* sp. aff. *P. walnutensis* Ross and Sabins
Axial sections, X35.75, FCM 266-1E, 266-4D, 256-3E.
FIGS. 8-13.—*Profusulinella springensis* n. sp.
Axial sections, X35.75, FCM 259-6H (holotype), 260-2E, 259-1B, 259-2A, 261-5D, 257-5A.
FIGS. 14-16—*Fusulinella lounsberyi* Thompson
Axial sections, X14.3, FCM 268-7F, 268-9A, 268-16E.
FIGS. 17-23.—*Fusulinella submatura* n. sp.
Axial sections, X7.15, FCM 281-2H, 281-2D, 281-3C, 281-5C, 281-7C, 281-1B (holotype), 281-3E.
FIGS. 24-29.—*Fusulinella euryangulata* n. sp.
Axial sections, X7.15, FCM 303-4B (holotype), 303-5F, 303-4F, 303-5C, 303-8B, 303-3M.

PLATE 3



ranges from 0.036 mm to 0.59 mm. The axial length in these specimens ranges from 0.59 mm to 0.95 mm and the form ratio ranges from 1.380 to 1.774. Volution height increases slowly from inner to outer volution. Lateral slopes of volution broadly convex. Coil axis straight. Orientation of coil axis uniform throughout the test. Septa plane except broadly folded at poles of some specimens. Spirotheca thin, composed of tectum, diaphanotheca and upper tectorium. Chomata inconsistently developed, low and broad to moderate and narrow where present. Tunnel angle moderate to broad ranging from 24° to 41°. Measurements of principal taxonomic characters presented on table 30.

Remarks.—*P. springensis* n. sp. is unique among other described species of this genus because of its small size, lack of consistently developed chomata, and truncated poles of some of the specimens. Among described fusulinids of about the same size and shape, *Eoschubertella oliviformis* Thompson (1935) has better developed chomata (this form may actually be more closely allied to *Profusulinella*), "*Fusulinella*" *trisulcata* Thompson (1935) has better developed chomata and concave lateral slopes, *Profusulinella fittsi* Thompson (1935) is larger and has better developed chomata, and *Profusulinella marblensis* Thompson (1947) is larger and has a smaller form ratio. The specimens here assigned to *P. springensis* show considerable variability and may not all be conspecific, but are all assigned here until further studies are made.

Holotype.—FCM 259-6H.

Occurrence.—Specimens referred to this species were collected from samples FCM 257 and 259-261.

TABLE 30

Profusulinella springensis n. sp.

Spec. No.	No. of vol.	Half-length				Radius Vector				Radius Vector Ratio				Height of Volution			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
259-6H	3 1/2	.10	.25	.38	.48	.09	.14	.25	.35	1.11	1.79	1.58	1.38	.04	.05	.10	.09
259-2A	3	---	---	---	---	.09	.15	.26	---	----	----	----	----	.05	.07	.11	---
259-1B	4	.07	.13	.25	.41	.09	.13	.19	.26	0.78	1.00	1.32	1.58	.04	.05	.06	.07
260-2E	3 1/2	---	---	---	---	.08	.13	.24	.31	----	----	----	----	.04	.05	.11	.13
261-5D	3	.08	.17	.34	---	.07	.13	.23	---	1.14	1.31	1.48	----	.03	.06	.09	---
257-7A	3	.08	.16	.31	---	.07	.13	.19	---	1.14	1.23	1.63	----	.03	.06	.07	---

Spec. No.	Tunnel Angle				Width	Length	Form Ratio	Diam. Pro.
	1	2	3	4				
259-6H	--	--	--	--	.59	.95	1.61	.10
259-2A	--	--	--	--	.46	.74	1.61	.11
259-1B	--	28	28	39	.50	.81	1.62	.09
260-2E	--	--	39	--	.55	.76	1.38	.08
261-5D	--	40	33	--	.40	.71	1.77	.08
257-7A	--	34	41	--	.36	.59	1.64	.07

PROFUSULINELLA spp.

Among specimens collected and sectioned, a number are probably referable to the genus *Profusulinella,* but are too poorly oriented for description or identification.

Genus FUSULINELLA Möller, 1877

FUSULINELLA LOUNSBERYI Thompson, 1945

Pl. 3, figs. 14-16

Fusulinella lounsberyi THOMPSON, 1945, p. 53-54, pl. 1, figs. 8-11.

Description.—Shell small, inflated fusiform with slightly concave lateral slopes, bluntly pointed poles, and straight axis of coiling. Length of shell in the three best-preserved and oriented specimens of five to six volutions ranges from 1.6 mm to 2.3 mm. Width of test in these specimens ranges from 0.8 mm to 1.1 mm, and the form ratio ranges from 1.8 to 2.1. Volution height increases gradually from inner to outer volutions. Orientation of coil axis uniform throughout test. Septa plane except broadly fluted at poles. Spirotheca fusulinellid, thin. Chomata well-developed, one-third to one-half volution height, extending to poles in inner volutions, more narrow in outer volutions.

Tunnel angle moderate for genus, ranging from 23° to 26°. Measurements of principal taxonomic characters presented on table 31.

Remarks.—The above-described specimens from the Bird Spring Formation referred to *F. lounsberyi* Thompson also are quite similar in size and shape to *F. whitensis* Ross and Sabins and *F. haymondensis* Skinner and Wilde. Measurement data from *F. lounsberyi* and *F. haymondensis* are so close that a careful statistical study of a large number of topotype specimens of each may show that they are really one species. *F. lounsberyi* is slightly smaller than *F. whitensis* Ross and Sabins, but measurement data overlaps somewhat and hence the latter may only be a geographic variant. *F. lounsberyi* resembles closely juvenile stages of *F. dexeva.* These two may be closely related.

Occurrence.—Specimens referred to this species were collected from samples FCM 267, 268 ann 269.

TABLE 31

Fusulinella lounsberyi Thompson

Spec. No.	No. of vol.	Half-length 1	2	3	4	5	6	Radius Vector 1	2	3	4	5	6	Radius Vector Ratio 1	2	3	4	5	6
268-7F	6	.10	.20	.40	.63	.90	1.20	.06	.12	.20	.29	.44	.58	1.67	1.67	2.00	2.17	2.05	2.07
268-9A	5	.08	.18	.24	.69	.86	----	.06	.10	.17	.28	.44	---	1.33	1.80	1.41	2.47	1.96	----
268-16E	5 1/2	.09	.17	.31	.52	.74	----	.04	.10	.17	.26	.39	.48	2.25	1.70	1.83	2.00	1.90	----

Spec. No.	Height of Volution 1	2	3	4	5	6	Tunnel Angle 1	2	3	4	5	6	Width	Length	Form Ratio	Diam. Pro.
268-7F	.02	.06	.07	.10	.15	.14	--	23	30	23	22	26	1.10	2.32	2.11	.09
268-9A	.02	.04	.07	.10	.15	---	--	--	25	29	26	--	0.80	1.64	2.05	.06
268-16E	.02	.04	.06	.09	.12	.13	--	--	--	26	28	31	0.87	1.60	1.84	.06

FUSULINELLA SUBMATURA n. sp.

Pl. 3, figs. 17-23

Description.—Shell of moderate size, fusiform to inflated fusiform, with straight to slightly concave lateral slopes, pointed poles, and an axis of coiling which is straight or slightly curved. Length of shell in the seven best-preserved and oriented specimens of five and one-half to seven volutions ranges from 2.32 mm to 2.88 mm. Width of test in these specimens ranges from 1.00 mm to 1.28 mm, and the form ratio ranges from 2.14 to 2.42. Volution height increases uniformly throughout. The form ratio in some typical specimens reaches maximum prior to the final volution. Septa plane except slightly folded at poles. Spirotheca fusulinellid, thin. Small amounts of axial deposits present. Chomata asymmetrical and narrow in outer volutions and about one-half volution height. Tunnel angle moderate in the middle volutions ranging from 16° to 26° and becoming wider in the outer volutions, ranging from 23° to 44°. Measurements of principal taxonomic characters presented on table 32.

Remarks.—The plane septa, pointed poles, slightly inflated central portion and presence of axial deposits are features which relate this species to the genus *Wedekindellina.* The placement of this species in the genus *Fusulinella* is somewhat arbitrary and is based on the lack of heavier axial deposits in conjunction with the presence of some septal folding in the polar regions. Of the species of *Wedekindellina, F. submatura* is most closely similar to *W. matura* Thompson from which it takes its name. *W. matura* has slightly heavier axial deposits, is more elongate, has smaller volution heights, and has a smaller tunnel angle. *F. submatura* may be ancestral to *W. matura* and some later species of *Wedekindellina.*

In comparison with *F. submatura, F. cabezasensis* Ross and Sabins is thicker, has a smaller form ratio, broader chomata, and smaller tunnel angle. *F. dosensis* Ross and Sabins is smaller, has more intensely folded septa, broader chomata, and a larger tunnel angle. *F. acuminata* Thompson has more intensely folded septa and a larger form ratio. *F. prospectensis* Ross and Sabins has a higher form ratio and narrower chomata.

Holotype.—FCM 281-1B.

Occurrence.—Specimens referred to this species were collected from samples FCM 280 and 281.

TABLE 32

Fusulinella submatura n. sp.

Spec. No.	No. of vol.	Half-length							Radius Vector						
		1	2	3	4	5	6	7	1	2	3	4	5	6	7
281-1B	5 1/2	0.14	0.33	0.57	0.73	1.24	1.40	----	0.08	0.14	0.20	0.33	0.51	0.63	----
281-2D	7	0.06	0.16	0.44	0.68	0.93	1.21	1.43	0.07	0.11	0.17	0.27	0.36	0.48	0.64
281-5C	6	0.05	0.16	0.30	0.56	0.83	1.18	----	0.04	0.08	0.15	0.24	0.39	0.53	----
281-3C	6	0.09	0.23	0.43	0.74	0.96	1.20	----	0.08	0.13	0.20	0.29	0.41	0.54	----
281-3E	6	0.08	0.17	0.37	0.65	0.92	1.23	----	0.06	0.10	0.19	0.30	0.44	0.61	----
281-7C	5 1/2	0.12	0.30	0.46	0.74	1.00	1.25	----	0.08	0.16	0.25	0.35	0.48	0.60	----
281-2H	6 1/2	0.07	0.24	0.44	0.75	1.15	1.44	1.52	0.06	0.10	0.17	0.29	0.44	0.59	0.68

Spec. No.	Radius Vector Ratio							Height of Volution							Tunnel Angle						
	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7
281-1B	1.75	2.36	2.85	2.21	2.43	2.22	----	.04	.06	.08	.12	.17	.17	---	--	--	30	26	44	--	--
281-2D	0.86	1.45	2.59	2.52	2.59	2.52	2.24	---	.04	.06	.09	.09	.12	.15	--	--	--	26	25	35	42
281-5C	1.25	2.00	2.00	2.34	2.13	2.23	----	---	.04	.07	.09	.15	.15	---	--	--	22	26	34	33	--
281-3C	1.13	1.77	2.15	2.55	2.34	2.22	----	---	.05	.08	.08	.12	.12	---	--	--	16	25	27	38	--
281-3E	1.33	1.70	2.48	2.17	2.09	2.02	----	---	.04	.08	.12	.13	.17	---	--	--	25	22	24	24	--
281-7C	1.50	1.88	1.84	2.18	2.08	2.08	----	.04	.08	.10	.09	.13	.15	---	--	29	25	26	23	25	--
281-2H	1.17	2.40	2.59	2.59	2.62	2.45	2.24	---	.04	.07	.12	.14	.15	.14	--	--	19	26	30	26	--

Spec. No.	Width	Length	Form Ratio	Diam. Pro.
281-1B	1.12	2.72	2.43	.07
281-2D	1.21	2.76	2.28	---
281-5C	1.00	2.32	2.32	---
281-3C	1.02	2.44	2.39	---
281-3E	1.19	2.40	2.02	---
281-7C	1.10	2.40	2.18	.08
281-2H	1.28	2.88	2.25	---

FUSULINELLA EURYANGULATA n. sp.

Pl. 3, figs. 24-29

Description.—Shell of moderate to large size, elongate fusiform with slightly convex lateral slopes, pointed poles, and an axis of coiling which is straight or slightly curved. Length of test in the six best-preserved and oriented specimens of five and one-half to six volutions ranges from 2.61 mm to 3.84 mm. Width of test in these specimens ranges from 1.11 mm to 1.44 mm and the form ratio ranges from 2.35 to 2.83. Mature form ratio attained by the third volution. Volution height expands slowly in the inner volutions and more rapidly in the outer volutions. Septa plane except gently folded at the poles. Spirotheca fusulinellid, thin. Chomata asymmetrical and quite broad in the inner volutions, becoming more nearly symmetrical and narrower in the outer volutions, and about one-half the volution height. Tunnel angle moderately wide in middle volutions, ranging from 32° to 39°, and markedly wide in the outer volutions, ranging from 42° to 70°. Measurements of principal taxonomic characters presented on table 33.

Remarks.—The distinctive features of this species are its elongate shape, plane septa, and wide tunnel angle. It resembles very closely *F. haywardi* Thompson which is somewhat thinner, has a larger form ratio and more intensely fluted septa. Statistical analysis of topotypes of both may show that they are the same. In comparison to *F. euryangulata, F. oakensis* Ross and Sabins has a larger form ratio for corresponding volutions, more intense septal folding, greater volution heights for inner volutions, smaller tunnel angles and is longer; *F. protensa* Thompson has a larger form ratio, lower, narrower, and less symmetrical chomata in outer volutions, larger form ratio, and smaller volution heights in outer volutions; *F. acuminata* Thompson has lower chomata, smaller volution heights in outer volutions, and smaller tunnel angles.

Holotype.—FCM 303-4B.

Occurrence.—Specimens referred to this species were collected from samples FCM 301 and 303-305.

FUSULINELLA spp.

A number of specimens of *Fusulinella* which are inadequate for species identification or description occur through the section.

TABLE 33
Fusulinella euryangulata n. sp.

Spec. No.	No. of vol.	Half-length 1	2	3	4	5	6	Radius Vector 1	2	3	4	5	6
303-4B	6	0.11	0.25	0.54	0.85	1.30	1.95	0.07	0.13	0.20	0.34	0.52	0.80
303-4F	5 1/2	0.10	0.19	0.47	0.72	1.02	1.75	0.08	0.12	0.20	0.33	0.50	0.66
303-3M	5 1/2	0.08	0.17	0.26	0.72	1.12	1.32	0.07	0.11	0.20	0.31	0.49	0.62
303-5F	5 1/2	0.14	0.27	0.47	0.76	1.28	1.46	0.08	0.13	0.20	0.32	0.49	0.64
303-5C	5 1/2	0.11	0.27	0.52	0.98	1.36	----	0.06	0.12	0.20	0.32	0.52	0.67
303-8B	6	0.09	0.16	0.40	0.67	1.03	1.28	0.07	0.10	0.16	0.28	0.44	0.66

Spec. No.	Radius Vector Ratio 1	2	3	4	5	6	Height of Volution 1	2	3	4	5	6	Tunnel Angle 1	2	3	4	5	6
303-4B	1.57	1.92	2.70	2.50	2.50	2.44	.04	.06	.08	.10	.17	.28	--	--	39	38	42	51
303-4F	1.25	1.58	1.35	2.19	2.04	2.65	.03	.04	.08	.15	.15	.23	--	--	--	35	58	54
303-3M	1.14	1.55	1.30	2.33	2.29	2.13	.04	.04	.07	.16	.17	.22	--	19	33	35	42	47
303-5F	1.75	2.08	2.35	2.38	2.61	2.29	.04	.05	.07	.12	.16	.24	--	--	35	38	54	64
303-5C	1.84	2.25	2.60	3.07	2.62	----	.03	.04	.08	.11	.22	.26	--	--	32	40	59	70
303-8B	1.29	1.60	2.50	2.39	2.34	1.94	.04	.03	.05	.11	.17	.22	--	--	--	36	45	42

Spec. No.	Width	Length	Form Ratio	Diam. Pro.
303-4B	1.44	3.84	2.67	.06
303-4F	1.16	3.28	2.83	.09
303-3M	1.11	2.61	2.35	.07
303-5F	1.12	3.00	2.68	.10
303-5C	1.21	2.94	2.43	.06
303-8B	1.21	2.84	2.35	.05

Genus WEDEKINDELLINA Dunbar and Henbest, 1933

WEDEKINDELLINA sp. aff. W. PSEUDOMATURA Ross and Tyrrell, 1965

Pl. 4, figs. 1-4

W. aff. *Wedekindellina pseudomatura* ROSS AND TYRELL, 1965, p. 628, pl. 75, figs. 11-13, table 2.

Description.—Shell small, elongate fusiform with a slightly inflated sagittal area, concave lateral slopes, pointed poles and a slightly curved axis of coiling. Length of test in the four best-preserved and oriented specimens of six to six and one-half volutions ranges from 2.05 mm to 2.48 mm. Width of test in these specimens ranges from 0.73 mm to 0.88 mm and the form ratio ranges from 2.6 to 2.9. Volution height expands slowly and uniformly throughout the test. Mature form ratio attained by third volution. Septa plane except slightly folded at poles. Spirotheca fusulinellid, thin. Light axial deposits present. Chomata small, low, asymmetrical, less than one-half volution height in the center of the chambers. Tunnel angle narrow in inner volutions, ranging from 11° to 20°, becoming wider in the middle and outer volutions, ranging from 25° to 48°. Measurements of principal taxonomic characters presented on table 34.

Remarks.—The specimens described herein are not sufficiently well preserved and oriented for positive identication. However, the data obtained indicates a very close resemblance of these specimens to *W. pseudomatura.* Some differences noted which may prove significant in future studies are the lighter axial deposits and smaller form ratios for corresponding volutions which these southern Nevada forms exhibit.

Occurrence.—Specimens referred to this species were collected from samples FCM 293 and 294.

WEDEKINDELLINA spp.

Abundant specimens of *Wedekindellina* are present in sample FCM 291. Most are small and show considerable evidence of abrasion, suggesting that they are all immature portions of larger specimens. Even the few larger forms show that outermost volutions are missing. This abrasion has rendered these specimens inadequate for identification. Some

TABLE 34

Wedekindellina sp. aff. *W. pseudomatura* Ross and Tyrrell

Spec. No.	No. of vol.	Half-length							Radius Vector						
		1	2	3	4	5	6	7	1	2	3	4	5	6	7
293-2E	6	----	0.12	0.29	0.51	0.68	1.08	----	----	0.08	0.14	0.20	0.28	0.39	----
293-3A	6	0.12	0.24	0.40	0.55	0.85	1.14	----	0.07	0.12	0.16	0.23	0.33	0.45	----
294-2A	6	0.16	0.28	0.54	0.70	1.03	1.36	----	0.08	0.12	0.18	0.26	0.36	0.47	----
294-6B	6 1/2	----	0.09	0.25	0.43	0.68	1.01	1.13	----	0.06	0.11	0.18	0.24	0.38	0.48

Spec. No.	Radius Vector Ratio							Height of Volution							Tunnel Angle						
	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7
293-2E	----	1.50	2.07	2.55	2.43	2.77	----	---	---	.05	.06	.07	.11	---	--	--	14	20	28	35	--
293-3A	1.72	2.00	2.50	2.39	2.58	2.53	----	.04	.04	.06	.06	.09	.12	---	--	--	20	21	31	48	--
294-2A	2.00	2.33	3.00	2.69	2.86	2.89	----	---	.04	.05	.08	.10	.12	---	--	--	23	20	30	38	--
294-6B	----	1.50	2.27	2.39	2.84	2.66	2.35	---	.02	.04	.07	.06	.12	.12	--	--	11	17	23	25	25

Spec. No.	Width	Length	Form Ratio	Diam. Pro.
293-2E	.73	2.05	2.81	---
293-3A	.86	2.48	2.89	.04
294-2A	.88	2.43	2.76	---
294-6B	.86	2.22	2.58	---

of the larger ones resemble the elongate group of *Wedekindellina* represented by *W. euthysepta* (Henbest) and *W. henbesti* (Skinner). Specimens of *Wedekindellina* are also scattered through a number of other samples which are inadequate for description here.

Genus FUSULINA Fischer de Waldheim, 1829

FUSULINA ROCKYMONTANA Roth and Skinner, 1930

Pl. 4, figs. 5-8

Fusulina rockymontana ROTH AND SKINNER, 1930, p. 344, pl. 31, figs. 4-6; THOMPSON, 1936, p. 109, pl. 16, figs. 1, 10, 11; ———, 1945, p. 62, pl. 5, figs. 19-25; THOMPSON, VERVILLE AND BISSELL, 1950, p. 440, pl. 57, figs. 1-8, pl. 59, fig. 6.

Description.—Shell moderately large, elongate fusiform with straight to slightly convex lateral slopes, straight to slightly curved axis of coiling and bluntly pointed to pointed poles. Length of test in the four best-preserved and oriented specimens of five to seven volutions ranges from 3.50 mm to 5.26 mm. Width of test in these specimens ranges from 1.20 mm to 1.96 mm, and the form ratio ranges from 2.65 to 2.92. Volution height increases slowly, uniformly throughout test, except in one specimen of seven volutions where it decreases in the last volution. Mature form ratio is attained by about the third

EXPLANATION OF PLATE 4

FIGS. 1-4.—*Wedekindellina* sp. aff. *W. pseudomatura* Ross and Sabins
Axial sections, X14.3, FCM 293-3A, 294-2A, 293-2E, 294-6B.

FIGS. 5-7.—*Fusulina rockymontana* Roth and Skinner
Axial sections, X7.15, FCM 293-6E, 293-5D, 293-6C, 293-5A.

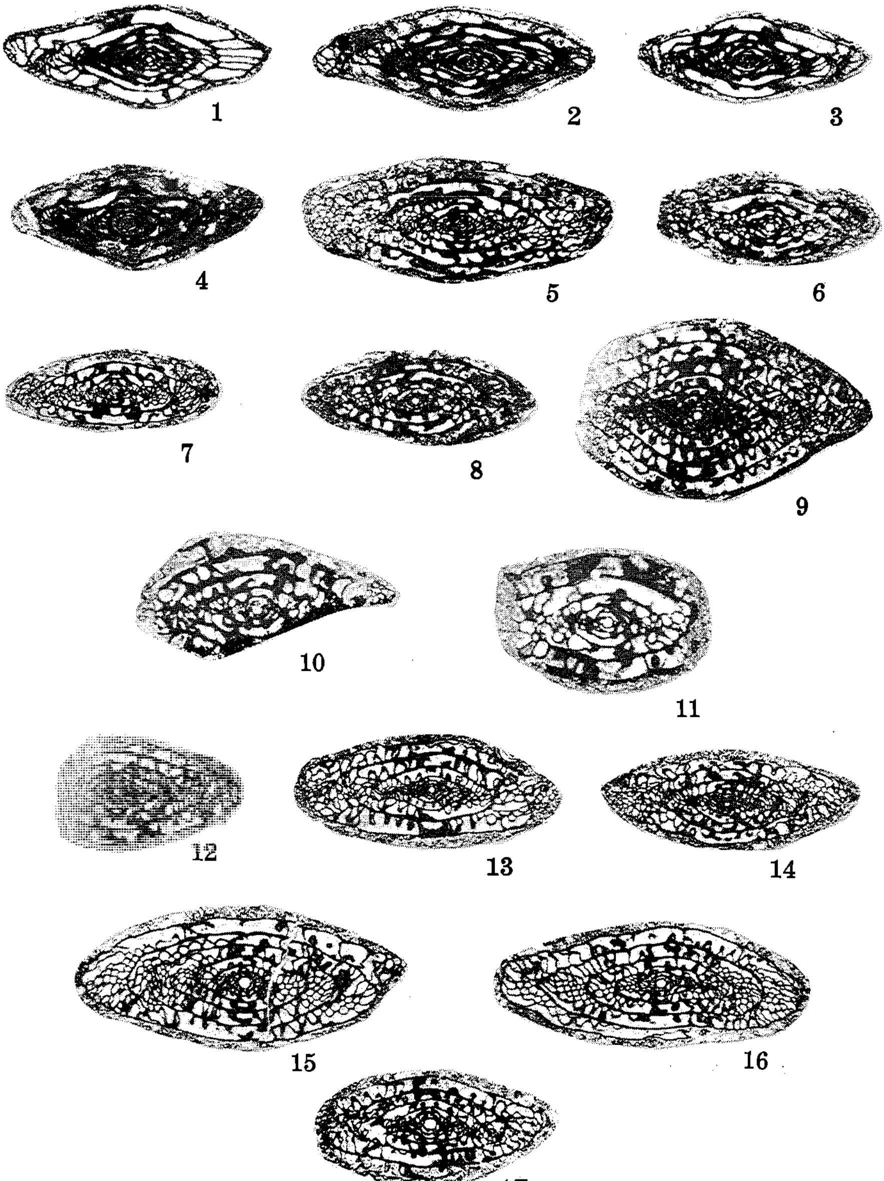
FIG. 9.—*Fusulina novamexicana* Needham
Axial section, X7.15, FCM 314-4D.

FIGS. 10, 11.—*Fusulina* sp. aff. *F. pattoni* Needham
Axial sections, X14.3, FCM 297-7B, 297-1C.

FIGS. 12-14.—*Fusulina* sp. aff. *F. retusa* Thompson and Thomas
Axial sections, X7.15, FCM 304-4D, 304-2C, 304-6C.

FIGS. 15-17.—*Fusulina* sp. aff. *F. weintzi* Verville, Thompson, and Lokke
Axial sections, X7.15, FCM 301-2A, 303-6F, 301-5C.

PLATE 4



volution in some specimens, though in others it increases gradually throughout the test. Septa intensely folded at the poles of each volution and more gently folded across the middle. Spirotheca fusulinellid, moderately thick. Chomata well developed, nearly symmetrical, broad, and about one-half volution height. Tunnel angle narrow to moderate in inner volutions, ranging from 18° to 35°, becoming wide in outer volutions, ranging from 32° to 65°. Measurements of principal taxonomic characters presented on table 35.

TABLE 35

Fusulina rockymontana Roth and Skinner

Spec. No.	No. of vol.	Half-length							Radius Vector						
		1	2	3	4	5	6	7	1	2	3	4	5	6	7
293-6E	7	0.11	0.34	0.50	0.78	1.40	2.05	2.67	0.10	0.10	0.28	0.40	0.60	0.84	1.00
293-6C	6	0.10	0.22	0.52	0.99	1.52	1.85	----	0.09	0.13	0.22	0.35	0.51	0.71	----
293-5A	5 1/2	0.16	0.32	0.56	1.10	1.52	1.85	----	0.08	0.15	0.25	0.44	0.61	0.76	----
293-5D	5	0.21	0.44	0.79	1.38	1.80	----	----	0.14	0.20	0.32	0.44	0.60	----	----

Spec. No.	Radius Vector Ratio							Height of Volution							Tunnel Angle						
	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7
293-6E	1.10	1.79	1.79	1.95	2.34	2.44	2.67	.07	.08	.09	.13	.20	.24	.16	--	18	23	32	36	57	44
293-6C	1.11	1.69	2.36	2.83	2.98	2.61	----	.04	.04	.08	.12	.16	.18	---	--	26	32	41	43	47	--
293-5A	2.00	1.53	2.24	2.50	2.49	2.43	----	.03	.06	.12	.18	.18	.19	---	--	24	35	35	34	65	--
293-5D	1.50	2.20	2.47	3.14	3.00	----	----	.06	.05	.12	.12	.16	---	---	30	24	23	37	44	--	--

Spec. No.	Width	Length	Form Ratio	Diam. Pro.
293-6E	1.96	5.26	2.69	.07
293-6C	1.31	3.64	2.78	.12
293-5A	1.38	3.66	2.65	.10
293-5D	1.20	3.50	2.92	.15

Remarks.—*F. socorroensis* Needham may be identical to F. rockylmontana Roth and Skinner. The former is supposed to have a wider tunnel, greater length, and greater form ratio. Measurement data obtained from photographs of the types of both species show very little differences in these features. Statistical analysis of a sufficient number of topotype specimens will be necessary to clear up these relationships. *F. apachensis* Ross and Sabins has fewer volutions, hence is smaller than *F. rockymontana.* It is also smaller for corresponding volutions than *F. rockymontana* and has a smaller tunnel angle. Compared to *F. rockymontana, F. portalensis* Ross and Sabins has a smaller form ratio, smaller radius vectors per volution, and a narrower tunnel angle; *F. stookeyi* Thompson is thicker, has a smaller form ratio, and more highly fluted septa; *F. plattensis* Thompson is thinner for corresponding volutions and has a narrower tunnel angle; and *F. leei* Skinner is smaller for corresponding volutions, has higher form ratios for corresponding volutions, and narrower tunnel angles.

Occurrence.—Forms referred to this species were collected from FCM 293.

FUSULINA NOVAMEXICANA Needham, 1937

Pl. 4, fig. 9

Fusulina novamexicana NEEDHAM, 1937, p. 23, pl. 2, figs. 11-15; DUNBAR AND HENBEST, 1942, p. 113, pl. 10, figs. 7-17; ROSS AND SABINS, 1965, p. 191-192, pl. 28, figs. 16-19.

?*Fusulina novamexicana* Needham, ALEXANDER, 1954, p. 38, pl. 3, figs. 1-3.

Description.—Shell large, inflated fusiform, with straight lateral slopes, slightly extended, bluntly pointed poles, and a straight axis of coiling. Length of test in the one best-preserved and oriented specimen of seven and one-half volutions is 6.08 mm. Width of test in this specimen is 3.08 mm and the form ratio is 1.97. Volution height increases moderately and uniformly for the first five volutions and remains more or less constant in the outer volutions. Form ratio increases very slowly throughout the test. Septa intensely fluted from pole to pole. Chomata well developed in the inner four volutions, highly tabular, about two-thirds volution height; thereafter chomata replaced by secondary deposits coating the septa around the tunnel (pseudochomata of Stewart, 1958, p. 1051). Tunnel angle narrow throughout, ranging from 12° in the inner volutions to 22° in the outer volutions. Measurements of principal taxonomic characters presented on table 36.

Remarks.—The one good specimen and three other poorly oriented specimens agree closely in their measurements with the holotype from New Mexico as described by Needham (1937, p. 23) and Dunbar and Henbest (1942, p. 113). Compared to *F. novamexicana, F. distenta* Roth and Skinner is somewhat smaller, has a smaller form ratio, and better developed chomata; *F. illinoisensis* Dunbar and Henbest is smaller, has smaller radius vectors, half lengths, and a larger form ratio, which is true also for *F. gordonensis* Stewart.

Occurrence.—Forms referred to this species were collected from sample FCM 314.

TABLE 36

Fusulina novamexicana Needham

Spec. No.	No. of vol.	Half-length								Radius Vector							
		1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
314-4D	7 1/2	0.27	0.40	0.60	0.95	1.50	1.96	2.50	3.04	0.16	0.28	0.40	0.64	0.90	1.16	1.44	1.62

Spec. No.	Radius Vector Ratio								Height of Volution							
	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
314-4D	1.69	1.43	1.50	1.49	1.67	1.69	1.74	1.88	.08	.12	.14	.20	.28	.25	.28	.30

Spec. No.	Tunnel Angle								Width	Length	Form Ratio	Diam. Pro
	1	2	3	4	5	6	7	8				
314-4D	--	12	14	15	16	17	22	22	3.08	4.08	1.97	.16

FUSULINA sp. aff. F. PATTONI Needham, 1937

Pl. 4, figs. 10, 11

F. aff. *Fusulina pattoni* NEEDHAM, 1937, p. 26, pl. 3, figs. 3-5.

Description.—Shell small, fusiform, with convex lateral slopes, pointed poles and a straight axis of coiling. Axial length in the best-preserved and oriented specimen of five volutions is 2.34 mm. Width of test in this and one other specimen 1.08 mm and 1.12 mm, respectively; the form ratio of the former being 2.17. Volution height increases slowly and uniformly except that in one specimen the volution height decreases slightly in the final volution. Mature form ratio attained by the third volution. Septa intensely folded at the poles and more broadly folded across the center of the shell. Chomata low, asymmetrical in inner volutions, more nearly symmetrical in outer volutions, and less than one-half volution in height. Tunnel angle moderate, ranging from 26° to 36°. Measurements of principal taxonomic characters presented on table 37.

TABLE 37

Fusulina sp. aff. *F. pattoni* Needham

Spec. No.	No. of vol.	Half-length					Radius Vector					Radius Vector Ratio				
		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
297-7B	5	0.11	0.20	0.52	0.79	1.23	0.08	0.16	0.26	0.42	0.56	1.38	1.25	2.00	1.88	2.20
297-1C	5	0.10	0.24	0.46	0.76	----	0.09	0.15	0.24	0.41	0.60	1.11	1.60	1.84	1.85	----

Spec. No.	Height of Volution					Tunnel Angle					Width	Length	Form Ratio	Diam. Pro.
	1	2	3	4	5	1	2	3	4	5				
297-7B	.04	.08	.09	.16	.13	--	--	28	34	36	1.08	2.34	2.17	.08
297-1C	.04	.05	.10	.12	.18	--	27	20	32	33	1.12	----	----	.09

Remarks.—Positive identification of this form is difficult because of an insufficient number of well-preserved and oriented specimens. It is possible that the forms described above may

Table 40 (Con't.)

	263	264	265	266	267	268	269	270	271	272	273	275	277	278	280	281	282	285	291	291 A	293	294	295	296	297	298	300	301	302	303
Millerella marblensis	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M. marblensis robusta	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M. sp. aff. *M. marblensis*	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M. pressa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M. springensis	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M. extensa	x	x	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M. sp. A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M. sp. B	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M. sp. C	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M. sp. D	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	x
M. spp.	x	x	--	--	--	x	--	x	--	x	--	--	x	x	--	--	--	--	--	--	x	x	--	x	--	--	x	--	x	--
Paramillerella sp. A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
P. spp.	x	x	--	--	--	--	--	--	--	x	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Staffella spp.	x	x	--	x	--	x	x	--	--	--	x	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	x	--
Schubertina circuli	--	--	--	--	--	x	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S. circuli compacta	--	x	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	x	--
S. circuli minuta	--	--	--	--	--	--	--	x	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	x	--	--	--	--	x	x
S. extensa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	x	--	--	--	--	x	--
Pseudoschubertella fusiforma	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	x	--
P. sp. A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	x	--	--	--	--	--	--	--	--	--
Eoschubertella bluensis	--	x	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
E. bluensis subsp. A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
E. bluensis subsp. B	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	x
E. sp. aff. *E. texana*	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
E. sp. aff. *E. mexicana*	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
E. sp. A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Table 40 (Con't.)

	263	264	265	266	267	268	269	270	271	272	273	275	277	278	280	281	282	285	291	291 A	293	294	295	296	297	298	300	301	302	303
E. sp. B	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
E. spp.	..	x	x	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Pseudostaffella needhami	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
P. sp. A	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
P. sp. A var. A	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
P. spp.	..	..	..	..	..	..	..	x	..	x	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
P. (?) sp. A	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Profusulinella sp. aff. *P. walnutensis*	..	..	..	x	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
P. springensis	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
P. spp.	..	x	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Fusulinella lounsberyi	..	..	..	..	x	x	x	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
F. submatura	..	..	..	..	..	..	..	..	..	..	..	..	..	..	x	x	..	..	..	..	..	..	..	..	..	..	..	..	..	..
F. euryangulata	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	x	..	x
F. spp.	..	..	..	..	..	..	..	..	x	x	..	x	..	x	..	x	x	x	x	x	..	..	..	x	..	..	..	..	..	..
Wedekindellina sp. aff. *W. pseudomatura*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	x	x	..	..	..	..	..	..	..	..
W. spp.	..	..	..	..	..	..	..	..	..	..	..	x	..	..	..	..	..	..	x	x	..	..	x	x	x	x	x	x	..	..
Fusulina rockymontna	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	x	..	..	..	..	..	..	..	..	..
F. novamexicana	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
F. sp. aff. *F. pattoni*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	x	..	..	..	..	..
F. sp. aff. *F. retusa*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
F. sp. aff. *F. weintzi*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	x	..	x
F. spp.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	x	..	x	..	..	x	..	..	..	..	..	..
Triticites	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

Table 40 (Con't.)

	304	305	306	307	313	314	315	316	321	322	324	325	326	327	328	329
Millerella marblensis	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
M. marblensis robusta	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
M. sp. aff. *M. marblensis*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
M. pressa	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
M. springensis	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
M. extensa	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
M. sp. A	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
M. sp. B	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
M. sp. C	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
M. sp. D	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
M. spp.	x	x	..	..	..	x	..	x	..	..	..	..	..	x	..	..
Paramillerella sp. A	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
P. spp.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Staffella spp.	..	..	..	..	..	..	x	..	..	..	..	..	..	..	..	x
Schubertina circuli	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
S. circuli compacta	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
S. circuli minuta	..	x	..	..	x	..	..	..	..	..	..	..	..	..	..	..
S. extensa	..	x	..	..	x	x	x	x	..	..	..	..	..	..	..	..
Pseudoschubertella fusiforma	..	x	..	..	..	..	x	..	..	..	..	..	..	..	..	..
P. sp. A	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Eoschubertella bluensis	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
E. bluensis subsp. A	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
E. bluensis subsp. B	..	x	..	x	..	..	..	..	..	..	..	..	..	..	..	..
E. sp. aff. *E. texana*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
E. sp. aff. *E. mexicana*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
E. sp. A	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
E. sp. B	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
E. spp.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Pseudostaffella needhami	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
P. sp. A	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
P. sp. A var. A	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
P. spp.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
P. (?) sp. A	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Profusulinella sp. aff. *P. walnutensis*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
P. springensis	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
P. spp.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Fusulinella lounsberyi	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
F. submatura	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
F. euryangulata	x	x	..	..	..	..	..	..	..	..	..	..	..	..	..	..
F. spp.	x	x	x	..	..	x	x	x	..	..	..	..	..	..	..	..
Wedekindellina sp. aff. *W. pseudomatura*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

Table 40 (Con't.)

	304	305	306	307	313	314	315	316	321	322	324	325	326	327	328	329
W. spp.	--	--	--	--	--	x	--	--	--	--	--	--	--	--	--	--
Fusulina rockymontna	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
F. novamexicana	--	--	--	--	--	x	--	--	--	--	--	--	--	--	--	--
F. sp. aff. *F. pattoni*	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
F. sp. aff. *F. retusa*	x	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
F. sp. aff. *F. weintzi*	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
F. spp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Triticites	--	--	--	--	--	--	--	--	x	x	x	x	x	x	x	x

TABLE 41

Summary of the Fusulinid Content of Suggested Infromal Zones

Zone of *Millerella*

- Zone A
  - Abundant occurrence:
    - *Millerella pressa*
- Zone B
  - Restricted occurrence:
    - *Millerella* sp. A
    - *M.* sp. B
- Zone C
  - Restricted occurrence:
    - *Millerella springensis*
    - *Eoschubertella* sp. aff. *E. texana*
    - *E.* sp. B
    - *Pseudostaffella needhami*
    - *P.* sp. A var. A
- Zone D
  - Restricted occurrence:
    - *Millerella* sp. C
  - Highest occurrence:
    - *Pseudostaffella* sp. A

Zone of *Profusulinella*

- Zone E
  - Restricted occurrence:
    - *Paramillerella* sp. A
    - *Eoschubertella bluensis*
    - *E. bluensis* subsp. A
    - *E.* sp. aff. *E. mexicana*
    - *Pseudostaffello* (?) sp. A
    - *Profusulinella* sp. aff. *P. walnutensis*
    - *P. springensis*
  - Lowest occurrence:
    - *Chaetetes* sp.
  - Highest occurrence:
    - *Millerella marblensis*
    - *M. marblensis robusta*
    - *M. extensa*
    - *Eoschubertella* sp. A
- Zone E1
  - Restricted occurrence:
    - *Paramillerella* sp. A.
    - *Eoschubertella bluensis* subsp A
    - *E.* sp. aff. *E. mexicana*
  - Lowest occurrence:
    - *Profusulinella* sp. aff. *P. walnutensis*
    - *P. springensis*
    - *Chaetetes* sp.
  - Highest occurrence:
    - *Millerella marblensis*
    - *M. marblensis robusta*
- Zone E2
  - Restricted occurrence:
    - *Eoschubertella bluensis*
    - *Pseudostaffella* (?) sp. A
  - Highest occurrence:
    - *Millerella extensa*
    - *Eoschubertella* sp. A
    - *Profusulinella* sp. aff. *P. walnutensis*
    - *P. springensis*
- Zone E1a
  - Assemblage:
    - *M. marblensis*
    - *M. marblensis robusta*
    - *Eoschubertella bluensis* subsp. A
    - *E.* sp. aff. *E. mexicana*
    - *E.* sp. A
    - *Profusulinella springensis*

Table 41 (Con't.)

Zone of *Fusulinella*
- Zone F
  - Restricted occurrence:
    - *Fusulinella lounsberyi*
    - *Schubertina circuli*

Zone of *Fusulina*
- Zone G
  - Restricted occurrence:
    - *Fusulinella submatura*
- Zone H
  - Restricted occurrence:
    - *Pseudoschubertella* sp. A
    - *Wedekindellina* sp. aff. *W. pseudomatura*
    - *Fusulina rockymontana*
- Zone I
  - Restricted occurrence:
    - *Millerella* sp. D
    - *Pseudoschubertella fusiforma*
    - *Eoschubertella bluensis* subsp. B
    - *Fusulinella euryangulata*
    - *Fusulina* sp. aff. *F. weintzi*
    - *F.* sp. aff. *F. retusa*
  - Highest occurrence:
    - *Schubertina circuli compacta*
    - *Chaetetes* sp.
- Zone I1
  - Restricted occurrence:
    - *Millerella* sp. D
    - *Fusulina* sp. aff. *F. weintzi*
  - Lowest occurrence:
    - *Pseudoschubertella fusiforma*
    - *Eoschubertella bluensis* subsp. B
    - *Fusulinella euryangulata*
- Zone I2
  - Restricted occurrence:
    - *Fusulina* sp. aff. *F. retusa*
  - Highest occurrence:
    - *Pseudoschubertella fusiforma*
    - *Eoschubertella bluensis* subsp. B
    - *Fusulinella euryangulata*
    - *Chaetetes* sp.
- Zone J
  - Restricted occurrence:
    - *Fusulina novamexicana*

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