BRIGHAM

YOUNG

UNIVERSITY

GEOLOGY STUDIES

Volume 8 November 1961

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Brigham Young University, Geology Studies

Volume 8 November 1961

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A publication of the
Department of Geology
Brigham Young University
Provo, Utah

Editors
David L. Clark and J. Keith Rigby

Brigham Young University Geology Studies is the successor to BYU Research Studies, Geology Series, which has been published in separate numbers since 1954. Geology Studies consists of graduate student and staff research in the Department.

Price $3.50

Stratigraphy and Leonardian Fusulinid Paleontology in Central Pequop Mountains, Elko County, Nevada*

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ABSTRACT.—Six sedimentary formations of Late Mississippian to Late Permian age and comprising an aggregate thickness of 7,200 feet in central Pequop Mountains, Elko County, Nevada were measured, described, and mapped. Contained in this thickness is a sequence of Desmoinesian age rock which is given the new name "Hogan Formation." In addition, two members of the Late Mississippian Diamond Peak Formation and five members of the Early Pennsylvanian Ely Limestone were differentiated.

Fusulinids of the Pequop Formation were studied, and the fauna, containing one species of *Pseudoschwagerina,* 14 species of *Schwagerina,* and 21 species of *Parafusulina* are systematically described. On the basis of fusulinid study, it is possible to recognize Early, Medial, and Late components of the Pequop Formation.

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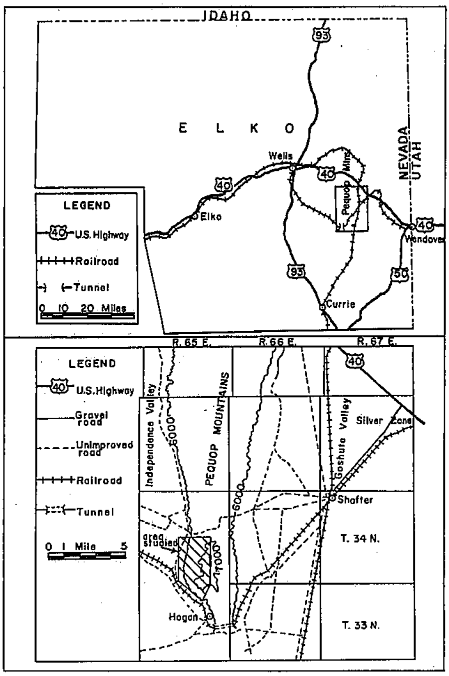
*A thesis submitted to the Faculty of the Department of Geology, Brigham Young University in partial fulfillment of the requirements for the degree Master of Science.

INTRODUCTION

Location and Accessibility

Pequop Mountains are located in the east-central part of Elko County, Nevada, approximately 30 miles west of Wendover, Nevada-Utah. The area under investigation lies in the central segment of the range and includes part or all of sections 2, 3, and 4 of T. 33 N., and the southeastern sections of T. 34 N., R. 65 E., Elko County, Nevada.

Accessibility is provided via the railroad siding of Shafter from U. S. Highway 40 at a point a few miles west of Silver Zone Pass. From Shafter a road leads west across the playa valley and through the mountain pass that divides the northern and central Pequop Mountains and approximately delimits the northern boundary of the area under discussion (Text-fig. 1). Fair to good



TEXT-FIGURE 1.—Index and locality map of area studied.

roads parallel the base on either side of the range, and numerous jeep trails and washes provide additional accessibility.

Physical Features

Pequop Mountains are in the eastern part of the Great Basin. They typify Basin and Range mountains as an eastward tilted, north-south trending, fault-block range approximately 40 miles long. The range can be divided into three topographic segments; those on the north and south are higher and broader than the central segment. Elevations in the central Pequop Mountains range from 7,752 feet above sea level at the highest peak to 5,600 feet in Goshute Valley to the east and in Independence Valley to the west.

Terrain is mountainous, with an abrupt, imposing western face and a slightly more gentle eastern dip slope. The abruptness of the western side and lack of weathering in the semi-arid type climate (Kincer, 1941, p. 979) provide nearly total rock exposure.

Purpose and Scope

General objectives of the research are: 1) to describe the stratigraphy of the Upper Mississippian to Middle Permian rocks, and to establish a stratigraphic nomenclature applicable in northeastern Nevada; 2) to map in detail a specifically selected area of approximately 10 square miles which contains the described section; 3) to study and describe the fusulinid fauna of Leonardian age in the Pequop Formation.

Previous Work

Until recently little has been published concerning geology of the northeastern Great Basin area. Recently, however, studies have been made, and are currently progressing, by various petroleum companies and university groups, but much of this work is unpublished.

Several papers concerning the geology of the eastern Great Basin appeared prior to 1900. Geologists of the Fortieth Parallel Survey described the general geology of the region with brief descriptions of stratigraphic sections. In addition, a generalized geologic map of the northeastern Great Basin including the Pequop Mountains was published (Hague & Emmons, 1877; Meek, 1877; King, 1878).

Recent work concerning the Pequop Mountains includes an unpublished Master's thesis by Snelson (1955 *ms.*) in the southern part of the range. Steele (1959 *ms.*; 1959; 1960) contributed much toward understanding the stratigraphy of the Pequop Mountains and adjacent areas.

At the present time Thoreson (personal communication, 1960) is mapping the area immediately north of the central Pequop Mountains as a thesis project at the University of Washington, and K. A. Hodgkinson (1961) is studying stratigraphy and sedimentation of the Permian in the area for a graduate thesis at Brigham Young University. Y. Mollazal (1961), another Brigham Young University graduate student, has included the central Pequop Mountains as one of three localities for a study of carbonates of the Ely Limestone.

Present Study

During the summer of 1960 the writer served as field assistant to Dr. H. J. Bissell, aiding in the measurement of Pennsylvanian and Permian stratigraphic sections in southeastern Idaho and central-eastern and northeastern Nevada. This provided an excellent regional background for the problem.

Field Investigations

Field work commenced in September 1960, and all measurements of stratigraphic sections, collecting of samples and fossils, and detailed mapping were completed by December 1960. Stratigraphic sections were measured by means of steel tape and Brunton Compass, and all parts of the section were examined and sampled where fusulinids occur. Stratigraphic units were marked at each base with painted numbers for future reference. Systematized field notes, modified after those suggested by Wengerd (1956, p. 42-48), were made.

Vertical aerial photographs of scale 1:20,000 were used to record the geologic field information. Formation contacts were plotted using a portable stereoscope while in the field. Inasmuch as no topographic map of the area of suitable scale is now available the geologic map was drafted by tracing data from the photos.

Color description of rock surfaces conforms to that of the National Research Council rock color chart.

Wentworth's scale was used for grain size analysis (1922).

A combination of Kelley (1956) and McKee & Weir (1953) terminology for bed thicknesses and weathering structure was used as follows:

Weathering Structure	*Thickness*	*Name*
Massive	Greater than six feet	Massive
Blocky	Three to six feet	Thick
Slabby	One to three feet	Medium
Flaggy	One inch to one foot	Thin
Platy	Two mm to one inch	Laminae
Papery	Less than two mm	Thin Laminae

Laboratory Investigations

Laboratory investigations consisted of preparation of 450 oriented fusulinid thin-sections, photographing these on enlarging paper at 10 power magnification, and systematic measuring of specimens from the photographs using vernier calipers. Final identification was made, making full use of systematic measurements and thin-sections. Representative specimens were then photographed on film for illustration.

ACKNOWLEDGMENTS

The writer expresses appreciation to a number of people who helped make this study possible. Dr. H. J. Bissell, who suggested the problem, served as major professor, and gave much-needed assistance in organizing and completing field and laboratory work. Drs. J. K. Rigby and D. L. Clark served as committee members and read and criticized the manuscript. Mr. K. A. Hodgkinson assisted in stratigraphic section measurement, fossil collection, and photographic work. Mr. G. B. Robinson, the writer's father, contributed funds for field expenses. Special appreciation is extended to the writer's wife, Virginia, whose patience and encouragement have been a constant source of inspiration.

STRATIGRAPHY

General Statement

This study is concerned with six sedimentary formations of Late Mississippian to early Late Permian ages; the total section aggregates approximately 7,200 feet. In order of ascending age these formations are: Late Mississippian to Early Pennsylvanian? Diamond Peak Formation, Early to Medial Pennsylvanian Ely Limestone, Medial Pennsylvanian Hogan Formation, Early Permian Ferguson Mountain Formation, Early to Medial Permian Pequop Formation, and Medial to Late Permian Loray Formation. In addition, two members (not of formal rank) of Diamond Peak Formation and five similar members of Ely Limestone were differentiated and mapped. Stratigraphic sections are shown as Text-figure 2.

Mississippian-Pennsylvanian Systems

Chainman Shale

Chainman Shale is not exposed in the map area, but crops out a few miles to the north. However, the lowest exposures of the Diamond Peak Formation shown on the geologic map approximate the contact with the Chainman Shale (Text-figure 3). Chainman Shale exposed to the north consists of interbedded chocolate-brown to black siliceous shale and siltstone, orthoquartzite, and siliceous small pebble-conglomerate; shale predominates. Bedding in the formation varies from thin and platy to thick. The formation is 1,200 to 1,500 feet thick five miles to the north (Bissell, 1960, personal communication). Contact with the overlying Diamond Peak Formation appears gradational, the predominance of shale distinguishing Chainman lithology.

Diamond Peak Formation

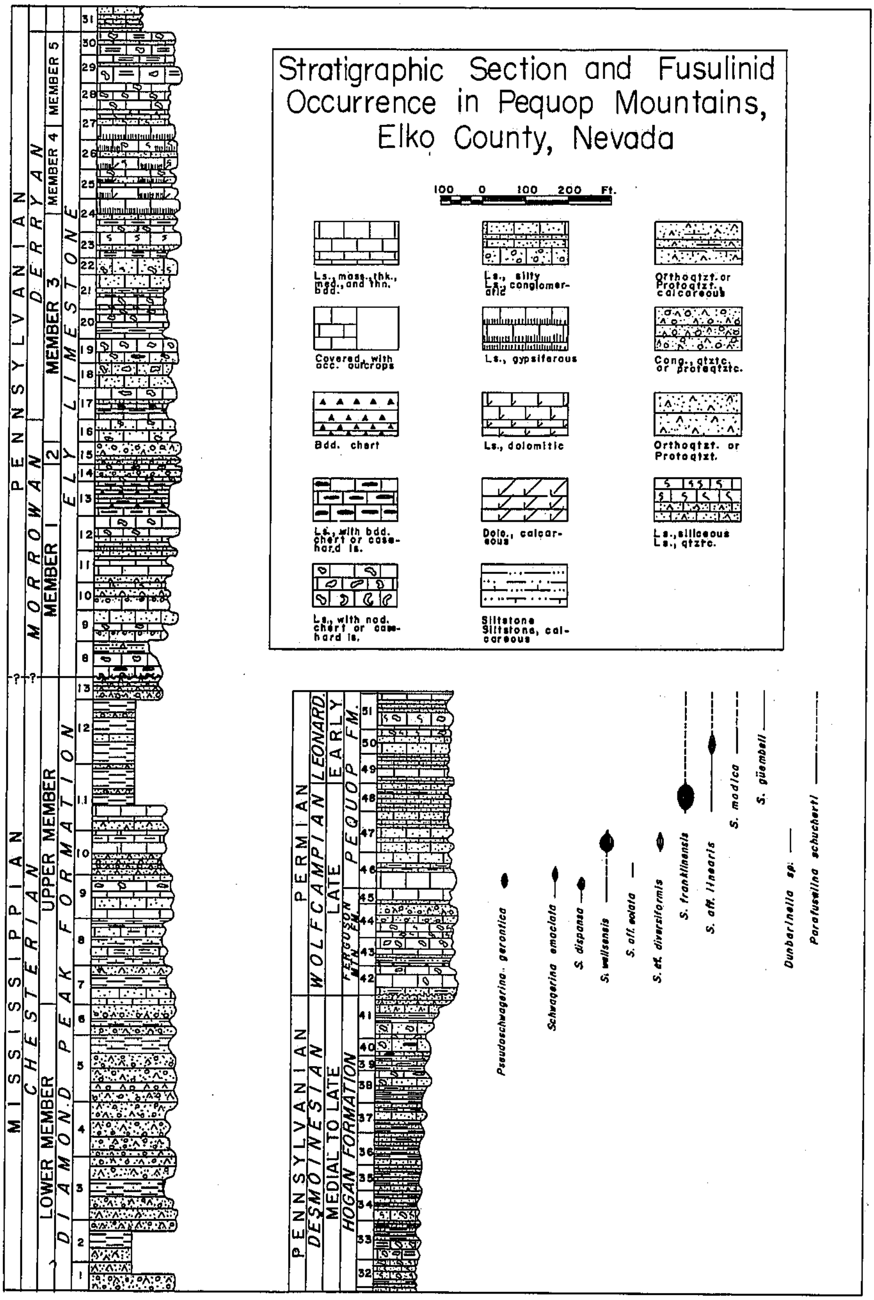
Hague (1883, pp. 268-270) described the Diamond Peak Formation as predominantly quartzite, but Nolan *et al.* (1956, p. 60) recommended that its name be changed to "Formation" because the sequence also contains considerable chert conglomerate, limestone, and shale. Nolan's recommendation has been followed in this study.

Steele (1960, p. 96) states that the formation varies in thickness from approximately 3,000 feet on Diamond Peak in the Diamond Range to less than 20 feet at Ferguson Mountain in the Goshute Range.

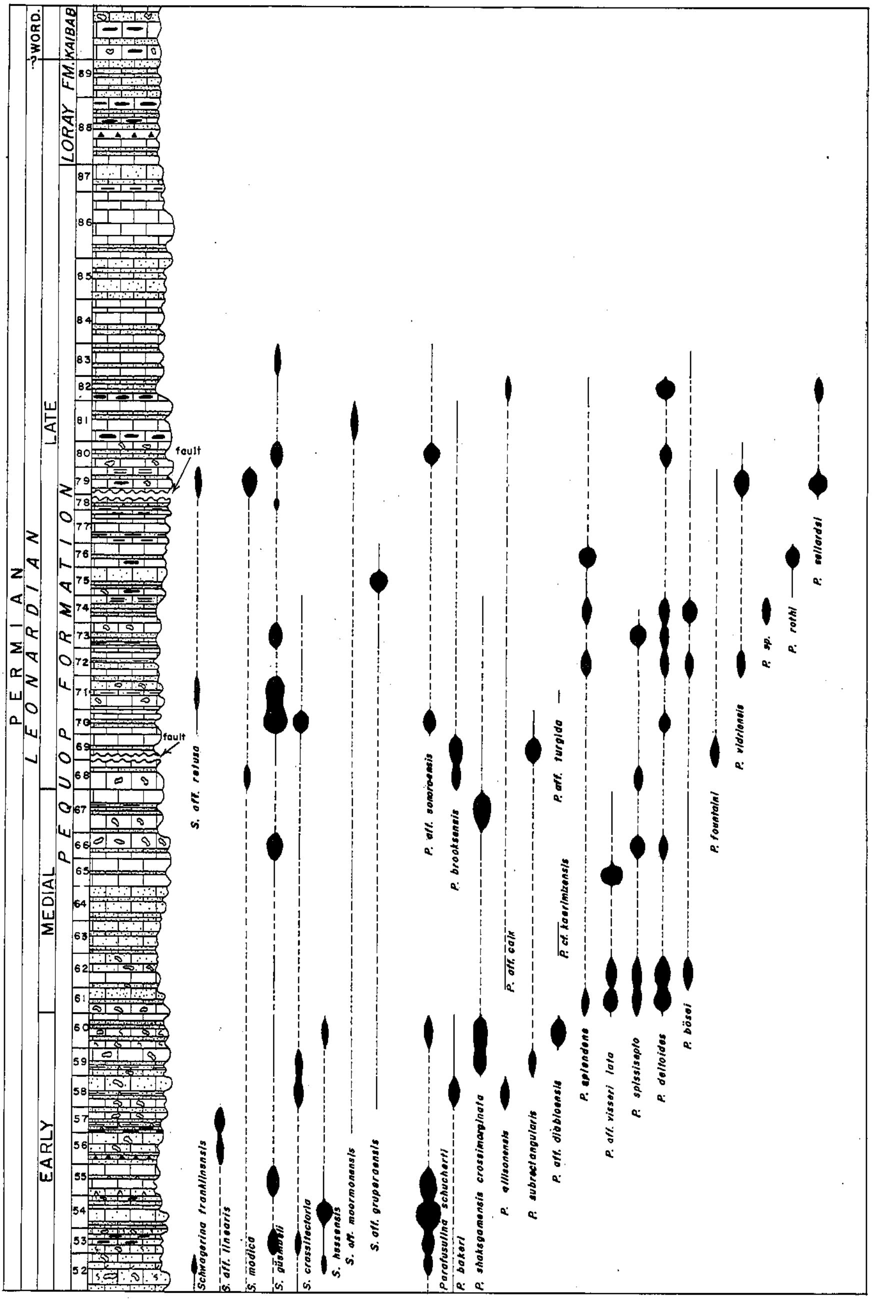
Lithology.—The Diamond Peak Formation is central Pequop Mountains is divisible into two members, the lower one consisting of interbedded protoquartzite, protoquartzitic medium to small pebble-conglomerate, and occasional siliceous shale to argillite. Most beds are strongly silica-cemented. Fine to medium-textured grains of quartz predominate in the protoquartzite; pebble-sized clasts of angular to subangular light gray, green-gray, and green-black chert fragments and rare to moderate quartzite fragments form the framework of the conglomerate. Shale near the top of the lower member is in part micaceous, and the protoquartzite beds commonly are cross-bedded. Bedding varies from laminated and thin-bedded in the shale to medium and thick-bedded in the conglomerate. Plant fragments were the only fossils noted in the measured section, although species of spiriferid brachiopods and bryozoans were noted in other parts of the map area.

The upper member consists of various types of limestone in the lower three-fourths, and interbedded siliceous shale, protoquartzite, and fine pebble-conglomerate above. This member is easily differentiated on aerial photos from the lower one by its lighter color and finer texture. Although limestone of matrix to matrix-with-detrital sand, silt, and clay, to argillaceous limestone and matrix-with-skeletal varieties predominates in the lower three-fourth of the upper member, siliceous and quartzitic shale-argillite, calcareous shale, and orthoquartzite to protoquartzite form interbeds. Colors of light to medium blue-gray and yellow-brown to gray-brown predominate in the section. Bedding varies from thin to thick, with medium bedding in predominance. Fossils, with exception of occasional crinoid stems, brachiopods, and gastropods, are also rare.

The top one-fourth of the upper member is composed primarily of siliceous-argillitic shale, with interbeds of platy siliceous limestone, fine-grained orthoquartzite and protoquartzite, and chert and jasper pebble-conglomerate. Bedding is mostly thin and platy. Rocks considered time equivalent, and perhaps



TEXT-FIGURE 2.—Stratigraphic section and fusulinid occurrence in Pequop Mountains, Elko County, Nevada.



TEXT-FIGURE 2.—Continued

more representative of the upper one-fourth of the upper member were measured and studied about a mile farther south from the section herein described (Text-figure 3). They consist of interbedded siliceous and quartzitic limestone, cross-bedded calcareous orthoquartzite, and small pebble-conglomerate. It is this sequence to which some geologists refer to as "Illipah" Formation.

Thickness, age, and correlation.—Total thickness of Diamond Peak Formation in central Pequop Mountains is 1,431 feet. Of this thickness, 656 feet is assigned to the lower member and 775 feet to the upper member. The measured section is located approximately in Section 22, T. 34 N., R. 65 E., (Text-fig. 3).

Although there is no fossil evidence on which to justify the conclusion, possibly the Late Mississippian-Early Pennsylvanian time boundary occurs within the Diamond Peak Formation, hence, most, if not all the formation, can be assigned Chesterian age. This is done on the basis of stratigraphic position below the Early Pennsylvanian Ely Limestone, and on regional correlation of the formation with the type area to the south. Excellent discussions of age of the Diamond Peak Formation and of contiguous strata below and above are given by Sadlick (1960) and Steele (1960, p. 99).

As previously mentioned, some geologists may attempt to apply the name "Illipah Formation" to the upper part of the sequence in central Pequop Mountains, and if so, it would probably be to approximately the upper 320 feet. The writer declines to do this, however, on the basis of the distance involved between the area of outcrop of so-called Illipah Formation near Moorman Ranch in White Pine County, Nevada, and to the lateral variability of the sequence in central Pequop Mountains which results in lack of identifying features.

Pennsylvanian System

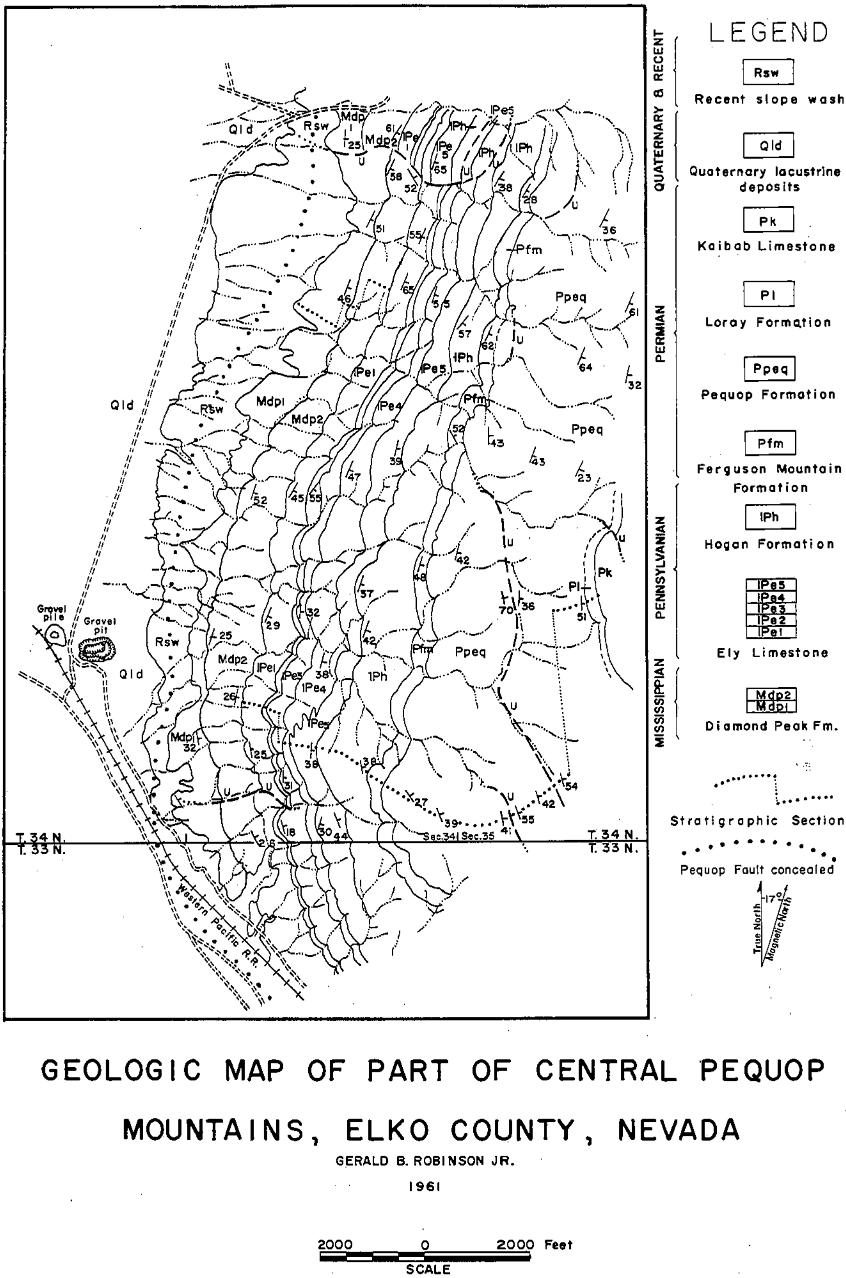
Ely Limestone

Lawson (1906, p. 295) named the Ely Limestone from outcrops in the Ruth Mining District near the town of Ely, White Pine County, Neveda. Spencer (1917, p. 26-27) and Pennebaker (1932) later redefined the formation, and Steele (1960, p. 100) still further restricted it as "stratigraphically above the Chainman Shale or Scotty Wash Quartzite, whichever is present, and below the regional Pennsylvanian unconformity." Inasmuch as a complete section of Ely Limestone is not continuously exposed in any one locality in Ruth Mining District, Steele (1960, p. 100) proposed a reference locality for the Ely Limestone approximately 30 miles west of the type section.

In this report the Ely Limestone of the Pequop Mountains region is described as lying stratigraphically above the Diamond Peak Formation and below a Medial Pennsylvanian silty limestone sequence referred to a separate formation.

Lithology.—Ely Limestone in central Pequop Mountains is divisible into five distinct members (not formal designation):

Member 1 consists of interbedded bioclastic, argillaceous, silty-sandy, and siliceous-cherty limestone, with subordinate units of calcareous, quartzitic siltstone to orthoquartzite, and chert small pebble-conglomerate to conglomeratic limestone. Member 1 displays alternating ledges and slopes in general not as resistant as the overlying members. Fossils consist only of few crinoid stem fragments, brachiopods, and bryozoans. Chert is rare in the lower beds, but is present in one inch to three inch nodules to bedded bands in the upper beds. The lower boundary of member 1 is difficult to differentiate because of gradational relations with the underlying Diamond Peak Formation. It was chosen,



TEXT-FIGURE 3.—Geologic map of part of central Pequop Mountains, Elko County, Nevada.

however, at the point in the section where limestone lithology predominates above.

Member 2 comprises a 50 foot thick conglomerate sequence with subordinate interbeds of sandy and pebbly limestone. These resistant beds appear distinctly on aerial photos as a darkened band. The sequence is persistant in thickness through the map area, and its boundaries are easily differentiated. Individual clasts in the conglomerate are of subround to angular granules and small pebbles of varicolored chert and quartzite.

Member 3 resembles member 1 in appearance, although it lacks the extreme clastic type of lithology present in the lower member. It consists mainly of micritic limestone, argillaceous limestone, silty and fine sandy limestone, and bioclastic limestone. Subordinate interbeds of shaly siltstone to orthoquartzite are also present. Bedding varies from thin and platy to massive; the bedding determines the physical weathering of alternating slopes and cliffs respectively. Fossils consist of crinoid debris, brachiopods, bryozoans, and a few corals. Chert, in the form of one inch to three inch nodules, lenses, and bands, is more prevalent in member 3 than in lower members. Its concentration ranges between five percent to ten percent. Member 3 boundaries are differentiated on the basis of the upper conglomerate bed of member 2 and the lower gypsiferous bed of member 4. It is persistant through the map area, but slightly thins and thickens locally due to the variability of the overlying gypsiferous member.

Member 4 has unique lithology in the usual normal marine type limestone of the Ely Limestone. It is composed of interbedded micritic limestone, dolomitic limestone to calcareous dolomite, gypsiferous limestone, hard siliceous limestone with fossil, silt, and fine-sand detritus. Locally, beds of hard, siliceous alabaster-like rock appear. Bedding varies from thin to massive, chert is rare to absent, and fossils consist of scattered crinoid stem fragments. The absence of fossils points to the high salinity which was present in the water at time of deposition. Lighter color of the member allows easy identification on aerial photos. The member is persistant through the map area, but is variable in thickness. Lower and upper boundaries were mapped respectively at points of first and last occurrence of abundant gypsiferous material. Locally this selection of boundaries is artificial, but throughout the larger area has utility.

Member 5 forms a nearly continuous cliff, although the lower 100 feet approximately forms a retreat slope. It consists of medium- to thick-bedded, aphanic to fine-crystalline limestone, argillaceous limestone, and silty fine-sandy limestone. It is this sequence which forms the prominent physiographic boundary between the slope and cliff-weathering Ely Limestone below and the slope-forming Hogan Formation above. Chert is present in concentration of five percent in the form of nodules, and fossils consist of crinoid stem fragments, bryozoans, and few fusulinids. The latter fossil is not visible on the rock surface, and hence, requires random sectioning of the rock for verification. The lower boundary of the member is placed at disappearance of abundant gypsiferous limestone, and the upper boundary is placed at the lithologic and physiographic change between the Ely Limestone and the Hogan Formation.

Thickness, age, and correlation.—Location of the measured section of Pennsylvanian Ely Limestone is in Section 34, T. 34 N., R. 65 E. Total thickness of the formation is 1,510 feet. Boundaries of the mapped members do not precisely coincide with time intervals considered to represent standard epochs of the Pennsylvanian. Therefore, it is necessary to list both thickness of rock series and individual members. Representatives, but not necessarily all time span of Morrowan and Derryan (Atokan) age rocks are found in the stratigraphic section of Ely Limestone in central Pequop Mountains, of which approximately 605 feet is considered Morrowan equivalent and 905 feet Derryan age. Unfortunately, fusulinid control in the formation is very limited; however, a few specimens of *Profusulinella* sp. were located in unit 28 of the upper beds which date the beds as being Derryan age. Due to the absence of fusulinid control normally present in the Ely Limestone, actual delineation of thickness to the separate epochs was done on the basis of physical resemblance to other areas displaying well-dated typical Morrowan and Derryan age rocks.

Thickness of individual members is as follows: member 1, approximately 500 feet; member 2, approximately 50 feet; member 3, approximately 527 feet; member 4, approximately 215 feet; and member 5, approximately 218 feet.

A regional epeirogenic uplift apparently acted in eastern Great Basin during mid-Pennsylvanian time, inasmuch as normally rocks of Desmoinesian, Missourian, and Virgilian age are not represented. Dott (1955, p. 2255) refers to this unconformity in the Elko-Eureka-Carlin area as the sub-Strathearn unconformity. As a result of the regional unconformity, upper limit of the Ely Limestone is not everywhere the same age in eastern Nevada and western Utah; normally, however, Late Derryan age strata are overlain disconformably by marine rocks of Early Wolfcampian age. The regional unconformity is present in central Pequop Mountains although it occurs between Late Desmoinesian and Late Wolfcampian age rocks. Hence, the area under investigation contains one of the few exposures of Desmoinesian age rocks in the northeastern Great Basin. Also, because these Desmoinesian age rocks are of entirely different lithology than the more typical Ely Limestone stratigraphically below, Ely Limestone in central Pequop Mountains is here described as restricted to Morrowan and Derryan ages, and the Desmoinesian age silty limestone is referred to a new formation.

Chaetetes sp., the well-known and normally widespread "hair coral" considered by Dott (1954) to be a synchronous time-stratigraphic marker of Derryan (Atokan) age, was not found in place in the Ely Limestone in the map area, but fragmentary pieces in float were noted by Bissell (personal communication, 1960).

Hogan Formation (new name)

In slight opposition to Steele's proposal (1960, p. 100) to refer all Pennsylvanian rocks below the regional unconformity to Ely Limestone, the Desmoinesian age rocks in central Pequop Mountains are here referred to a new formation, the Hogan Formation. Type section of the formation is located in Section 34, T. 34 N., R. 65 E., Elko County, Nevada, and the section was measured on the west side of the range on the most prominent spur in the area (Text-fig. 3). The name "Hogan" is derived from a Western Pacific railroad siding located approximately one mile south of the type section.

The same sequence is present near Moorman Ranch, White Pine County, Nevada, and is of the same lithology and thickness, and occupies approximately the same stratigraphic position superjacent to the Ely Limestone as in central Pequop Mountains. Lane (1960, p. 114-116) recognized these strata to be different from the Ely Limestone, and referred to them as an "unnamed sequence."

Lithology.—Detailed description of the measured section of the type Hogan

Formation is found under "Measured section." General lithology of the Hogan Formation consists primarily of thin to medium-bedded, silty to quartzitic platy limestone, calcareous siltstone, calcareous shale, and argillaceous limestone. Interbedded with the sequence are a few siliceous, cherty limestone and fine-crystalline limestone to medium-crystalline and coarse-textured bioclastic limestone beds. A notable feature of the sequence is the high percentage of silt content and the absence of chert as found in the underlying Ely Limestone. This observance is also recorded by Lane in Moorman Ranch area (1960, p. 116). Occasional thicker bedded limestone beds interrupt the pronounced slope forming sequence, one of which near the top contains rare to moderately abundant fusulinids. Other fossils present in the strata are crinoid stem fragments and brachiopods, corals, gastropods, and bryozoans, all of which are rare in occurrence.

Thickness, age, and correlation.—Thickness of the Hogan Formation in central Pequop Mountains is approximately 750 feet thick. The only age delineation which can be presented for the formation is that given by the fusulinids occurring approximately 620 feet above the base. These fusulinids are identified as follows: *Fusulina weintzi* Verville, Thompson, & Lokke, and *Wedekindellina* cf. *W. euthysepta* (Henbest). Thus, the age of the strata containing these fusulinids is Medial to Late Desmoinesian. It is admitted that the contact of Derryan-Desmoinian age strata could occur within the formation, but the formation was mapped solely on lithology. Derryan fusulinids, however, do occur a few tens of feet below the formational contact in the underlying Ely Limestone, a fact which lends strength to this conclusion.

The upper contact with Permian Wolfcampian marine sediments also was mapped solely on the basis of lithology, inasmuch as fusulinid control is also absent for approximately three-fourths of the section of Wolfcampian age.

There are few exposures of Desmoinesian strata in eastern Great Basin due to the regional unconformity, and past workers have not differentiated Desmoinian strata as being a separate formation; therefore, correlation is restricted to: 1) the sequence described by Lane (1960) as mentioned above; 2) comparable sequences mentioned by Dr. H. J. Bissell (1961, personal communication) in Gold Hill, Butte Mountains, and Cherry Creek Mountains, and Mr. K. A. Hodgkinson (1961, personal communication) in Gold Hill and A-1 Canyon in the Leppy Range.

Permian System

Ferguson Mountain Formation

Berge (1960, p. 18-19) proposed the name Ferguson Mountain Formation for a thick carbonate sequence overlying Ely Limestone, or possibly Strathearn-equivalent strata, at Ferguson Mountain in sections 21 and 22, T. 30 N., R. 69 E., Elko County, Nevada. Steele (1960, p. 101) proposed the name Ferguson Springs Formation for the same sequence of strata, but his publication postdates that of Berge by five months.

Berge mapped the formation according to standard practice as a physical entity, which in this case is time transgressive. Slade (1961, p. 10) working in the same area, however, would make the physical boundaries coincide with time boundaries on the basis of certain lithic elements plus fusulinid occurrence. The writer follows Berge in this matter, since physical boundaries were the basis on which the formations were mapped in Pequop Mountains.

Lithology.—Several varieties of cherty limestone characterize Ferguson Mountain Formation in the map area. Predominantly, it consists of thick-bedded, ledge- and cliff-forming crystalline to bioclastic limestone, some of which is sandy and silty, but most of which is fine- to medium-crystalline in texture. Subordinate interbeds of thin-bedded, siliceous and cherty limestone and siliceous siltstone to shale form slopes between the ledges. A ledge-forming unit, 20 feet thick, consisting of thick-bedded, chert-limestone fragment-quartzite pebble conglomerate appears near the top of the sequence. Chert and case-hard limestone nodules make up 20 percent of some beds, and fossils consist of bryozoans and crinoid stems, and rarely of brachiopods and corals. Abundant diagnostic Late Wolfcampian age fusulinids occur in the upper beds of the sequence.

Lower boundary for the formation is taken where the platy and thin-bedded silty limestone of the Hogan Formation below the regional unconformity changes upward into thicker bedded crystalline to bioclastic limestone of the Ferguson Mountain Formation. The upper boundary is mappable on the presence of a distinctive limestone containing the regionally occurring coral biostrome *Corwenia?* sp., which marks approximately the break in lithology from the thick-bedded crystalline limestone of the Ferguson Mountain Formation to sandy and thin limestone beds of the Pequop Formation.

Thickness, age and correlation.—Total thickness of the Ferguson Mountain Formation in central Pequop Mountains is 250 feet thick. Location of the measured section is approximately in Section 34, T. 34 N., R. 65 E., and on the same spur and directly above the type section of the Hogan Formation.

Fusulinids were collected from the highest unit of the sequence, the only fusulinid bed of the formation in the map area. Among this limited species fauna were several specimens of *Schwagerina dispansa* Ross which have previously been described as occurring in the Upper Wolfcampian Lennox Hills Formation of the Glass Mountains, Texas (Ross, 1959, p. 304-305). In Pequop Mountains this species ranges into the lower beds of the overlying Pequop Formation where it is associated with *Pseudoschwagerina gerontica* Dunbar & Skinner, also a Late Wolfcampian fusulinid. Hence, the age of the Ferguson Mountain Formation in the area under discussion is essentially Late Wolfcampian.

Steele (1960, p. 101) has correlated his "Ferguson Springs Formation" over an areal extent of approximately 5,300 square miles. For excellent discussions of the correlation of this formation, the interested reader is referred to Steele (1960), Berge (1960), Bissell (1960), and Hodgkinson (1961).

Pequop Formation

Steele (1960, p. 106) named the Pequop Formation for a thick sequence of thin-bedded, fusulinid-bearing limestone which was measured one and one-half miles north of the Jasper Railroad Tunnel in central Pequop Mountains, Section 3, T. 33 N., R. 65 E., Elko County, Nevada. It is here pointed out with reference to the Elko NK11-12 topographic sheet, printed by the Army Map Service, that in designating the type section location two errors were unintentionally committed: 1) a distance of one and one-half miles north of the Jasper tunnel would locate the type section in section 11 or 12, and not in Section 3. Sections 11 and 12 both include an area of complex folding, faulting, and possibly contain rocks older than Leonardian; 2) if Section 3 was intended, the location would contain approximately Ely Limestone, Hogan Formation, Ferguson Mountain Formation, and lower beds of the Pequop Formation. In addition, the area would occupy the south slope of the prominent east-west trending spur which definitely exposes the best Pequop Formation on its crest. This spur was obviously intended to be the one containing the type Pequop Formation, but was improperly located according to sections. Therefore, according to recommendations of the American Commission on Stratigraphic Nomenclature concerning the designation of reference localities to supplement a type locality, the writer hereby proposes a reference locality to the Pequop Formation in central Pequop Mountains in sections 34 and 35, T. 34 N., R. 65 E., Elko County, Nevada. The measured section is found on the first large prominent west-trending spur north of the Jasper tunnel, and directly above the measured sections of Ely Limestone, Hogan Formation, and Ferguson Mountain Formation (Text-fig. 3).

Lithology.—In the reference locality, Pequop Formation consists of thin-bedded and platy, fine- to medium-crystalline, silty to fine-sandy limestone which is interbedded with medium- to thick-bedded, pure aphanic to fine-crystalline limestone. Repetitious exposures of the two lithologies display alternation of ledges and slopes throughout the entire Pequop sequence. Predominant colors in the formation are purplish-gray, maroon to tan, medium to dark brown-gray and gray-brown. Chert and quartzitic case-hard-limestone is not abundant through the section, although it occurs in nodular form locally in abundance of two to ten percent.

The prolific occurrence of fusulinids in the Pequop Formation at its type locality probably is the most spectacular feature of the formation. Although they are abundant in most parts of the section and occur in both lithologies, the platy, silty limestone contains greatest abundance.

Other fossils in the Pequop Formation are crinoid stems, brachiopods, bryozoans, corals, gastropods, and algae. The colonial coral *Corwenia* ? sp. occurs in the basal bed of the Pequop Formation, and is present throughout the entire map area; it deserves special comment. Steele (1960, p. 106) makes reference to this coral as being present in the basal beds of the formation at numerous localities in the northeastern Great Basin, including Ferguson Mountain, East-Humboldt Range, Carbon Ridge, and Pequop Mountains. *Corwenia* ? sp. not only has wide areal distribution, but also *approximately* marks the Wolfcampian-Leonardian time boundary. In some localities, for example at Ferguson Mountain, several biostromes of *Corwenia* ? sp. can be found above the unit of its initial occurrence. In many other places, however, only one bed containing this coral has been noted, and normally that is essentially the basal unit of the Pequop Formation, and often the lowest zone of rocks of Leonardian age. Commonly, abundant forms of Early Leonardian *Parafusulina* spp. are present in the same bed which contains *Corwenia* ? sp. This is not true in central Pequop Mountains, however, as valid Late Wolfcampian age fusulinids occur several hundred feet above the biostrome. Thus, the *Corwenia* ? sp. bed, because of distinctive lithic characteristics, forms the lower mappable unit of the Pequop Formation in Pequop Mountains, but the mappable boundary does not precisely coincide with the Wolfcampian-Leonardian time boundary. As a result, the Pequop Formation in this area is not a time rock unit, as 245 feet of the Lower Pequop Formation are of Late Wolfcampian age.

The upper boundary of the formation is mapped on the change in lithology from cliff-forming, thick-bedded crystalline limestone of the Upper Pequop

Formation to the thin and platy, slope-forming, cherty, calcareous siltstone-silty limestone of the Loray Formation.

Thickness, age, and correlation.—A total thickness of 3,087 feet of Pequop Formation was measured in its reference locality in central Pequop Mountains. This thickness is at variance with the thickness of 1,570 feet designated by Steele (1960, p. 106) for the formation in the same area. Perhaps, Steele suspected repetition of the formation by at least one of two faults, which occur 1,692 feet and 2,318 feet respectively within the section, and therefore restricted the thickness in the original designation. However, the present study proves stratigraphic continuity, because distinctive beds are not duplicated or omitted, and detailed study of fusulinids indicates no important gaps. The reader is referred to the fusulinid range chart (Text-fig. 2) to note the continuance of the species above and below the faults, and the first occurrence of younger species above the faults. Therefore, any faulting in the measured section is here reported as having negligible displacement.

Steele (1960, p. 106) divided the Pequop Formation into three members in the Moorman Ranch section in White Pine County, Nevada on the basis of presence of an evaporitic sequence within the Pequop Formation. He assigned 1,750 feet to the Lower Moorman Ranch Member, which is separated unconformably from 1,050 feet of Upper Moorman Ranch Member by a few feet of "thin, yellow gypsiferous-looking siltstone." He postulates the missing interval between the lower and upper members is represented in the Butte Mountains, White Pine County, Nevada by an evaporitic sequence called the Summit Springs Evaporite Member of the Pequop Formation. This same sequence was measured in the Butte Mountains in the summer of 1960, and it is agreed that Steele's designation of the three members is valid. The present study does not justify extension of these members of the Pequop Formation northward to central Pequop Mountains because the physical subdivision listed above does not appear to exist this far north. The present study has resulted in the division of the formation in the Pequop Mountains into parts having respectively Early, Medial, and Late Leonardian ages on the basis of diagnostic fusulinids. These divisions did not prove to be mappable in this study, and hence, are not intended to be interpreted as members. Thickness designations are as follows: Pequop Formation rocks of Early Leonardian age, 1,105 feet; Medial, 522 feet; and Late, 1,460 feet.

The sequence in this study containing association of *Schwagerina hessensis* Dunbar & Skinner, *Parafusulina schucherti* Dunbar & Skinner, *P. bakeri* Dunbar & Skinner, and *P. allisonensis* Ross is designated as Early Leonardian age. Association of *P.* aff. *P. visseri lata* Reichel and *P. spissisepta* Ross in conjunction with occurrence of upper and lower limits of other distinctive species delineates Medial Leonardian age rocks. Late Leonardian age rocks are so designated in this study on the basis of association of *P. bösei* Dunbar & Skinner, *P. fountaini* Dunbar and Skinner, *P. vidriensis* Ross, *P. rothi* Dunbar & Skinner, and *P. sellardsi* Dunbar & Skinner (Text-fig. 2).

Steele (1960, p. 106) recognized that areal distribution of the Pequop Formation occupies over 18,000 square miles in northeastern Nevada and northwestern Utah. Interested readers are referred to discussions by Steele (1960), Bissell (1960), and Hodgkinson (1961).

Loray Formation

Loray Formation was proposed by Steele (1960, p. 106-107) for a sequence of yellow-tan, gypsiferous siltstone and thin bioclastic limestone exposed at the head of Loray Wash on the southwest side of Montello Valley, Elko County, Nevada. The formation has a characteristic evaporitic type of lithology in most areas of occurrence. The writer has recognized the formation in central Pequop Mountains and, although it is rather thin, it compares favorably in lithology with outcrops reported from the type locality.

Lithology.—Loray Formation in the Pequop Mountains consists of interbedded calcareous siltstone and fine-grained orthoquartzite, silty and fine-sandy limestone, medium-textured bioclastic limestone, and medium-crystalline matrix limestone. Thin- to medium-bedding predominates in the sequence. Most of the section contains fine sand and silt and is chert free, although the middle beds contain less than five percent chert in one inch nodules to two foot thick beds. Contained fossils are crinoid stem fragments, bryozoans, and brachiopods. Gypsiferous material, reportedly present in the type locality, is absent in the area under current investigation. The nature of the lithology contained in the formation, however, suggests that the sequence in the Pequop Mountains represents a less restricted evaporite suite than that of the type locality.

The formation rests with apparent conformity on upper beds of the Pequop Formation, and is distinguished on the basis of lithology difference. The upper beds of the Pequop Formation are 100% carbonates that are medium- to thick-bedded, have shades of gray as distinctive color, are practically silt and sand free, and weather into prominent ledge-cliff and slope topography. The Loray Formation is thin-bedded, contains a predominance of silt and sand, is tan to maroon and yellow-brown in color, and weathers into prominent receding slopes. The upper boundary is chosen at approximately the base of a 20 foot thick limestone unit of what may be Kaibab Limestone, or its equivalent. Identification of this unit as basal Kaibab Limestone is on the basis that it is overlain by a sequence of siltstone and phosphatic, cherty shale, which was previously identified in Indian Canyon approximately ten miles south. At this locality the phosphatic beds overlie an excellent stratigraphic section of Kiabab Limestone.

Thickness and age.—The measured section was obtained on a prominent spur immediately north of that containing the type Pequop Formation. It is approximately located in sections 35 and 26, T. 34 N., R. 65 E. Total measured thickness is 245 feet.

Steele (1960, p. 106-107) gives an Early Guadalupian age to the Loray Formation. However, the Permian Subcommittee of the National Research Council's Committee on Stratigraphy (1960, Dunbar, *et al.*) has listed the entire Kaibab Limestone sequence as Late Leonardian. The writer chooses to follow the latter interpretation, although it as admitted the Leonardian-Guadalupean boundary may occur within the Kaibab Limestone. Therefore, the Loray Formation is accepted in this study as of Late Leonardian age.

Tertiary System

Volcanics

Several small outcrops of volcanic rocks are found in the map area but were not mapped nor studied. They are acidic in composition, possibly rhyolite or quartz-latite, and possibly are Tertiary in age.

Quaternary and Recent Systems

Unconsolidated sediments are found in the map area in the form of fans, gravels, and Recent colluvium and alluvium. Alluvial fans, although well developed on both sides of the range, are best exposed on the western side. On this side, mappable lake deposits of sand and silt overlap and intermingle with the fan material and show an apparent reworking of the basal deposits (Text-fig. 3). The lake deposits are interpreted to be Quaternary in age and are probably equivalent to the Lake Bonneville sediments which occur approximately 20 miles to the east.

STRUCTURAL GEOLOGY

General Statement

Structural features of the Pequop Mountains are characteristic of a type of structure commonly referred to as "Basin and Range block faulting." This north-south trending, east dipping range is possibly the result of one of several tectonic possibilities: 1) The range was at one time a limb of an anticlinal fold which was uplifted relative to the surrounding topography and block faulted; 2) The range was upfaulted with associated rotation relative to the surrounding valleys. Of these two interpretations, the writer prefers the first. The relatively large fault which limits and exposes the western side of the range as a fault line scarp has long since been covered by Quaternary and Recent alluvium. As in the case of most structures of similar magnitude in the Great Basin, Nevadan-Laramide folding appears to have been the cause of the existing uplift, and Tertiary Basin and Range block faulting has subsequently collapsed the structure (or raised certain blocks), thus exposing the present topography.

Minor faulting has occurred in the area of normal longitudinal or transverse type. No evidence of thrust faulting or strike-slip faulting has been found.

Folding

Folding is restricted to the 35°-40° eastward dip which occurs uniformly throughout the stratigraphic sequence. If range-wide structural interpretations are correct, then the Pequop Mountains were at one time the eastern limb of a doubly plunging anticlinal structure which has since had the western limb downfaulted to form the present western valley. The central Pequop Mountains were located on the southward plunge of this anticline, with older rocks exposed to the north. Subsequent Basin and Range faulting followed by covering with Tertiary and Recent alluvium have long since eliminated most traces of such a structure.

Normal faulting

Most of the faults in this area are of the normal type. Apparently the largest fault is the one postulated to have destroyed the Nevadan-Laramide fold structure and exposed the scarp-like western side of the range. This longitudinal fault, possible of several thousand feet displacement, is believed to be present beneath the Quaternary and Recent alluvium in approximately the position indicated on the geologic map (Text-fig. 3).

A relatively large transverse normal fault is postulated to trend approximately east-west through the pass that separates the northern segment of the range from the central segment.

Several other transverse to longitudinal normal faults of smaller vertical movement can be seen on the geologic map (Text-fig. 3), all of which were recognized on the basis of brecciation and stratigraphic displacement. It is realized that numerous other faults exist near the top of the mountain approximately in Section 26, T. 34 N., R. 65 E., as indicated by disruption of beds and brecciation, but low throw and lithologic similarity of all Upper Pequop strata made it impractical to map these faults on scale of the map.

SYSTEMATIC PALEONTOLOGY

General Statement

Specimens described are from 450 thin-sections prepared from rocks collected in central Pequop Mountains, Elko County, Nevada, BYU Locality 12,042. These thin-sections are deposited in the Brigham Young University Paleontology Repository. Terminology, measurements, and method of description are similar to those of Dunbar & Skinner (1937). Measurements include outside diameter of proloculus, radius-vector, half-length, form-ratio, and wall-thickness.

The following genera are illustrated but not described in this study: 1) *Dunbarinella,* plate 17, fig. 2; 2) *Schubertella,* plate 20, fig. 12; 3) *Boultonia,* plate 20, fig. 13.

Family FUSULINIDAE Möller, 1878
Subfamily SCHWAGERININAE Dunbar & Henbest, 1930
Genus PSEUDOSCHWAGERINA Dunbar & Skinner, 1936
Pl. 17, figs. 1, 4.

Pseudoschwagerina gerontica Dunbar & Skinner

Pseudoschwagerina gerontica DUNBAR & SKINNER, 1937, Univ. Texas Bull. 3701, p. 660-662, pl. 51, figs. 1-6.

Description.—Shell large and highly inflated fusiform, slightly curved axis of coiling, extended poles broadly pointed to narrowly rounded, convex lateral slopes becoming concave in outer volutions. Specimen six to seven volutions, 11.9 to 15.5 mm long and 5.4 to 7.2 mm wide, giving average form ratio of 1.3 for first volution to 2.4 for last volution. Proloculus large, varies from 260 to 450 microns. Juvenarium closely coiled with sharp poles, beyond third volution shell expands rapidly and poles more rounded. Chamber height same from tunnel to poles. Height in last 1 to 2 whorls declines notably. Spirotheca thick, averaging 30 to 150 microns. Septa narrowly and highly fluted mainly in end zones. Tunnel narrow, chomata well defined inner 3 volutions, but absent in inflated outer whorls.

Table of Measurements

	Specimens 155	156	157	158
Proloculus (mm)	.45	.35	.30	.39

	Vol.	Specimens 155	156	157	158
Radius-vector (mm)	1	.41	.35	.34	.40
	2	.68	.65	.50	.64
	3	1.34	1.14	.78	1.33
	4	2.18	2.18	1.76	2.15
	5	2.88	3.09	2.70	2.73
	6	3.23	3.63	3.25	3.29

	Vol.	Specimens 155	156	157	158
Half length (mm)	1	.70	.54	.35	.60
	2	1.33	1.15	.72	1.09
	3	2.77	2.19	1.32	2.61
	4	4.66	3.70	3.00	3.73
	5	6.37	5.00	4.50	5.59
	6	7.77	6.48	5.96	6.70

	Vol.	Specimens 155	156	157	158
Form-ratio	1	1.7	1.5	1.0	1.5
	2	2.0	1.8	1.4	1.7
	3	2.1	1.9	1.7	2.0
	4	2.1	1.7	1.7	1.7?
	5	2.2	1.6	1.7	2.0
	6	2.4	1.8	1.8	2.0

	Vol.	Specimens 155	156	157	158
Wall-thick. (mm)	1	.05	.07	.08	.07.
	2	.15	.09	.10	.08
	3	.08	.11	.10	.07
	4	.13	.10	.11	.10
	5	.15	.18	.14	.13
	6		.16	.13	.15

Discussion.—*Pseudoschwagerina gerontica* is the largest known species of the genus and hence, on size alone, is distinguished from other species. It most closely resembles *P. uddeni* Beede & Kniker in the early whorls, but upon reaching maturity polar regions are extended and expansion is less rapid than in *P. uddeni.* Ten specimens were studied. Holotype from the upper beds of the Hueco Limestone, Franklin Mountains, Texas.

Occurrence.—*Pseudoschwagerina gerontica* occurs in Pequop Mountains in the lower and middle parts of unit 46 of the Late Wolfcampian portion of the Pequop Formation.
Repository.—BYU 155, 156, 157, 158.

Genus SCHWAGERINA Möller, 1877
Schwagerina emaciata (Beede)
Pl. 17, fig. 3.

Fusulina emaciata BEEDE, 1916, Indiana Univ. Studies, v. 3, p. 14; DUNBAR & CONDRA, 1928, Nebraska Geol. Surv. Bull. 2, 2nd ser., p. 116-117, pl. 10, figs. 1-3, (1927).
Triticites emaciatus WHITE, 1932, Univ. Texas Bull. 3211, p. 44-47.
Schwagerina emaciata NEEDHAM, 1937, New Mexico Bur. Mines Bull. 14, p. 46-47. (Not pl. 7, fig. 6-9); DUNBAR & SKINNER, 1937, Univ. Texas Bull. 3701, p. 633-635, pl. 56, figs. 1-12.
Description.—Shell small, elongate fusiform, straight axis of coiling, poles sharply pointed, inner volutions becoming blunter as shell reaches maturity, straight to gently convex lateral slopes. Specimens five volutions, 6.2 to 7.2 mm long, 2.2 to 2.9 mm wide, form ratio 2.2 first volution to 2.9 last volution. Proloculus small, 150 to 200 microns average size. Inner two whorls rather tightly coiled, gradually expanding in outer whorls. Each volution increases in height from middle to poles. Spirotheca thin, attaining 60 to 80 microns at maturity, well defined keriotheca. Septa regularly and strongly fluted as high septal loops in axial section. Chomata and tunnel almost obsolete.

Table of Measurements

	Specimens 159	160	161
Proloculus (mm)	.015	.020	

	Vol.	Specimens 159	160	161
Radius-vector (mm)	1	.22	.20	.20
	2	.33	.28	.37
	3	.54	.40	.64
	4	.78	.64	1.00
	5	1.10	.90	1.48
	6		1.20	

	Vol.	Specimens 159	160	161
Half-length (mm)	1	.52	.45	.45
	2	.73	.68	1.09
	3	1.46	1.03	1.73
	4	2.52	1.69	3.01
	5	3.19	2.40	3.61
	6		3.30	

	Vol.	Specimens 159	160	161
Form-ratio	1	2.4	2.3	2.2
	2	2.2	2.4	3.0
	3	2.7	2.6	2.7
	4	3.2	2.6	3.0
	5	2.9	2.7	2.4
	6		2.8	

	Vol.	Specimens 159	160	161
Wall-thick. (mm)	1	.03	.03	.02
	2	.03	.03	.05
	3	.03	.04	.07
	4	.06	.05	.09
	5	.08	.07	
	6		.06	

Discussion.—This species is one of the smallest and earliest of the genus. In general appearance it most closely resembles *S. graciliatis* Dunbar & Skinner, but, in all respects, is a smaller form. In size and shape the species resemble *Triticites,* but, absence of pronounced chomata and presence of abundant septal fluting across the central part distinguish *Schwagerina.* Three specimens were studied.
Occurrence.—*Schwagerina emaciata* occurs in Pequop Mountains in the lower and middle parts of unit 46 of the Late Wolfcampian portion of the Pequop Formation.
Repository.—BYU 159, 160, 161.

Schwagerina dispansa Ross
Pl. 17, figs. 5, 7.

Schwagerina dispansa, ROSS, 1959, Jour. Washington Acad. Sci., v. 49, no. 9, p. 304, 305, pl. 2, figs. 7-12.
Description.—Shell moderate size, elongate, inflated fusiform, pointed poles, straight axis of coiling, and concave lateral slopes. Specimens five to six volutions, 9.50 to 9.64 mm long, 3.02 to 3.28 mm wide, form ratios 1.9 to 2.0 for first volution and 3.0 to 3.1 for

last volution. Inner volutions inflated fusiform, outer volutions elongate fusiform. Polar regions greatly extended in outer whorls forming wing-like projections. Proloculus small, averaging 100 microns. Uniform expansion. Spirotheca thin and averages 30 microns in first volution and 100 microns in last volution, coarsely alveolar keriotheca. Septa strongly and regularly folded throughout shell with even spacing. Tunnel medium and straight, chomata rudimentary, secondary deposits often occur in polar regions of each volution except outer two.

Table of Measurements

	Specimens 162	163
Proloculus (mm)	.10	

	Vol.	Specimens 162	163		Vol.	Specimens 162	163
	1	.22			1	.45	
Radius-vector (mm)	2	.36	.35	*Half-length* (mm)	2	.88	.65
	3	.55	.63		3	1.64	1.38
	4	.80	.98		4	2.80	2.30
	5	1.11	1.33		5	3.50	3.64
	6	1.51	1.64		6	4.75	4.82

	Vol.	Specimens 162	163		Vol.	Specimens 162	163
	1	2.0			1	.02	
Form-ratio	2	2.4	1.9	*Wall-thick.* (mm)	2	.03	.05
	3	3.0	2.2		3	.05	.08
	4	3.5	2.4		4	.05	.08
	5	3.2	2.7		5	.07	.12
	6	3.1	3.0		6	.09	.09

Discussion.—The specimens referred to this species compare perfectly with the type species described by Ross (1959). The inflated fusiform shape with extended polar regions is in accord with the description given for the type species. Five good specimens were studied. Holotype found in the Lenoxhills Formation, north of Wolf Camp Hills, Texas.

Occurrence.—This species occurs in Pequop Mountains in the lower part of unit 46 of the Late Wolfcampian portion of the Pequop Formation. It is there found associated with *Pseudoschwagerina gerontica* Dunbar & Skinner and *Schwagerina emaciata* (Beede). It also abundantly occurs in the upper part of unit 45 in the upper beds of the Late Wolfcampian Ferguson Mountain Formation.

Repository.—BYU 162, 163.

Schwagerina wellsensis Thompson & Hansen
Pl. 17, fig. 6.

Schwagerina wellsensis, THOMPSON & HANSEN, 1954, Univ. Kansas, Paleont. Contrib. Protozoa, Art. 5, p. 64, pl. 32, figs. 1-6, 7-9; pl. 34, figs. 1-12.

Description.—Shell medium, slightly inflated fusiform, straight axis of coiling, rather sharply pointed poles, and slightly convex lateral slopes. Specimens of five to six volutions, 8.2 to 10.8 mm long, 2.94 to 3.40 wide, form ratio average 2.3 first volution and 2.9 last volution. First volution elongate fusiform; shape remains constant throughout growth. Proloculus large, outside diameter 270 to 310 microns. Shell expands slowly and uniformly, chamber heights increase as approach poles. Spirotheca coarsely alveolar and moderately thin, 30 to 40 microns in first volution and 70 to 90 microns in outer volutions. Septa narrowly fluted through shell length, fluting extends to chamber tops, forming closed chamberlets two-thirds the height of the chambers. Phrenotheca present in outer volutions. Tunnel narrow and irregular with chomata poorly developed. Axial fillings slight to heavy in polar ends.

Table of Measurements

	Specimens 165	166	167	168
Proloculus (mm)	.22	.28	.31	.28

	Vol.	Specimens 165	166	167	168
Radius-vector (mm)	1	.35	.34	.24	.35
	2	.59	.57	.39	.62
	3	.94	.91	.60	1.06
	4	1.39	1.38	1.19	1.68
	5	1.50	1.75	1.50?	1.95
	6				

	Vol.	Specimens 165	166	167	168
Half-length (mm)	1	.51	1.07	.58	.79
	2	.99	1.44	1.14	1.43
	3	1.62	2.36	2.19	2.63
	4	2.94	3.88	3.50	3.96
	5	4.29	4.10	4.60	5.40
	6	5.27			

	Vol.	Specimens 165	166	167	168
Form-ratio	1	2.3	3.2	2.4	2.3
	2	1.7	2.5	2.9	2.3
	3	1.7	2.6	3.6	2.5
	4	2.1	2.8	3.8	2.4
	5	2.9	2.3	3.9	2.8
	6				

	Vol.	Specimens 165	166	167	168
Wall-thick. (mm)	1	.04	.03	.03	.04
	2	.06	.04	.04	.05
	3	.06	.06	.06	.07
	4	.09	.08	.06	.09
	5	.09		.07	.10
	6				

Discussion.—Specimens referred to *Schwagerina wellsensis* in this study compare very favorably with the types. *Schwagerina wellsensis* is distinguished from other American forms of the genus by its inflated shell, loosely coiled volutions, pointed polar ends, and massive axial fillings. It most closely resembles *S. eolata* Thompson and *S. neolata* Thompson, but is longer and more slender and slightly less fluted. Five rather poorly preserved forms of this species were studied. Holotype of species from a section exposed one mile southeast of Wells, Nevada.

Occurrence.—*Schwagerina wellsensis* occurs in Pequop Mountains in the lower part of units 46 and 47 of the Late Wolfcampian portion of the Pequop Formation.
Repository.—BYU 165, 166, 167, 168.

Schwagerina sp. aff. *S. eolata* Thompson
Pl. 17, fig. 9.

Schwagerina eolata THOMPSON, 1954, Univ. Kansas Paleont. Contrib., Protozoa, Art. 5, p. 64-65, pl. 36, figs. 1-8.

Description.—Shell size moderate, sub-elongate fusiform, moderately pointed polar ends, almost straight axis of coiling, and convex to slightly concave lateral slopes. Shell of six volutions 9.68 mm long and 2.76 mm wide, form ratio 1.7 first volution and 2.6 outer volution. Early volutions distinctly elliptical, become progressively elongated at maturity. Proloculus not visible on single specimen studied. Shell expansion slow and uniform, chamber height increases little from tunnel to poles. Spirotheca distinctly alveolar and moderately thin, thickness first volution 30 microns, last volution 70 to 90 microns. Septa narrowly fluted to tops of chambers so that closed chamberlets formed two-thirds height of chambers. Tunnel moderately wide and straight, chomata poorly developed, axial fillings pronounced in polar regions of inner three volutions.

Table of Measurements

	Vol.	Specimens 169
Form-ratio	1	1.7
	2	2.6
	3	2.4
	4	2.5
	5	2.6
	6	2.6

	Vol.	Specimens 169
Radius-vector (mm)	1	.29
	2	.49
	3	.74
	4	1.08
	5	1.45
	6	1.88

	Vol.	Specimens 169
	1	.50
Half-	2	1.26
length	3	1.75
(mm)	4	2.69
	5	3.74
	6	4.84

	Vol.	Specimens 169
	1	.03
Wall-	2	.04
thick.	3	.05
(mm)	4	.07
	5	.09
	6	.07

Discussion.—This form is referred to *Schwagerina eolata* with question, inasmuch as it is the only specimen in the collection. The single specimen does, however, compare very well with the type species described by Thompson. *S. eolata* is similar to *S. neolata* Thompson, but is more elongate and slender, has thinner spirotheca, and smaller proloculus. Holotype from the Middle Hueco Limestone at head of Powwow Canyon, Texas.

Occurrence.—*Schwagerina* sp. aff. *S. eolata* was found in Pequop Mountains only in the middle part of unit 46 of the Late Wolfcampian portion of the Pequop Formation.
Repository.—BYU 169.

Schwagerina cf. *S. diversiformis* Dunbar & Skinner
Pl. 17, fig. 8.

Schwagerina diversiformis DUNBAR & SKINNER, 1937, Univ. Texas Bull. 3701, p. 647-648, pl. 60, figs. 1-7.

Description.—Shell large and fusiform, almost straight axis of coiling, sharply pointed poles in inner volutions, becoming blunter at maturity, central part of shell cylindrical, but ends steep and gently convex. One specimen of six volutions, 11.46 mm long, 3.74 mm wide, form ratio 2.3 inner volution, 3.1 outer volution. Shell shape changes little with growth. Proloculus small, outside diameter 20 microns, shell expansion slow and uniform, chamber height increases slightly from tunnel to poles. Spirotheca thin with coarsely alveolar keriotheca, thickness 30 microns inner whorl and 70 microns outer whorl. Septa narrowly and highly fluted through shell length forming closed chamberlets. Tunnel inconspicuous due to absence of distinct chomata. Axial filling completely fills polar regions of inner three volutions.

Table of Measurements

	Specimens 170	171
Proloculus (mm)	.20	.19

	Vol.	Specimens 170	171
	1	.24	.33
Radius-	2	.40	.56
vector	3	.68	.90
(mm)	4	1.04	1.28
	5	1.40	1.64
	6	1.87	1.98

	Vol.	Specimens 170	171
	1	.54	.58?
Half-	2	.97	1.49
length	3	1.79	2.31
(mm)	4	2.43	3.55
	5	4.28	4.74
	6	5.73	5.60

	Vol.	Specimens 170	171
	1	2.3	1.8
Form-	2	2.4	2.7
ratio	3	2.6	2.6
	4	2.3	2.8
	5	3.1	2.9
	6	3.1	2.8

	Vol.	Specimens 170	171
	1	.03	
Wall-	2	.04	.05
thick.	3	.05	.07
(mm)	4	.05	.10
	5	.07	.07
	6	.07?	.07

Discussion.—Because of the poor preservation of the two specimens studied, the forms are referred to *Schwagerina diversiformis* with some question. The forms have the general elongate hexagonal outline, cylindrical center area, and massive axial fillings of *S. diversiformis,* and therefore appear most closely similar to this species. Two forms of this species were studied. Holotype from Hueco Limestone at White Spur, north of El Paso, Texas.

Occurrence.—*Schwagerina* cf. *S. diversiformis* occurs in Pequop Mountains in the lower part of unit 47 of the Late Wolfcampian portion of the Pequop Formation.
Repository.—BYU 170, 171.

Schwagerina franklinesis Dunbar & Skinner
Pl. 17, figs. 10, 11.

Schwagerina franklinensis DUNBAR & SKINNER, 1937, Univ. Texas Bull. 3701, p. 628-630, pl. 66, figs. 1-11.

Description.—Shell large, elongate, fusiform to subcylindrical, bluntly pointed to rounded poles, nearly straight axis of coiling, convex lateral slopes. Specimens of six to seven volutions, 9.84 to 12.74 mm long, 2.92 to 3.84 mm wide, form ratio 1.6 to 2.0 first volution, 3.5 to 4.0 last volution. Early volutions more fusiform, becoming subcylindrical with growth. Proloculus small and thin walled, 180 to 220 microns. First two or three volutions tightly coiled, outer three or four gradually progress in height. Spirotheca thin and coarsely alveolar, 10 to 30 microns inner volution, 80 to 100 microns outer volution. Septa strongly fluted and folds irregular in size and weak on upper part of septum. Chamberlets produced, but irregular in size. Tunnel inconspicuous due to lack of chomata. Light to moderate axial fillings in polar regions of inner two to three volutions, phrenotheca abundant.

Table of Measurements

	Specimens 172	173	174	175
Proloculus (mm)	.22	.22	.22	.18

	Vol.	Specimens 172	173	174	175
	1	.26	.22	.28	.15
Radius-	2	.38	.32	.45	.27
vector	3	.58	.45	.56	.43
(mm)	4	.83	.69	.87	.70
	5	1.18	.98	1.23	.99
	6	1.58	1.30	1.50?	1.46?
	7	1.92	1.71		

	Vol.	Specimens 172	173	174	175
	1	.52	.35	.46	.31
Half-	2	.91	.78	1.09	.83
length	3	1.88	1.41	1.34	1.40
(mm)	4	2.96	2.28	2.46	2.46
	5	4.30	3.70	3.37	3.87
	6	5.56	5.23	4.72	5.08
	7	6.37	6.06		

	Vol.	Specimens 172	173	174	175
	1	2.0	1.6	1.6	2.1
Form-	2	2.4	2.4	2.4	3.1
ratio	3	3.2	4.0	2.4	3.3
	4	3.6	3.3	2.8	3.5
	5	3.6	3.8	2.8	3.9
	6	3.5	4.0	3.3	3.5?
	7	3.3	3.5		

	Vol.	Specimens 172	173	174	175
	1	.01	.03	.03	.01
Wall-	2	.03	.05	.05	.02
thick.	3	.07	.04	.04	.03
(mm)	4	.10	.06	.08	.06
	5	.09	.05	.10	.06
	6	.09	.08		.10
	7				

Discussion.—Forms were distinguished by the subcylindrical shape of the shell even in the inner volutions. This species resembles *Schwagerina huecoensis* Dunbar & Skinner and in fact is difficult to distinguish on the basis of external features. *S. franklinensis* has a smaller proloculus and the first three or four volutions are thin-walled and low, thus causing it to appear more slender and less inflated than *S. huecoensis. S. franklinensis* also resembles *Parafusulina shaksgamensis crassimarginata* Knight in external fluting, but lacks the cuniculi present in *Parafusulina.* Eight specimens of this species were studied. Holotype from the Hueco Limestone of White Spur, Franklin Mountains, Texas.
Occurrence.—*Schwagerina franklinensis* occurs in Pequop Mountains in units 48, 50, and 52 of the Late Wolfcampian-Early Leonardian part of the Pequop Formation.
Repository.—BYU 172, 173, 174, 175.

Schwagerina sp. aff. *S. linearis* Dunbar & Skinner
Pl. 17, fig. 12.

Schwagerina linearis DUNBAR & SKINNER, 1937, Univ. Texas Bull. 3701, p. 637-638; pl. 62, figs. 12-15; pl. 63, figs. 1-7.

Description.—Shell large, extremely slender, subcylindrical, straight axis of coiling, poles obtusely rounded, convex to irregular lateral slopes, equatorial part scarcely inflated. Specimens six to seven volutions, 8.2 mm to 11.98 mm long, 2.06 to 2.10 mm wide, form ratio 2.2 to 2.4, first volution, 5.5 to 6.0 last volution. First two volutions ellipsoidal, later volutions elongated to subcylindrical. Proloculus medium size, 180 to 250 microns, very thin-walled. Shell expansion slow and gradual, chamber height same thoughout volution except increases at extreme polar ends. Spirotheca thin to moderately thin, 10 to 30 microns first volution, 70 to 80 microns last volution, well defined alveoli. Septa fluted in lower half throughout length, form small cell-like chamberlets where regular folds of adjacent septa touch. Tunnel difficult to distinguish due to crushed nature of shells and lack of chomata. Axial fillings inner three to four volutions in polar regions.

Table of Measurements

	Specimens			
Proloculus	176	177	178	179
(mm)	.25?	.16	.18	.25

		Specimens						Specimens			
	Vol.	176	177	178	179		*Vol.*	176	177	178	179
	1	.28	.24	.18	.18		1	.66	.40	.44	.56
Radius-	2	.40	.35	.23	.27	*Half-*	2	1.21	.51	.80	.97
vector	3	.51	.46?	.32	.45	*length*	3	2.27	1.18	1.37	2.04
(mm)	4	.64	.64	.52	.60	(mm)	4	3.52	1.93	2.17?	3.01
	5	.81	.87	.70	.84		5	4.29	2.96	3.14	4.37
	6	1.04		.85	1.03		6	6.24	4.10	4.30	5.70
	7			1.05			7			5.99	

		Specimens						Specimens			
	Vol.	176	177	178	179		*Vol.*	176	177	178	179
	1	2.4	1.7	2.4	2.2		1	.03	.02	.02	.01
Form-	2	3.0	1.5	3.5	3.6	*Wall-*	2	.04	.03	.02	.03
ratio	3	4.5	2.6	3.7	4.5	*thick.*	3	.05	.05	.04	.04
	4	5.5	3.0	4.0	5.0	(mm)	4	.05	.07	.06	.05
	5	5.3	3.4	4.5	5.2		5	.06	.07	.07	.08
	6	6.0		5.1	5.5		6	.08		.08	.08
	7			5.7			7			.08	

Discussion.—These forms are assigned with question to *Schwagerina linearis* due to the crushed nature and poor preservation of the shells. However, the highly elongate shell, septal fluting, high form-ratios, and general external shape make this assignment probable. The forms resemble *Parafusulina sublinearis* Knight, but lack the *Parafusulina* cuniculi, have larger form-ratios and are more cylindrical in shape. Seven rather poorly preserved specimens were studied. Holotype from highest part of Wolfcampian Formation, Glass Mountains, Texas.

Occurrence.—*Schwagerina* sp. aff. *S. linearis* occurs in Pequop Mountains in units 48, 49, 56, 57 of the Late Wolfcampian and Early Leonardian part of the Pequop Formation. *Repository.*—BYU 176, 177, 178, 179.

Schwagerina modica Thompson & Hazzard
Pl. 17, fig. 13.

Schwagerina modica THOMPSON & HAZZARD, 1946, Geol. Soc. Amer., Mem. 17, p. 44-45, pl. 11, figs. 1-7.

Description.—Shell small to medium size, fusiform, straight axis of coiling, low convex lateral slopes, and bluntly pointed poles. Specimens five to six volutions, 4.2 to 5.6 mm long, 1.98 to 3.0 mm wide, form-ratio 1.4 to 2.0 first volution, 2.0 to 2.5 last volution. Proloculus large, 170 to 290 microns, shell expansion uniform, chamber height increase little center to poles. Spirotheca thick, coarsely alveolar, 10 to 40 microns first volution, 60 to 110 microns last volution. Septa fluted throughout shell length, in center form chamberlets only in basal parts. Fluting more intense in polar regions. Tunnel low, broad, and poorly defined, chomata very poorly developed.

Table of Measurements

	Specimens 180	181	182	183
Proloculus (mm)	.28	.25	.29	.17

	Vol.	Specimens 180	181	182	183
Radius-vector (mm)	1	.25	.25	.36	.30
	2	.36	.38	.57	.44
	3	.58	.60	.82	.60
	4	.80	.87	1.08	.87
	5	.99?	1.16	1.50	1.14

	Vol.	Specimens 180	181	182	183
Half-length (mm)	1	.34	.40	.50	.60
	2	.68	.85	.93	.87
	3	1.32	1.34	1.48	1.41
	4	1.84	1.96	2.13	1.96
	5		2.73	2.78	2.80

	Vol.	Specimens 180	181	182	183
Form-ratio	1	1.4	1.6	1.4	2.0
	2	1.9	2.2	1.6	2.0
	3	2.3	2.2	1.8	2.4
	4	2.3	2.3	2.0	2.3
	5		2.4	1.9	2.5

	Vol.	Specimens 180	181	182	183
Wall-thick. (mm)	1	.03	.02	.04	.01
	2	.03	.03	.05	.04
	3	.05	.05	.07	.05
	4		.08	.09	.07
	5		.11		.09

Discussion.—Specimens here referred to *Schwagerina modica* fit well the original description of Thompson & Hazzard, but are found to range much higher stratigraphically than do those of the original description. *S. modica* resembles *S. powwowensis* (Dunbar & Skinner), but has thinner spirotheca, smaller size, more volutions at maturity, and less inflated chambers. Eight rather well preserved specimens were studied. Holotype from Bird Spring Formation of southern California.

Occurrence.—*Schwagerina modica* occurs in Pequop Mountains in units 50, 68, 78, 79, in beds of the Pequop Formation of Early, Medial, and Late Leonardian age.
Repository.—BYU 180, 181, 182, 183.

Schwagerina güembeli Dunbar & Skinner
Pl. 17, figs. 14, 15.

Schwagerina güembeli DUNBAR & SKINNER, 1937, Univ. Texas Bull. 3701, p. 639-640, pl. 61, figs. 1-13.

Description.—Shell large, short, thick fusiform, straight axis of coiling, bluntly pointed poles, straight to gently convex lateral slopes, central portion flattens and assumes shape of short cylinder. Each volution appears as an ellipse flattened on either side at middle. Specimens six to seven volutions, 6.82 to 10.86 mm long, 3.0 to 4.02 mm wide, form ratio 1.4 to 2.0 first volution, 2.1 to 2.7 last volution. Proloculus large and variable, 290 to 350 microns with average of 310 microns. Initial volution high, succeeding volutions continue to increase height giving loosely coiled appearance, chamber height increases only slightly center to poles. Spirotheca thin, inner volutions, 20 to 40 microns, rather thick outer volutions, 100 to 150 microns, coarsely alveolar. Septa strongly and regularly folded throughout shell length, form closed chamberlets. Tunnel straight and moderately narrow, chomata lacking or rudimentary, heavy secondary fillings on either side of tunnel and on high chambers throughout the test, fillings extend into central regions of test.

Table of Measurements

	Specimens 184	185	186	187
Proloculus (mm)	.30	.35	.35	.29

	Vol.	Specimens 184	185	186	187
Radius-vector (mm)	1	.29	.42	.34	.33
	2	.47	.64	.47	.50
	3	.74	.88	.70	.76
	4	1.10	1.16	.95	1.05
	5	1.44	1.55	1.22	1.40
	6	1.80	1.94	1.58	
	7			2.02	

	Vol.	Specimens 184	185	186	187
Half-length (mm)	1	.41	.70	.55	.59
	2	.83	1.16	.89	1.10
	3	1.38	1.70	1.26	1.73
	4	2.39	2.58	1.87	2.47
	5	3.37	3.20	2.57	3.59
	6	4.46	4.02	3.34	
	7			4.53	

	Vol.	Specimens 184	185	186	187
Form-ratio	1	1.4	1.7	1.6	1.8
	2	1.8	1.8	1.9	2.2
	3	1.9	1.9	1.8	2.3
	4	2.2	2.2	2.0	2.4
	5	2.3	2.1	2.1	2.6
	6	2.3	2.1	2.1	
	7			2.3	

	Vol.	Specimens 184	185	186	187
Wall-thick. (mm)	1	.02	.03	.03	.03
	2	.03	.04	.04	.05
	3	.08	.05	.03	.05
	4	.08	.08	.08	.08
	5	.07	.13	.05	.11
	6	.10	.15	.10	
	7			.14	

Discussion.—*Schwagerina güembeli* is similar to *S. crassitectoria* Dunbar & Skinner, but *S. güembeli* is not nearly so evenly elliptical and has heavier axial fillings. It becomes progressively larger and thicker near the top of its occurrence. *S. güembeli* is also similar to *S. gruperaensis* Thompson & Miller, but differs in being smaller in size. Stratigraphic range of *S. güembeli* is much younger in Pequop Mountains than has been formerly reported in Texas. Thirty-eight well preserved specimens were studied. Holotype from 450 feet above base of Leonard Formation west of Gap Tank, Glass Mountains, Texas.

Occurrence.—*S. güembeli* occurs in abundance in Pequop Mountains in units 51, 53, 55, 59, 60, 62, 65, 66, 69, 70, 71, 73, 78, 80, 82, 83. Thus its range is through the entire extent of the Pequop Formation of Early, Medial, and Late Leonardian age.
Repository.—BYU 184, 185, 186, 187.

Schwagerina crassitectoria Dunbar & Skinner
Pl. 17, fig. 16; Pl. 18, fig. 1.

Schwagerina crassitectoria DUNBAR & SKINNER, 1937, Univ. Texas Bull. 3701, p. 641, pl. 65, figs. 1-15; THOMPSON, 1954, Kansas Contrib. Paleont., Protozoa, Art. 5, p. 35 figs. 10-13.

Schwagerina güembeli var. *pseudoregularis* DUNBAR & SKINNER, 1937, Univ. Texas Bull. 3701, p. 640, pl. 61, figs. 14-20, 22-24 (not fig. 21).

Description.—Shell large, thick fusiform, evenly elliptical, straight axis of coiling, bluntly pointed polar ends, convex to straight lateral slopes. Specimens six volutions, 7.36 to 10.12 mm long, 2.52 to 3.98 mm wide, form ratio 1.6 to 2.0 first volution, 2.4 to 2.9 last volution. Proloculus large, 270 to 330 microns, some of larger irregular in shape. All volutions loosely coiled, expansion rapid. Chamber height increases slightly center to poles. Spirotheca normally thin inner two volutions, twenty to forty microns, but becomes rather thick outer volutions, 70 to 110 microns, coarsely alveolar. Septa highly fluted into high regular folds extending across entire chamber, chamberlets formed entire length. Tunnel moderately broad, irregular, chomata rudimentary or lacking, axial fillings present in some specimens in end zones of all volutions and part way up chambers, absent entirely in other specimens.

Table of Measurements

	Specimens 188	189	190	191
Proloculus (mm)	.28	.33	.31	.27

	Vol.	Specimens 188	189	190	191
	1	.36	.25	.36	.28
Radius-	2	.56	.39	.57	.44
vector	3	.84	.56	.84	.68
(mm)	4	1.19	.78	1.11	.90
	5	1.57	1.00	1.52	1.20
	6	1.99	1.26	1.83	1.57

	Vol.	Specimens 188	189	190	191
	1	.57	.40	.70	.56
Half-	2	1.07	.77	1.14	1.06
length	3	1.55	1.27	1.58	1.64
(mm)	4	2.43	2.04	2.58	2.10
	5	3.59	2.76	3.62	3.12
	6	4.70	3.68	4.80	4.26

	Vol.	Specimens 188	189	190	191
	1	1.6	1.6	1.9	2.0
Form-	2	1.9	2.0	2.0	2.4
ratio	3	1.8	2.3	1.9	2.3
	4	2.0	2.6	2.3	2.6
	5	2.3	2.8	2.4	2.7
	6	2.4	2.9	2.6	2.8

	Vol.	Specimens 188	189	190	191
	1	.05	.02	.03	.04
Wall-	2	.05	.02	.05	.05
thick.	3	.06	.04	.05	.04
(mm)	4	.08	.04	.08	.07
	5	.11	.06	.12	.10
	6	.09	.07	.06	.11

Discussion.—Because *Schwagerina güembeli* var. *pseudoregularis* Dunbar & Skinner falls within the range of variation of *Schwagerina crassitectoria,* Ross (1960) considers the former to be a synonym of the latter and the writer has referred the forms to *S. crassitectoria* without question since the thin walls of the early whorls, high and regular septal folds, distinctive secondary fillings, and the thick fusiform shape seem to fit the description by Ross (1960) for *S. crassitectoria. S. crassitectoria* greatly resembles *S. güembeli* and there is an apparent gradation between the two. Its more elongate fusiform shape distinguishes it, however. Twenty good specimens were studied. Holotype from 400 to 500 feet above base of Leonard Formation, eastern Glass Mountains, Texas.
Occurrence.—*S. crassitectoria* occurs abundantly in Pequop Mountains throughout most of the Pequop Formation in units 46, 52, 53, 58, 59, 62, 66, 69, 70, 72, 74, and hence ranges from Early to Late Leonardian in age. It is usually found associated with *S. güembeli* Dunbar & Skinner.
Repository.—BYU 188, 189, 190, 191.

Schwagerina hessensis Dunbar & Skinner
Pl. 18, fig. 2 ,3.

Schwagerina hessensis DUNBAR & SKINNER, 1937, Univ. Texas Bull. 3701, p. 630-632, pl. 58, figs. 1-11.
Description.—Shell large, fusiform, nearly straight axis of coiling, polar extremities bluntly truncated, commonly extended at maturity, steeply convex to straight lateral slopes. Specimens six to seven volutions, 9.08 to 11.86 mm long, 3.10 to 4.24 mm wide, form ratio first volution 1.6 to 2.3, last volution 2.5 to 3.3. Proloculus large, 200 to 400 microns. Volutions expand rapidly from first. Spirotheca thick and finely to coarsely alveolar, 20 to 65 microns first volution, 80 to 120 microns last volution. Septa regularly and strongly fluted, septal loops high and narrow, cell-like chamberlets basally. Tunnel narrow and inconspicuous, chomata absent. Axial filling normally not developed. Phrenotheca abundantly present in all outer volutions.

Table of Measurements
Specimens

	192	193	194	195
Proloculus (mm)	.20	.27	.27	.27

	Vol.	Specimens 192	193	194	195
	1	.28	.28	.30	.23
Radius-	2	.50	.45	.54	.35
vector	3	.80	.68	.78	.50
(mm)	4	1.22	1.08	1.13	.85
	5	1.65	1.45	1.59	1.18
	6	2.12	1.80	1.87	1.50?
	7				1.87?

	Vol.	Specimens 192	193	194	195
	1	.77	.61	.64	.40
Half-	2	1.58	1.14	1.05	.78
length	3	2.74	1.79	1.69	1.25
(mm)	4	4.00	2.90	2.74	1.91
	5	4.99	3.71	4.15	2.73
	6	5.80	4.54	5.93	4.00
	7				5.41

	Vol.	Specimens 192	193	194	195
	1	2.7	2.3	2.1	1.7
Form-	2	3.2	2.5	1.9	2.2
ratio	3	3.4	2.6	2.2	2.5
	4	3.3	2.7	2.4	2.3
	5	3.0	2.5	2.6	2.3
	6	2.7	2.5	3.2	2.7
	7				2.9

	Vol.	Specimens 192	193	194	195
	1	.06	.03	.03	.02
Wall-	2	.05	.05	.04	.04
thick.	3	.08	.05	.06	.05
(mm)	4	.09	.08	.09	.07
	5	.12	.11	.11	.08
	6	.09	.10	.08	.10
	7				.11

Discussion.—This species is marked by its large proloculus, loosely coiled shell, thick walls, bluntly truncated poles, and abundant phrenotheca. It resembles *S. diversiformis* Dunbar & Skinner, but has a larger proloculus, less numerous whorls for a given diameter, and lacks axial deposits. It also resembles *S. huecoensis* Dunbar & Skinner, but is more inflated, has higher volutions, and a narrower tunnel. Ten excellent specimens were studied. Holotype from base of Leonard Formation on Dugout Mountain, western Glass Mountains, Texas.

Occurrence.—*S. hessensis* occurs in Pequop Mountains in units 52, 53, 54, 55, and 60 of the Early Leonardian part of the Pequop Formation.

Repository.—BYU 192, 193, 194, 195.

Schwagerina sp. aff. *S. moormanensis* Knight
Pl. 18, fig. 5.

Schwagerina moormanensis KNIGHT, 1956, Jour. Paleontology, v. 30, p. 781-782, pl. 84, figs. 4-5.

Description.—Shell large, elongate fusiform, curved axis of coiling, poles pointed inner volutions, rounded outer volutions, straight to slightly concave lateral slopes. Specimens five to six volutions, 8.50 to 9.06 mm long, 2.20 to 2.50 mm wide, form ratio 1.6 to 2.3 first volution, 4.1 to 5.3 last volution. Proloculus large, varies 220 to 320 microns, subspherical. Shell tightly coiled inner two to three volutions expanding uniformly outer volutions. Chamber height increases slowly equator to poles. Spirotheca moderately thin, finely alveolar, 20 to 30 microns first volution; 60 to 90 microns last volution. Septa strongly and regularly to irregularly folded throughout shell and septal arches extend nearly height of chambers, extremely vesicular folding in polar regions. Tunnel not well defined, chomata absent. Axial fillings in end zones of inner two to four volutions.

Table of Measurements

	Specimens 196	197	198
Proloculus (mm)		.22	.22

	Vol.	Specimens 196	197	198
	1	.24	.30	.29
Radius-	2	.42	.49	.40
vector	3	.64	.73	.54
(mm)	4	.83	.98	.61
	5	1.10		

	Vol.	Specimens 196	197	198
	1	.59	.49	.60
Half-	2	.98	1.09	1.10
length	3	1.64	1.74	1.99
(mm)	4	2.56	3.06	3.20
	5	4.53	4.25	

	Vol.	Specimens 196	197	198
	1	2.3	1.6	2.1
Form-	2	2.3	2.2	2.8
ratio	3	2.6	2.4	3.7
	4	3.1	3.1	5.3
	5	4.1		

	Vol.	Specimens 196	197	198
	1	.03	.02	.02
Wall-	2	.04	.05	.04
thick.	3	.07	.08	.05
(mm)	4	.07	.09	.06
	5	.06		

Discussion.—These forms are referred with some question to *S. moormanensis* since they all have fewer volutions than the holotype described by Knight. They do, however, have the other characteristics given for *S. moormanensis* and hence, are referred to this species.

S. moormanensis is similar to *S. franklinensis* Dunbar & Skinner, but differs in having a shorter diameter, a form ratio of about 5.0 at maturity instead of 3.8, and a less cylindrical shape. Four specimens were studied, two of which were poorly preserved. Holotype from middle of section at Moorman Ranch, White Pine County, Nevada.

Occurrence.—*S.* sp. aff. *S. moormanensis* occurs in Pequop Mountains in units 57, 65, 81, of Early, Medial, and Late Leonardian parts of the Pequop Formation.
Repository.—BYU 196, 197, 198.

Schwagerina sp. aff. *S. gruperaensis* Thompson & Miller
Pl. 18, fig. 4.

Schwagerina gruperaensis THOMPSON & MILLER, 1944, Jour. Paleontology, v. 18, p. 495, pl. 79, figs. 1-4.

Description.—Shell large, hexagonal, middle third cylindrical, straight axis of coiling, lateral slopes steep convex to concave, poles rather sharply pointed. Specimens six to seven volutions, 8.94 to 13.96 mm long, 3.42 to 4.04 mm wide, form ratio 1.5 to 2.3 first volution, 2.3 to 3.0 last volution. Outer five volutions have same outline.

Proloculus large and spherical, 300 to 390 microns. Shell expansion slow and uniform, chamber height increases slightly equator to poles. Spirotheca thick and coarsely alveolar, 20 to 40 microns first volution, 90 to 120 microns outer volution. Fluting intense, with folds of adjacent septa meeting to form closed chamberlets. Tunnel wide, chomata lacking. Dense secondary deposits fill narrow polar region, as well as areas adjacent to tunnel, with intervening lateral regions free of such deposits. Fillings found in all volutions.

Table of Measurements

	Specimens			
	199	200	242	243
Proloculus (mm)	.39	.37	.33	.33

	Vol.	Specimens 199	200	242	243
Radius-vector (mm)	1	.36	.30	.45	.29
	2	.57	.44	.63	.52
	3	.78	.69	.89	.79
	4	1.09	.95	1.29	1.12
	5	1.41	1.31	1.59	1.45
	6	1.85	1.71	1.99	1.88
	7				

	Vol.	Specimens 199	200	242	243
Half-length (mm)	1	.77	.60	.85	.67
	2	1.20	1.10	1.29	1.31
	3	1.93	1.73	1.96	2.19
	4	2.77	2.27	3.22	3.16
	5	3.54	3.54	3.99	4.30
	6	4.47	4.95	6.10	5.60
	7			6.98	

	Vol.	Specimens 199	200	242	243
Form-ratio	1	2.1	2.0	1.9	2.3
	2	2.1	2.5	2.1	2.5
	3	2.5	2.5	2.2	2.8
	4	2.5	2.4	2.6	2.8
	5	2.5	2.7	2.5	3.0
	6	2.4	2.9	3.1	3.0
	7				

	Vol.	Specimens 199	200	242	243
Wall-thick. (mm)	1	.04	.01	.03	
	2	.04	.02	.03	.05
	3	.05	.03	.05	.06
	4	.06	.05	.07	.09
	5	.12	.08	.10	.10
	6	.10	.10	.11	.09
	7				

Discussion.—This species is similar in shape to *Schwagerina güembeli* Dunbar & Skinner, but is considerably longer, somewhat wider, and has a smaller form ratio. Also, *S. güembeli* has fewer volutions and a different distribution of secondary deposits. The distinctive hexagonal outline and the unusual secondary deposits should distinguish this species from other species of *Schwagerina*. The forms also resemble *Parafusulina sonoranensis* Dunbar, but lack the cuniculi characteristic of *Parafusulina*. Eight good specimens were studied.The holotype of this form is described by Thompson & Miller from Mexico.

Occurrence.—*Schwagerina* sp. aff. *S. gruperaensis* occurs in Pequop Mountains in units 58, 73, 75, 76 of the Early and Late Leonardian parts of the Pequop Formation.
Repository.—BYU 199, 200, 242, 243.

Schwagerina sp. aff. *S. retusa* Knight
Pl. 18, fig. 6.

Schwagerina retusa KNIGHT, 1956, Journ. Paleontology, v. 30, p. 783-784, pl. 84, figs. 10, 11.

Description.—Tests medium-sized, inflated fusiform, straight axis of coiling, bluntly pointed poles, evenly convex to slightly concave lateral slopes. Two individuals studied six to seven volutions, 9.22 to 9.60 mm long, 3.52 to 3.58 mm wide, form ratio 1.3 to 1.8 first volution, 2.6 to 2.7 last volution. Axial profile constant after first two pointed poles. Proloculus large, 360 to 410 microns. Shell expansion uniform, loosely coiled. Spirotheca thick, moderately coarsely alveolar, 20 to 30 microns first volution, 100 to 140 microns outer volution. Septa strongly fluted throughout shell length, shows tendency toward triangular axial loops. Tunnel narrow, chomata absent. Strong band of axial filling present in all except outer two whorls.

Table of Measurements

	Specimens	
	244	245
Proloculus (mm)	.41	

	Vol.	Specimens 244	245
Radius-vector (mm)	1	.35	.33
	2	.53	.49
	3	.76	.75
	4	1.06	1.06
	5	1.40	1.40
	6	1.76	1.79

	Vol.	Specimens 244	245
Half-length (mm)	1	.47	.73
	2	.90	1.14
	3	1.40	1.85
	4	2.64	2.59
	5	3.52	3.39
	6	4.80	4.61

	Vol.	Specimens 244	245
Form-ratio	1	1.3	1.8
	2	1.7	2.2
	3	1.8	2.3
	4	2.5	2.5
	5	2.5	2.5
	6	2.7	2.6

	Vol.	Specimens 244	245
Wall-thick. (mm)	1	.03	.03
	2	.04	.06
	3	.06	.08
	4	.09	.12
	5	.11	.11
	6	.10	.14

Discussion.—Because these forms are larger than the holotype of *S. retusa*, they are referred to the species with question. They do, however, have the same shape and axial fillings. Further study with more specimens may prove them to be another species. *S. retusa* is much shorter than *Parafusulina diabloensis* Dunbar & Skinner, although there is a resemblance in general appearance. Also, it lacks the cuniculi characteristic of *Parafusulina*. Only two good specimens were studied. Holotype from 200 feet below top of section 1 near Moorman Ranch, White Pine County, Nevada.

Occurrence.—*S.* sp. aff. *S. retusa* occurs in Pequop Mountains in units 70, 71, 79, of the Late Leonardian part of the Pequop Formation.

Repository.—BYU 244, 245.

Genus PARAFUSULINA Dunbar & Skinner, 1931

Coogan (1960, p. 262-264) subdivided the genus *Parafusulina* into four subgenera on the basis of difference in size, shape, cuniculi development, and number of volutions. The writer attempted to apply this classification in the present study, but found it lacked utility, and therefore it is not accepted.

Parafusulina schucherti Dunbar & Skinner
Pl. 18, figs. 7, 8.

Parafusulina schucherti DUNBAR & SKINNER, 1937, Univ. Texas Bull. 3701, v. 3, pt. 2, p. 672-674, pl. 64, figs. 9-12.

Parafusulina (*Skinnerella*) *schucherti* COOGAN, 1960, Univ. California Pub. Geol. Sciences, v. 36, no. 5, p. 262-263, pl. 23, fig. 3.

Description.—Shell large, thickly fusiform, straight axis of coiling, rather neatly pointed poles, convex lateral slopes. Specimens six to seven volutions, 10.74 to 14.60 mm long, 3.32 to 4.98 mm wide, form ratio 1.4 to 2.0 first volution, 2.5 to 3.3 last volution. Early volutions inflated fusiform with pointed poles, later volutions tend to elongate. Proloculus large, subspherical, 260 to 350 microns. Shell rather tightly coiled inner three volutions, but expands uniformly in later volutions. Chamber height increases moderately equator to poles. Spirotheca coarsely alveolar, 10 to 50 microns first volution, 100 to 140 microns last volution. Septa fluted heavily and high entire shell length, cuniculi present in outer few volutions, but early stage of development. Tunnel narrow and irregular, chomata absent. Strong secondary filling coats polar regions of inner four to five volutions, and coats wall some distance on each side of tunnel.

Table of Measurements

	Specimens 287	288	289	290
Proloculus (mm)	.35	.33	.34	

	Vol.	Specimens 287	288	289	290
Radius-vector (mm)	1	.45	.34	.37	.36
	2	.68	.49	.65	.58
	3	.93	.60	.96	.84
	4	1.25	.85	1.29	1.14
	5	1.59	1.13	1.73	1.45
	6	2.16	1.41	2.19?	1.86?
	7	2.49	1.82		

	Vol.	Specimens 287	288	289	290
Half-length (mm)	1	.67	.46	.72	.62
	2	1.15	.89	1.30	1.23
	3	1.72	1.64	1.89	1.69
	4	2.60	2.19	3.20	2.60
	5	3.00	3.46	5.12	3.98
	6	4.61	4.77	6.89	6.19
	7	7.30?	5.06		

	Vol.	Specimens 287	288	289	290
Form-ratio	1	1.5	1.4	1.9	1.7
	2	1.7	1.8	2.0	2.1
	3	1.9	2.7	2.0	2.0
	4	2.1	2.6	2.5	2.3
	5	1.9	3.1	3.0	2.7
	6	2.1	3.4	3.2?	3.3
	7	2.9?	3.9		

	Vol.	Specimens 287	288	289	290
Wall-thick. (mm)	1	.03	.01	.04	.05
	2	.05	.03	.06	.05
	3	.06	.03	.09	.07
	4	.07	.05	.10	.09
	5	.10	.10	.12	.12
	6	.13	.09	.10	.11
	7	.14	.13		

Discussion.—The forms here referred to *Parafusulina schucherti* are somewhat larger in all measurements than in the tables given by Dunbar & Skinner for their specimens. It is noted, however, that their tables do not contain the largest measurements as described in their text. Therefore, since the forms here described are in the same proportions, although larger, and appear to be identical with the holotype, they are referred without question to *P. schucherti. P. schucherti* resembles *P. splendens* Dunbar & Skinner, especially in the arrangement of axial fillings, but is less slender, has a smaller proloculus, and is found lower in the section. Closest affinity appears to be with *P. diabloensis* Dunbar & Skinner which has similar axial deposits. *P. diabloensis* however, has a larger proloculum, more open whorls, and a thicker wall. Eighteen well preserved specimens were studied. Holotype from lower Bone Spring Formation south of Victoria Peak, Sierra Diablo, Texas.

Occurrence.—*P. schucherti* occurs in Pequop Mountains in units 49, 52, 53, 54, 55, and 60, and, in conjunction with associated *P. bakeri* Dunbar & Skinner, is used to delineate the Early Leonardian part of the Pequop Formation.
Repository.—BYU 287, 288, 289, 290.

Parafusulina bakeri Dunbar & Skinner

Pl. 18, figs. 9, 10.

Parafusulina bakeri DUNBAR & SKINNER, 1937, Univ. Texas Bull. 3701, v. 3, pt. 2, p. 677-678, pl. 71, figs. 1-10.

Parafusulina (*Skinnerella*) *bakeri* COOGAN, 1960, Univ. California Pub. Geol. Sciences, v. 36, no. 5, p. 262-263, pl. 23, fig. 3.

Description.—Shell large, subcylindrical, straight to slightly curved axis of coiling, bluntly pointed to rounded poles, convex lateral slopes. Specimens six to seven volutions, 12.10 to

13.92 mm long, 3.50 to 4.32 mm wide, form ratio 1.5 to 2.5 first volution, 2.8 to 3.3 last volution. Proloculus large, thick walled, spherical, 370 to 420 microns. First two volutions rather tightly coiled and thickly fusiform, uniform expansion later volutions, ends become blunter with growth, adults become cylindrical with little inflation. Spirotheca thin to moderately thick, coarsely alveolar, 20 to 30 microns first volution, 90 to 110 microns last volution. Septa abundant, regularly and highly fluted, numerous closed chamberlets formed, cuniculi in early form of development present in outer whorls. Tunnel moderate and difficult to measure, no trace of chomata, slight axial fillings end zones of first few volutions.

Table of Measurements

	Specimens 291	292	293
Proloculus (mm)	.42	.56	.66

	Vol.	Specimens 291	292	293
	1	.30	.37	.44
Radius-	2	.45	.57	.60
vector	3	.67	.81	.81
(mm)	4	.99	1.12	1.09
	5	1.14	1.46	1.40
	6	1.48	1.84	1.75
	7	1.84?	2.16	

	Vol.	Specimens 291	292	293
	1	.75	.56	.66
Half-	2	1.36	1.09	1.03
length	3	2.03	1.80	1.62
(mm)	4	2.78	2.91	2.68
	5	3.52	3.89	3.50
	6	4.95	6.37	4.94
	7	6.05	6.96	

	Vol.	Specimens 291	292	293
	1	2.5	1.5	1.5
Form-	2	3.0	1.9	1.7
ratio	3	3.0	2.2	2.0
	4	2.8	2.6	2.5
	5	3.1	2.7	2.5
	6	3.3	3.5	2.8
	7	3.3	3.2	

	Vol.	Specimens 291	292	293
	1	.02	.03	.03
Wall-	2	.03	.04	.06
thick.	3	.04	.07	.07
(mm)	4	.06	.08	.06
	5	.09	.11	.05
	6	.10	.09	.05
	7			

Discussion.—This species resembles *Schwagerina hessensis* Dunbar & Skinner, but is larger and more nearly cylindrical. It also has reached the stage where cuniculi are present in the outer volutions, although it has not advanced far from the *Schwagerina-Parafusulina* transition. The species, with its blunt ends and cylindrical shape, also resembles *P. rothi* Dunbar & Skinner and *P. sellardsi* Dunbar & Skinner, but the species is older than both, smaller than *P. sellardsi,* has a larger proloculus and is thicker than *P. rothi,* and has cuniculi only in the outer volutions. Six specimens were studied, of which four are well-preserved. Holotype from Lower Leonard Formation, Glass Mountains, Texas.

Occurrence.—*P. bakeri* occurs in Pequop Mountains in units 52, 58, 59, 60, and in conjunction with associated *P. schucherti* Dunbar & Skinner is used to delineate Early Leonardian age strata of the Pequop Formation.
Repository.—BYU 291, 292, 293.

Parafusulina shaksgamensis crassimarginata Knight
Pl. 18, figs. 12, 14.

Parafusulina shaksgamensis crassimarginata KNIGHT, 1956, Jour. Paleontology, v. 30, p. 787-788, pl. 87, figs. 1-3.

Parafusulina (*Skinnerella*) *shaksgamensis crassimarginata* COOGAN, 1960, Univ. California Pub. Geol. Sci., v. 36, no. 5, p. 262-263, pl. 23, fig. 3.

Description.—Shell large to moderate, elongate-fusiform to cylindrical, straight axis of coiling, evenly convex lateral slopes, poles slightly pointed to bluntly rounded. Forms six to eight volutions, 10.38 to 13.90 mm long, 2.90 to 4.00 mm wide, form ratio 1.4 to 2.1 first volution, 2.6 to 3.4 last volution. Throughout growth, shape predominantly sharply pointed ellipse, becomes cylindrical often in outer two volutions. Proloculus thin walled, 240 to 380 microns. Shell loosely coiled, expands uniformly, gradual increase in chamber height equator to poles. Spirotheca moderately to coarsely alveolar, tectum and keriotheca well-developed, 20 to 30 microns first volution, 80 to 130 microns last volution. Septa strongly and evenly fluted throughout shell length, cuniculi found at least in outer three volutions. Tunnel narrow and indistinct, chomata absent, light axial fillings in end zones of all but outer two to three volutions.

Table of Measurements

	Specimens 294	295	296	297
Proloculus (mm)	.28	.24	.37	.38

	Vol.	Specimens 294	295	296	297
Radius-vector (mm)	1	.22	.18	.38	.45
	2	.35	.30	.55	.68
	3	.49	.45	.79	.90
	4	.70	.63	1.05	1.11
	5	.97	.87	1.40	1.60
	6	1.23	1.10	1.79	1.90
	7	1.55	1.45		
	8	1.90			

	Vol.	Specimens 294	295	296	297
Half-length (mm)	1	.40	.30	.78	.76
	2	.79	.63	1.17	1.67
	3	1.23	1.00	1.87	2.45
	4	1.71	1.58	3.00	3.57
	5	2.58	2.24	4.70	4.54
	6	3.78	3.44	6.00	5.35
	7	4.51	4.93	6.95	
	8	5.76	6.72		

	Vol.	Specimens 294	295	296	297
Form-ratio	1	1.8	1.7	2.1	1.7
	2	2.3	2.1	2.1	2.5
	3	2.5	2.2	2.4	2.7
	4	2.5	2.5	2.9	3.2
	5	2.7	2.6	3.4	2.8
	6	3.1	3.1	3.4	2.8
	7	2.9	3.4		
	8	3.0			

	Vol.	Specimens 294	295	296	297
Wall-thick. (mm)	1	.02	.02	.02	.10
	2	.03	.03	.03	.07
	3	.05	.05	.04	.09
	4	.07	.06	.08	.12
	5	.07	.07	.09	.13
	6	.05	.09	.08	.10
	7	.10	.13		
	8	.07	.08		

Discussion.—The forms here referred to *Parafusulina shaksgamensis crassimarginata* appear to be perfect in most respects with the holotype reported by Knight, but they are slightly larger in size. However, overall proportions and characteristics are very similar. The variety differs from the typical *P. shaksgamensis* in having lighter axial filling, thicker spirotheca at maturity, and shorter shell. It resembles *Schwagerina franklinensis* Dunbar & Skinner, but is differentiated from *Schwagerina* by presence of cuniculi. Thirteen good specimens were studied. Holotype of variety from Moorman Ranch, White Pine County, Nevada.

Occurrence.—Parafusulina shaksgamensis crassimarginata occurs in Pequop Mountains in units 59, 60, 66, 67, 69, and 74 of the Early to Late Leonardian part of the Pequop Formation.

Repository.—BYU 294, 295, 296, 297.

Parafusulina allisonensis Ross
Pl. 18, figs. 11, 13.

Parafusulina allisonensis ROSS, 1960, Contrib. Cushman Foundation Foram. Research, v. XI, pt. 4, p. 126, pl. 19, figs. 1-9.

Description.—Shell small to moderate, fusiform, nearly straight axis of coiling, slightly pointed to bluntly rounded poles, convex lateral slopes. Specimens five to six volutions, 7.64 to 7.74 mm long, 2.2 to 3.18 mm wide, form ratio 1.7 to 1.9 first volution, 2.4 to 2.7 last volution. Early volutions globose, but length gradually increases. Proloculus small, spherical, 250 to 340 microns. Shell loosely coiled, expansion rapid and even, chamber height increases center to poles. Spirotheca thin, coarsely alveolar, 30 microns first volution, 70 to 100 microns last volution. Septa highly fluted in regular folds, folds symmetrical and have rounded crests, cuniculi in outer two volutions. Tunnel medium width, chomata lacking, secondary deposits fill axial portions of test.

Table of Measurements

	Specimens 298	299
Proloculus (mm)	.34	.25

	Vol.	Specimens 298	299
Radius-vector (mm)	1	.26	.25
	2	.39	.42
	3	.57	.62
	4	.82	.89
	5	1.10	1.25
	6		1.59

	Vol.	Specimens 298	299
Half-length (mm)	1	.35	.43
	2	.75	.62
	3	1.35	1.23
	4	2.06	1.78
	5	3.00	2.62
	6	3.87	3.82

	Vol.	Specimens 298	299
Form-ratio	1	1.3	.17
	2	1.9	1.5
	3	2.4	2.0
	4	2.5	2.0
	5	2.7	2.1
	6		2.4

	Vol.	Specimens 298	299
Wall-thick. (mm)	1	.03	.03
	2	.04	.04
	3	.04	.05
	4	.09	.06
	5	.07	.10?
	6		.08

Discussion.—*Parafusulina allisonensis* differs from *P. retusa* Knight and *P. apiculata* Knight in having a different shape and ontogeny. It resembles *P. bakeri* Dunbar & Skinner but is smaller, has axial deposits, and has less fluted and more irregular septa. Two specimens were studied. Holotype from lower part of Hess member of Leonard Formation, eastern Glass Mountains, Texas.

Occurrence.—*Parafusulina allisonensis* occurs in Pequop Mountains in unit 58 of the Early Leonardian part of the Pequop Formation.

Repository.—BYU 298, 299.

Parafusulina subrectangularis Kling
Pl. 18, figs. 15, 17.

Parafusulina subrectangularis KLING, 1960, Jour. Paleontology, v. 34, p. 654, pl. 82, figs. 2-5.

Description.—Shell very large, subrectangular shape, straight axis of coiling, early poles sharply rounded, outer poles bluntly rounded to rectangular, gently convex to almost flat lateral slopes, often flattens across equator. Specimens seven to eight volutions, 15.6 to 19.24 mm long, but average 16.0 mm, 3.8 to 4.9 mm wide, form ratio 1.5 to 2.3 first volution, 3.5 to 4.1 last volution. Early volutions distinctly elongate with sharply pointed poles, outer volutions expanded and poles bluntly rounded. Proloculus large, spherical,270 to 450 microns diameter. Shell expansion gradual and regular. Spirotheca medium to thick, moderately alveolar, 20 to 50 microns first volution, 70 to 120 microns last volution. Septa regularly and intensely fluted, closely spaced with high septal loops inner and middle volutions, loops often fail to appear in outer volutions because septa widely spaced. Well developed cuniculi. Tunnel, moderate, chomata lacking, secondary fillings moderate to heavy inner three to five volutions only.

Table of Measurements

	Specimens 300	301	302	303
Proloculus (mm)	.30	.31	.27	.45

	Vol.	Specimens 300	301	302	303
	1	.27	.26	.24	
Radius-	2	.43	.37	.43	.47
vector	3	.62	.52	.68	.78
(mm)	4	.88	.78	1.00	1.12
	5	1.16	1.07	1.35	1.53
	6	1.48	1.50	1.77	2.02
	7	1.90	1.86	2.33?	2.45
	8		2.28		

	Vol.	Specimens 300	301	302	303
	1	.68	.46	.35	
Half-	2	.99	.87	.96	1.00
length	3	2.04	1.24	1.68	1.82
(mm)	4	2.73	2.05	2.54	3.75
	5	4.54	3.26	4.49	6.89
	6	6.79	4.89	7.07	8.44
	7	7.80	6.67	8.45	9.62
	8		8.00		

	Vol.	Specimens 300	301	302	303
	1	2.3	1.8	1.5	
Form-	2	2.3	2.4	2.2	2.1
ratio	3	3.3	2.4	2.5	2.3
	4	3.1	2.6	2.5	3.3
	5	3.9	3.0	3.3	4.5
	6	4.6	3.3	4.0	4.2
	7	4.1	3.6	3.7?	3.9
	8		3.5		

	Vol.	Specimens 300	301	302	303
	1	.02	.02	.04	
Wall-	2	.03	.03	.03	.05
thick.	3	.05	.03	.07	.05
(mm)	4	.07	.06	.07	.10
	5	.09	.07	.10	.12
	6	.11	.07	.09	.12
	7	.07	.09		.09
	8		.10		

Discussion.—The holotype was described by Kling (1960) from the middle of the Cochal Limestone of Leonardian to Guadalupean age from Purulha, Guatemala. The forms reported in the present study fit very well the descriptions and measurements given by Kling. The species is very distinctive, with a subrectangular outline, flattened equatorial regions, and narrow and pointed inner volutions. *Parafusulina subrectangularis* is similar in shape to *P. sellardsi* Dunbar & Skinner, which has similarly blunted poles. *P. subrectangularis,* however, is normally smaller, has a smaller proloculus, less numerous septa and less intense septal fluting. Seven well preserved and oriented specimens were studied. Holotype from middle part of Chochal Limestone, Purulha, Guatemala.

Occurrence.—*P. subrectangularis* occurs in Pequop Mountains in units 59, 69, and 70 of the Early and Late Leonardian portions of the Pequop Formation.

Repository.—BYU 300, 301, 302, 303.

Parafusulina sp. aff. *P. diabloensis* Dunbar & Skinner

Pl. 18, fig. 16.

Parafusulina diabloensis DUNBAR & SKINNER, 1937, Univ. Texas Bull. 3701, v. III, pt. 2, p. 674-675, pl. 60, figs. 8-11.

Parafusulina (*Skinnerella*) *diabloensis* COOGAN, 1960, California Univ. Pub. Geol. Sciences, v. 36, no. 5, p. 262, pl. 23, fig. 3.

Description.—Shell medium to large, rather thickly fusiform, straight axis of coiling, acutely pointed poles, and straight to gently convex lateral slopes. Specimens five to six volutions, 9.45 to 10.72 mm long, 3.48 to 3.50 mm wide, form ratio 1.4 to 1.6 first volution, 2.7 to 3.1 last volution. Early volutions loosely coiled. Proloculus large, spherical, 460 microns, early volutions short, outer volutions progressively elongated. Spirotheca moderately thick, coarsely alveolar, 20 to 30 microns first volution, 100 microns outer volution. Septa intensely fluted throughout most of shell length. Cuniculi present outer whorls, but in early stage of development. Tunnel moderately wide, chomata lacking. Strong axial filling in inner volutions, fill most of chambers. Filling also coats septa and walls in outer volutions.

Table of Measurements

	Specimens 304	305
Proloculus (mm)	.61	.46

EXPLANATION OF PLATE 17

FIG. 1, 4—*Pseudoschwagerina gerontica* Dunbar & Skinner
Axial sections, X5, BYU 158, 155.
FIG. 2—*Dunbarinella* sp.
Axial section, X10, BYU 354.
FIG. 3—*Schwagerina emaciata* (Beede)
Axial section, X7.5, BYU 159.
FIG. 5, 7—*Schwagerina dispansa* Ross.
Axial sections, X5, BYU 162, 164.
FIG. 6—*Schwagerina wellsensis* Thompson & Hansen.
Axial section, X5, BYU 166.
FIG. 8—*Schwagerina* cf. *S. diversiformis* Dunbar & Skinner.
Axial section, X5, BYU 170.
FIG. 9—*Schwagerina* sp. aff. *S. eolata* Thompson.
Axial section, X5, BYU 169.
FIG. 10, 11—*Schwagerina franklinensis* Dunbar & Skinner.
Axial sections, X5, BYU 172, 173.
FIG. 12—*Schwagerina* sp. aff. *S. linearis* Dunbar & Skinner.
Axial section, X5, BYU 176.
FIG. 13—*Schwagerina modica* Thompson & Hazzard.
Axial section, X7.5, BYU 180.
FIG. 14, 15—*Schwagerina güembeli* Dunbar & Skinner.
Axial sections, X5, BYU 184, 356.
FIG. 16—*Schwagerina crassitectoria* Dunbar & Skinner.
Axial section, X5, BYU 188.

EXPLANATION OF PLATE 18

FIG. 1—*Schwagerina crassitectoria* Dunbar & Skinner.
Axial section, X5, BYU 191.
FIG. 2, 3—*Schwagerina hessensis* Dunbar & Skinner.
Axial sections, X5, BYU 355, 192.
FIG. 4—*Schwagerina* sp. aff. *S. gruperaensis* Thompson & Miller.
Axial section, X5, BYU 199.
FIG. 5—*Schwagerina* sp. aff. *S. moormanensis* Knight.
Axial section, X5, BYU 196.
FIG. 6—*Schwagerina* sp. aff. *S. retusa* Knight.
Axial section, X5, BYU 244.
FIG. 7, 8—*Parafusulina schucherti* Dunbar and Skinner.
Axial sections, X5, BYU 287, 289.
FIG. 9—*Parafusulina bakeri* Dunbar & Skinner.
Axial section, X5, BYU 291.
FIG. 10—*Parafusulina bakeri* Dunbar & Skinner.
Tangential section, X5, BYU 357.
FIG. 11—*Parafusulina allisonensis* Ross.
Axial section, X5, BYU 298.
FIG. 13—*Parafusulina allisonensis* Ross.
Tangential section, X5, BYU 298.
FIG. 12, 14—*Parafusulina shaksgamensis crassimarginata* Knight.
Axial sections, X5, BYU 294, 296.
FIG. 15, 17—*Parafusulina subrectangularis* Kling.
Axial sections, X4.5, BYU 301, 300.
FIG. 16—*Parafusulina* sp. aff. *P. diabloensis* Dunbar & Skinner.
Axial section, X5, BYU 304.

PLATE 17

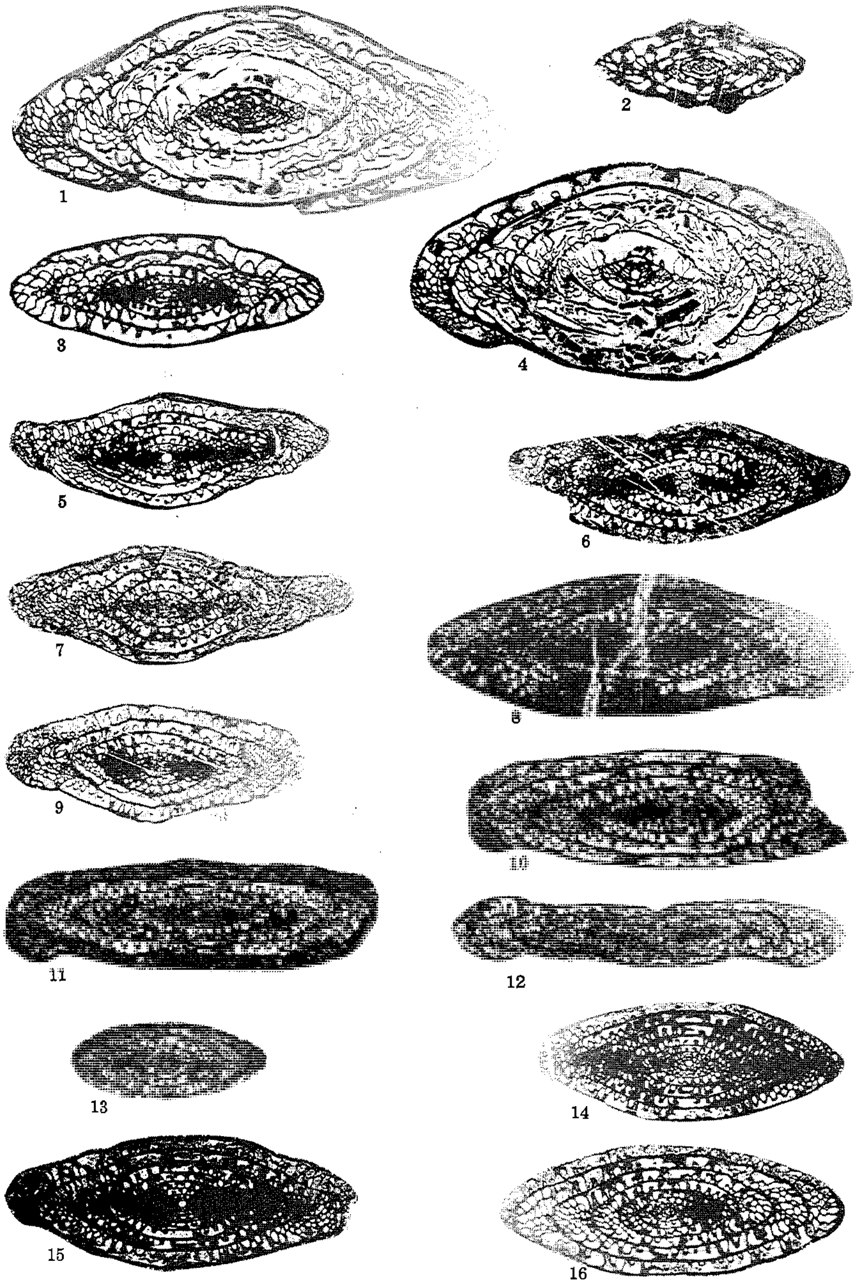


PLATE 18

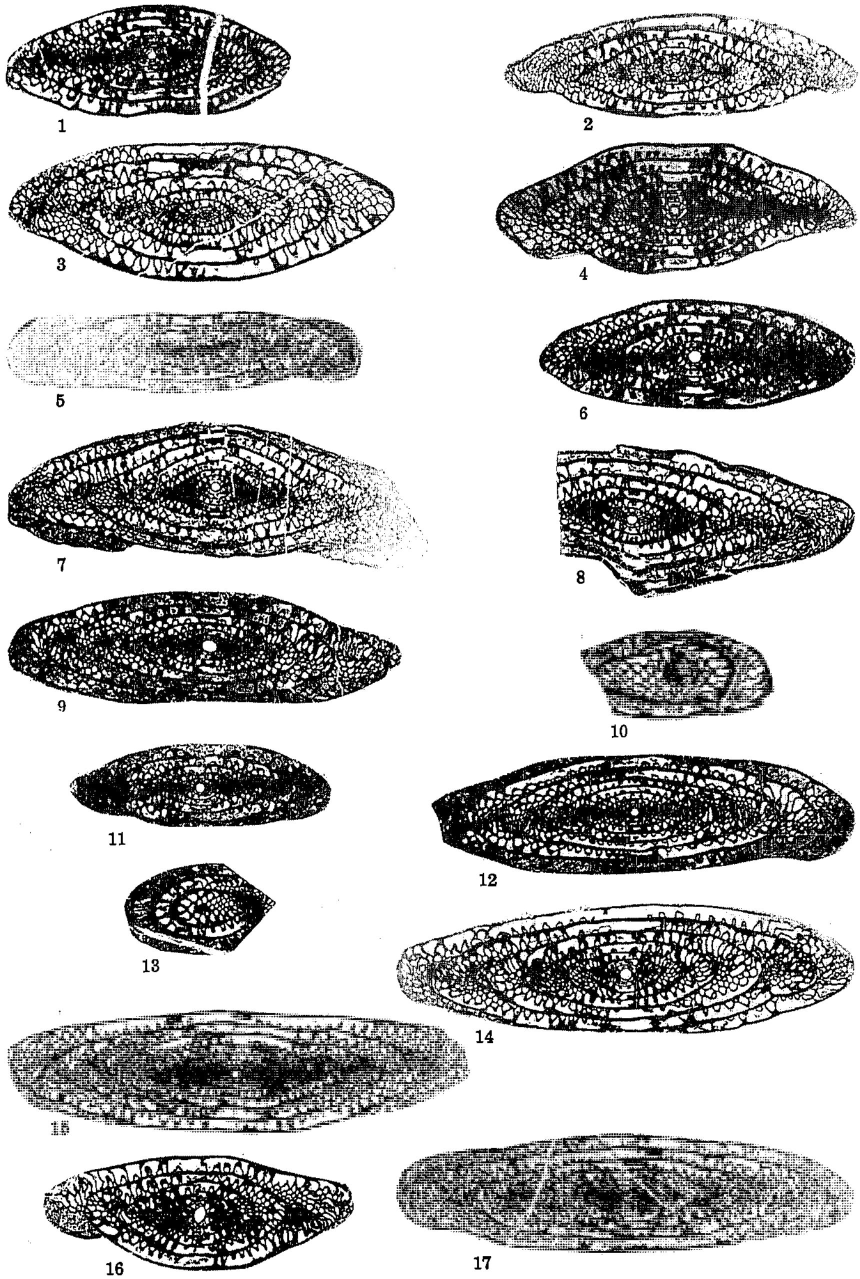


PLATE 19

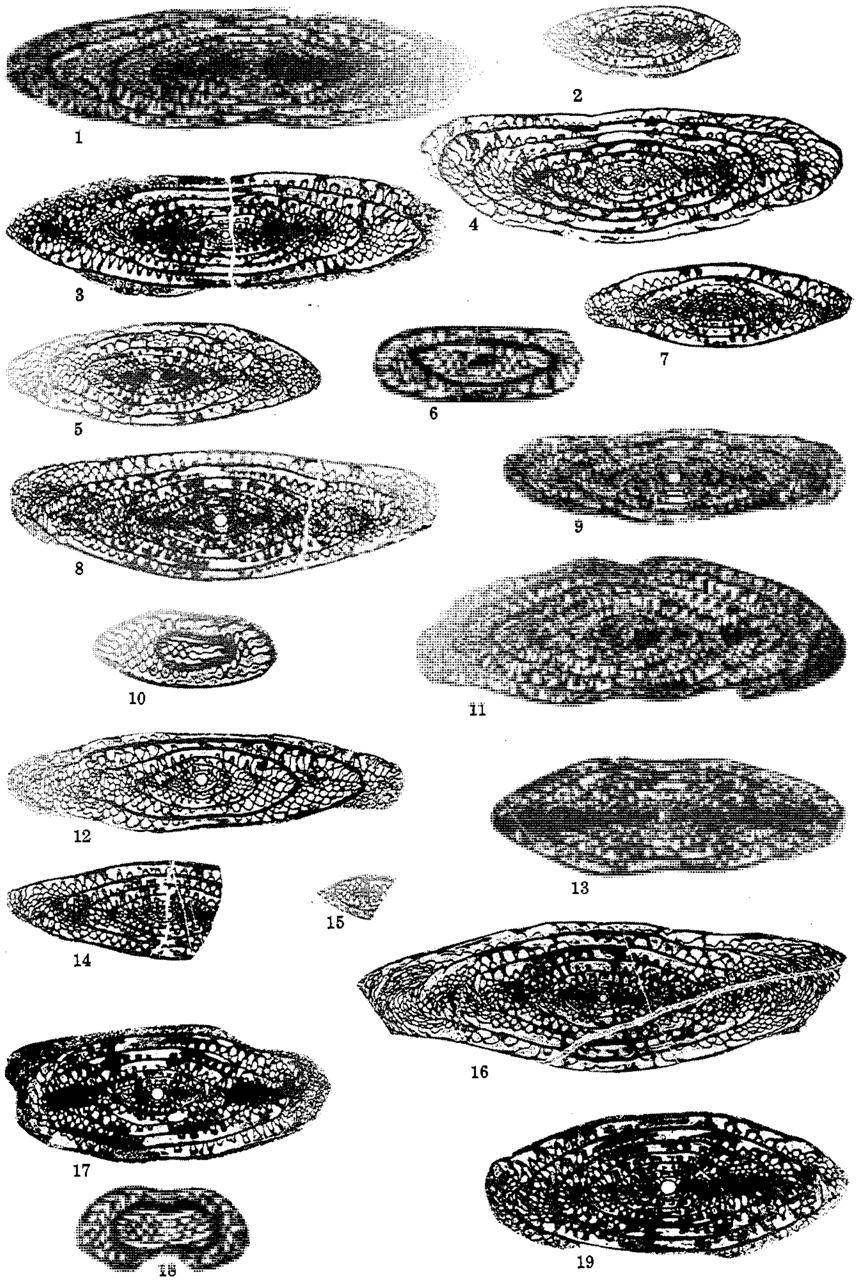
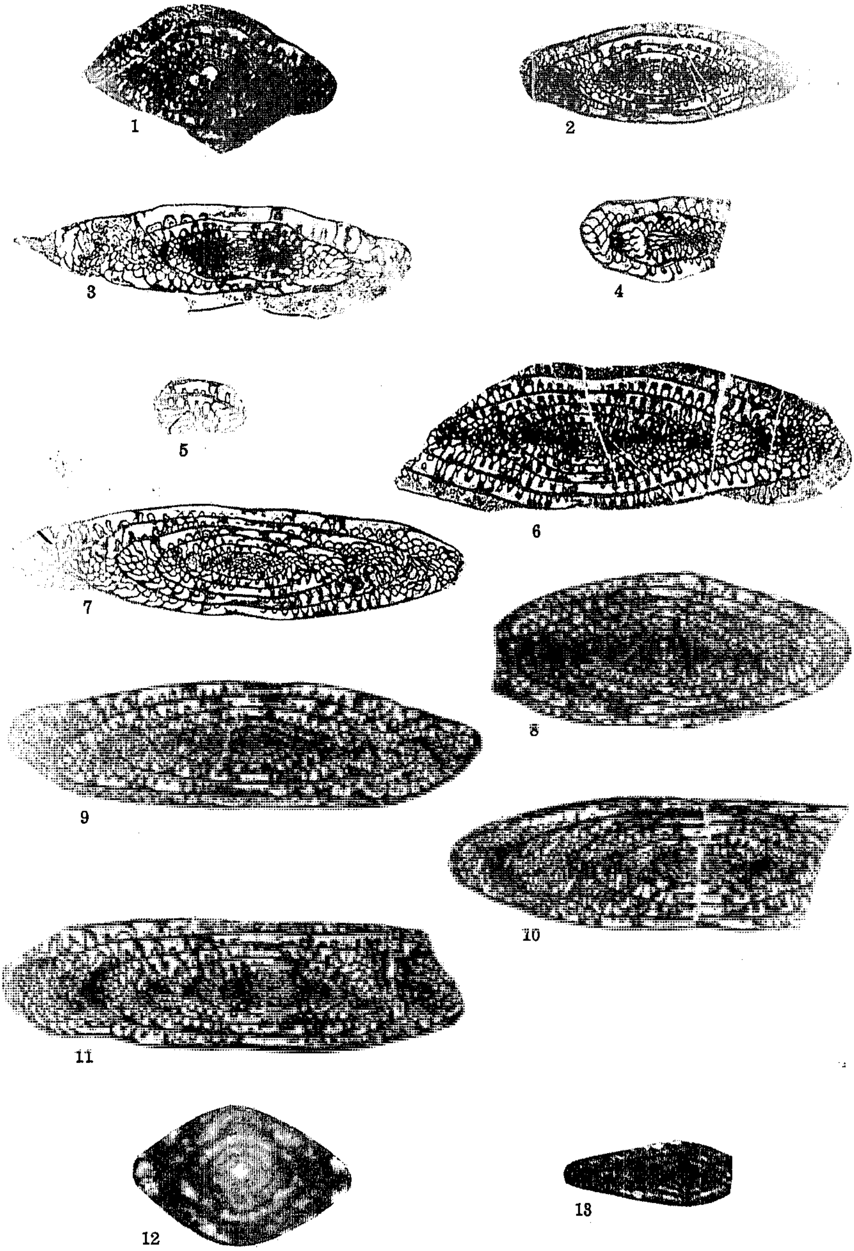


PLATE 20



EXPLANATION OF PLATE 19

FIG. 1, 3—*Parafusulina splendens* Dunbar & Skinner.
Axial sections, X4.5, & 5, BYU 306, 307.
FIG. 2—*Parafusulina spissisepta* Ross.
Axial section, X5, BYU 314.
FIG. 4—*Parafusulina* sp. aff. *P. visseri lata* Reichel.
Axial section, X5, BYU 310.
FIG. 5, 7—*Parafusulina deltoides* Ross.
Axial sections, X5, BYU 318, 319.
FIG. 6—*Parafusulina deltoides* Ross.
Tangential section, X5, BYU 318.
FIG. 8, 9—*Parafusulina bösei* Dunbar & Skinner.
Axial sections, X5, BYU 322, 323.
FIG. 10—*Parafusulina bösei* Dunbar & Skinner.
Tangential section, X5, BYU 322.
FIG. 11—*Parafusulina* sp. aff. *P. calx* Thompson & Wheeler.
Axial section, X5, BYU 326.
FIG. 12—*Parafusulina* cf. *P. kaerimizensis* (Ozawa).
Axial section, X5, BYU 329.
FIG. 13, 14—*Parafusulina brooksensis* Ross.
Axial sections, X5, BYU 330, 332.
FIG. 15—*Parafusulina brooksensis* Ross.
Tangential section, X5, BYU 332.
FIG. 16—*Parafusulina fountaini* Dunbar & Skinner.
Axial section, X5, BYU 334.
FIG. 17, 19—*Parafusulina* sp. aff. *P. sonoraensis* Dunbar.
Axial sections, X5, BYU 336, 337.
FIG. 18—*Parafusulina* sp. aff. *P. sonoraensis* Dunbar.
Tangential section, X5, BYU 337.

EXPLANATION OF PLATE 20

FIG. 1—*Parafusulina?* sp. aff. *P. turgida* Thompson & Wheeler.
Axial section, X5, BYU 340.
FIG. 2—*Parafusulina vidriensis* Ross.
Axial section, X5, BYU 341.
FIG. 3—*Parafusulina* sp.
Axial section, X5, BYU 345.
FIG. 4—*Parafusulina* sp.
Tangential section, X5, BYU 345.
FIG. 5—*Parafusulina rothi* Dunbar & Skinner.
Tangential section, X5, BYU 347.
FIG. 6, 7—*Parafusulina rothi* Dunbar & Skinner.
Axial sections, X5, BYU, 346, 347.
FIG. 8, 9, 10, 11—*Parafusulina sellardsi* Dunbar & Skinner
Axial sections, X5, BYU 353, 352, 350, 351.
FIG. 12—*Schubertella* sp.
Axial section, X25, BYU 358.
FIG. 13—*Boultonia* sp.
Axial section, X25, BYU 359.

	Vol.	Specimens 304	305
	1	.49	.39
Radius-	2	.71	.54
vector	3	1.02	.75
(mm)	4	1.25	1.08
	5	1.74	1.33
	6		1.75

	Vol.	Specimens 304	305
	1	.66	.64
Half-	2	1.26	1.10
length	3	1.73	1.60
(mm)	4	2.78	2.50
	5	4.73	3.38
	6		5.36

	Vol.	Specimens 304	305
	1	1.4	1.6
Form-	2	1.8	2.0
ratio	3	1.7	2.1
	4	2.2	2.3
	5	2.7	2.5
	6		3.1

	Vol.	Specimens 304	305
	1	.03	.03
Wall-	2	.04	.04
thick.	3	.05	.03
(mm)	4	.08	.08
	5	.10	.10
	6		.10

Discussion.—*P. diabloensis* resembles *Schwagerina diversiformis* Dunbar & Skinner in size and adult shape, and in possession of an axial filling, but differs in ontogeny, size of proloculus, thickness of walls, and in having more intense fluting. It also resembles *P. schucherti* Dunbar & Skinner, but has a more inflated shape. Two good specimens were studied. Holotype from lower Bone Spring Formation, Victorio Park, Sierra Diablo, Texas.

Occurrence.—*Parafusulina* sp. aff. *P. diabloensis* occurs in Pequop Mountains only in unit 60 of the upper beds of the Early Leonardian part of the Pequop Formation.
Repository.—BYU 304, 305.

Parafusulina splendens Dunbar & Skinner

Parafusulina splendens DUNBAR & SKINNER, 1937, Univ. Texas Bull. 3701, v. 3, pt. 2, p. 682; pl. 75, figs. 1-11.

Parafusulina (*Parafusulina?*) *splendens* COOGAN, 1960, Univ. of California Pub. Geol. Sci., v. 36, no. 5, p. 264.

Description.—Shell large, elongate-fusiform, gently convex lateral slopes, straight to slightly curved axis of coiling, acutely rounded poles. Specimens seven to eight volutions, 13.45 to 17.66 mm long, 3.64 to 4.52 mm wide, form ratio 1.6 to 1.8 first volution, 3.1 to 4.1 last volution. Early volutions have sharper poles than later ones. Proloculus large, ranging from 280 to 450 microns, commonly flattened on one or two sides, thick walled. Expansion of shell uniform after first two tightly coiled volutions. Chamber height increases slowly center to poles. Spirotheca medium to thick, 20 to 30 microns first volution, 90 to 120 microns last volution, moderately to coarsely alveolar. Septa numerous and intensely fluted with high septal loops, loops are crowded, narrow and high in axial sections. Cuniculi well developed in outer volutions. Tunnel moderate to wide, chomata lacking. Axial fillings prominent in end zones of inner three or four whorls.

Table of Measurements

	Specimens 306	307	308	309
Proloculus (mm)	.28	.27	.45	.40

	Vol.	Specimens 306	307	308	309
	1	.25	.24	.33	.31
Radius-	2	:41	.39	.50	.46
vector	3	.64	.63	.70	.68
(mm)	4	.88	.89	.95	.96
	5	1.16	1.16	1.23	1.24
	6	1.44	1.45	1.50	1.67
	7	1.74	1.82	1.87	
	8	2.11		2.26	

	Vol.	Specimens 306	307	308	309
	1	.40	.41	.60	.50
Half-	2	.89	.95	1.08	1.00
length	3	1.50	1.60	1.82	1.56
(mm)	4	2.48	2.57	2.28	2.33
	5	3.50	3.45	3.04	3.10
	6	4.92	4.83	4.04	5.09
	7	7.17	6.73	5.42	
	8	8.58?		6.84	

		Specimens			
	Vol.	306	307	308	309
	1	1.6	1.7	1.8	1.6
Form-	2	2.2	2.4	2.2	2.2
ratio	3	2.3	2.5	2.6	2.3
	4	2.8	2.9	2.4	2.4
	5	3.0	3.0	2.5	2.5
	6	3.4	3.3	2.7	3.1
	7	4.1	3.7	2.9	
	8	4.1?		3.0	

		Specimens			
	Vol.	306	307	308	309
	1	.02	.02	.02	.02
Wall-	2	.04	.04	.04	.02
thick.	3	.05	.05	.05	.05
(mm)	4	.05	.05	.08	.07
	5	.08	.08	.08	.07
	6	.08	.10	.12	.10
	7	.09	.10	.12	
	8				

Discussion.—The acute poles, crowded and high septal loops, low inner whorls, and distinctive axial fillings distinguish this species from other species of *Parafusulina.* Thirteen well-preserved and oriented specimens were studied. Holotype from 400 feet above base of Word Formation, Sullivan Peak, Glass Mountains, Texas.

Occurrence.—*Parafusulina spendens* occurs in Pequop Mountains in units 61, 72, 74, 75, 76, and 82 of the lower Early and Late Leonardian parts of the Pequop Formation.
Repository.—BYU 306, 307, 308, 309.

Parafusulina sp aff. *P. visseri lata* Reichel

Pl. 19, fig. 4.

Parafusulina visseri var. *lata* KNIGHT, 1956, Jour. Paleontology, v. 30, p. 788-789, pl. 87, figs. 5, 6.

Description.—Shell large, cylindrical, straight to slightly curved axis of coiling, bluntly rounded poles, straight to concave lateral slopes outer volutions. Specimens seven to eight volutions, 10.88 to 13.50 mm long, 3.50 to 4.20 mm wide, form ratio 1.4 to 1.7 first volution, 2.9 to 3.2 last volution. Early volutions have sharply rounded poles. Proloculus large, 270 to 380 microns, commonly flattened. Shell loosely coiled, expansion uniform. Chamber height increases rapidly in poles of the mature volutions. Spirotheca moderately thick, 30 to 50 microns first volution, 70 to 120 microns last volutions, moderately alveolar. Septal folding extends length of shell, extremely vesicular in outer whorls, high and rectangular in last two whorls. Cuniculi poorly developed. Tunnel moderate, chomata lacking, irregular secondary fillings. Phrenotheca in outer whorls.

Table of Measurements

Specimens

	310	311	312	313
Proloculus (mm)	.34	.38	.30	.27

		Specimens			
	Vol.	310	311	312	313
	1	.28	.28	.30	.31
Radius-	2	.43	.38	.42	.44
vector	3	.61	.57	.65	.62
(mm)	4	.89	.80	.92	.86
	5	1.22	1.14	1.20	1.08
	6	1.49	1.42	1.59	
	7	1.77	1.73	1.91	
	8	2.10	2.10		

		Specimens			
	Vol.	310	311	312	313
	1	.40	.46	.50	.52
Half-	2	.62	.90	.90	.88
length	3	1.08	1.65	1.61	1.43
(mm)	4	1.70	2.24	2.56	2.08
	5	3.09	3.18	3.67	2.80
	6	3.82	4.55	4.55	3.75
	7	5.13	5.78	5.44	
	8	6.39	6.75		

		Specimens			
	Vol.	310	311	312	313
	1	1.4	1.6	1.7	1.7
Form-	2	1.4	2.4	2.1	2.0
ratio	3	1.8	2.9	2.5	2.3
	4	1.9	2.8	2.8	2.4
	5	2.5	2.8	3.1	2.6
	6	2.6	3.2	2.9	
	7	2.9	3.3	2.9	
	8	3.0	3.2		

		Specimens			
	Vol.	310	311	312	313
	1	.03	.04	.03	.05
Wall-	2	.04	.04	.04	.08
thick.	3	.05	.04	.07	.07
(mm)	4	.08	.07	.08	.09
	5	.13	.08	.10	.10
	6	.05	.11	.12	.12
	7	.10	.08	.07	.07
	8	.06	.05		

Discussion.—The specimens here referred to *Parafusulina visseri lata* are based on the description given by Knight (1956, p. 788-789) for specimens collected in the Moorman Ranch area, White Pine County, Nevada. Knight had some doubt as to the validity of this species occurring in the area, because he points out the great similarity with *Schwagerina moormanensis* Knight and the fact that Reichel failed to illustrate an equatorial section of this variety. Therefore, the present forms are referred to the variety with some question. Knight (1956, p. 788-789) gives synonymy for this species. Twelve well preserved and oriented sections were obtained and studied. Holotype from upper Artinskian of Kashmir.

Occurrence.—*Parafusulina* sp. aff. *P. visseri lata* occurs in Pequop Mountains in units 61, 62, 65, and 67 of the Medial Leonardian portion of the Pequop Formation.

Repository.—BYU 310, 311, 312, 313.

Parafusulina spissisepta Ross
Pl. 19, fig. 2.

Parafusulina spissisepta ROSS, 1960, Contrib. Cushman Found. Foram. Research, v. XI, pt. 4, p. 127-128; pl. 18, figs. 7-13.

Description.—Shell small to medium, straight axis of coiling, poles bluntly pointed, gently convex lateral slopes. Specimens five to seven volutions, 5.86 to 9.40 mm long, 2.08 to 3.38 mm wide, form ratio 1.4 to 2.1 first volution, 2.4 to 2.9 last volution. First two or three volutions low and tightly coiled. Successive volutions increase in height and elongate. Proloculus medium to large, 240 to 350 microns, spherical. Expansion rapid last two volutions. Spirotheca moderately thin, 20 to 40 microns first volution, 90 to 100 microns last volution, moderately alveolar. Septa regularly fluted into high folds across entire chamber length. Folds closely spaced early volutions, more widely spaced outer volutions. Cuniculi low and primitive outer two or three volutions. Tunnel straight and narrow, chomata lacking. Secondary fillings coat septa near axis of coiling and little in end zones of inner two to three volutions.

Table of Measurements

	Specimens			
Proloculus	314	315	316	317
(mm)	.25	.28	.25	.27

	Vol.	314	315	316	317
	1	.26	.25	.24	.29
Radius-	2	.38	.32	.30	.40
vector	3	.50	.46	.51	.63
(mm)	4	.78	.69	.78	.85
	5	.97	.94	1.04	1.14
	6		1.27		1.45
	7				1.69

	Vol.	314	315	316	317
	1	.50	.27	.29	.60
Half-	2	.86	.65	.63	.82
length	3	1.14	1.03	1.03	1.29
(mm)	4	2.01	1.59	1.60	2.40
	5	3.00	2.30	2.93	3.05
	6		3.05		4.08
	7				4.70

	Vol.	314	315	316	317
	1	1.9	2.0	1.3	2.1
Form-	2	2.3	2.2	2.1	2.1
ratio	3	2.3	2.3	2.0	2.1
	4	2.6	2.4	2.1	2.8
	5	3.1	2.4	2.8	2.7
	6				2.8
	7				2.8

	Vol.	314	315	316	317
	1	.02	.04	.02	.02
Wall-	2	.03	.05	.02	.04
thick.	3	.05	.08	.03	.04
(mm)	4	.06	.10	.07	.08
	5	.07	.13	.10	.07
	6				.10
	7				.07

Discussion.—These forms of *Parafusulina spissisepta* are very typical of the species as described by Ross. They resemble *Schwagerina aculeata* Thompson and Hazzard, but differ in possessing cuniculi and having more regularly folded septa. *P. bakeri* Dunbar & Skinner is less tightly coiled in early whorls and has a different shape. *P. splendens* Dunbar & Skinner differs in shape, size, ontogeny, and axial deposit distribution. Fifteen well pre-

served and oriented specimens were studied. Holotype from 1,090 feet above base of Hess Member of Leonard Formation, eastern Glass Mountains, Texas.
Occurrence.—Parafusulina spissisepta occurs in Pequop Mountains in units 61, 62, 66, 68, 69, and 73 of the Medial and early Late Leonardian parts of the Pequop Formation.
Repository.—BYU 314, 315, 316, 317.

Parafusulina deltoides Ross
Pl. 19, figs. 5-7.

Parafusulina deltoides ROSS, 1960, Contrib. Cushman Found. Foram. Research, v. XI, pt. 4, p. 126-127; pl. 19, figs. 12, 13; pl. 20, figs. 1-5.

Description.—Shell medium to large, elongate fusiform, straight axis of coiling, acutely rounded and extended poles, straight to gently convex lateral slopes. Specimens six to seven volutions, 7.20 to 12.10 mm long, 2.66 to 3.78 mm wide, form ratio 1.4 to 2.1 first volution, 2.7 to 3.2 last volution. Early volutions low and long, polar regions extended outer volutions. Proloculus small to medium, 220 to 320 microns, spherical, thin walled. Expansion slow and uniform. Chamber height increases slowly center to poles. Spirotheca relatively thin, 20 to 40 microns first volution, 60 to 100 microns last volution, coarsely alveolar. Septa regularly fluted into high, closely spaced folds throughout entire chamber folds steep, narrow, and rectangular in outline. Cuniculi in third or fourth volution. Tunnel wide, chomata lacking, conical shaped secondary fillings in chambers of early volutions and often coating septal folds throughout test.

Table of Measurements

	Specimens			
Proloculus	318	319	320	321
(mm)	.25	.32	.27	.22

	Vol.	Specimens 318	319	320	321
	1	.20	.23	.24	.31
Radius-	2	.34	.32	.40	.51
vector	3	.49	.45	.60	.78
(mm)	4	.73	.68	.87	1.12
	5	1.00	.90	1.13	1.49
	6	1.38	1.33	1.46?	1.89
	7		1.63		

	Vol.	Specimens 318	319	320	321
	1	.28	.35	.46	.44
Half-	2	.59	.67	.82	.94
length	3	1.05	1.10	1.55	1.82
(mm)	4	1.98	1.72	2.56	2.90
	5	2.60	2.32	3.27	3.88
	6	4.00	3.40	4.75	6.05
	7		4.69		

	Vol.	Specimens 318	319	320	321
	1	1.4	1.5	1.9	1.4
Form-	2	1.7	2.1	2.1	1.8
ratio	3	2.1	2.5	2.6	2.3
	4	2.7	2.5	2.9	2.6
	5	2.6	2.6	2.9	2.6
	6	2.9	2.6	3.2	3.2
	7		2.8		

	Vol.	Specimens 318	319	320	321
	1	.04	.02	.02	.04
Wall-	2	.04	.03	.03	.04
thick.	3	.03	.04	.05	.05
(mm)	4	.02	.04	.08	.06
	5	.07	.06	.06	.10
	6	.09	.08		.10
	7		.09		

Discussion.—Parafusulina deltoides is very similar to *P. shaksgamensis crassimarginata* Knight, and is indeed, very difficult to distinguish even on the basis of measurements. The only notable differences appear to be flatter lateral slopes and extended polar regions of *P. deltoides.* Further study, however, may prove them to be the same species. *P. allisonensis* Ross has a different pattern of septal folds, is smaller per volution, and has axial deposits. *P. deltoides* differs from *P. skinneri* Dunbar in being more fusiform in shape and having more pointed poles. Twenty-eight specimens were identified and studied. Holotype from 640 feet above base of Hess Member of Leonard Formation, Glass Mountains, Texas.

Occurrence.—Parafusulina deltoides occurs in Pequop Mountains in units 61, 62, 66, 70, 72, 73, 74, 80, 82 of the Medial and Late Leonardian portions of the Pequop Formation.
Repository.—BYU 318, 319, 320, 321.

Parafusulina bösei Dunbar & Skinner
Pl. 19, figs. 8, 10.

Parafusulina bösei DUNBAR & SKINNER, 1937, Univ. Texas Bull. 3701, v. 3, pt. 2, p. 679; pl. 73, figs. 1-9.

Description.—Shell moderately large, fusiform, straight axis of coiling, well rounded poles, straight to slightly convex lateral slopes, becoming slightly concave in outer volutions. Specimens six volutions, 9.08 to 12.00 mm long, 2.98 to 4.0 mm wide, form ratio 1.4 to 1.8 first volution, 2.7 to 3.6 last volution. Profile changes from sharply pointed fusiform in early volutions to bluntly rounded poles at maturity. Proloculus large, usually spherical, often flattened, 430 to 550 microns. Early whorls low, expansion uniform, chamber height increases slowly center to poles. Spirotheca thin, 20 to 40 microns first volution, 90 to 100 microns last volution, coarsely alveolar. Septa intensely fluted and high throughout chamber, end zones very vesicular with fluting. Tunnel moderate in width, chomata absent. Slight secondary deposit coats septa on each side of tunnel, and partly fills end zones of inner two to three volutions. Phrenotheca present outer volutions.

Table of Measurements

	Specimens			
Proloculus	322	323	324	325
(mm)	.43	.41	.45	.55

		Specimens			
	Vol.	322	323	324	325
	1	.48	.39	.42	.50
Radius-	2	.69	.52	.60	.70
vector	3	.90	.70	.80	.97
(mm)	4	1.20	.93	1.08	1.27
	5	1.58	1.22	1.49	1.62
	6	1.85	1.51?		2.00

		Specimens			
	Vol.	322	323	324	325
	1	.65	.69	.76	.73
Half-	2	1.04	1.18	1.27	1.50
length	3	1.59	1.65	1.78	2.53
(mm)	4	2.90	2.92	2.80	3.53
	5	4.14	4.54	4.59	4.61
	6	5.08			6.00

		Specimens			
	Vol.	322	323	324	325
	1	1.4	1.8	1.8	1.5
Form-	2	1.5	2.3	2.1	2.1
ratio	3	1.8	2.4	2.2	2.6
	4	2.4	3.1	2.6	2.8
	5	2.6	3.0	3.1	2.8
	6	2.7			3.0

		Specimens			
	Vol.	322	323	324	325
	1	.04	.02	.02	.03
Wall-	2	.04	.04	.02	.06
thick.	3	.06	.05	.03	.07
(mm)	4	.09	.08	.05	.10
	5	.10	.10	.06	.14
	6	.09		.10	.09

Discussion.—The specimens resemble the associated species, *P. splendens,* Dunbar & Skinner, but are distinguished by their more bluntly rounded poles, lower and less crowded septal loops, larger proloculus, and lighter axial fillings. Eleven well preserved and oriented specimens were studied. Holotype of *P. bösei* from 400 feet above the base of the Word Formation, Glass Mountains, Texas.

Occurrence.—*P. bösei* occurs in Pequop Mountains in units 62, 67, 72, 74, 79, and 83 of the Medial and Late Leonardian portions of the Pequop Formation. Thus, a much lower range for *P. bösei* is recorded in Pequop Mountains area than in the Glass Mountains, Texas.

Repository.—BYU 322, 323, 324, 325.

Parafusulina sp. aff. *P. calx* Thompson & Wheeler
Pl. 19, fig. 11.

Parafusulina? calx THOMPSON & WHEELER, 1946, Geol. Soc. Amer. Mem. 17, p. 29-30; pl. 4, figs. 4-6; pl. 6, figs. 4, 5.

Description.—Shell large, inflated fusiform, straight axis of coiling, rather sharply pointed poles, low and flat to gently convex lateral slopes becoming slightly concave outer volutions. Specimens six to seven volutions, 12.72 to 14.58 mm long, 4.08 to 4.90 mm wide, form-ratio 1.3 to 1.6 first volution, 2.5 to 3.1 last volution. Early volutions almost round and loosely coiled. Proloculus large, 450 to 560 microns, spherical. Shell expansion uniform, chamber height increases slightly center to poles. Spirotheca thick, 30 to 70 microns first volution, 100 to 130 microns last volution, coarsely alveolar. Septa thin and very numerous, narrowly and highly fluted; fluting extends very high in chamber, almost to base of next volution, closed chamberlets high in chamber. Cuniculi well developed outer volutions. Tunnel low and narrow, chomata absent. Heavy secondary fillings in polar regions of inner volutions and irregularly on either side of tunnel.

Table of Measurements

	Specimens		
Proloculus	326	327	328
(mm)	.56	.45	.55

	Vol.	326	327	328
Radius-vector (mm)	1	.58	.67	.58
	2	.82	.93	.86
	3	1.12	1.21	1.25
	4	1.47	1.61	1.70
	5	1.76	2.02	2.05
	6	2.04		2.45

	Vol.	326	327	328
Half-length (mm)	1	.84	1.06	.78
	2	1.38	1.67	1.73
	3	2.50	2.56	2.70
	4	3.95	3.59	3.78
	5	5.13	5.08	5.12
	6	6.36		7.10?

	Vol.	326	327	328
Form-ratio	1	1.4	1.6	1.3
	2	1.7	1.8	2.0
	3	2.2	2.1	2.2
	4	2.7	2.2	2.2
	5	2.9	2.5	2.5
	6	3.1		2.9?

	Vol.	326	327	328
Wall-thick. (mm)	1	.04	.07	.03
	2	.05	.05	.04
	3	.08	.07	.05
	4	.06	.08	.10
	5	.10	.12	.09
	6	.13		.11

Discussion.—Parafusulina sp. aff. *P. calx* is perhaps closer to *Schwagerina* than to *Parafusulina.* It has a thicker wall than most *Parafusulina* specimens and differs in shape with its highly inflated fusiform outline. Its only distinguishing *Parafusulina* feature is its possession of cuniculi. The species resembles *Schwagerina hessensis* Dunbar & Skinner in outline, general nature of septal fluting, and spirotheca thickness. It differs, however, in possessing heavy axial fillings and more well developed cuniculi. Three specimens were studied. Holotype from 980 feet above the base of the McCloud Limestone in Northern California.

Occurrence.—Parafusulina sp. aff. *P. calx* occurs in Pequop Mountains in units 62, 72, 82 of the Medial and Late Leonardian portions of the Pequop Formation.
Repository.—BYU 326, 327, 328.

Parafusulina cf. *P. kaerimizensis* (Ozawa)
Pl. 19, fig. 12.

Schellwienia kaerimizensis OZAWA, 1925, Jour. Coll. Sci. Imp. Univ. Tokyo, v. XLV, art. 6, p. 31, 32, pl. IV, figs. 6, 7; pl. VI, fig. 5.

Pseudofusulina kaerimizensis HUZIMOTO, 1936, Sci. Repts. Tokyo Bunrika Daigaku, Sec. C, v. 1, no. 2, p. 65-67, pl. VII, figs. 6-8; pl. VIII, figs. 1-4.

Parafusulina kaerimizensis MORIKAWA, 1955, Sci. Repts. Saitama Univ., Ser. B, v. II, no. 1, p. 107, 108, pl. XV, figs. 11-13.

Description.—Shell moderately large, elongate fusiform, straight axis of coiling, straight to somewhat depressed medium portion, bluntly pointed poles, gently convex lateral slopes. Single specimen five volutions, 10.98 mm long, 3.00 mm wide, form ratio 1.1 first volution, 3.7 last volution. First volution subspherical, axis extends rapidly with growth. Proloculus large, 440 microns, subspherical. Shell expansion rapid and uniform. Chamber height increases slowly center to poles. Spirotheca moderate thickness, 40 microns first volution, 110 microns last volution, moderately coarsely alveolar. Septa highly and narrowly fluted throughout shell length, closed chamberlets reach almost to top of chamber. Cuniculi not observable on single specimen studied. Tunnel wide, chomata absent. No axial fillings on single specimen studied.

Table of Measurements

	Specimen
Proloculus	329
(mm)	.44

	Vol.	Specimen 329
	1	.44
Radius-	2	.64
vector	3	.90
(mm)	4	1.19
	5	1.50

	Vol.	Specimen 329
	1	.48
Half-	2	1.21
length	3	2.01
(mm)	4	3.75
	5	5.49

	Vol.	Specimen 329
	1	1.1
Form-	2	1.9
ratio	3	2.2
	4	3.2
	5	3.7

	Vol.	Specimen 329
	1	.04
Wall-	2	.05
thick.	3	.07
(mm)	4	.12
	5	.11

Discussion.—Only one specimen of this species was located and studied from Pequop Mountains, therefore the form is referred to *P. kaerimizensis* with some question. *P. kaerimizensis* is one of the most common species found in the middle Permian rocks of Japan.

Occurrence.—*P.* cf. *P. kaerimizensis* occurs in Pequop Mountains in unit 63 of the Medial Leonardian portion of the Pequop Formation.
Repository.—BYU 329.

Parafusulina brooksensis Ross
Pl. 19, figs. 13-15.

Parafusulina brooksensis ROSS, 1960, Contrib. Cushman Found. Foram. Research, v .XI, pt. 4, p. 129-130; pl. 20, figs. 7-14; pl. 21, figs. 1-4, 6.

Description.—Shell small to medium size, elongate fusiform to subcylindrical, straight axis of coiling, bluntly pointed poles, straight to slightly convex lateral slopes, concave outer volutions. Specimens six to seven volutions, 9.36 to 10.70 mm long, 3.10 to 3.38 mm wide, form ratio 1.3 to 2.5 first volution, 2.9 to 3.2 last volution. Initial volution low and long. Proloculus small, 220 to 340 microns, subspherical. Expansion increases rapidly between second and third volution, giving zoned appearance. Chamber height increases slightly center to poles. Spirotheca moderately thin, 20 to 30 microns first volution, 60 to 110 microns last volution, moderately coarsely alveolar. Septa strongly fluted into high and regular folds across full chamber length. Folds steep sided and have rectangular outline. Cuniculi low and primitive outer two volutions. Tunnel narrow and deviates inner whorls, chomata on proloculus, lacking on whorls. Secondary deposits along axis and coating septa adjacent to tunnel.

Table of Measurements

	Specimens 330	331	332	333
Proloculus (mm)	.30		.26	.26

	Vol.	Specimens 330	331	332	333
	1	.26	.22	.30	.30
Radius-	2	.38	.38	.44	.43
vector	3	.53	.59	.67	.63
(mm)	4	.82	.80	.98	.87
	5	1.10	1.10	1.28	1.24
	6	1.36	1.37	1.64	1.55
	7	1.69	1.69		

	Vol.	Specimens 330	331	332	333
	1	.49	.53	.74	.38
Half-	2	.78	.94	1.15	.70
length	3	1.28	1.45	1.75	1.16
(mm)	4	2.20	2.40	2.74	1.86
	5	3.27	3.24	3.70	3.30
	6	4.32	3.99	4.94	4.84
	7	5.35	5.35		

	Vol.	Specimens 330	331	332	333
	1	1.9	2.4	2.5	1.3
Form-	2	2.1	2.5	2.6	1.6
ratio	3	2.4	2.5	2.6	1.8
	4	2.7	3.0	2.8	2.1
	5	3.0	2.9	2.9	2.7
	6	3.2	2.9	3.0	3.1
	7	3.2	3.2		

	Vol.	Specimens 330	331	332	333
	1	.02	.03	.03	.02
Wall-	2	.03	.03	.04	.03
thick.	3	.06	.05	.07	.04
(mm)	4	.08	.06	.10	.07
	5	.09	.10	.10	.08
	6	.11	.11	.11	.06
	7	.10	.10		

Discussion.—The forms here described are slightly larger than the holotype of *Parafusulina brooksensis* described by Ross (1960). They are, however, of the same proportions in measurements and have the same characteristics. *P. gracilis* (Meek) and *Schwagerina linearis* Dunbar & Skinner are much more elongate and have different ontogeny. Closest similarity appears to be with *P. vidriensis* Ross and *P. deltoides* Ross, but *P. vidriensis* is thicker, less tightly coiled, and has a different distribution of secondary deposits. *P. deltoides* has a different shape and ontogeny. Six well preserved and oriented specimens were collected and studied. This species, along with *P. vidriensis,* forms the highest fusulinid zone in the Hess Member of the eastern Glass Mountains, Texas. Holotype is from 1,450 feet above the base of the Hess Member of the Leonard Formation.

Occurrence.—*P. brooksensis* occurs in Pequop Mountains in units 68, 69, and 81 of the Late Leonardian portion of the Pequop Formation.
Repository.—BYU 330, 331, 332, 333.

Parafusulina fountaini Dunbar & Skinner
Pl. 19, fig. 16.

Parafusulina fountaini DUNBAR & SKINNER, 1937, Univ. Texas Bull. 3701, p. 675-676, pl. 70.

Parafusulina (*Skinnerella*) *fountaini* COOGAN, 1960, Univ. California Pub. Geol. Sci., v. 36, no. 5, p. 262-263, pl. 23, fig. 3.

Description.—Shell large, robust, slightly inflated fusiform, slightly curved axis of coiling, neatly rounded poles, gently convex to gently concave lateral slopes. Specimens six to seven volutions, 14.16 mm long, 4.68 mm wide, form ratio 1.8 to 2.3 first volution, 2.9 to 3.0 last volution. Proloculus medium, 310 microns, thin walled, spherical. Shell rather tightly coiled, expands uniformly throughout. Chamber height increases only slightly center to poles as shell elongates. Spirotheca thin, 20 to 30 microns first volution, 90 to 100 microns last volution, moderately coarsely alveolar. Septal fluting strong and regular and folds are high, septa crowded in early volutions, polar ends extremely vesicular-looking with pronounced fluting. Cuniculi low and rather primitive outer volutions. Tunnel difficult to distinguish, chomata lacking. Secondary deposits absent to very slightly developed.

Table of Measurements

	Specimens 334	335
Proloculus (mm)	.31	.21

	Vol.	Specimens 334	335
	1	.36	.28
Radius-	2	.55	.45
vector	3	.86	.60
(mm)	4	1.20	1.00
	5	1.60	1.26
	6	2.05	1.55
	7	2.34	

	Vol.	Specimens 334	335
	1	.66	.65
Half-	2	1.53	.90
length	3	2.10	1.45
(mm)	4	2.90	1.94
	5	4.62	3.01
	6	5.59	4.46
	7	7.08	

	Vol.	Specimens 334	335
	1	1.8	2.3
Form-	2	2.8	2.0
ratio	3	2.4	2.4
	4	2.4	1.9
	5	2.9	2.4
	6	2.7	2.9
	7	3.0	

	Vol.	Specimens 334	335
	1	.02	.03
Wall-	2	.03	.05
thick.	3	.05	.04
(mm)	4	.07	.07
	5	.10	.09
	6	.10	.10
	7	.08	

Discussion.—*Parafusulina fountaini* is one of the most primitive forms of *Parafusulina.* Cuniculi are primitive and are found only in the outer volution. Apparently, this species is transitional between *Schwagerina* and *Parafusulina.* Three specimens were collected. Holotype from the Bone Springs Limestone in the Guadalupe Mountains, Texas.

Occurrence.—*Parafusulina fountaini* occurs in Pequop Mountains in units 69 and 79? of the Late Leonardian portion of the Pequop Formation.
Repository.—BYU 334, 335.

Parafusulina sp. aff. *sonoraensis* Dunbar
Pl. 19, figs. 17-19.

Parafusulina sonoraensis DUNBAR, 1939, Geol. Soc. Amer. Bull., v. 50, p. 1745-1760, pl. 3, figs. 1-8.

Description.—Shell medium to large, thickly fusiform, straight axis of coiling, poles acutely rounded to pointed, shell middle flattened or slightly constricted, straight to slightly convex lateral slopes. Specimens six to seven volutions, 9.76 to 11.68 mm long, 3.90 to 4.24 mm wide, form ratio 1.6 to 1.8 first volution, 2.2 to 2.9 last volution. Inner volutions short. Proloculus large, 390 to 500 microns, spherical. Shell expands uniformly, appears tightly coiled throughout. Chamber height increases only slightly center to poles. Spirotheca medium thickness, 30 to 50 microns first volution, 100 to 120 microns last volution, distinctly alveolar. Septa deeply and regularly folded throughout shell length. Cuniculi small and rather poorly developed outer volutions only. Tunnel narrow to moderately wide, chomata absent. Distinctive secondary deposits exist along axis and border either side of tunnel.

Table of Measurements

	Specimens 336	337	338	339
Proloculus (mm)	.39	.46	.50	.40

	Vol.	Specimens 336	337	338	339
	1	.44	.46	.55	.45
Radius-	2	.65	.68	.84	.59
vector	3	.96	.95	1.16	.83
(mm)	4	1.25	1.25	1.50	1.09
	5	1.60	1.63	1.94	1.36
	6	2.00	1.95		1.73
	7				2.08?

	Vol.	Specimens 336	337	338	339
	1	.78	.72	.90	.77
Half-	2	1.40	1.24	1.56	1.09
length	3	2.13	1.72	2.19	1.52
(mm)	4	2.94	2.69	3.18	2.03
	5	3.97	3.60	4.19	2.83
	6	5.84	4.63		3.94
	7				4.88

	Vol.	Specimens 336	337	338	339
	1	1.8	1.6	1.6	1.7
Form-	2	2.2	1.8	1.9	1.8
ratio	3	2.2	1.8	1.9	1.8
	4	2.4	2.2	2.1	1.9
	5	2.5	2.2	2.2	2.1
	6	2.9	2.4		2.3
	7				2.4

	Vol.	Specimens 336	337	338	339
	1	.05	.04	.03	.03
Wall-	2	.07	.05	.07	.03
thick.	3	.05	.08	.09	.04
(mm)	4	.07	.09	.12	.05
	5	.12	.12	.10	.09
	6	.10	.11		.10
	7				

Discussion.—The forms here described compare very well with measurements of *P. sonoraensis* with the exception that the form ratio is considerably lower in the outer volutions. The other characteristics of the species, including the distinctive pattern of axial fillings and the presence of cuniculi in the outer volutions, are found in the present forms.

P. sonoraensis greatly resembles *P. diabloensis* Dunbar & Skinner in size, proportions, medial constriction, size of proloculus, and character of axial deposits, but expands less rapidly and has more crowded and abundant septa. The species also resembles *Schwagerina güembeli* Dunbar & Skinner, but is larger, has slightly different arrangement of secondary fillings, has a much larger proloculus, and possesses typical *Parafusulina* cuniculi. Eight well preserved and oriented specimens were studied. Holotype from 1990 feet below top of the Permian section in Cañon de Santa Rosa, Sonora, Mexico.

Occurrence.—*Parafusulina* sp. aff. *P. sonoraensis* occurs in Pequop Mountains in units 70, 80, and 83 of the Late Leonardian portion of the Pequop Formation.
Repository.—BYU 336, 337, 338, 339.

Parafusulina ? sp. aff. *P.* ? *turgida* Thompson & Wheeler
Pl. 20, fig. 1.

Parafusulina ? turgida THOMPSON & WHEELER, 1946, Geol. Soc. Amer. Mem. 17, p. 30-31.
Description.—Shell small to medium, inflated fusiform, irregular axis of coiling, sharply pointed poles, steep and straight to strongly concave lateral slopes. Single specimen six volutions, 7.96 mm long, 3.98 mm wide, form ratio 1.1 first volution, 2.0 last volution. Proloculus large, 550 microns, irregular. Shell rather loosely coiled. Chamber height increases slightly center to poles. Spirotheca moderate in thickness, 40 microns first volution, 90 microns last volution, moderately coarsely alveolar. Septa narrowly and highly fluted throughout shell length. No tangential sections located on which to observe cuniculi. Tunnel obscured due to poor preservation.

Table of Measurements

	Specimen
	340
Proloculus (mm)	.55

	Vol.	Specimen 340
Radius-vector (mm)	1	.46
	2	.66
	3	.86
	4	1.22
	5	1.57
	6	1.99

	Vol.	Specimen 340
Half-length (mm)	1	.52
	2	1.01
	3	1.60
	4	2.04
	5	3.03
	6	3.98

	Vol.	Specimen 340
Form-ratio	1	1.1
	2	2.2
	3	1.9
	4	1.7
	5	1.9
	6	2.0

	Vol.	Specimen 340
Wall-thick. (mm)	1	.04
	2	.05
	3	.06
	4	.10
	5	.09
	6	

Discussion.—Only one specimen similar to this species was located in the thin-sections studied from Pequop Mountains. Holotype from about 1100 feet above the base of the McCloud Limestone in northern California.

Occurrence.— *P.* ? sp. aff. *P.* ? *turgida* occurs in Pequop Mountains in unit 71 of the early Late Leonardian portion of the Pequop Formation.
Repository.—BYU 340.

Parafusulina vidriensis Ross

Pl. 20, fig. 2.

Parafusulina vidriensis ROSS, 1960, Contrib. Cushman Found. Foram. Research, v. XI, pt. 4, p. 130-131, pl. 21, figs. 5, 7, 10, 11, 13.

Description.—Shell small to moderately large, evenly fusiform to subcylindrical, straight axis of coiling, bluntly pointed poles, straight to gently convex lateral slopes. Specimens six to seven volutions, 6.60 to 8.70 mm long, 2.20 to 3.30 mm wide, form ratio 1.5 to 1.8 first volution, 2.5 to 3.0 last volution. Proloculus small, 130 to 320 microns, subspherical, expansion uniform throughout the entire shell. Chamber height increases little center to poles. Spirotheca thin, 20 to 40 microns first volution, 80 to 100 microns last volution, coarsely alveolar. Septa closely fluted into high folds with broadly rounded crests throughout shell length, folds commonly overlap one another. Cuniculi present in outer two volutions. Tunnel moderate to wide, chomata lacking. Secondary fillings on folds adjacent to tunnel and commonly in polar regions of inner two or three volutions.

Table of Measurements

Specimens	341	342	343	344
Proloculus (mm)	.32	.13	.18	

	Vol.	341	342	343	344
Radius-vector (mm)	1	.30	.14	.22	.28
	2	.46	.23	.34	.40
	3	.64	.39	.53	.61
	4	.88	.61	.76	.90
	5	1.14	.84	1.02	1.10
	6	1.46	1.10	1.38	1.60
	7			1.65	

	Vol.	341	342	343	344
Half-length (mm)	1	.45	.22	.40	.42
	2	.88	.41	.70	1.00
	3	1.47	.90	1.16	1.64
	4	2.00	1.47	1.74	2.25
	5	3.00	2.15	2.59	3.12
	6	3.85?	3.30	3.34	4.00
	7			4.35	

	Vol.	341	342	343	344
Form-ratio	1	1.5	1.6	1.8	1.5
	2	1.9	1.8	2.1	2.5
	3	2.3	2.3	2.2	2.7
	4	2.3	2.4	2.3	2.5
	5	2.6	2.6	2.5	2.8
	6	2.6?	3.0	2.4	2.5
	7			2.5	

	Vol.	341	342	343	344
Wall-thick. (mm)	1	.02	.02		
	2	.05	.02	.04	.08
	3	.07	.04	.06	.08
	4	.07	.05	.05	.10
	5	.09	.05	.09	
	6	.08	.09	.10	
	7			.09	

Discussion.—*Parafusulina vidriensis* differs from *P. deltoides* Ross in shape and ontogeny, from *P. brooksensis* Ross in size, ontogeny, and axial deposit distribution, from *P. spissisepta* Ross in lacking tightly coiled early whorls, and from *P. allisonensis* Ross in being less elongate. Six well preserved and oriented sections of *P. vidriensis* were studied. Holotype from 1350 feet above base of Hess Member, Leonard Formation, Glass Mountains, Texas.

Occurrence.—*P. vidriensis* occurs in Pequop Mountains in units 72, 79, 80 of the Late Leonardian portion of the Pequop Formation.

Repository.—BYU 341, 342, 343, 344.

Parafusulina sp.

Pl. 20, figs. 3, 4.

The axial section and tangential section illustrated and one additional section were the only specimens obtained of this species.

Description.—Shell large, cylindrical, flattened and slightly depressed across middle, straight axis of coiling, bluntly pointed poles, pole on outer volution greatly extended, straight to slightly concave lateral slopes. Specimen eight volutions, 12.00 mm long, 3.22 mm wide, form ratio 1.9 first volution, 3.7 last volution. Early volutions long, narrow, and cylindrical shaped, shape constant throughout test. Proloculus very small, 10 microns. Shell tightly coiled first seven volutions, greatly expands last volution. Chamber height increases little center to poles. Spirotheca thin, 10 microns first volution, 70 microns last volution, coarsely alveolar. Septa strongly and highly fluted and crowded first seven volutions, become widely spaced, very broad, and highly irregular outer volution. Cuniculi outer two volutions. Tunnel moderately wide, chomata lacking. Secondary deposits prominent and fills chambers on either side of tunnel inner six volutions.

Table of Measurements

	Specimen
Proloculus	345
(mm)	.10

	Vol.	Specimen 345
	1	.11
Radius-	2	.15
vector	3	.26
(mm)	4	.38
	5	.58
	6	.80
	7	1.18
	8	1.61?

	Vol.	Specimen 345
	1	.21
Half-	2	.43
length	3	.74
(mm)	4	1.13
	5	1.73
	6	2.79
	7	3.58
	8	6.00

	Vol.	Specimen 345
	1	1.9
Form-	2	2.9
ratio	3	2.8
	4	3.0
	5	3.0
	6	3.5
	7	3.0
	8	3.7

	Vol.	Specimen 345
	1	.01
Wall-	2	.02
thick.	3	.03
(mm)	4	.03
	5	0.4
	6	.06
	7	.07
	8	.07

Discussion.—This form's extremely narrow and elongate cylindrical shape, tightly coiled inner seven volutions with rapidly expanding eighth volution, small proloculus, and unusual distribution of secondary deposits sets it apart as radically different from any previously described American fusulinid. It is possible that the form constitutes a new species, but lack of sectioned specimens makes naming of a new species impossible. It is also possible that the specimen represents a bizarre form of some other already described species.

Occurrence.—*Parafusulina* sp. occurs in Pequop Mountains in unit 74 of the early Late Leonardian part of the Pequop Formation.

Repository.—BYU 345.

Parafusulina rothi Dunbar & Skinner
Pl. 20, figs. 5-7.

Parafusulina rothi DUNBAR & SKINNER, 1937, Univ. Texas Bull. 3701, v. III, pt. 2, p. 684-685, pl. 76.

Parafusulina (*Parafusulina*) *rothi* COOGAN, 1960, Univ. California Pub. Geol. Sci., v. 36, no. 5, p. 263-264.

Description.—Shell large, subcylindrical, slightly curved axis of coiling, poles bluntly rounded, straight to gently convex or concave lateral slopes. Specimens seven volutions, 14.46 to 15.12 mm long, 3.38 to 4.32 mm wide, form ratio 1.7 to 2.0 first volution, 3.1 to 4.3 last volution. Proloculus moderately large, 220 to 300 microns, subspherical. Entire shell rather tightly coiled, expansion slow and uniform. Spirotheca moderately thin, 20 to 40 microns first volution, 80 to 100 microns last volution, coarsely alveolar. Septa intensely fluted into high folds with broadly rounded crests throughout the shell. Cuniculi well developed outer volutions. Tunnel narrow to moderately wide, chomata lacking. Secondary deposits absent or slightly developed along axis of coiling.

Table of Measurements

	Specimens			
Proloculus	346	347	348	349
(mm)	.27	.22	.30	.26

	Vol.	Specimens 346	347	348	349
	1	.36	.25	.28	.28
Radius-	2	.54	.39	.43	.42
vector	3	.78	.59	.64	.61
(mm)	4	1.01	.89	.91	.90
	5	1.29	1.09	1.28	1.25
	6	16.7	1.37	1.67	1.67
	7	2.08	1.69	2.16	

	Vol.	Specimens 346	347	348	349
	1	.66	.50	.48	.57
Half-	2	1.20	1.04	.90	.96
length	3	1.75	1.80	1.38	1.64
(mm)	4	2.20	2.67	2.38	2.38
	5	3.54	3.87	4.08	3.80
	6	5.28	4.63	6.26	5.19
	7	7.56	7.23		

	Vol.	Specimens 346	347	348	349
	1	1.8	2.0	1.7	2.0
Form-	2	2.2	2.7	2.1	2.3
ratio	3	2.2	3.0	2.2	2.7
	4	2.2	3.0	2.6	2.6
	5	2.7	3.5	3.2	3.0
	6	3.2	3.4	3.7	3.1
	7	3.6	4.3		

	Vol.	Specimens 346	347	348	349
	1	.04	.02	.03	.03
Wall-	2	.03	.03	.03	.03
thick.	3	.06	.07	.04	.05
(mm)	4	.08	.06	.08	.09
	5	.10	.07	.09	.09
	6	.14	.08	.10	.10
	7	.10	.08		

Discussion.—*P. rothi* is shorter than *P. wordensis* Dunbar & Skinner and is larger and blunter than *P bösei* Dunbar & Skinner and lacks the secondary deposits of that species. Four well preserved and oriented specimens were studied. Holotype from the lower third of the Delaware Mountain Formation near Guadalupe Point, Texas.

Occurrence.—*P. rothi* occurs in Pequop Mountains in units 75 and 76 of the Late Leonardian portion of the Pequop Formation. Thus, the lower age of the species is considerably older in Pequop Mountains than previously found in the Texas region.
Repository.—BYU 346, 347, 348, 349.

Parafusulina sellardsi Dunbar & Skinner
Pl. 20, figs. 8-11.

Parafusulina sellardsi DUNBAR & SKINNER, 1937, Univ. Texas Bull. 3701, v. III, pt. 2, p. 688-689, pl. 78.

Parafusulina (*Parafusulina*) *sellardsi,* COOGAN, Univ. California, Pub. Geol. Sci., v. 36, no. 5, p. 263-264.

Description.—Shell large, subcylindrical, straight to slightly curved axis of coiling, bluntly rounded poles, gently convex lateral slopes. Specimens seven volution, 14.10 to 15.72 mm long, 3.58 to 3.98 mm wide, form ratio 1.2 first volution, 3.9 to 4.1 last volution. Early volutions long and linear. Proloculus large and thick-walled, 330 to 420 microns, spherical. Shell rather tightly coiled and expansion slow and uniform. Spirotheca moderately thick, 20 to 30 microns first volution, 110 to 140 microns last volution, moderately coarsely alveolar. Septa numerous, intensely fluted throughout shell. Cuniculi well developed in outer volutions. Tunnel wide, chomata lacking, slight to moderate amount of secondary filling along axis inner four to five volutions.

Table of Measurements

	Specimens 350	351	352
Proloculus (mm)	.42		.33

	Vol.	Specimens 350	351	352
	1	.24		.26
Radius-	2	.42	.38	.42
vector	3	.69	.58	.56
(mm)	4	.99	.85	.85
	5	1.27	1.14	1.11
	6	1.66	1.50	1.48
	7	1.99	1.88	1.79

	Vol.	Specimens 350	351	352
	1			.31
Half-	2	.99?	.89	.80
length	3	1.75	1.61	1.40
(mm)	4	2.76	2.28	2.34
	5	4.16	4.04	3.30
	6	6.38	5.26	5.70
	7	7.86	7.75	7.05

	Vol.	Specimens 350	351	352
	1			1.2
Form-ratio	2	2.4	2.3	1.9
	3	2.5	2.8	2.5
	4	2.8	2.7	2.8
	5	3.3	3.5	3.0
	6	3.8	3.5	3.9
	7	4.0	4.1	3.9

	Vol.	Specimens 350	351	352
	1	.02		.03
Wall-thick. (mm)	2	.04	.02	.04
	3	.07	.07	.06
	4	.09	.10	.07
	5	.12	.12	.09
	6	.14	.13	.10
	7	.12	.14	.11

Discussion.—*P. sellardsi* resembles *P. rothi* Dunbar & Skinner in having the same type of bluntly rounded poles, but attains a larger size and has more numerous septa which appear to be much more crowded in axial section. *P. wordensis* Dunbar & Skinner also has blunt poles, but is twice as large and is much more elongate than *P. sellardsi.* Six well preserved and fairly oriented sections of this species were studied. Holotype from King's Limestone member 3 of the Word Formation, Glass Mountains, Texas.

Occurrence.—*P. sellardsi* occurs in Pequop Mountains in units 79 and 82 of the late Late Leonardian portion of the Pequop Formation. Thus, its lower range is much older in Pequop Mountains than formerly reported in Texas.
Repository.—BYU 350, 351, 352.

MEASURED STRATIGRAPHIC SECTION

Section of the Hogan Formation
in Section 34, T. 34 N., R. 65 E., Elko County, Nevada

Permian; Late Wolfcampian:
Ferguson Mountain Formation.
Disconformity.
Pennsylvanian; Late Desmoinesian:
Hogan Formation:

Unit	Description	Feet
41	Limestone; matrix with skeletal and silty-argillaceous detrital to aphanic siliceous; light blue-gray, to brown-gray; weathers buff to blue-gray; aphanic to fine crystalline texture; interbeds of calcareous, quartzitic siltstone; thin, medium, and thick-bedded; 5-20% nodular to bedded, tan, quartzitic case-hard limestone; crinoid stems, bryozoans, gastropods, and brachiopods.	100
40	Limestone; matrix with argillaceous, silty, and fine sandy detrital, matrix with skeletal, siliceous matrix; medium brown-gray to light blue-gray; weathers tan to blue and brown-gray; aphanic and fine- to medium-crystalline; medium to thick-bedded; weathers blocky to slabby; 10-20% brown and tan quartzitic, bedded to nodular chert and case-hard limestone; brachipods, gastropods, bryozoans, algae, tetracorals, and fusulinids lower beds *Wedekindellina euthysepta* Dunbar, and *Fusulina weintzi* Thompson, Verville, and Lokke.	40
39	Interbedded; limestone, matrix with detrital silt and clay; siltstone, argillaceous and calcareous; and shale, calcareous and silty; medium brown-gray to maroon-gray; weathers light blue-gray to tan-gray; thin-bedded; weathers chippy to platy; siliceous matrix limestone at base.	35
38	Limestone; matrix, matrix with detrital clay and silty, matrix-skeletal, and skeletal-detrital; aphanic and fine-crystalline to medium-bioclastic texture; interbeds of calcareous-silty shale and calcareous siltstone; thin, medium, and thick-bedded; weathers chippy and platy to small-blocky; 15% brown weathering case-hard limestone nodules upper one-third; crinoid stems, bryozoans, brachiopods, gastropods, and few scaphopods lower one-third.	75
37	Interbedded; limestone, matrix with detrital clay, silt, and fine sand; siltstone, calcareous and sandy; shale, calcareous and silty;	

dary gray, brown-gray, maroon-gray; weathers buff, blue-gray, maroon-gray; fine- and medium-crystalline texture; thin- and medium-bedded; weathers chippy and platy to small-blocky; 2% nodular to bedded chert and case-hard limestone; few crinoid stems. 70

36 Interbedded; limestone, matrix with skeletal, matrix with detrital silt and fine sand; skeletal-detrital; siltstone, argillaceous-calcareous; shale, calcareous; medium brown-gray, light blue-gray and maroon-gray; weathers blue-gray to buff-gray; fine and medium-crystalline to medium-bioclastic texture; thin- to medium-bedded; weathers chippy to platy; 5% black nodular chert to case-hard limestone; crinoid stems, bryozoan and brachiopod "hash." 75

35 Interbedded; limestone, matrix with skeletal, matrix with detrital silt and fine sand; and siltstone, calcareous to non-calcareous and quartzitic; bioclastic limestone at top; medium brown-gray to light blue-gray and maroon-gray; weathers same; fine crystalline to medium-bioclastic texture; all thin-bedded and chippy to platy-weathering; chert absent; crinoid stems, spines, algae? 60

34 Interbedded; upper one-half, limestone, matrix with detrital clay, silt, and fine sand; and siltstone, argillaceous and calcareous; lower one-half, limestone, matrix, and argillaceous-matrix; dark gray to medium brown- and blue-gray; weathers buff and light brown-gray; aphanic to fine-crystalline and fine-grained; thin- to medium-bedded; weathers platy to small-blocky; 10-20% case-hard limestone and chert nodules with liesegang banding lower one-half of unit. 70

33 Interbedded; upper one-half, siltstone, argillaceous; shale silty; lower one-half, limestone, matrix, to matrix with detrital clay and silt; dark blue-gray to black and medium brown-gray; weathers light blue-gray, yellow-gray, brown-gray; aphanic to fine-crystalline texture; thin- to medium-bedded; weathers chippy to platy; 30% liesegang banded case-hard limestone to black chert lower one-half; crinoid stems. 90

32 Limestone; matrix with skeletal and matrix with detrital silt, matrix-siliceous; calcareous siltstone interbeds near base; dark gray, medium brown-gray, maroon-gray; weathers medium blue-gray to buff-gray; fine- to medium-crystalline texture; thin- to medium-bedded; weathers slabby; 30% nodular to bedded liesegang banded case-hard limestone; crinoid stems, bryozoans. 65

31 Limestone; matrix with detrital clay, silt, and fine sand, matrix with skeletal; calcareous siltstone interbed near top; dark gray, medium brown-gray, maroon-gray; weathers light pink-gray to buff-gray; aphanic to fine- and medium-crystalline and fine-bioclastic texture; thin- to medium-bedded; weathers chippy to platy; some case-hard, siliceous limestone near center of unit; crinoid stems, brachiopod and bryozoan fragments. 70

Total Hogan Formation 750

Pennsylvanian; Derryan:
Ely Limestone.

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