AN ABSTRACT OF THE THESIS OF

Dixie Jane Lembach (Name) for the M.S. (Degree) in Invertebrate Paleontology (Major)

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Title Fauna of the Permian Rocks Near Quinn River Crossing, Nevada

Abstract approved [redacted] (Major Professor)

The Permian rocks near Quinn River Crossing, Humboldt County, Nevada, crop out as a north-trending block-faulted ridge and consist of more than 2600 feet of middle Permian fossiliferous limestone. About 1000 feet of unfossiliferous cherty shales, sandstones, and conglomerates are associated with the limestone and are assumed also to be of Permian age. In addition, tertiary igneous rocks make up part of the ridge.

Normal faults transect the ridge at several localities along its 9500-foot length, and some of the beds have been folded.

The fauna of the limestone is middle and upper Leonardian in age and consists mainly of fusulinids and associated small Foraminifera, solitary and colonial corals, bryozoans, and brachiopods. The fusulinid fauna is described and illustrated as are two corals and one bryozoan.

The fusulinid fauna is considered to be correlative, at least in part, with that of the Coyote Butte Formation in central Oregon, the upper part of the McCloud Formation in northern California, the middle part of the Owens Valley Formation in east central California, and the upper part of the lower limestone member of the Garden Valley

Formation and the upper part of the Carbon Ridge Formation in east central Nevada. The fusulinids are believed to be somewhat older than those of the lower Nosoni Formation in northern California and the second member of the Garden Valley Formation in east central Nevada.

FAUNA OF THE PERMIAN ROCKS
NEAR
QUINN RIVER CROSSING, NEVADA

by

DIXIE JANE LEMBACH

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APPROVED:

[redacted]

Associate Professor of Geology

In Charge of Major

[redacted]

Chairman of Department of Geology

[redacted]

Chairman of School Graduate Committee

[redacted]

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FAUNA OF THE PERMIAN ROCKS

NEAR

QUINN RIVER CROSSING, NEVADA

INTRODUCTION

One of the few reported occurrences of fossiliferous limestone in the thick Permian sequences of sedimentary and igneous rocks in northwestern Nevada is exposed as part of a block-faulted ridge in central Humboldt County. The fauna of this middle Permian limestone and the general geology of the limestone and associated unfossiliferous conglomerates, sandstones, shales, and igneous rocks are presented in this report. A fossiliferous limestone section 2615 feet thick was measured and sampled. The other sedimentary rocks and the igneous rocks were mapped but their thicknesses were not measured. Because of the scarcity and poor preservation of megafossils in most of the measured limestone units, the dating and correlations were based mainly upon the fusulinid fauna.

Location

The area described is located in central Humboldt County, Nevada, 2 miles east of Nevada State Highway 8A, 6 miles southeast of Quinn River Crossing, 36 miles southeast of Denio, and 63 miles northwest of Winnemucca, Nevada. The area covers approximately 2 square miles and extends southward from the SE$\frac{1}{4}$ sec. 36, T. 43 N., R. 32 E. and the SW$\frac{1}{4}$ sec. 31, T. 43 N., R. 33 E. to the NW$\frac{1}{4}$ sec. 7, T. 42 N., R. 33 E. in the Quinn River Crossing Quadrangle (Plate 1).

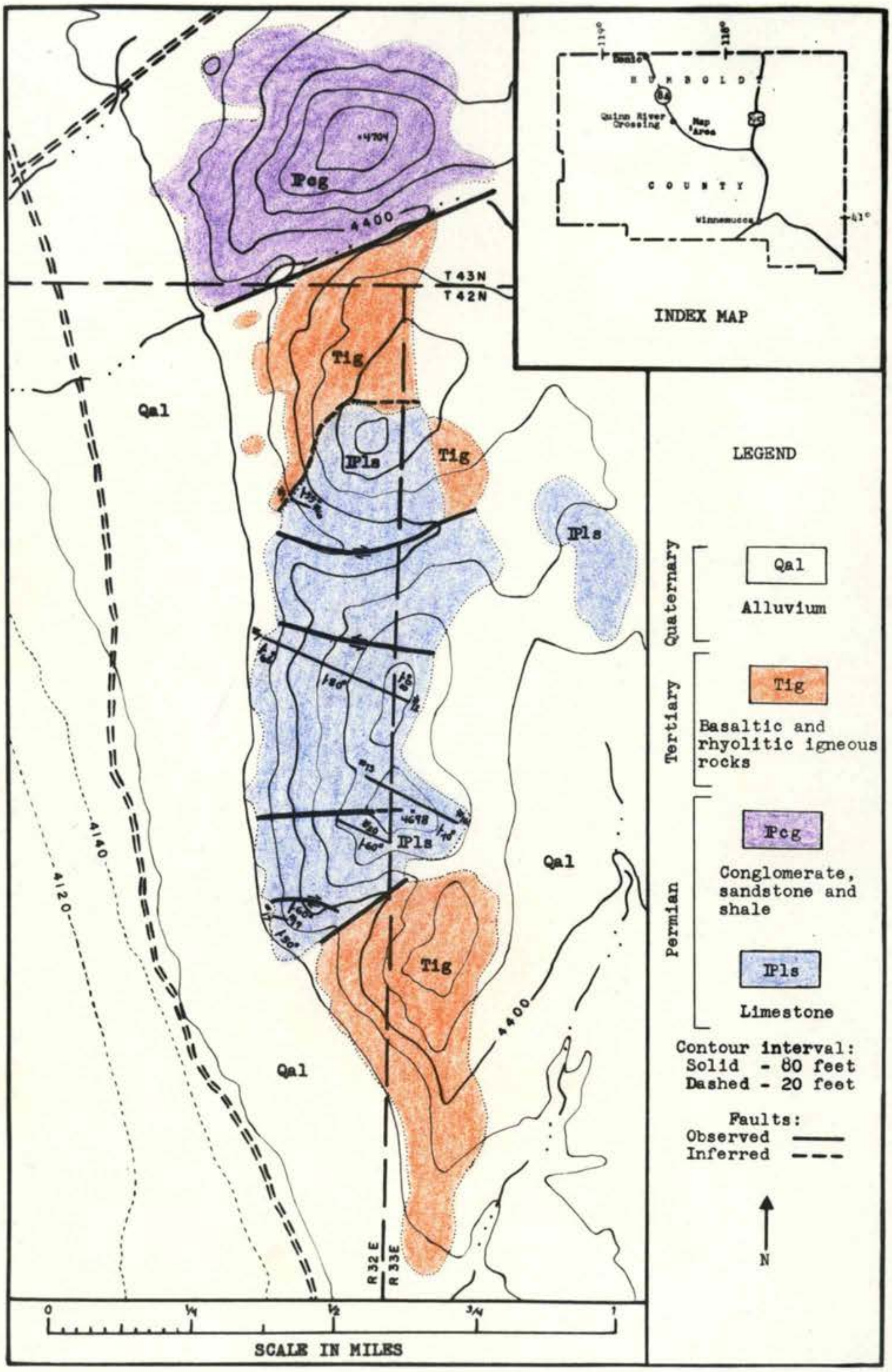

Plate 1. Geologic map showing Permian rocks near Quinn River Crossing, Nevada

Geography

The area in the vicinity of Quinn River Crossing has an arid climate, with an annual rainfall of four to five inches. The sparse desert vegetation consists chiefly of greasewood, which occurs, for the most part, on the alkali flats of the valley floors, and sage-brush, which is confined mainly to the more elevated areas.

The elevation of the valley floor just west of the outcrop of Permian rocks is about 4100 feet, and the maximum elevation of the ridge is 4704 feet. These give a total relief of approximately 600 feet.

The ridge is cut by several small gullies, most of which have formed along east-trending faults. Drainage is mainly to the west.

Previous Work

Muller has reported the presence of Wolfcampian and lower Leonardian fusulinids in the limestone near Quinn River Crossing, and he considers the outcrop to represent an eastward extension of the McCloud Formation of California (9, p. 1781). However, he does not name the forms upon which he based this correlation or further elaborate upon the outcrop. No other reference to the outcrop seems to have been made in previous published reports or surveys.

The nearest reported outcropping Permian strata occur in the Black Rock area about 30 miles southwest of Quinn River Crossing. According to Gianella, the Black Rock Permian consists of over 1800 feet of volcanic sediments and limestone, some of which contains upper? Permian brachiopods (14). The brachiopods have not been described, and so the faunal and age relationships of these Permian sediments to those near Quinn River Crossing are not known at this time.

METHODS OF STUDY

One week in each of the months of March, July, and September 1961 was spent in the field measuring the section, collecting samples, and mapping the outcropping beds. The field mapping was done on air photos with a scale of 1/20,000 and transferred later to an enlarged portion of the advance print of the Quinn River Crossing Quadrangle.

The limestone beds were sampled at stratigraphic intervals not more than 50 feet apart. The samples were slabbed, chips containing properly oriented specimens were cut from the slabs, and thin sections of fusulinids and other fossils were made from the chips. The peel method, described by Buehler (4), was tried on a few representative samples, but the preservation of the fossils was such that more detail could be obtained from thin sections.

Measurements of the fusulinids were made from oriented axial and sagital sections, and tabulated measurements for most of the species are included in the appendix.

Silicified megafossils were obtained from some of the limestone samples by etching them in three to four normal HCl. A few microfossils were obtained in this manner, but for the most part they were too poorly preserved to be identified.

STRATIGRAPHY AND STRUCTURE

The area under consideration is a north-trending block-faulted ridge of typical Basin-and-Range type with a west-facing fault scarp. It is about 9500 feet long and consists of limestone, shale, sandstone, conglomerate, and igneous rocks. The ridge is cut by several east-trending faults, some of which cause offsets within the limestone section.

Stratigraphy

The north end of the ridge is composed of approximately 1000 feet of medium-bedded ($1\frac{1}{2}$ to 4 feet) to thick-bedded (over 4 feet) varicolored cherty shales, sandstones, and conglomerates (Plate 1). These clastic sedimentary rocks are tentatively referred to the Permian System; however, they are unfossiliferous and are not visibly in contact with the middle Permian limestone. Thus, the age relationship of these rocks within the Permian cannot be determined at this time.

The shales have thin, colored laminations and a coarse blocky fracture. They range in color from black to tan. The black shales contain euhedral pyrite crystals, some of which are as much as one-half millimeter in diameter.

The coarser clastics range from fine sandstones to pebble conglomerates and consist of subangular to subrounded chert, metaquartzite, and slate particles in a fine-grained chert matrix. The sandstones appear to be well sorted but the conglomerates are very poorly sorted. Graded bedding was observed in these rocks on some freshly fractured surfaces. The presence of silt- to sand-sized carbonate inclusions in the chert matrix suggests that these clastics were deposited in an alkaline environment. Although a few small quartz overgrowths were observed, most of the boundaries between the clastic particles and the matrix are sharp; therefore, the chert matrix is assumed to be syngenetic. This fits well with Bissell's conclusion that at least 95 percent of the silica cement in Upper Paleozoic sediments of the Cordilleran area is syngenetic (2, p. 185).

The chert conglomerates are lithologically similar to a bed of chert conglomerate (unit 11) in the limestone section. This similarity suggests that these rocks had the same provenance.

The middle part of the ridge consists of 2615 feet of fossiliferous limestone (Plate 1). This limestone is thin-bedded to massive, microcrystalline to coarse-crystalline, dark gray to black on fresh surfaces, and contains numerous cherty beds, chert stringers and irregular chert masses. Bedded cherts (unit 16) also are present. Detailed lithologic descriptions of the units comprising the limestone section are presented in the appendix.

A small exposure of limestone just to the east of the main ridge may be an eroded part of the main ridge or, more probably, an erosional remnant of another fault block of the same limestone. Two random samples were taken from this exposure, and they were found to be lithologically and faunally similar to, and in the same stratigraphic order as, units 7 and 12 of the measured section.

A zone of igneous rocks, which consists of rhyolite, basalt and basaltic breccia and porphyries, is present between the cherty clastic sedimentary rocks and the limestone (Plate 1). Some of these igneous rocks seem to be of an intrusive nature, but exposures are poor and no contact between them and the antecedent country rock was observed. These rocks may represent feeder dikes and basalt and rhyolite flows, remnants of which also occur in a second igneous zone at the south end of the ridge (Plate 1) and on the ridges surrounding the area. Altered tuffs also are present in the igneous zone to the south. The rocks in both of these igneous zones are similar to the middle Tertiary rhyolites and basalts reported in northeastern and northwestern Nevada by Roberts (25) and other authors; therefore, the igneous rocks are assumed to be Tertiary in age.

The valley floor west of the ridge consists of late Tertiary and Quaternary lake beds overlain by Quaternary alluvium.

Structure

Several east-trending faults cut across the block-faulted ridge near Quinn River Crossing (Plate 1). One of these occurs between the cherty clastic sedimentary rocks at the north end of the ridge and the northern zone of igneous rocks. Another fault is believed to separate the igneous zone from the limestone section; the limestone, in turn, is separated by a fault from the zone of igneous rocks that comprise the south end of the ridge. The attitudes of these faults and the stratigraphic separation could not be determined.

The average strike and dip of the limestone beds is N. 22° E., 63° SE. The average trend of the cherty clastic rocks is N. 45° E., 60° SE., and that of the layered igneous rocks is N. 30° E., 45° SE. A few of the basalts in the northern igneous zone dip about 45° NW. and the rhyolites and basaltic porphyries in this same zone trend N. 80° W. and have an apparent dip of 45° NE.

Several easily recognizable fossiliferous beds served as horizon markers and permitted recognition of four east-trending faults within the limestone section. Three of these faults cause offsets which range from approximately 200 to 500 feet, but the fault which occurs between the lower 2100-foot part and the upper 535-foot part of the section may have produced an offset of greater extent and will be discussed later. The attitudes of these faults could not be determined. Tan- to buff-weathered rhyolite dikes occur along the fault in the thin-bedded siliceous limestone at the south end of the section.

Minor folds and faults occur in the outcrop of cherty shales, sandstones, and conglomerates, and a small anticlinal fold is exposed at the southern end of the limestone outcrop.

GEOLOGIC HISTORY

The lithology and fauna of the rocks near Quinn River Crossing indicate that this area is near the eastern boundary of the eugeosynclinal facies of the Cordilleran geosyncline, which covered the present area of the Great Basin from late Pre-cambrian to early Tertiary time.

According to Osmond (24), the geosyncline was divided during the early Paleozoic by a north-northeast trending tectonic zone through central Nevada [the Antler orogenic belt of Roberts (26)], forming an eastern miogeosynclinal zone of shallow-water carbonates and a western eugeosynclinal zone of deeper-water clastics, volcanics, and subordinate carbonates. The tectonic zone rose and expanded to the east and west until, by early Tertiary time, it included the former area of the geosyncline (24). Osmond states further that this rise and expansion was accompanied by deformation which was especially intense in Mississippian (Antler), Jurassic-Cretaceous (Nevadan), and Cretaceous-Tertiary (Laramide) times (24).

During the late Paleozoic, according to Sharp, deposition in northwestern Nevada took place in several deep basins rather than in a single large epicontinental sea (27). The sedimentary rocks near Quinn River Crossing were deposited during middle Permian time in a warm, relatively shallow near-shore environment in one of these basins. The coarse cherty clastic rocks and the fauna of the limestone have closer affinities to eugeosynclinal deposits and faunas in central Oregon and northern California than to miogeosynclinal deposits and faunas to the east. Some fluctuation in sediment supply or water level is indicated by the presence of the chert conglomerate (unit 11) within the limestone section. The major late Paleozoic rock types that have been described from northwestern Nevada are similar to those near Quinn River Crossing and include quartzite, slate, chert, volcanics and minor amounts of limestone.

These rock types have lithologic affinities with those found in northern California and central Oregon, according to Ferguson (13). Bissell states that much of the Upper Paleozoic volcanism was in the form of submarine flows (2, p. 179). According to Douglas, extensive thrusting, primarily in the Mesozoic, resulted in the juxtaposition of contemporaneous deposits of the eastern and western Paleozoic facies in several localities in northern and central Nevada (8).

Dunbar suggests that the Laramide thrusting may have continued into the Eocene and that the scarcity of Eocene and Oligocene strata is due to the high mountainous surface and exterior drainage of the Basin and Range region during early Cenozoic time (10, p. 417). King, however, states that during this time the western area of the Great Basin was a "low-upland" which had a worn down and deeply decayed surface (16, p. 156). According to Lovejoy, much of this area was covered later by Mio-Pliocene Lake Nevada and by its Pleistocene successor, Lake Lahonton (18).

Basaltic and silicic volcanic flows were numerous and wide-spread in the Quinn River area during Miocene and Pliocene times, and the volcanism was accompanied by block faulting and folding (35, p. 26).

According to Osmond, the faulting decreased in frequency in the late Tertiary with the cessation of volcanism, but movement along the faults has continued since the Miocene (24).

The post Mio-Pliocene elevation of the Cascade, Klamath and Sierra Nevada (1) mountain ranges resulted in lowered rainfall over the western Nevada lowlands to the east, and the lake waters gradually receded. Subaerial erosion followed and has continued to the present.

FAUNAL SUMMARY

The fauna collected from the measured limestone section near Quinn River Crossing is considered to be middle and upper Leonardian (Permian) in age and consists of fusulinids and associated small Foraminifera, corals, bryozoans, brachiopods, and minor fossil constituents. The only significant difference between this and most other described Permian faunas of the western United States is the apparent absence of cephalopods. It is assumed that if any are present in the outcrop they are rare.

All of the fossils collected were embedded in dense limestone, and the calcareous specimens could be studied only in slabs or in thin sections. The partly silicified fossils obtained from the uppermost unit of the section were etched from their matrix and identifications were made from the freed specimens.

Age

The middle and upper Leonardian age of the fauna is based upon the ages previously assigned to faunas of other formations which contain species or faunal associations similar to those obtained from the beds near Quinn River Crossing. The lower 2100-foot part of the section is assigned a middle Leonardian age because it contains several fusulinid species which most closely resemble forms generally reported to range below the middle Leonardian and one fusulinid species which is closely similar to, but seemingly somewhat more primitive than, forms generally reported to be lower Wordian in age. The upper 535-foot part of the section contains only the last species and is considered to be upper Leonardian or perhaps younger. A columnar section of the limestone showing the stratigraphic distribution of the fusulinids is shown in Plate 2.

Fauna

Specimens of Climacammina, Geintzina, Cribrostomum, and Textularia were identified from slabbed material obtained from several units throughout the section. The etched residue from unit 20 contained several very poorly preserved foraminiferal specimens. Of these, however, only a specimen of Textularia could be identified.

A few of the fusulinid generic groups have restricted stratigraphic ranges over wide areas and thus are useful as "zone fossils" for interregional correlations. The genus Parafusulina is one of these "zone fossils" and its presence has been used by other authors to designate the Leonardian to lower Guadalupian (Wordian) "Zone of Parafusulina" (32, p. 24). Intense septal fluting and the presence of cuniculi were the original criteria used to distinguish Parafusulina from similar genera; however, according to Thompson, "cuniculi have since been observed in Permian fusulinids obviously not generically related to [the genotype] Parafusulina wordensis" (32, p. 55).

Of those fusulinids collected from the limestone near Quinn River Crossing, cuniculi were observed in all properly oriented specimens which have a two-layered, or Triticites, wall. These include two species which are more or less typical of the genus Parafusulina.

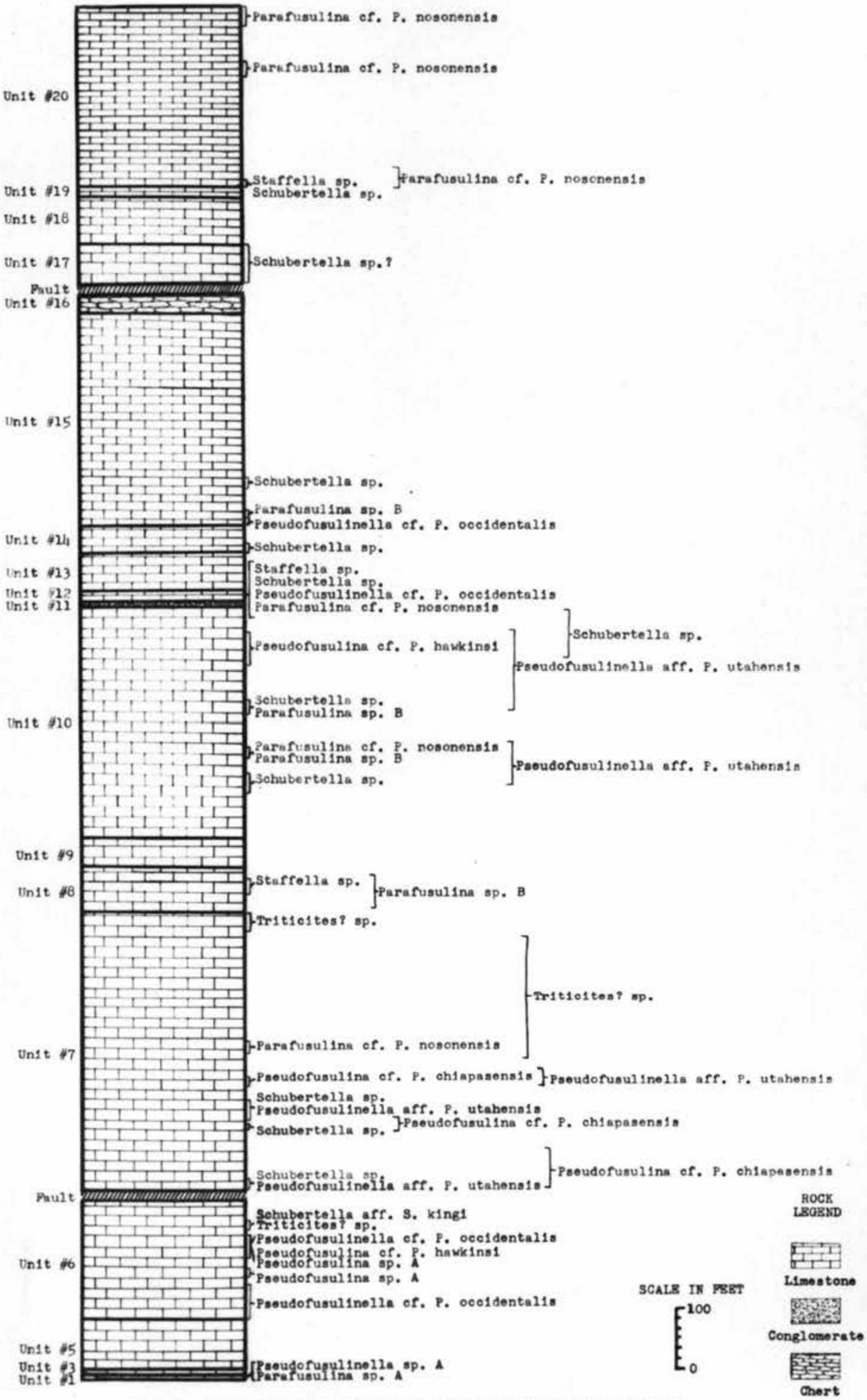

Plate 2. Columnar section of the limestone near Quinn River Crossing showing the stratigraphic distribution of the fusulinids.

Forms referred to Parafusulina sp. A occur in unit 1 of the section and forms referred to Parafusulina cf. P. nosonensis occur in a few units near the middle and in the uppermost unit (unit 20) of the section. Therefore, the entire limestone section is considered to be within the "Zone of Parafusulina." Of the other species which possess cuniculi, one is referred to Triticites?, three to Pseudofusulina, and one to Parafusulina. Until now, no described form possessing cuniculi has been assigned to the genus Triticites. The reasons for doing so in this paper are presented in the description of Triticites? sp. in the Systematic Paleontology section.

The lower 2100-foot part of the limestone section contains the following species of fusulinids:

Staffella sp.

Schubertella aff. S. kingi (Dunbar & Skinner)

Schubertella sp.

Pseudofusulinella cf. P. occidentalis (Thompson & Wheeler)

Pseudofusulinella aff. P. utahensis (Thompson & Bissell)

Pseudofusulinella sp. A

Triticites? sp.

Pseudofusulina cf. P. chiapasensis (Thompson & Miller)

Pseudofusulina cf. P. hawkinsi (Dunbar & Skinner)

Pseudofusulina sp. A

Parafusulina cf. P. nosonensis (Thompson & Wheeler)

Parafusulina sp. A

Parafusulina sp. B

Most of these species resemble forms which have been reported from beds of Leonardian age. Thompson and Wheeler described Pseudofusulinella occidentalis from the lower Leonardian upper McCloud Formation in northern California (34, p. 25-26). A form resembling Pseudofusulinella occidentalis also occurs with forms which are similar to Pseudofusulina chiapasensis and Pseudofusulina hawkinsi in the Leonardian Coyote Butte Formation near Suplee in central Oregon. Triticites? sp. is very similar to a form which Chen has described as Triticites truncatus from the Lower Artinskian (Lower Leonardian) Swine Limestone in South China (5, p. 39). Pseudofusulina chiapasensis was described by Thompson and Miller from the Grupera Formation in Southern Mexico (33, p. 484). Pseudofusulina hawkinsi was described by Dunbar and Skinner from the middle Hueco and lower Leonard formations in West Texas (11, p. 633), and it also has been reported with specimens of Parafusulina from the lower Moorman Ranch member of the Pequop Formation in Eureka County, Nevada (29, p. 106). An association of specimens of Pseudofusulina and Parafusulina was reported by Henbest from the upper part of the Carbon Ridge Formation in the Diamond Mountains east of Eureka, Nevada (23, p. 66). Specimens of Pseudofusulina and Parafusulina also occur together in the middle part of the Owens Valley Formation in the South Inyo Mountains of California (22, p. 11). The upper part of the lower limestone member of the Garden Valley Formation contains specimens identified as "Triticites" sp. and Parafusulina sp. which, according to Henbest, is intermediate between Schwagerina linearis Dunbar and Skinner and Parafusulina lineata Dunbar and Skinner and which has more axial filling than P. nosonensis Thompson and Wheeler (23, p. 68).

The upper 535-foot part of the section is separated by a fault from the lower part of the section. These upper beds contain *Parafusulina* cf. *P. nosonensis* in association with a few specimens of *Staffella* sp. and *Schubertella* sp. The more primitive fusulinids found in the lower part of the section are absent in the upper part. The fault between the two parts of the section makes it virtually impossible to determine their exact stratigraphic relationship, and, although there appears to be no repetition of beds or faunas across the fault, it is possible that some intervening beds have been faulted out of the section. Specimens of *Parafusulina nosonensis* were described by Thompson and Wheeler from the lower Nosoni Formation (34, p. 33-34). Similar specimens were reported by Henbest from the upper part of the lower limestone member of the Garden Valley formation (23, p. 58) and by Steele from the second member of the same formation (29, p. 103).

Two beds containing abundant colonial corals are present in the section. One occurs near the middle of unit 7 and the other near the middle of unit 15. These corals are loosely aggregated and have been assigned to the genus *Waagonophyllum* (Plate 9). They resemble specimens of *Waagonophyllum washburni* Merriam and *Waagonophyllum ochocoensis* Merriam which have been described from the Coyote Butte Formation (20, p. 375-376). Large, poorly preserved solitary corals occur in the lower part of the section and seem to be most closely related to cyathophylloid corals described by Merriam from the Coyote Butte Formation (20, p. 380). Compact colonial corals comprise nearly the whole of the exposed portion of unit 3. Some of the corallites are very similar to specimens which Merriam has identified as Lithostrotion? genomorph Diphystrotion sp. from the Coyote Butte Formation (20, p. 380). However, individuals which appear to belong to the genomorph Diphyphyllum, as defined by McLaren and Sutherland (19, p. 626), also are present. The latter forms in unit 3 are similar to specimens described by Easton from Nevada and California (12, p. 579).

The genomorph concept in corals is important to coral taxonomy and is restated here. The term "genomorph" was first used by Smith and Lang to express a trend "which some external or internal stimulus has provoked to rapid development in a colony or in certain individuals of a colony" (28, p. 179). It does not constitute a true genus, but "is the forerunner of an evolution which may take place in closely or distantly related stocks and may give rise to new generic forms" (28, p. 179). Hill has listed the possible developmental trends of the genus Lithostrotion and concluded that all of these trends might be found in the same individual (15, p. 83). According to McLaren and Sutherland, however, it is more common for only one trend to be pronounced, and such individuals may be united in "genomorphic groups" (19, p. 627). The genomorphs Diphyphyllum and Diphystrotion, then, are the trends exhibited by the corallites which form the Lithostrotion colony comprising unit 3 (Plate 8, fig. 5-7).

Specimens of Bryozoa referred to the genus Rhombotrypella (Plate 8, fig. 1-4) occur in units 1 and 12, and they are especially abundant in beds near the top of unit 20. This genus has been reported by Duncan from the upper (Leonardian) part of the Carbon Ridge Formation near Eureka, Nevada (23, p. 66) and has been identified from the Coyote

Butte Formation in central Oregon. Species belonging to this genus have been described by Nikiforova from the Permian of Russia (3, p. 279), but, as yet, none seems to have been described from North America.

Partly silicified brachiopods were obtained from several beds in unit 20. These were identified as follows:

Steinoscisma sp.

Crurithyris sp.

Composita spp.

Schuchertella sp.

Derbyia sp.

Chonetes sp.

Spiriferella sp.

Spiriferina cf. *S*. *billingsi* Schumard

Punctospirifera aff. *P*. *campestris* (White)

Dialasma sp.

Productid fragments

Some of the above identifications were made from incomplete specimens, and only two specimens were preserved well enough to be referred with reservation to particular species. Similar middle Permian brachiopod faunas have been reported by Stehli from the Bone Spring limestone in West Texas (30, p. 263-358), by Cooper from the Coyote Butte Formation in central Oregon (6, p. 1-79) and from Sonora, Mexico (7, p. 22-76), and by Nolan *et al*, from the Carbon Ridge Formation near Eureka, Nevada (23, p. 66).

The gastropod *Baylea* sp. is associated with the brachiopods in unit 20. It also has been found in some of the formations mentioned above, but its range is too long for it to be of value as an age indicator. Two other gastropods were found but were not preserved well enough to be identified.

Tubular structures tentatively identified as worm tubes are relatively common in several beds throughout the section.

Round crinoid columnals are present throughout the section and are very abundant in some beds; however no other crinoid parts were observed.

Two poorly preserved ostracod valves were obtained from the etched residue from unit 20. These were not identifiable.

CORRELATIONS

On the basis of faunal similarities, the limestone section near Quinn River Crossing is considered to be approximately equivalent in age to the Coyote Butte Formation in central Oregon, the upper part of the McCloud Formation in northern California, the middle part of the Owens Valley Formation in east central California, and the upper part of the lower limestone member of the Garden Valley Formation and the upper part of the Carbon Ridge Formation in east central Nevada (Fig. 1).

The age of the fauna of the Coyote Butte Formation was first discussed by Merriam and Berthiaume. They reported that the fusulinids, corals, and brachiopods indicated a Permian age but the fusulinids implied that the formation is not lowest Permian. They further stated that Cooper believed the brachiopods indicated a lower Permian Age (21, p. 157-158). Cooper later assigned a Wordian

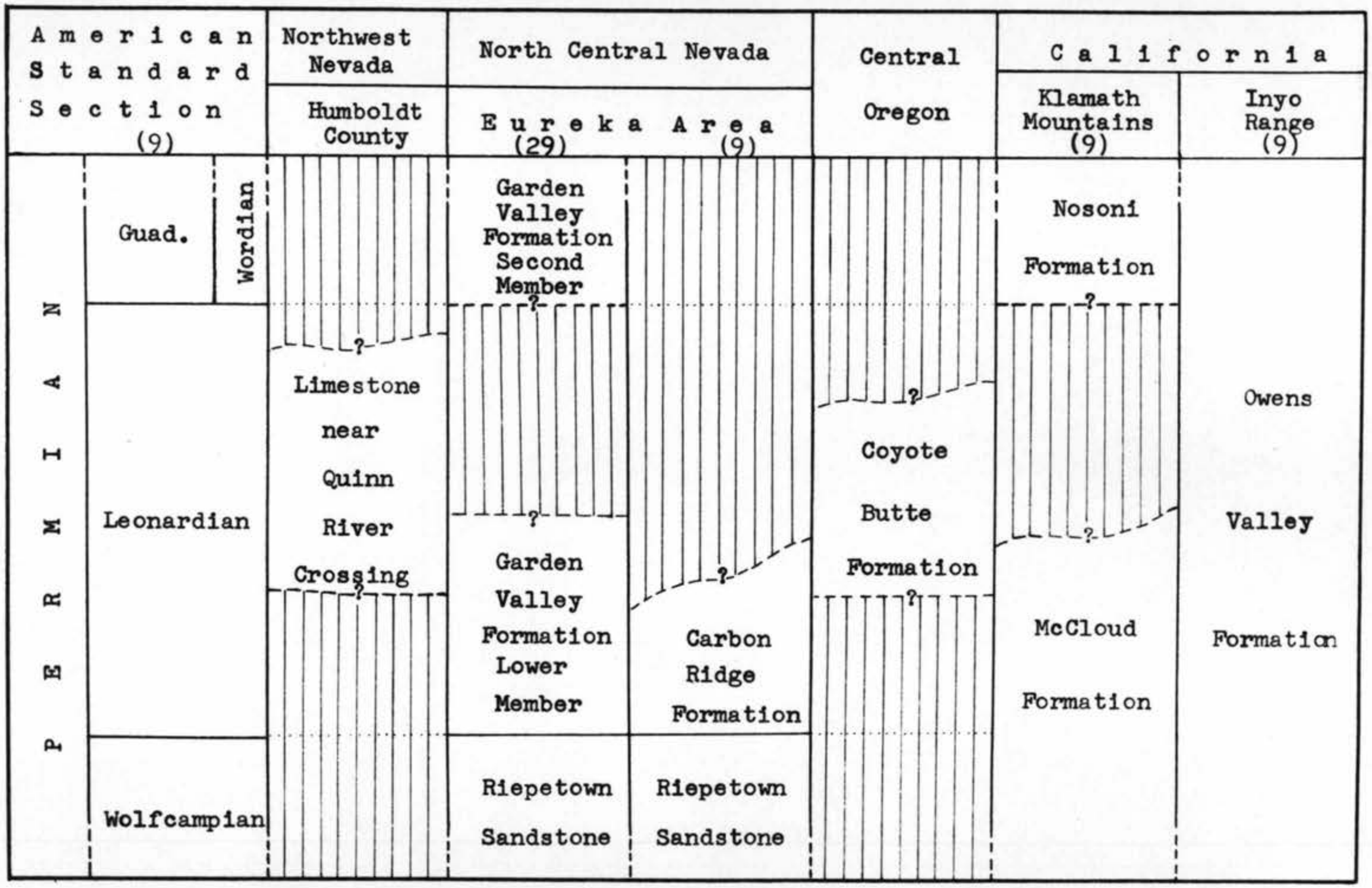

Fig. 1. Correlation of the limestone near Quinn River Crossing with formations in Nevada, Oregon and California. Numbers at heads of columns refer to references in the bibliography.

age to the formation because of the presence of the brachiopod Muirwoodia (6, p. 18). Henbest, however, observed that the fusulinids resemble Upper Wolfcampian and Leonardian species rather than those found in the Word formation or its equivalents (9, p. 1781). The fusulinid fauna of the limestone near Quinn River Crossing more closely resembles that of the Coyote Butte Formation than that of any other formation described up to this time.

The upper part of the McCloud Formation was assigned a Leonardian age by Thompson and Wheeler on the basis of the fusulinid fauna (34, p. 11).

Williams determined that the age of the brachiopod fauna of the middle part of the Owens Valley Formation is probably Leonardian or younger (22, p. 12), and Merriam and Hall concluded that it is the same age as the Carbon Ridge Formation on the basis of the fusulinid and cephalopod faunas (22, p. 12).

Henbest has studied the fusulinid fauna from the upper part of the lower limestone member of the Garden Valley Formation. He concluded that a late Hueco (Wolfcampian) or more likely Leonard age is indicated (23, p. 68). Steele, however, states that the basal limestone member contains middle Wolfcampian fusulinids and that it correlates faunally with the middle Wolfcampian Riepe Spring limestone (29, p. 112). As he does not mention the characteristically Leonardian genus Parafusulina, which was previously identified by Henbest from the upper part of the member, it is assumed that Steele did not study the entire fauna and, therefore, wrongly assigned a middle Wolfcampian age to the entire member.

According to Henbest, the fusulinid fauna of the upper part of the Carbon Ridge Formation probably is not older than upper Hueco, and may be Leonardian or even as young as the lower part of the Nosoni Formation (23, p. 66).

Two other formations in east central Nevada are believed to extend into the Leonard and may be partly equivalent to the limestone near Quinn River Crossing. Henbest has determined the fusulinid fauna from the lower beds of the Havallah Formation in the Winnemucca Quadrangle to be of Wolfcampian and possibly Leonardian age but, according to Roberts, no fossils have been found in the upper beds of this formation (25). Fusulinids of possible Leonard age also have been reported by Langenheim _et al_. from the Arcturus Formation in the Shell Creek Range in Lincoln County, Nevada (17, p. 154).

Fusulinids in the limestone section near Quinn River Crossing referred to _Parafusulina_ cf. _P_. _nosonensis_ resemble but perhaps are not conspecific with the type specimens of the species described from the lower beds of the Nosoni Formation. Representatives of _Parafusulina nosonensis_ in the lower Nosoni, as well as forms identified as _Parafusulina_ cf. _P_. _nosonensis_ from the second member of the Garden Valley Formation, occur in association with morphologically more advanced forms of _Parafusulina_. No such association was observed in the limestone section near Quinn River Crossing. For this reason, the beds containing _Parafusulina_ cf. _P_. _nosonensis_ in the limestone section are believed to be older than, and therefore not correlative with, those of the lower Nosoni Formation and the second member of the Garden Valley Formation.

SYSTEMATIC PALEONTOLOGY OF THE FUSULINIDS

STAFFELLA SP.

Poorly preserved specimens referable to the genus Staffella were observed in several samples collected throughout the section. Because of their small size and the fact that most of them are mineralized, they were not measured or illustrated.

Remarks. Staffella is widespread in North America in rocks of Middle Pennsylvanian to Late Permian age.

Occurrence. Forms of Staffella sp. are present in units 8, 12, and 20.

SCHUBERTELLA aff. S. KINGI

Dunbar & Skinner, 1937

Plate 3, figure 1

Schubertella kingi DUNBAR & SKINNER, 1937, Univ. Texas, Bull. 3701, p. 610-611, pl. 45.

Only a few improperly oriented and poorly preserved specimens of Schubertella aff. S. kingi were found in the section. Tests of these specimens are minute, elongate fusiform, and have bluntly rounded poles. They have an endothyroid juvenarium of at least one volution that has an axis of coiling approximately at right angles to that of the succeeding volutions. Specimens appear to have five volutions, of which at least the outer three are fusiform.

The proloculus is minute, the tunnel is essentially straight, and the tunnel angle increases from about 26° in the first fusiform volution to 38° in the last volution. Chomata are small, narrow, and rounded, and more prominent in the outer volutions.

The extremely thin spirotheca consists of a tectum and lower light layer and is practically invisible over the tunnel. No septal fluting was observed.

Measurements other than the tunnel angles were not made because of the lack of properly oriented specimens.

Remarks. This form closely resembles specimens of Schubertella kingi Dunbar and Skinner, which was first described from the Hueco Formation in West Texas (11, p. 611). Its affinities to this form, however, could not be determined because of the lack of well-oriented specimens. Forms of Schubertella kingi also have been reported from middle Wolfcampian rocks in Texas, Kansas, Nebraska (11, p. 611), Utah, and California (34, p. 25). Schubertella aff. S. kingi differs from specimens of S. melonica Dunbar and Skinner and S. mullerriedi Thompson and Miller in its smaller size and less inflation.

Occurrence. Schubertella aff. S. kingi is present in unit 6.

SCHUBERTELLA SP.

Poorly preserved specimens referable to the genus Schubertella were observed in collections from several units throughout the section, but no properly oriented specimens were obtained. Specimens of this species were not measured or illustrated.

Remarks. These specimens may be the same as Schubertella aff. S. kingi, which was found lower in the section, but insufficient material, along with the poor condition of the specimens, made comparisons uncertain. Schubertella is very widespread in North America and ranges from Upper Pennsylvanian to Late Permian.

Occurrence. Schubertella sp. is present in units 7, 10, 12, 14, 15, 17?, and 20.

PSEUDOFUSULINELLA cf. P. OCCIDENTALIS

(Thompson & Wheeler, 1946)

Plate 3, figures 5-7

Neofusulinella occidentalis THOMPSON & WHEELER, 1946, Geol. Soc. Amer. Mem. 17, pt. 1, p. 25-26, pl. 2, fig. 1-4.

Pseudofusulinella occidentalis (THOMPSON & WHEELER). Thompson, 1951, Cushman Found. Foram. Research, Contr., Vol. 2, p. 118, pl. 12, fig. 6-11.

Tests of Pseudofusulinella aff. P. occidentalis from the limestone near Quinn River Crossing are small, inflated fusiform, and have bluntly pointed poles and a straight axis of coiling. Three specimens of nine volutions are from 3.0 to 4.0 mm long and from 1.9 to 2.4 mm wide. The average length and diameter are 3.5 mm and 2.2 mm respectively. The form ratio stays about the same throughout, although in some specimens there is a slight increase with growth to about the fourth volution and a slight decrease in the outer volutions. The average form ratio for the ninth volution of 3 specimens is 1.6 and the maximum for this volution is 1.7. The maximum form ratio occurs in the fourth volution and is 2.3.

The proloculus is small and has an average outside diameter in 3 specimens of 115 microns. The shell shows uniform expansion to the fourth or fifth volution, after which the chambers of most specimens tend to become slightly more inflated.

The tunnel is singular, high and narrow, and fairly straight. The chomata are well-developed and asymmetrical, and they commonly reach the tops of the chambers.

The spirotheca is thin and consists of an upper tectorium, tectum, and diaphanotheca. Extensions of the massive chomata in some specimens give the wall a four-layered appearance over the tunnel. The wall thickness increases gradually from an average of 24 microns in the second volution of 4 specimens to a maximum of 107 microns in the ninth volution of 1 specimen. The septa are thin, numerous and broadly fluted. The fluting increases in intensity toward the poles. Measurements of specimens referred to this species are given in Table 1.

Remarks. This form resembles specimens of *Pseudofusulinella occidentalis* (Thompson and Wheeler), which was originally described from the basal McCloud Formation in northern California (34, p. 25-26), but it differs from the McCloud forms in its smaller size, smaller form ratio and greater wall thickness. It can be distinguished from specimens of *Pseudofusulinella montis* (Thompson and Wheeler) by its smaller size and more highly inflated chambers. Forms nearly identical to *Pseudofusulinella* cf. *P. occidentalis* occur in the central Oregon Coyote Butte Formation of middle Leonardian age.

Occurrence. Pseudofusulinella cf. P. occidentalis is present in units 6, 12 and 15.

PSEUDOFUSULINELLA aff. P. UTAHENSIS

Thompson & Bissell, 1954

Plate 3, figures 2-4

Pseudofusulinella utahensis THOMPSON AND BISSELL, 1954, Univ. Kans. Paleont. Contr., Protozoa, Art. 5, p. 34-35, pl. 7, figs. 1-10.

Tests of Pseudofusulinella aff. P. utahensis are small, elongate fusiform, and have sharply pointed poles, highly inflated central regions, concave lateral slopes, and irregular axies of coiling. Two specimens of 7 volutions average 3.9 mm in length and 2.7 mm in width. The form ratio increases gradually from a minimum of 1.0 in the first volution of 1 specimen to a maximum of 2.0 in the fourth volution of another. The average form ratio for the seventh volution of 2 specimens is 1.5. There is a uniform polar elongation with growth.

The proloculus is small and spherical. The outside diameter in 8 specimens ranges from 110 to 140 microns and averages 128 microns. The chambers are of about equal height throughout the length of the shell.

The tunnel is singular, high and narrow, and slightly irregular. The chomata are massive and asymmetrical, with steep to overhanging tunnel margins and moderate to steep polar sides. The chomata commonly extend to the tops of the chambers in the outer volutions.

The spirotheca is thin and composed of an upper tectorium, tectum, and diaphanotheca. The wall thickness increases rather uniformly from about 25 microns in the first volution of 7 specimens to 70 microns in the seventh volution of 1 specimen. The septa are thin and numerous, moderately fluted in the axial and polar regions, and relatively unfluted across the central part of the shell. Measurements of specimens referred to this species are given in Table 2.

Remarks. This form most closely resembles specimens of Pseudofusulinella utahensis Thompson and Bissell which was originally described from specimens obtained 1000 feet above the Pennsylvanian-Permian contact in the Oquirrh Formation in the southern Wasatch Mountains near Provo, Utah (31, p. 34-35), and which also has been reported from beds of Lower Permian age in other parts of western North America. The form described here differs from the type specimens in having smaller form ratios, a straighter and more narrow tunnel, and more uniform expansion. It does not closely resemble any other described form of Pseudofusulinella.

Occurrence. Pseudofusulinella aff. P. utahensis is present in units 7 and 10.

PSEUDOFUSULINELLA SP. A

Plate 3, figures 8-9

All of the specimens of Pseudofusulinella sp. A appear to have been distorted by compression during or after preservation; therefore, measurements other than those of the wall thickness and proloculus diameter were not considered to be reliable and are not given here.

Tests of this form are small and inflated fusiform. They have sharply pointed poles and slightly concave lateral slopes. Most specimens appear to have from five to six volutions; however, the preservation of the outer volutions is very poor, and there are some indications that some of these forms may have had one or more additional volutions. There appears to be an irregular polar elongation with growth, but most of this may be due to compression.

The proloculus is small and spherical, and its outside diameter in 14 specimens ranges from 112 to 218 microns and averages about 150 microns. The chambers show little inflation and tend to exhibit a slight increase in height toward the poles.

The tunnel is singular and fairly straight. Chomata are asymmetrical and moderately well developed. They extend to the tops of the chambers in a few specimens, but in others they are low.

The spirotheca is thin and composed of an upper tectorium, tectum, and diaphanotheca. The wall increases uniformly in thickness and averages 30 microns in the first volution of 6 specimens and 90 microns in the fifth and sixth volutions of 4 specimens. Septa are thin, fairly numerous, and moderately fluted in the polar regions. Measurements of specimens referred to this species are given in Table 3.

Remarks. This form resembles specimens of *Pseudofusulinella* aff. *P. utahensis*, which is found higher in the section, but it differs in being less inflated and in having lower and less massive chomata.

Occurrence. *Pseudofusulinella* sp. A is present in unit 1.

TRITICITES? SP.

Plate 3, figures 10-16; Plate 4, figures 1-5

Tests of Triticites? sp. are of moderate size, elongate cylindrical, and have very bluntly rounded, or truncated, poles. Two specimens of 7 volutions are about 1.6 mm in width and 2.9 mm in length. The first volution appears to be coiled nearly at right angles to the other volutions, and the tests appear to have a somewhat irregular axis of coiling throughout the later volutions. The form ratio increases with growth from a minimum of 1.0 in the second volution to an average of 1.8 in the seventh volution. The maximum form ratio observed is 2.2 in the sixth volution.

The proloculus is small and spherical. The outside diameter in 11 specimens ranges from 56 to 120 microns and the average is 85 microns. Expansion of the shell is irregular, and there is some variation in the axial profile.

The spirotheca consists of a tectum and moderately coarse keriotheca. The wall thickness increases with growth from 10 to 17 microns in the first volution to a maximum of 74 microns in the sixth volution of 1 specimen. Septa are thick and fairly numerous, strongly and highly fluted in the axial region, but almost straight across the central part of the shell. Well-developed cuniculi are present.

The tunnel is singular, low, broad, and fairly straight. The chomata are small and asymmetrical; they are well developed only in the inner volutions and were not observed past the fifth volution. Measurements of specimens referred to this species are given in Table 4.

Remarks. Triticites? sp. closely resembles in most respects specimens of Triticites truncatus Chen which were described from the Lower Artinskian (Lower Leonardian) Swine limestone in South China (5, p. 39). It differs significantly from the Chinese form in possessing cuniculi. No forms previously referred to Triticites by other authors have been characterized by possession of cuniculi. However, specimens of Triticites? sp. more closely resemble described species of Triticites than they resemble forms referred to any other genus. Moreover, specimens of Triticites? sp. do not, except for possession of cuniculi, bear a close resemblance to any species of genera characterized by cuniculi. In view of the general resemblance to well known forms of Triticites, it seems best to refer the specimens found in the limestone near Quinn River Crossing to Triticites, with question. It is fully recognized that these forms may, upon further study, prove more closely related to Parafusulina or some other genus known to possess cuniculi. Inasmuch as the forms in the Swine limestone and in the limestone near Quinn River Crossing occur in rocks which are considered to be of an age at or beyond the generally accepted upper age limit of Triticites and inasmuch as cuniculi have been observed in the more advanced forms of several genera other than those characterized by the presence of cuniculi, it is concluded that the development of cuniculi may very possibly have taken place within advanced and aberrant forms of the genus Triticites.

Occurrence. Triticites? sp. is present in units 6 and 7.

PSEUDOFUSULINA cf. P. CHIAPASENSIS

(Thompson & Miller, 1944)

Plate 4, figures 6-7; Plate 5, figures 1-8

Schwagerina chiapasensis THOMPSON & MILLER, 1944, Jour. Paleon., Vol. 18, No. 6, p. 494-495, pl. 83, fig. 1, 2; pl. 84, fig. 1-3.

Pseudofusulina chiapasensis (THOMPSON & MILLER). Thompson, 1948, Univ. Kans. Paleont. Contr., Protozoa, Art. 1, p. 52, pl. 12, fig. 1, 2.

Tests of Pseudofusulina cf. P. chiapasensis are large, inflated fusiform, and have an irregular axis of coiling. The inner three to four volutions have sharply pointed poles and convex lateral slopes, while the outer two to three volutions have bluntly rounded poles and concave lateral slopes. Specimens have from five to six volutions but the sixth volution is partly or entirely missing in all of the specimens examined. The length and width of one specimen with part of the sixth volution preserved are 14.5 mm and 8.5 mm respectively. With the exception of a decrease in the third volution of 5 out of the 7 specimens examined, the form ratio increases gradually with growth from an average of 1.2 in the first volution to maximums of 1.8 and 1.7 in the fifth and sixth volutions.

The proloculus is large, thick-walled, and spherical. The outside diameter ranges from 370 microns to 608 microns and averages 515 microns for 15 specimens. The shell shows rapid and rather uniform expansion.

The spirotheca consists of a tectum and coarse keriotheca. The thickness increases rapidly to the fourth volution, then decreases slightly in the fifth and sixth volutions of most specimens. The maximum thickness in the fourth volution of 1 specimen is 250 microns. The walls decrease in thickness toward the poles. Septa are numerous and highly and narrowly fluted, and cuniculi, as well as distinct phrenothecae, are present.

The tunnel is obscure owing to the high degree of septal fluting. Minute chomata occur on the proloculus but do not appear to be developed beyond this. Measurements of specimens referred to this species are given in Table 5.

Remarks. This form closely resembles specimens of Pseudofusulina chiapasensis (Thompson and Miller) originally described from the Grupera Formation in southern Mexico (33, p. 484), but it differs in that it has a greater maximum diameter, more rapid expansion and inflation, lower number of septa and a slightly smaller proloculus. It also has smaller form ratios but shows a similar decrease in form ratio in the third volution. It is similar to specimens of Parafusulina? turgida Thompson and Wheeler from the upper McCloud Formation (34, p. 30-31) but differs in being more highly inflated and in having fewer septa per corresponding volution and smaller form ratios.

Occurrence. Pseudofusulina cf. P. chiapasensis is present in units 7 and 12.

PSEUDOFUSULINA cf. P. HAWKINSI

(Dunbar & Skinner, 1937)

Plate 6, figures 1-3

Schwagerina hawkinsi DUNBAR & SKINNER, 1937, Univ. Texas Bull. 3701, p. 632-633, pl. 59; pl. 56, fig. 15, 16.

Pseudofusulina hawkinsi (DUNBAR & SKINNER). Thompson, 1948, Univ. Kans. Paleont. Contr., Protozoa, Art. 1, p. 52.

Tests of Pseudofusulina cf. P. hawkinsi are large, inflated fusiform, and have slightly convex lateral slopes and bluntly pointed poles. The average length and diameter for 3 specimens of 6 and 7 volutions are 6.6 mm and 4.6 mm respectively. One specimen of 7 volutions has a maximum length of 7.9 mm and a maximum diameter of 5.3 mm. The form ratio remains about the same throughout growth, and the average is about 1.5 for 6 specimens.

The proloculus is large, thick-walled, and spherical. The outside diameter in 11 specimens ranges from 365 to 475 microns and averages 418 microns. The shell expands rapidly and uniformly and shows little or no change in axial profile.

The spirotheca consists of a tectum and coarse keriotheca and increases in thickness with growth. In four specimens examined, the maximum wall thickness occurs in the sixth volution. The septa are regularly and strongly fluted. Phrenothecae and cuniculi are present.

The tunnel is obscure owing to the high degree of septal fluting. The minute chomata seem to occur only on the proloculus. Measurements of specimens referred to this species are given in Table 6.

Remarks. This form closely resembles specimens of Pseudofusulina hawkinsi (Dunbar and Skinner), which was originally described from the base of the Leonard Formation in West Texas (11, p. 633), but the Nevada form has a larger number of septa per corresponding volution and is shorter and slightly less inflated. It differs from Pseudofusulina hessensis (Dunbar and Skinner) and P. heucoensis (Dunbar and Skinner) in being less inflated and in having a larger form ratio and a greater number of septa. Pseudofusulina hawkinsi also occurs in the middle Hueco Formation in West Texas (11, p. 633) and in the lower member of the Pequop Formation in east central Nevada (29, p. 106).

Occurrence. Pseudofusulina cf. P. hawkinsi is present in units 6 and 10.

PSEUDOFUSULINA SP. A

Plate 6, figures 4-6

Tests of Pseudofusulina sp. A are of medium size, inflated fusiform, somewhat elongated, and have bluntly pointed to rounded poles. One specimen of 6 volutions is 8.6 mm in length and 3.7 mm in width. Form ratios of the two specimens measured are 2.0 in the first volution and 2.1 and 2.3 in the fifth and sixth volutions.

The proloculus is medium to large, subspherical to oval, and the outside diameter in three specimens ranges from 245 microns to 375 microns. The average diameter is 305 microns. The whorls are not tightly coiled and expansion is uniform.

The spirotheca consists of a tectum and fine keriotheca and is of moderate thickness. The thickness gradually increases from a minimum of 20 microns in the first volution of one specimen to a maximum of 120 microns in the sixth volution of the other. Septa are numerous, irregularly spaced, and highly fluted throughout, forming high narrow septal loops and very narrow cuniculi.

The tunnel is obscure owing to the high degree of septal fluting. Minute chomata are present only on the proloculus. Axial filling occurs in the early volutions. Measurements of specimens referred to this species are given in Table 7.

Remarks. This form greatly resembles specimens of Pseudofusulina meloformata Roberts, and may be conspecific with that species, but exact affinities cannot be determined because of the lack of properly oriented and adequately preserved specimens.

Occurrence. Pseudofusulina sp. A is present in unit 6.

PARAFUSULINA cf. P. NOSONENSIS

Thompson & Wheeler, 1946

Plate 7, figures 3-9

Parafusulina nosonensis THOMPSON & WHEELER, 1946, Geol. Soc. Amer. Mem. 17, pt. 1, p. 33-34, pl. 7, fig. 1-12.

Tests of Parafusulina cf. p. nosonensis are large, elongate, and sylindrical in shape, and have low convex lateral slopes and bluntly rounded poles. Four specimens of 7 volutions are from 11.8 to 13.2 mm in length and 3.3 to 3.7 mm in width. The average length is 12.5 mm and the average diameter is 3.1 mm. The form ratio increases during growth from an average of 1.9 for the first volution of 8 specimens to an average of 3.7 for the seventh volution of 3 specimens.

The proloculus is large and commonly irregular in shape. The average outside diameter in 23 specimens is 430 microns and the range is from 278 to 574 microns. The shell expands rather uniformly, but there is a slight elongation of the axial profile in the outer volutions.

The spirotheca consists of a tectum and relatively thin, fine keriotheca. Thickness of the spirotheca increases gradually from about 40 microns in the first volution of 7 specimens to a maximum of 120 microns in the sixth volution of 1 specimen. Septa are numerous and narrowly and highly fluted throughout the length of the shell. Cuniculi are well developed.

The tunnel is singular, low and broad, and commonly somewhat irregular. Minute chomata are present only on the proloculus. Axial filling occurs in the inner volutions of all specimens and is commonly very dense. Specimens which have heavy axial filling also have thickened septa. Measurements of specimens referred to this species are given in Table 8.

Remarks. This form closely resembles specimens of *Parafusulina nosonensis* Thompson and Wheeler, which was originally described from the lower Nosoni Formation in northern California (34, p. 33-34), but it differs in being shorter and slightly more inflated, and in having chomata and heavy axial filling. It can be distinguished easily from specimens of *Parafusulina californica* Thompson and Wheeler by its smaller size.

Occurrence. Parafusulina cf. P. nosonensis is present in units 7, 10, 12 and 20.

PARAFUSULINA SP. A

Plate 6, figures 7-10

Like Pseudofusulinella sp. A, with which it is associated, all of the specimens of Parafusulina sp. A appear to have been distorted by compression and, therefore, only measurements of the wall thickness and proloculus diameter are given here.

Tests of Parafusulina sp. A are of moderate size, elongate fusiform in shape, and have bluntly rounded poles. Three specimens have five volutions and another specimen has six.

The proloculus is spherical and of moderate size. The outside diameter in 10 specimens ranges from 183 to 276 microns and has an average of 225 microns. The shell expands rather uniformly and exhibits considerable elongation in the outer volutions; however, much of this elongation appears to be the result of compression.

The spirotheca consists of a tectum and thin keriotheca. The wall thickness increases gradually from an average of about 25 microns in the first volution to 85 and 90 microns in the fifth volution of 2 specimens. Septa are numerous and fluted throughout the shell, except for the area directly over the tunnel. Well developed cuniculi are present.

The tunnel is relatively narrow in the first three volutions, but it becomes quite broad in the fourth volution. Minute chomata are present on the proloculus. Measurements of specimens referred to this species are given in Table 9.

Remarks. This form is smaller and has less fluting and a smaller proloculus than *Parafusulina* cf. *P. nosonensis*, which occurs higher in the section. It resembles other described species of *Parafusulina* but cannot be referred to any particular species because of the poor condition of the specimens.

Occurrence. *Parafusulina* sp. A is present in unit 1.

PARAFUSULINA SP. B

Plate 7, figures 1-2

Tests of *Parafusulina* sp. B are of moderate size, elongate, subcylindrical to cylindrical, and have low lateral slopes and very bluntly rounded poles. Mature specimens appear to have five or possibly six volutions, but the outer volutions were nearly always missing in the specimens examined. One specimen of five volutions is 3.1 mm in width and 5.9 in length, and it has a form ratio of 2.9. The form ratio increases gradually with growth.

The proloculus is large and usually crushed or irregular in shape. Its outside diameter in 6 specimens ranges from 260 to 590 microns and the average is 400 microns. The shell expands gradually with uniform elongation of the axial profile.

The spirotheca is of moderate thickness and consists of a tectum and keriotheca. The wall thickness in 7 specimens increases rapidly from an average of 40 microns in the first volution to a maximum of

100 microns in the third volution. Septa are fairly numerous and fluted throughout the length of the shell. Cuniculi are present, and heavy axial filling occurs in the axial region of the inner volutions.

The tunnel is almost entirely obscured by the septal fluting, although the dense axial filling on both sides of the tunnel area gives the appearance of a low, broad tunnel in axial section. Minute chomata occur on the proloculus of one of the five specimens examined. Measurements of specimens referred to this species are given in Table 10.

Remarks. This form differs from the genotype of the genus *Parafusulina* in its short cylindrical outline. It resembles specimens which occur in the Coyote Butte Formation, but it has a larger proloculus and its axial filling is confined to a greater degree to the axial region of the inner volutions than is true of the Coyote Butte form.

Occurrence. *Parafusulina* sp. B is present in units 8, 10 and 15.

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APPENDIX

LITHOLOGIC DESCRIPTIONS AND FAUNA

(Measured from the base upward)

Unit Number	Thickness in Feet	Lithology and Fauna
1	4	Limestone, thin-bedded, light brownish gray, weathering brown to tan; contains carbonate fossils in a fine-grained chert matrix. Climacammina sp., Pseudofusulinella sp. A., Parafusulina sp. A, Rhombotrypella sp., unidentified brachiopods, crinoid columnals.
2	(9)	Rhyolite sill, light tan, weathering tan to reddish brown, highly weathered. Tertiary?
3	8	Limestone, medium-bedded, brownish gray, weathering brown to buff, numerous calcite veins, colonial coral in a carbonate matrix. Lithostrotion sp., genomorphs Diphyphyllum and Diphystrotion.
4	(3)	Rhyolite sill, light tan, weathering tan to reddish brown, highly weathered. Tertiary?
5	89	Limestone, massive, light brown, weathering light brown to buff, fine-crystalline; contains cherty seams and irregular masses which become more abundant toward the top. No fossils observed.
6	228	Limestone, dark gray to black, weathering dark gray, organic debris in a matrix which grades from coarse-crystalline at the bottom to microcrystalline at the top; contains pink and white calcite veins and numerous gray chert seams and irregular stringers which give a thin-bedded appearance to the unit. Climacammina sp., Geinitzina sp., Schubertella aff. S. kingi, Pseudofusulinella cf. P. occidentalis, Triticites? sp., Pseudofusulina cf. P. hawkinsi, Pseudofusulina sp. A. unidentified bryozoan and brachiopods, worm tubes?, crinoid columnals.
		Fault
7	548	Limestone, black, weathering dark gray, organic debris in a microcrystalline matrix; contains calcite veins and chert seams and irregular

Unit Number	Thickness in Feet	Lithology and Fauna
		stringers which give a thin-bedded appearance to the bottom of the unit but which decrease in abundance toward the top; a few oolites occur in the top beds and a one-foot bed of colonial corals is present near the middle of the unit. Climacammina sp., Geinitzina sp., Schubertella sp., Pseudofusulinella aff. P. utahensis, Triticites? sp., Pseudofusulina cf. P. chiapasensis, Parafusulina cf. P. nosonensis, Waagonophyllum sp., unidentified gastropod, crinoid columnals.
8	90	Limestone, thick-bedded, medium gray, weathering light gray to tan, fine-crystalline calcareous and cherty matrix; contains a few chert seams and irregular masses, some fossils partly silicified. Climacammina sp., Staffella sp., Parafusulina sp. B, unidentified horn coral, bryozoans and brachiopods, crinoid columnals.
9	57	Limestone, thick-bedded, tan, weathering very light tan to buff, fine-crystalline; contains a few calcite veins. No fossils observed.
10	450	Limestone, thick-bedded, dark gray, weathering medium gray to reddish gray in the top beds, organic debris in a microcrystalline matrix; contains white, pink and tan calcite veins and a few chert seams and irregular masses. Climacammina sp., Cribrostomum sp., Geinitzina sp., Schubertella sp., Pseudofusulinella aff. P. utahensis, Pseudofusulina cf. P. hawkinsi, Parafusulina cf. P. nosonensis, Parafusulina sp. B, crinoid columnals.
11	9	Chert conglomerate, thick-bedded, fine to medium-sized subangular black, gray and red chert and metaquartzite pebbles in a tan and red fine-grained porous chert matrix. No fossils observed.
12	21	Limestone, medium to thick-bedded, dark brownish gray, weathering gray and tan, organic debris in a microcrystalline calcite and chert matrix; contains numerous small calcite veins. Climacammina sp., Geinitzina sp., Textularia sp., Staffella sp., Schubertella sp., Pseudofusulinella cf. P. occidentalis, Pseudofusulina cf. P. chiapasensis, Parafusulina cf. P. nosonensis,

Unit Number	Thickness in Feet	Lithology and Fauna
		Rhombotrypella sp., unidentified brachiopods and gastropods, crinoid columnals.
13	76	Limestone, medium-bedded, light gray, weathering light gray to tan, fine-crystalline; contains pink and tan calcite veins and a few chert seams and irregular masses. No fossils observed.
14	50	Limestone, medium-bedded, dark gray, weathering medium gray, microcrystalline; contains white and tan calcite veins and some chert seams and irregular masses. Schubertella sp., worm tubes?
15	413	Limestone, medium-bedded, dark gray to brownish gray, weathering medium gray to brownish and reddish gray in places, organic debris in a fine to microcrystalline matrix; contains white, orange and tan calcite veins and some cherty beds and chert seams and irregular masses. A one-foot colonial coral bed is present near the middle of the unit. Schubertella sp., Pseudofusulinella cf. P. occidentalis, Parafusulina sp. B, Waagonophyllum sp., crinoid columnals.
16	37	Chert, medium-bedded, dark brown and gray, weathering brown and reddish brown to black, fine-grained; contains minute iron oxide and carbonate inclusions. No fossils observed.
		Fault
17	75	Limestone, thick-bedded, medium gray, weathering medium to light gray, microcrystalline; contains some calcite veins and irregular chert masses. Schubertella sp.?
18	87	Limestone, thick-bedded, dark gray to black, weathering dark to medium gray, fine-crystalline; contains numerous calcite veins and chert seams and irregular masses which increase in abundance toward the top of the unit. The top beds contain numerous poorly preserved and unidentified coral fragments.
19	21	Limestone, thin to medium-bedded, black, weathering black, microcrystalline; contains short, thin chert seams and a few irregular chert masses.

Unit Number	Thickness in Feet	Lithology and Fauna
		The top one foot of the unit is thin-bedded and very black and cherty. Contains a few poorly preserved and unidentified fusulinid fragments.
20	352	Limestone, thin to medium-bedded, thick beds at the top, dark to medium gray and brownish gray, weathering brown and tan, organic debris in a microcrystalline calcite and fine-grained chert matrix, beds become very siliceous toward the top of the unit; contains numerous chert beds, seams and irregular masses and some calcite veins. <u>Climacammina</u> sp., <u>Cribrostomum</u> sp., <u>Geinitzina</u> sp., <u>Textularia</u> sp., <u>Staffella</u> sp., <u>Schubertella</u> sp., <u>Parafusulina</u> cf. <u>P</u>. <u>nosonensis</u>, unidentified horn corals, <u>Rhombotrypella</u> sp., worm tubes?, <u>Stenoscisma</u> sp., <u>Schuchertella</u> sp., <u>Derbyia</u> sp., <u>Chonetes</u> sp., <u>Rhipidomella</u> sp., <u>Spiriferella</u> sp., <u>Spiriferina</u> cf. <u>S</u>. <u>billingsi</u>, <u>Punctospirifer</u> aff. <u>P</u>. <u>campestris</u>, <u>Dialasma</u> sp., productid fragments and unidentified brachiopods, <u>Baylea</u> sp., unidentified gastropods, crinoid columnals.
	2615	

Table 1. Measurements of Pseudofusulinella cf. P. occidentalis

Half length in mm.

Specimen	1	2	3
Volution			
1	0.1	0.1	0.1
2	0.2	0.1	0.2
3	0.3	0.2	0.2
4	0.4	0.4	0.4
5	0.7	0.6	0.6
6	0.9	0.7	0.8
7	1.2	0.9	1.1
8	1.4	1.1	1.4
9	1.9	1.5	2.0

Radius vector in mm.

Specimen	1	2	3
Volution			
1	0.1	0.1	0.1
2	0.1	0.1	0.1
3	0.1	0.2	0.1
4	0.2	0.3	0.2
5	0.4	0.4	0.3
6	0.5	0.5	0.4
7	0.7	0.6	0.6
8	0.9	0.8	0.9
9	1.2	1.0	1.2

Form ratio

Specimen	1	2	3
Volution			
1	1.9	1.1	1.4
2	2.1	1.2	2.3
3	2.0	1.4	2.0
4	1.9	1.5	2.3
5	1.9	1.6	2.2
6	1.8	1.6	2.2
7	1.6	1.4	1.7
8	1.6	1.4	1.6
9	1.6	1.6	1.7

Wall thickness in microns

Specimen	1	2	3	4
Volution				
1	--	--	12	--
2	26	19	21	30
3	32	30	27	47
4	45	32	40	58
5	60	40	77	60
6	70	49	80	65
7	55	93	--	80
8	65	75	--	93
9	83	--	--	107

Septal Count

Specimen	5
Volution	
1	--
2	20
3	21
4	26
5	31
6	--
7	--
8	--
9	--

Outside diameter of proloculus in microns

Specimen	3	4	6
Diameter	94	118	132

Table 2. Measurements of Pseudofusulinella aff. P. utahensis

Half length in mm.

Specimen	1	2	3	4	5	6
Volution						
1	0.1	0.2	0.1	0.2	0.2	0.2
2	0.2	0.3	0.3	0.3	0.3	0.3
3	0.4	0.5	0.4	0.6	0.5	0.5
4	0.7	0.7	0.7	0.9	0.7	0.7
5	1.1	1.0	1.0	1.4	1.1	1.0
6	1.5	1.4	1.4	---	---	---
7	2.0	1.9	2.0	---	---	---

Radius vector in mm.

Specimen	1	2	3	4	5	6
Volution						
1	0.1	0.1	0.1	0.1	0.1	0.1
2	0.2	0.2	0.2	0.2	0.2	0.2
3	0.3	0.3	0.3	0.3	0.3	0.4
4	0.5	0.5	0.5	0.5	0.4	0.6
5	0.7	0.8	0.8	0.7	0.7	0.8
6	1.0	1.1	1.0	0.9	---	---
7	1.4	1.4	---	---	---	---

Form ratio

Specimen	1	2	3	4	5	6
Volution						
1	1.0	1.5	1.3	1.5	1.6	1.2
2	1.1	1.4	1.4	1.7	1.5	1.3
3	1.2	1.4	1.2	1.8	1.7	1.4
4	1.4	1.4	1.4	2.0	1.7	1.3
5	1.5	1.3	1.3	1.9	1.6	1.4
6	1.5	1.3	1.4	---	---	---
7	1.5	1.4	---	---	---	---

Table 2 (continued)

Wall thickness in microns

Specimen	1	2	3	4	5	6	7
Volution							
1	32	25	25	30	21	25	22
2	39	37	35	45	27	52	40
3	46	42	—	46	45	45	—
4	50	—	70	—	61	60	—
5	60	40	55	67	—	—	—
6	60	85	—	—	—	—	—
7	70	—	—	—	—	—	—

Septal count

Specimen	8
Volution	
1	12
2	16
3	20
4	—
5	—
6	—
7	—

Outside diameter of proloculus in microns

Specimen	1	2	3	4	5	6	7	8
Diameter	140	138	120	110	130	132	122	134

Table 3. Measurements of Pseudofusulinella sp. A

Wall thickness in microns

Specimen	1	2	3	4	5	6
Volution						
1	33	11	45	17	35	34
2	38	27	45	40	53	50
3	55	35	60	64	65	55
4	89	50	95	60	80	95
5	88	55	105	88	--	--
6	100	--	--	--	--	--

Septal count

Specimen	7	8	9
Volution			
1	9	10	--
2	13	12	13
3	18	15	15
4	21	17	--
5	--	--	--
6	--	--	--

Outside diameter of proloculus in microns

Specimen	1	2	3	4	5	6	7
Diameter	140	117	150	114	160	164	112

Specimen	10	11	12	13	14	15	16
Diameter	136	200	175	145	150	137	218

Table 4. Measurements of Triticites? sp.

Half length in mm.

Specimen	1	2	3	4	5	6	7
Volution							
1	---	---	---	---	---	---	---
2	0.2	0.2	0.2	0.2	0.2	0.2	0.1
3	0.3	0.3	0.3	0.3	0.3	0.4	0.3
4	0.4	0.5	0.5	0.5	0.4	0.5	0.5
5	0.7	0.7	0.7	0.7	0.7	0.8	---
6	1.1	0.9	1.2	1.1	1.0	---	---
7	1.5	1.4	---	---	---	---	---

Radius vector in mm.

Specimen	1	2	3	4	5	6	7
Volution							
1	---	---	---	---	---	---	---
2	0.2	0.1	0.1	0.1	0.1	0.1	0.1
3	0.2	0.2	0.2	0.2	0.2	0.2	0.2
4	0.3	0.3	0.3	0.3	0.3	0.4	0.3
5	0.4	0.4	0.4	0.4	0.5	0.5	---
6	0.6	0.5	0.5	0.5	---	---	---
7	0.9	0.8	---	---	---	---	---

Form ratio

Specimen	1	2	3	4	5	6	7
Volution							
1	---	---	---	---	---	---	---
2	1.0	1.6	1.2	1.7	1.3	1.3	1.3
3	1.1	1.6	1.4	1.9	1.3	1.6	1.6
4	1.3	1.7	1.9	1.9	1.5	1.4	1.7
5	1.6	1.8	1.9	2.1	1.6	1.4	---
6	1.8	1.8	2.2	---	---	---	---
7	1.8	1.8	---	---	---	---	---

Table 4 (continued)

Wall thickness in microns

Specimen	1	2	3	4	5	6	7
Volution							
1	17	13	11	--	10	12	12
2	28	15	16	17	14	21	--
3	32	21	20	26	23	30	30
4	35	33	26	39	35	34	51
5	47	47	43	54	55	45	--
6	74	60	73	--	--	--	--
7	55	68	--	--	--	--	--

Septal Count

Specimen	8	9	10	11	12
Volution					
1	--	--	--	--	--
2	8	8	8	8	7
3	10	10	11	10	10
4	11	11	13	13	13
5	13	13	17	15	--
6	16	17	--	17	--
7	--	--	--	--	--

Outside diameter of proloculus in microns

Specimen	1	2	3	5	6	7	9	11	12	13	14
Diameter	120	90	100	84	56	76	63	70	83	90	85

Table 5. Measurements of Pseudofusulina cf. P. chiapasensis

Half length in mm.

Specimen	1	2	3	4	5	6	7
Volution							
1	---	0.6	0.3	0.4	1.0	0.7	1.3
2	2.3	1.7	0.9	1.3	2.2	1.5	2.5
3	3.3	2.4	1.9	2.2	3.4	2.2	3.8
4	4.3	3.3	3.1	2.9	5.1	3.2	4.4
5	6.2	4.3	4.0	4.2	6.6	---	---
6	7.2	---	---	---	---	---	---

Radius vector in mm.

Specimen	1	2	3	4	5	6	7
Volution							
1	---	0.5	0.3	0.3	1.0	0.5	1.1
2	1.6	0.9	0.8	0.8	1.9	1.0	1.9
3	2.5	1.5	1.7	1.4	2.6	1.6	2.4
4	3.1	2.1	2.4	2.2	3.2	2.2	3.1
5	3.8	2.7	2.9	2.8	3.8	---	---
6	4.3	---	---	---	---	---	---

Form ratio

Specimen	1	2	3	4	5	6	7
Volution							
1	1.2	1.3	1.2	1.4	1.0	1.4	1.2
2	1.4	1.9	1.3	1.6	1.1	1.6	1.3
3	1.4	1.6	1.1	1.5	1.3	1.3	1.6
4	1.4	1.6	1.3	1.3	1.6	1.5	1.5
5	1.6	1.6	1.4	1.5	1.8	---	---
6	1.7	---	---	---	---	---	---

Table 5 (continued)

Wall thickness in microns

Specimen	1	2	3	4	5	6	7
Volution							
1	85	78	36	25	62	64	95
2	100	100	47	38	77	78	150
3	130	113	55	145	110	114	190
4	252	238	70	82	110	160	---
5	180	155	81	88	120	---	---
6	---	---	---	---	---	---	---

Septal count

Specimen	8	9	10	11	12	13	14	15
Volution								
1	8	10	11	11	11	11	9	11
2	16	15	15	15	15	17	15	16
3	19	22	21	26	22	21	20	20
4	26	29	32	32	31	---	---	---
5	37	31	38	---	---	---	---	---
6	39	42	---	---	---	---	---	---

Outside diameter of proloculus in microns

Specimen	2	3	4	5	6	8	10	11
Diameter	556	375	371	452	608	522	490	605

Specimen	12	13	14	16	17	18	19
Diameter	490	580	375	565	600	546	390

Table 6. Measurements of Pseudofusulina cf. P. hawkinsi

Half length in mm.

Specimen	1	2	3	4	5	6
Volution						
1	0.7	0.6	0.4	0.7	0.5	0.6
2	1.0	0.9	0.6	1.3	1.1	1.1
3	1.4	1.2	1.0	1.9	1.8	1.6
4	1.9	1.7	1.4	2.3	2.6	2.7
5	2.5	2.3	1.8	3.3	---	---
6	3.0	3.1	3.0	---	---	---
7	---	3.9	---	---	---	---

Radius vector in mm.

Specimen	1	2	3	4	5	6
Volution						
1	0.5	0.4	0.3	0.4	0.4	0.4
2	0.9	0.6	0.4	0.7	0.7	0.7
3	1.2	0.9	0.7	1.1	1.1	0.9
4	1.6	1.3	1.1	1.6	1.5	1.5
5	2.0	1.7	1.5	1.9	---	2.0
6	2.3	2.2	1.9	---	---	---
7	---	2.7	---	---	---	---

Form ratio

Specimen	1	2	3	4	5	6
Volution						
1	1.3	1.6	1.6	1.9	1.5	1.5
2	1.2	1.4	1.5	1.9	1.6	1.6
3	1.2	1.3	1.4	1.7	1.7	1.7
4	1.2	1.3	1.4	1.5	1.8	1.8
5	1.3	1.4	1.2	1.7	---	---
6	1.3	1.4	1.6	---	---	---
7	---	1.5	---	---	---	---

Table 6 (continued)

Wall thickness in microns

Specimen	1	2	3	4	5	6
Volution						
1	---	---	---	---	74	35
2	88	62	---	61	80	43
3	100	90	66	72	134	88
4	117	100	85	81	145	115
5	190	97	100	96	126	137
6	192	115	141	130	---	---
7	118	109	---	100	---	---

Septal count

Specimen	1	2	3	4	5	6
Volution						
1	10	10	10	10	10	10
2	15	15	17	18	18	17
3	16	22	15	23	23	20
4	23	26	23	29	--	--
5	24	27	--	--	--	--
6	--	--	--	--	--	--
7	--	--	--	--	--	--

Outside diameter of proloculus in microns

Specimen	1	2	3	4	5	6
Diameter	475	470	285	442	380	345

Specimen	7	8	9	10	11	12
Diameter	310	385	372	265	410	438

Table 7. Measurements of Pseudofusulina sp. A

Wall thickness in microns

Specimen	1	2
Volution		
1	---	20
2	40	40
3	54	48
4	63	---
5	70	80
6	120	---

Half length in mm.

Specimen	1	2
Volution		
1	0.3	0.3
2	0.6	0.7
3	1.1	1.2
4	1.9	1.9
5	2.7	2.4
6	4.3	---

Radius vector in mm.

Specimen	1	2
Volution		
1	0.2	0.2
2	0.3	0.3
3	0.5	0.5
4	0.9	0.8
5	1.4	1.2
6	1.9	---

Form ratio

Specimen	1	2
Volution		
1	2.0	2.0
2	2.5	2.7
3	2.2	2.6
4	2.0	2.3
5	2.0	2.1
6	2.3	---

Septal count

Specimen	3	4
Volution		
1	10	10
2	15	15
3	22	22
4	---	---
5	---	---
6	---	---

Outside diameter of proloculus in microns

Specimen	2	3	4
Diameter	245	375	325

Table 8. Measurements of Parafusulina cf. P. nosonensis

Half length in mm.

Specimen	1	2	3	4	5	6	7	8
Volution								
1	.5	.8	.4	.5	.6	.6	.5	.5
2	.8	1.7	.6	1.1	1.1	1.0	1.1	1.1
3	1.1	2.5	1.3	1.4	2.1	1.9	1.7	1.8
4	2.0	3.9	2.1	2.1	3.5	2.5	2.6	2.6
5	3.0	4.9	3.5	3.1	4.7	3.0	3.3	3.5
6	4.5	5.7	5.0	4.5	5.6	---	---	---
7	5.9	6.2	6.6	5.5	---	---	---	---

Radius vector in mm.

Specimen	1	2	3	4	5	6	7	8
Volution								
1	.3	.3	.2	.3	.4	.3	.3	.3
2	.4	.5	.4	.5	.5	.4	.4	.4
3	.6	.7	.5	.6	.7	.6	.7	.6
4	.8	.9	.8	.8	1.0	.8	.9	.8
5	1.1	1.1	1.1	1.1	1.2	1.0	1.2	1.1
6	1.3	1.3	1.4	1.4	1.6	---	---	---
7	1.6	1.7	1.8	---	---	---	---	---

Form ratio

Specimen	1	2	3	4	5	6	7	8
Volution								
1	2.0	2.4	1.6	2.0	1.7	2.0	1.8	1.9
2	2.1	3.2	1.7	2.2	2.1	2.3	2.4	2.6
3	1.9	3.8	2.5	2.2	2.9	3.1	2.6	3.0
4	2.6	4.6	2.7	2.6	3.5	3.1	2.9	3.1
5	2.8	4.5	3.3	3.0	3.8	2.9	2.7	3.1
6	3.5	4.4	3.4	3.3	3.6	---	---	---
7	3.7	3.8	3.7	---	---	---	---	---

Table 8 (continued)

Wall thickness in microns

Specimen	1	2	4	5	6	7	8
Volution							
1	35	45	30	45	30	35	40
2	40	55	30	45	40	35	34
3	50	58	41	60	48	55	55
4	42	80	52	68	57	70	64
5	63	90	60	95	61	—	—
6	78	80	78	120	—	—	—
7	80	—	—	—	—	—	—

Septal count

Specimen	9	10	11	12	13	14	15	16
Volution								
1	11	11	10	11	11	11	10	11
2	22	17	16	16	16	15	16	17
3	24	20	18	20	22	18	24	19
4	25	26	25	26	22	20	24	21
5	24	31	22	24	25	22	—	—
6	—	—	—	—	—	—	—	—
7	—	—	—	—	—	—	—	—

Outside diameter of proloculus in microns

Specimen	1	2	3	4	5	6	7	8	9
Diameter	354	378	372	386	421	445	454	420	566

Specimen	10	11	12	13	14	15	16	17	18
Diameter	408	392	477	289	278	453	323	448	400

Specimen	19	20	21	22	23	24	25	26	27
Diameter	574	500	408	564	389	450	468	356	440

Table 9. Measurements of *Parafusulina* sp. A

Wall thickness in microns

Specimen	1	2	3	4
Volution				
1	21	36	—	23
2	31	40	25	36
3	55	83	41	65
4	64	84	77	80
5	85	90	—	—

Septal count

Specimen	5	6	7	8	9	10
Volution						
1	—	9	9	9	9	—
2	12	12	14	14	13	13
3	17	20	17	17	17	17
4	24	—	—	—	—	—
5	26	—	—	—	—	—

Outside diameter of proloculus in microns

Specimen	1	2	3	4	7	11	12	13	14	15
Diameter	188	183	233	230	255	276	220	222	238	191

Table 10. Measurements of Parafusulina sp. B

Half length in mm.

Specimen	1	2	3	4
Volution				
1	0.2	---	---	1.1
2	0.7	0.8	1.3	1.8
3	0.9	1.0	1.8	2.6
4	---	1.9	2.6	3.5
5	---	---	---	4.5

Radius vector in mm.

Specimen	1	2	3	4
Volution				
1	0.2	0.2	0.4	0.5
2	0.3	0.5	0.7	0.7
3	0.4	0.6	0.9	1.0
4	---	0.8	---	1.2
5	---	---	---	1.5

Wall thickness in microns

Specimen	1	2	3	4	5	6	7
Volution							
1	--	45	--	48	36	--	46
2	18	58	55	70	40	64	72
3	--	62	76	100	55	80	90
4	--	--	85	100	60	95	97
5	--	--	--	78	--	--	--

Septal count

Specimen	8	9
Volution		
1	10	8
2	18	15
3	21	24
4	--	--
5	--	--

Outside diameter of proloculus in microns

Specimen	1	2	3	4	5	8
Diameter	262	342	463	590	589	260

EXPLANATION OF PLATE 3

Figure

1 — Schubertella aff. S. kingi DUNBAR & SKINNER, 1937. Axial section from unit 6, X40.

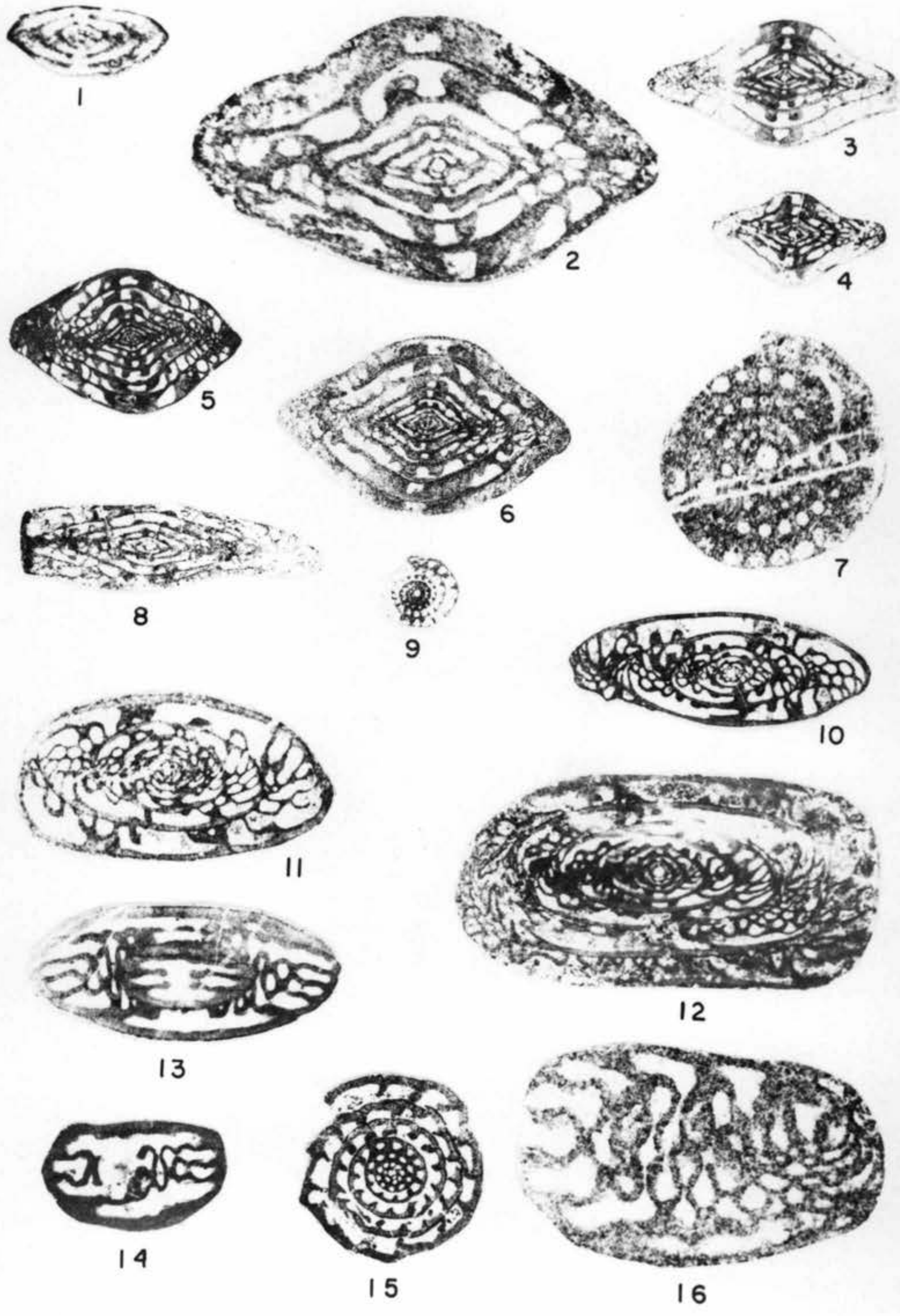
2-4 — Pseudofusulinella aff. P. utahensis THOMPSON & BISSELL, 1954. Axial sections from unit 7; 2, X 40; 3-4, X 10.

5-7 — Pseudofusulinella cf. P. occidentalis (THOMPSON & WHEELER, 1946). 5, Axial section from unit 6, X 10; 6, axial section from unit 12, X 10; 7, sagital section from unit 12, X 40.

8-9 — Pseudofusulinella sp. A. 8, Axial section; 9, sagital section; both from unit 1 and both X 10.

10-16 — Triticites? sp. 10-12, Axial sections; 13-14, tangential sections showing cuniculi; 15, sagital section; all from unit 7 and all X 20; 16, tangential section from unit 6 showing cuniculi, X 40.

PLATE 3



EXPLANATION OF PLATE 4

Figure

1-5 *Triticites?* sp. 1, 4, Axial sections; 2, 5, tangential sections showing cuniculi; 3, tangential section showing lack of septal fluting across the central part of the test; all from random samples collected by D. A. Bostwick and all X 10.

6-7 *Pseudofusulina* cf. *P. chiapasensis* (THOMPSON & MILLER, 1944). 6, Axial section showing phrenothecae; 7, tangential section showing cuniculi; both from unit 12 and both X 10.

PLATE 4

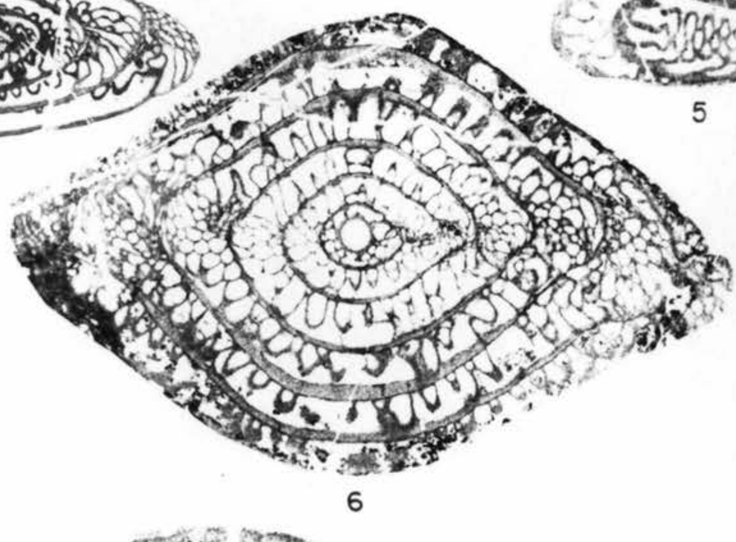
1

2

3

4

5



6

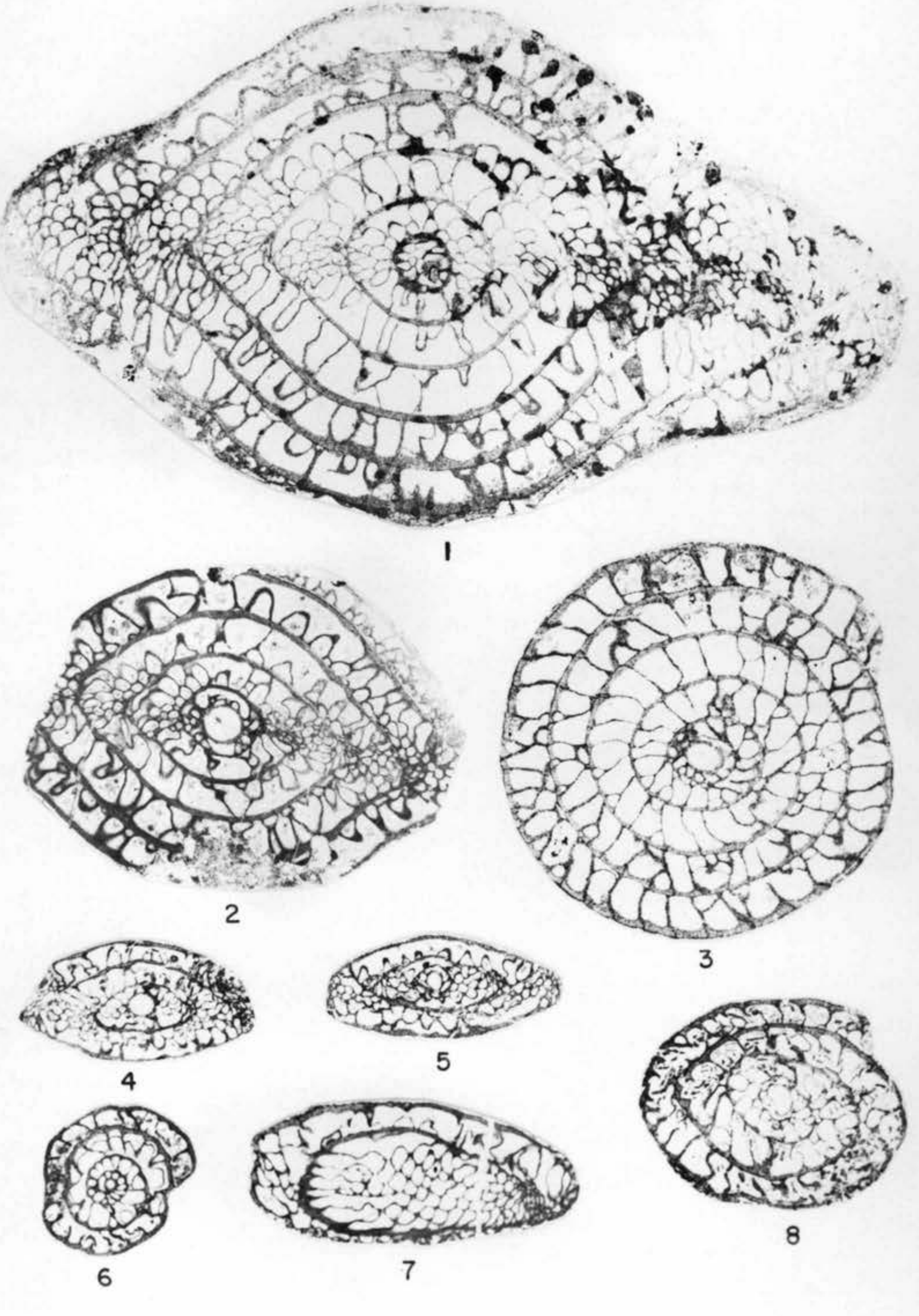
7

EXPLANATION OF PLATE 5

Figure

1-8 Pseudofusulina cf. P. chiapasensis (THOMPSON & MILLER, 1944). 1-2, Axial sections from unit 12 showing phrenothecae; 3, sagital section from unit 12; 4-5, axial sections from unit 7; 6, 8, sagital sections from unit 7 showing phrenothecae; 7, tangential section from unit 7 showing cuniculi; all X 10.

PLATE 5



EXPLANATION OF PLATE 6

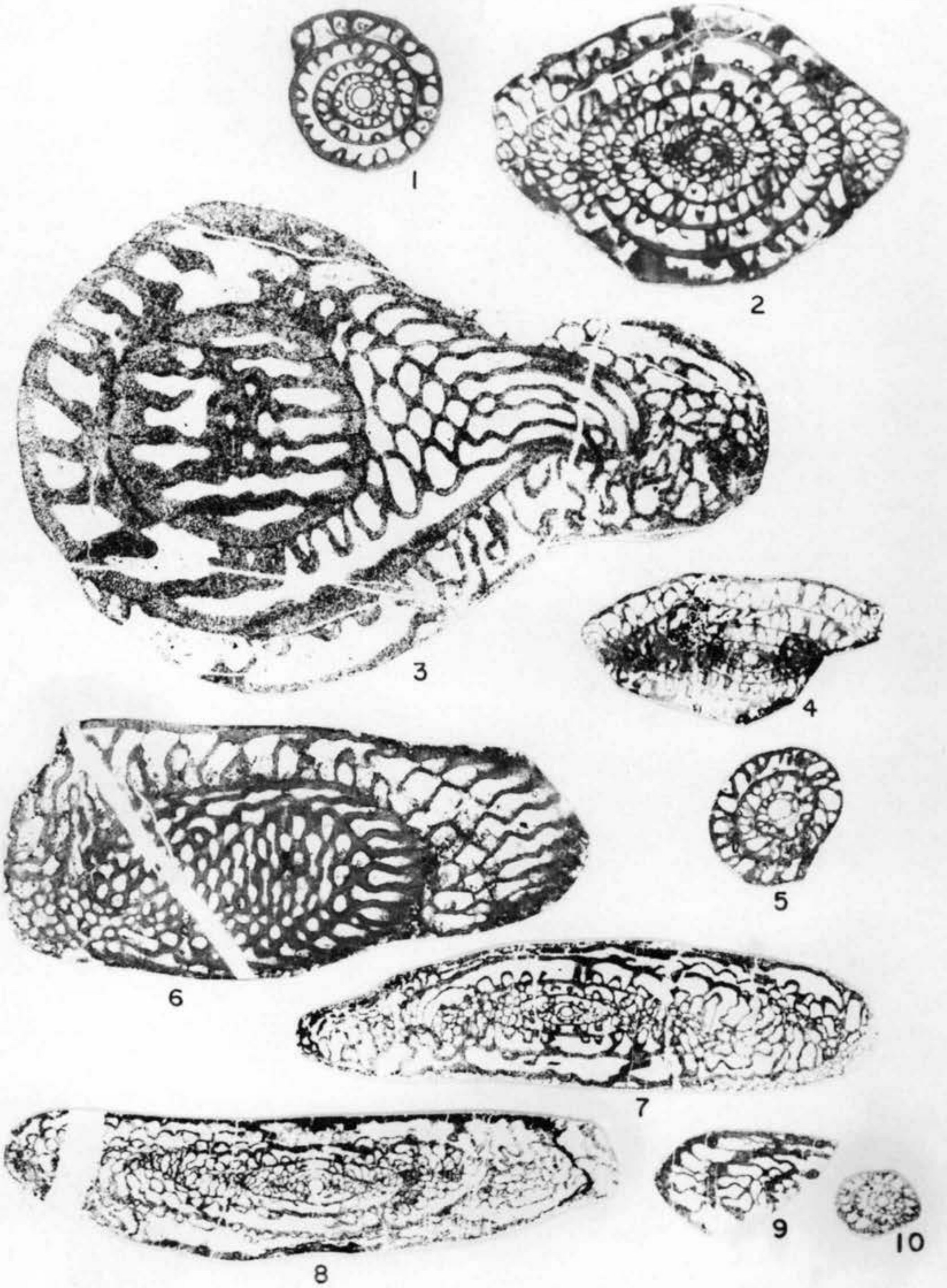
Figure

1-3 Pseudofusulina cf. P. hawkinsi (DUNBAR & SKINNER, 1937). 1, Sagital section, X 10; 2, axial section, X 10; 3, tangential section showing cuniculi, X 20; all from unit 10.

4-6 Pseudofusulina sp. A. 4, Axial section, X 10; 5, sagital section, X 10; 6, tangential section showing cuniculi; all from unit 6.

7-10 Parafusulina sp. A. 7-8, Axial sections; 9, tangential section showing cuniculi; 10, sagital section; all from unit 1 and all X 10.

PLATE 6



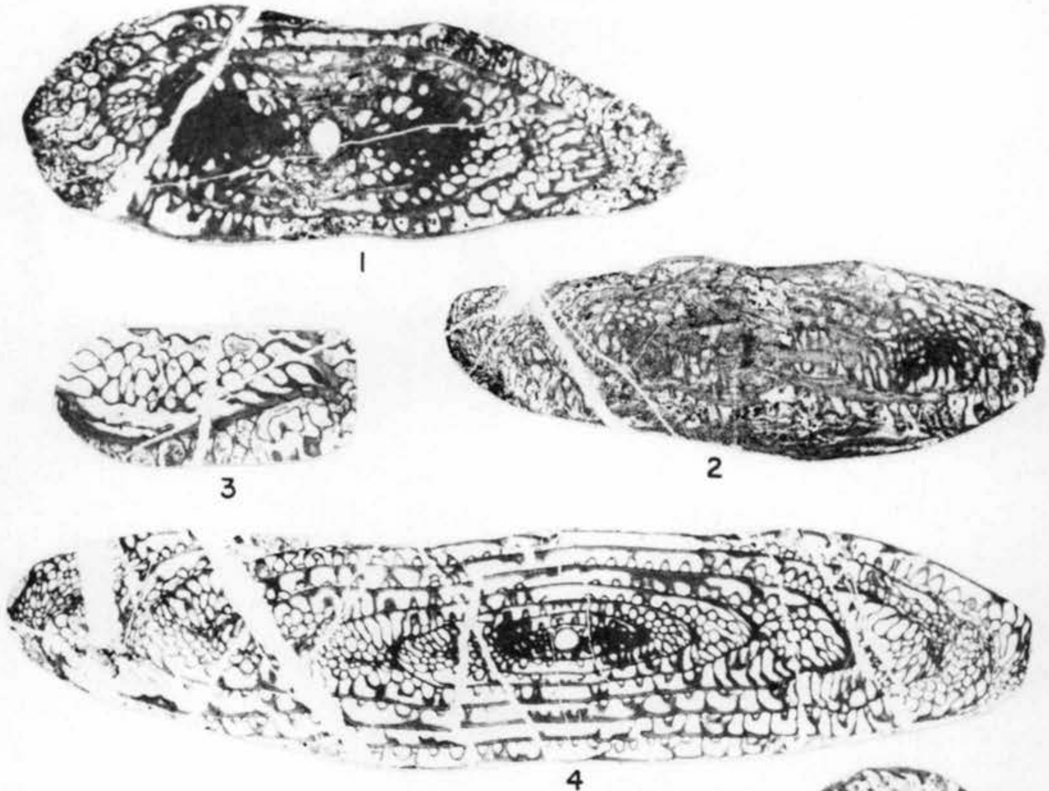
EXPLANATION OF PLATE 7

Figure

1-2 *Parafusulina* sp. B. 1, Axial section; 2, tangential section showing cuniculi; both from unit 8 and both X 10.

3-9 *Parafusulina* cf. *P. nosonensis* THOMPSON & WHEELER, 1946. 3, Tangential section from unit 7 showing cuniculi, X 10; 4, axial section from unit 20, X 9; 5, 8, sagital sections from unit 20, X 10; 6, 9, axial sections from unit 20, X 10; 7, tangential section from unit 20, X 10.

PLATE 7

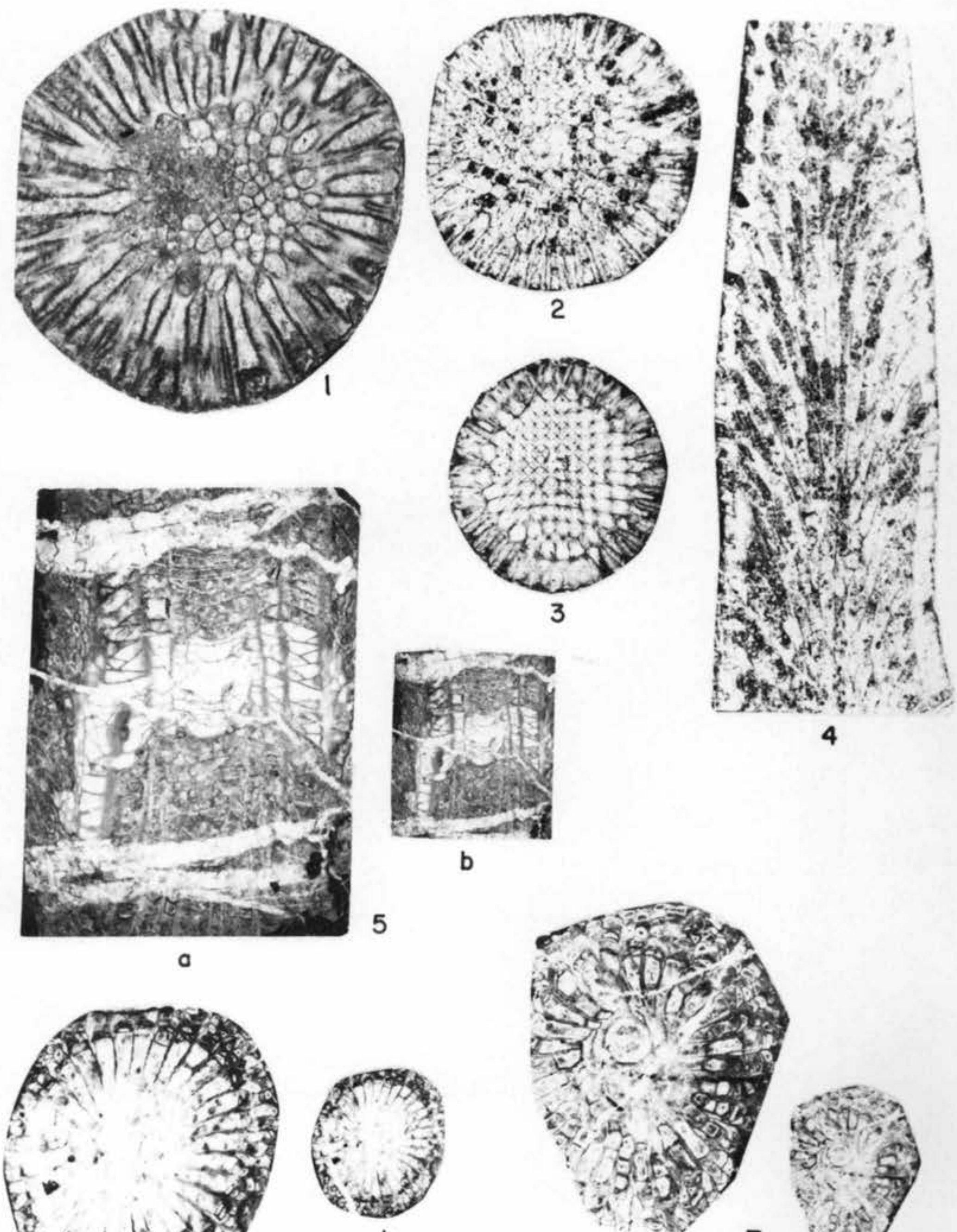


EXPLANATION OF PLATE 8

Figure

1-4	Rhombotrypella sp. 1-3, Cross sections; 1, X 4; 2-3, X 2; 4, longitudinal section, X 2; all from unit 20.
5-7	Lithostrotion sp., genomorphs Diphyphyllum and Diphystrotion. 5, Longitudinal section; 5a, X 2; 5b, X 1; 6, Diphyphyllum, cross section; 6a, X 2; 6b, X 1; 7, Diphystrotion, cross section; 7a, X 2; 7b, X 1; all from unit 3.

PLATE 8



EXPLANATION OF PLATE 9

Figure

1-6 *Waaganophyllum* sp. 1-3, 5-6, Cross sections; 4, longitudinal section; 1a, 4, 5a, 6a, X 2; 2a & 3a, X 3; 1b, 2b, 3b, 5b, 6b, X 1. Figures 1-4 are from unit 7; figures 5-6 are from unit 15.

PLATE 9