CONTRIBUTIONS
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FRANCES L. PARKER

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236. FUSULINIDS FROM THE LEONARD FORMATION (PERMIAN), WESTERN GLASS MOUNTAINS, TEXAS

CHARLES A. ROSS
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ABSTRACT

From the Leonard Formation in the western part of the Glass Mountains, eleven species of fusulinids are recognized. The lowest member of the formation, member A, has **Schwagerina dugoutensis** n. sp., **S. hawkinsi** Dunbar and Skinner, **S. hessensis** Dunbar and Skinner, **S. crassitectoria** Dunbar and Skinner, **S. guembeli** Dunbar and Skinner, **Monodiexodina linearis** (Dunbar and Skinner), **Parafusulina leonardensis** n. sp., and **P. allisonensis** Ross. The middle member, member B, contains **Schwagerina hessensis**, **S. hawkinsi?**, **Parafusulina spissisepta** Ross, **P. leonardensis**, and **Schubertella muellerriedi** Thompson and Miller. Member C at the top of the formation has the distinctive species **Parafusulina durhami** Thompson and Miller.

In the shelf deposits that form the Leonard Formation in the western part of the Glass Mountains, the base of member B is believed to correlate with the Hess fossil bed in the upper part of the Hess Member of the basin deposits of the eastern part of the Glass Mountains. Member C is correlative with the beds overlying the Hess Member. Several fusulinid species from near the base of the Leonardian Series show close similarity with species from the Sterlitamak beds of the Russian Sakmarian Series and fusulinid species from higher beds in the Leonardian bear close resemblance to those from the Russian Artinskian Series.

INTRODUCTION

The Leonardian Series takes its name from the Leonard Formation of the Glass Mountains, Texas, where it overlies the Wolfcampian Series. These two series form the lower part of the standard North American Permian succession. Exposed for more than 40 miles along the southern escarpment of the Glass Mountains, the Leonard Formation is a complex sequence of intertonguing lithologies that total nearly 2000 feet in thickness.

The present study is principally concerned with the fusulinids and their zonation in the Leonard Formation at its type section at Leonard Mountain and to the southwest in the western part of the Glass Mountains. The fusulinids and their stratigraphic distribution in the Hess Member of the Leonard Formation in the eastern part of the Glass Mountains were discussed by Ross (1960a).

The history of previous stratigraphic nomenclature applied to the Leonardian Series was summarized by Ross (1960a, p. 117-120), and only discussion pertinent to the Leonard Formation in the western part of the Glass Mountains will be added here. The Leonard Formation was named by Udden, Baker, and Böse (1916, p. 51) for about 1800 feet of beds on and to the north of Leonard Mountain. The relations between the thin-bedded Hess Member in the eastern part of the Glass Mountains and the coarse conglomeratic limestone, siliceous shale, and siliceous siltstone in the western part have been variously classified as additional data became available. Udden (1917, p. 43-47), King and King (1928, p. 126, 127), and P. B. King (1931, p. 57, and 1932, p. 338-341) considered the Hess and Leonard as separate formations, but later P. B. King (1934, p. 730, 1937, p. 98, and 1942, p. 650), Ross (1960a, p. 117-121) and others have considered the Hess as a member of the Leonard Formation. In general relations, the fine-grained, thin-bedded limestone in the eastern part of the Glass Mountains escarpment (the Hess Member) changes to conglomeratic biohermal limestone and intertonguing shale and siltstone in the western part of the Glass Mountains.

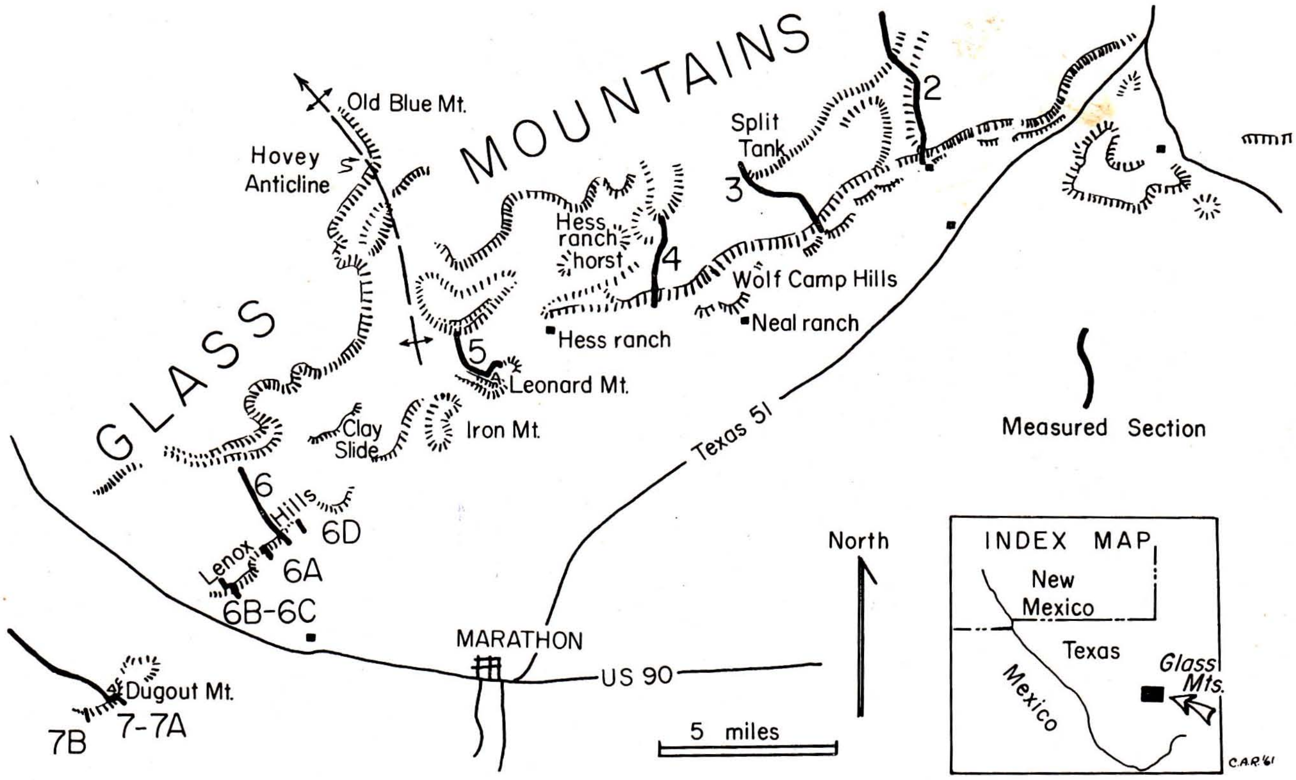
Three total sections and seven partial sections of the Leonard Formation were measured and sampled in the western part of the Glass Mountains and three sections and one partial section were measured between the top of the Hess Member and the base of the Word Formation in the eastern part of the Glass Mountains (text figures 1 and 2).

The Leonard Formation in the western part of the Glass Mountains can be divided conveniently into three members that are most clearly delimited in the southwest and may be traced from Dugout Mountain through the Lenox Hills to Leonard Mountain and possibly farther east.

The lowest member, member A, includes the basal conglomeratic limestone, conglomeratic sandstone, and dark gray shale and interbedded fine-grained limestone extending up to the base of the first limestone member (as designated by P. B. King, 1931, p. 64) of the Leonard Formation. Member A reaches a thickness of 340 feet in the Lenox Hills but apparently thins northeast of section 6 to about 120 feet and thickens again at Leonard Mountain and farther east.

The middle member, member B, includes the first through fifth limestone members (as designated by P. B. King, 1931, p. 64) of the Leonard Formation and the overlying dark gray shale, sandstone, and thin bituminous limestone extending up to the base of the conglomeratic sandstone. Member B reaches a thickness of 620 feet in the Lenox Hills.

Members A and B are lithologically similar in being composed of many diverse beds that pinch out in short distances. Individual beds can seldom be traced more than a few hundred yards although overlapping



TEXT FIGURE 1. Index map to location of measured sections and place names referred to in text: Section 2, north of the Brooks Ranch house; Section 3, about 3 miles southwest of the Brooks Ranch house extending to Split Tank on the Old Word Ranch, (remeasurement of P. B. King's Section 26, 1931); Section 4, 3 miles east of Hess Ranch house; Section 5, north slope of Leonard Mountain; Section 6, in Lenox Hills, one-half mile south of Sullivan Ranch road; Section 6A, near center of Lenox Hills; Section 6B and 6C toward southern end of Lenox Hills; Section 7 and 7A, in face of and to top of Dugout Mountain and then west to base of Word Formation; and Section 7B, southeast point on spur south of Dugout Mountain.

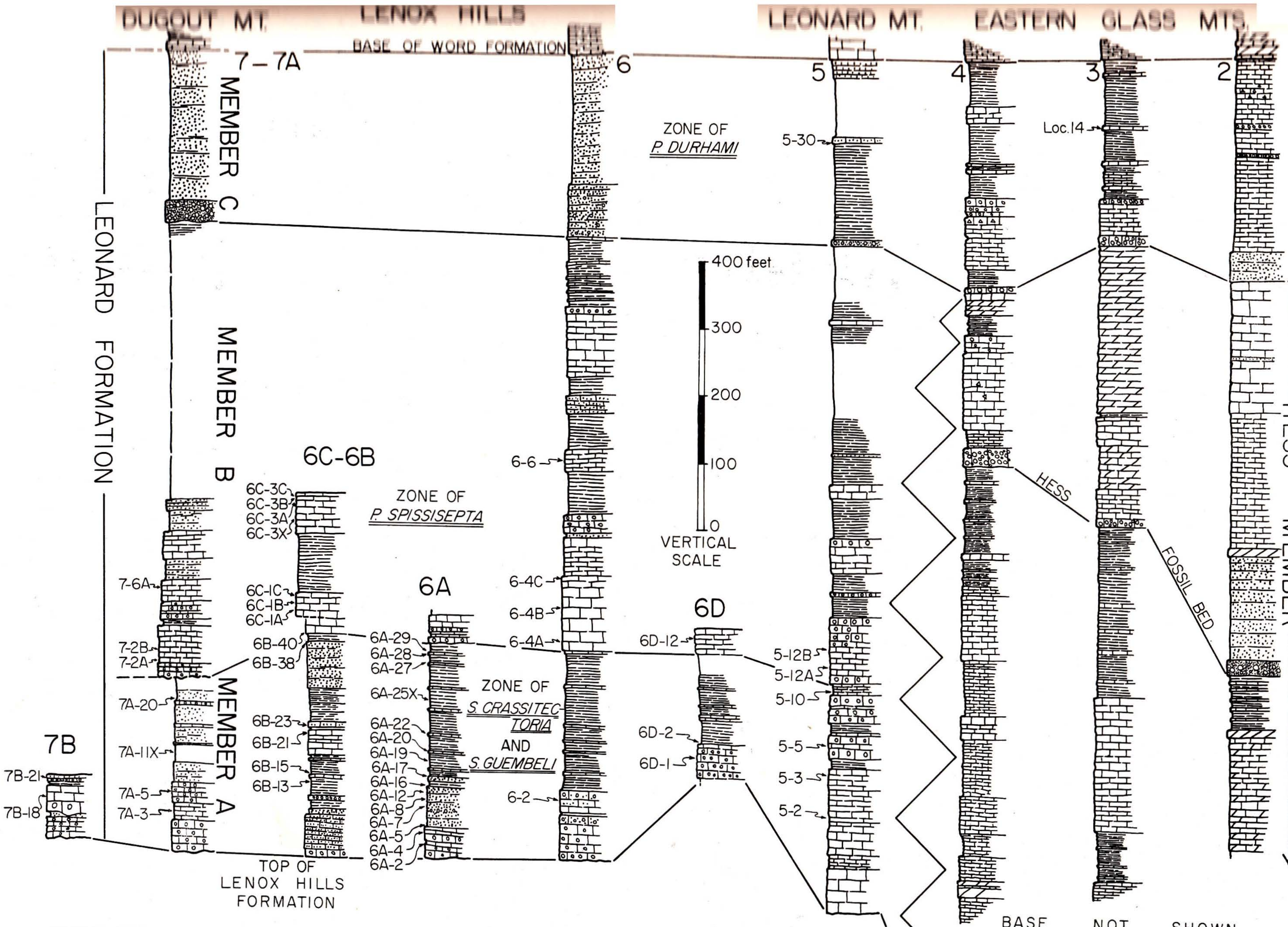
and intertonguing beds of similar lithology may persist for several miles.

The highest member, member C, is marked by a persistent conglomeratic bed that grades vertically into quartz sandstone (section 7 and 6, text figure 2) and changes laterally (section 5, text figure 2) into sandy siltstone. In the hills west of the Lenox Hills, member C is nearly 300 feet thick. Lithologically these sandy siltstones and sandstones are more similar to the sandstones of the overlying Word Formation than to the darker shales and siltstones in the two members below. East of Leonard Mountain, these beds intertongue with bioherms near Split Tank, east of the Word Ranch house. Throughout the Glass Mountains, member C is conformably overlain by fine-grained bituminous limestones marking the base of the Word Formation.

FUSULINID DISTRIBUTION

In comparison to the Hess Member, the remainder of the Leonard Formation, except for member C, has a more varied and more specialized fauna dominated by Brachiopoda, Gastropoda, Cephalopoda, and Fusulinidae. The Brachiopoda were studied by R. E. King (1931), and more recently Muir-Wood and Cooper (1960) and Cooper (1960) have discussed additional Glass Mountains material. The Gastropoda have been the subject of several studies by Batten (1958) and Yochelson (1956, 1960). The Cephalopoda were the first part of the fauna to receive close scrutiny, first by Böse (1919) and later in papers by Plummer and Scott (1937), Miller and Furnish (1940), Miller (1945), and Miller and Youngquist (1949).

The Fusulinidae of the Leonard Formation are known largely through the studies of Dunbar and Skinner (1937). Of the species of fusulinids present in the Leonard Formation in the western part of the Glass Mountains, Dunbar and Skinner (1937) described *Schwagerina hawkinsi* Dunbar and Skinner, *S. hessensis* Dunbar and Skinner, and *Parafusulina bakeri* Dunbar and Skinner. They (Dunbar and Skinner, 1937) listed identifications from 8 collections in this area but the stratigraphic ranges of these species have remained unstudied. Several species described from the Hess Member in the eastern part of the Glass Mountains also are present in the Leonard Formation in its western exposures including *Schwagerina guembeli* Dunbar and Skinner, *S. crassitectoria* Dunbar and Skinner, *Parafusulina allisonensis* Ross, and *P. spissisepta* Ross. *Monodiexodina linearis* (Dunbar and Skinner) is found in the lower part of the Leonard Formation and ranges upward from the underlying Lenox Hills Formation of the Wolfcampian Series. In addition to these species, *Schwagerina dugoutensis* Ross n. sp. and *Parafusulina leonardensis* Ross n. sp. are herein described, *P. durhami* Thompson and Miller is recognized in the upper part of the formation, and *Schubertella muellerriedi* Thompson and Miller is recorded from near the base of member B.



TEXT FIGURE 2. Measured sections of the Leonard Formation showing locations of collections; collections are numbered by section and bed, letters indicate position within a bed. (Only the upper part of the Hess Member in the eastern part of the Glass Mountains is shown.)

Just as the lithologic relations in the Leonard Formation in the western part of the Glass Mountains are more complex than in the Hess Member, the vertical and lateral distribution of species of fusulinids are more complex, and a species commonly reappears in the succession in lenses of similar lithology (Ross, 1960b, 1961).

Schwagerina hawkinsi is most abundant in conglomeratic biohermal limestone in the lowest 100 feet of the formation. These biohermal lenses may contain blocks of limestone that reach 2 feet in diameter and have an assemblage of specialized attached brachiopods and large crinoid fragments. These features suggest high wave energy conditions of near-shore deposition. *S. hawkinsi* occurs only in member A except for one collection (6-4C) from a conglomeratic limestone 400 feet above the base of the Leonard formation (100 feet above the base of member B). As the specimens are abraded, they may have been derived by erosion of older beds.

S. hessensis is most common in well sorted, coarse calcarenite and pebble sandstone in member A and in the lower 60 feet of member B. These beds, usually the lateral tongues of the conglomeratic biohermal lenses, appear to have been deposited in a medium to high wave energy environment.

Parafusulina leonardensis, the most long ranging of the Leonardian fusulinids, occurs in poorly sorted calcarenite that commonly is rich in black carbonaceous material. This species is most common in member A but ranges 300 feet into member B and, except for *P. durhami,* has the highest range of species of fusulinids from the western exposures of the Leonard Formation.

Parafusulina allisonensis occurs in calcilutite beds lacking appreciable amounts of clay, above the coarse biohermal lenses at Dugout Mountain, both in member A and the lower part of member B, but the species is poorly represented elsewhere in the western part of the Glass Mountains.

Parafusulina spissisepta occurs in poorly sorted, fine calcarenite in the lower 100 feet of member B and is commonly associated with calcareous algae and shell fragments in beds probably representing inter-reef deposition. It has not been found in member A or member C.

Parafusulina durhami, known only from three localities high in the Leonard Formation in the Glass Mountains, occurs in poorly sorted biohermal limestone that may have appreciable amounts of clay and silt. This species is associated with abundant crinoid fragments, echinoid fragments, brachiopods, and bryozoans that represent accumulation of small patch reef debris.

Schwagerina guembeli and *S. crassitectoria,* although abundant in the lower part of the Hess Member, are represented in only a few samples from member A in the western part of the Glass Mountains. Where they are present they are usually abundant, but silty calcilutite in which *S. crassitectoria* occurs and slightly clayey calcilutite in which *S. guembeli* occurs are rare in the lower part of the Leonard Formation west of Leonard Mountain.

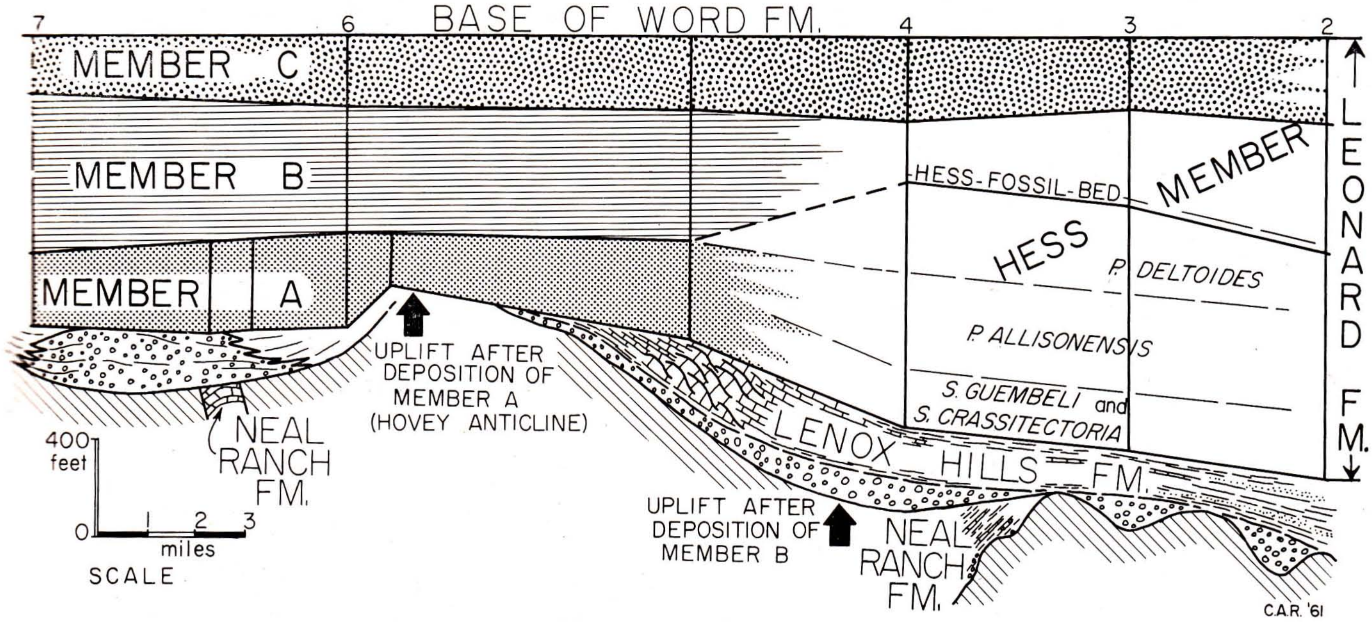
Of interest is the occurrence in member A and in the lower part of member B of *Monodiexodina linearis* in well sorted calcarenite lacking appreciable amounts of clay or silt, whereas in the underlying Lenox Hills Formation of the Wolfcampian Series, this species is most abundant in clayey or silty calcarenite having appreciable amounts of sand.

Parafusulina bakeri was not recognized in any of the Leonardian samples studied, and its range and distribution remain a question.

CORRELATION

The type section of the Leonard Formation lies near the crest of a northwest-trending anticlinal flexure that includes the Hovey and several adjacent, subparallel anticlines which delimit the southwestern edge of the Delaware Basin (King, 1942, Pl. 1). This structural ridge, initially mobile in late Wolfcampian time, apparently strongly influenced sedimentation during Leonardian time. Primarily fine-grained limestone (Hess Member) accumulated to the northeast of this flexure toward the Delaware Basin, and dominantly conglomeratic limestone, siltstone, and sandstone (members A and B) accumulated to the southwest on the shelf. Because of this great contrast between lithologies in the northeastern and southwestern parts of the Glass Mountains, correlation of the Leonardian deposits between these two areas has been a major problem. Many of the difficulties result because of considerable lithologic change in a critical area between Leonard Mountain and the high escarpment east of the Hess Ranch house where lateral tracing of beds is not possible because the Leonard Formation is largely covered by alluvium and in part is missing as a result of faulting associated with the Hess Ranch horst structure.

The relation between the Hovey and adjacent anticlines and sediments accumulated during Leonardian time is shown in text-figure 3. Southwest of this flexure belt (Sections 6, 6A, 6B, and 7A), member A remains nearly constant in thickness. Northeast of Section 6D near the crest of the Hovey anticline (the Gilliland Canyon anticline of P. B. King, 1931), the two members A and B are difficult to separate because the shale and thin limestone beds commonly are missing between the base of member B and the conglomeratic limestone in the lower part of member A. Faunally, the zones of *Schwagerina crassitectoria* and *S. guembeli* and *Parafusulina allisonensis* are represented on both sides of the anticlinal belt in member A and in the lower part of the Hess Member, but the zone of *P. deltoides* is known only from the eastern side in the Hess Member. The absence of *P. deltoides* suggests that the part of the Glass Mountains west of the



TEXT FIGURE 3. Generalized relations of the Leonard Formation in the western and eastern parts of the Glass Mountains. Dashed line indicates the suggested correlation between the base of member B and the Hess fossil bed. The third fusulinid zone of the Hess Member (zone of *Parafusulina deltoides*) is not represented in the western sections. Arrows indicate possible positions of two separate uplifts that caused a gradual shift of the edge of the basin to the northeast. The relations of the Neal Ranch and Lenox Hills formations (Wolfcampian Series) are those discussed by Ross (1959).

Hovey anticline was uplifted and perhaps eroded prior to deposition of member B. This break in deposition may be represented by the persistent conglomeratic beds at the base of the Hess fossil bed in the eastern part of the Glass Mountains and the conglomeratic limestone at the base of member B in the western part of the Glass Mountains. The appearance of *P. spissisepta* in both the Hess fossil bed and the basal part of member B supports this correlation.

If the Hess fossil bed and the base of member B are correlative, as suggested in text-figure 3, then, prior to deposition of member C, a flexure nearer the edge of the basin (that is, one lying northeast of the Hovey anticline) apparently raised part of the eastern Glass Mountains (Sections 4 and 3) 350 to 400 feet. The base of member C in Section 2 lacks conglomeratic beds, and here the thickness from the base of the Hess fossil bed to the base of member C is comparable to the thickness of member B west of Leonard Mountain.

Member C and the upper part of member B have only scattered fusulinids. The persistent conglomerate at the base of member C is in about the same stratigraphic position as the conglomeratic beds near Split Tank (Section 3) which King (1942, p. 653) believed directly overlay the Hess Member. The occurrences of *Parafusulina durhami* in member C, at the Clay Slide, in the type section at Leonard Mountain, and in the biohermal beds at Split Tank, at approximately the same position below the base of the Word Formation, supports this correlation.

In western North America, few fusulinids have been described from strata of Leonardian age. From the Bone Spring Formation in the Sierra Diablo, west Texas, Dunbar and Skinner (1937) described several species, *Parafusulina schucherti* Dunbar and Skinner, *P. diabloensis* Dunbar and Skinner, and *Schwagerina setum* Dunbar and Skinner. Of these, *P. schucherti* shows a general resemblance to *S. dugoutensis* Ross n. sp. but differs in having cuniculi, and is apparently more advanced in its evolution. The other two species are not closely similar to species from the Glass Mountains.

Knight (1956, p. 774-775) described from east-central Nevada a few species of *Schwagerina,* including *S. guembeli* Dunbar and Skinner, *S. guembeli pseudoregularis* Dunbar and Skinner, and several species of *Parafusulina* having Asian affinities that all ranged through nearly 800 feet of beds. Except for these two species of *Schwagerina,* this fauna shows little similarity with the fusulinids from the Leonard Formation in the western part of the Glass Mountains although they have reached the same general stage of evolution.

Dunbar (1939b) described several species of *Parafusulina* from Sonora, Mexico, that he believed were of Leonardian age. Of these, only one species shows similarity with fusulinids in the Leonard Formation in the western part of the Glass Mountains. *P. skinneri* Dunbar from near El Tigre, Sonora, is similar to *P. leonardensis* Ross n. sp. from members A and B of the Leonard Formation.

From Chiapas, Mexico, (Thompson and Miller, 1944) and adjacent Guatemala (Dunbar, 1939a, and Kling, 1960), *Parafusulina guatemalaensis* Dunbar is similar to *P. leonardensis* Ross n. sp. from the lower part of the Leonard Formation in the western part of the Glass Mountains and *P. erratoseptata* Kling is similar to *P. vidriensis* Ross from the upper part of the Hess Member in the eastern part of the Glass Mountains. *Schubertella muellerriedi* Thompson and Miller in the Paseo Hondo Formation of Chiapas, the Chochal Limestone of Guatemala, and the lower part of member B in the Glass Mountains supports the correlation of these beds as suggested by Thompson and Miller (1944), Kling (1960), and Ross (1960a). From collections from Colombia, Thompson and Miller (1949, p. 5) reported *Parafusulina durhami* Thompson and Miller and the appearance of this species in the upper part of the Leonard Formation in the Glass Mountains suggests that late Leonardian strata are present in the northern part of South America.

Fusulinids from the upper part of the Belcher Channel Formation on Grinnell Peninsula, Baffin Island, northern Canada (Thorsteinsson, 1960) are similar in evolutionary development with species from the Leonard Formation. *Schwagerina jenkinsi* Thorsteinsson is an advanced species of *Schwagerina,* and specimens identified as *S. hyperborea* (Salter) (Thorsteinsson, 1960, p. 26) have low cuniculi and are closely similar to *Parafusulina durhami* Thompson and Miller from the Leonard Formation.

Perhaps lithologically the sequence most similar to the Leonard Formation of the western part of the Glass Mountains is that of the Sterlitamak beds of the upper part of the Sakmarian Series and the lower beds of the Artinskian Series of the southern Ural Mountains where shale, coarse sandstone, and conglomerate intertongue in a complex sequence. *Schwagerina globosa* (Schellwien) and *S. vulgaris* (Schellwien) from the Sterlitamak beds have many similarities to *S. hawkinsi* Dunbar and Skinner and *S. hessensis* Dunbar and Skinner, respectively, from the lower part of the Leonard Formation. *Parafusulina lutugini* (Schellwien) from the lower part of the Artinskian Series is similar to *P. leonardensis* Ross n. sp. from the Leonard Formation. From beds higher in the Artinskian, *P. tschussovensis* Rauser-Chernoussova shows similarities to *P. durhami* from near the top of the Leonard. These similarities suggest that part of the Leonardian Series may be correlative with the upper part of the Sakmarian Series although most of it is equivalent to the Artinskian Series.

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Repository.—The collections and type specimens are housed in Peabody Museum, Yale University (YPM), and the U. S. National Museum (USNM), and the type specimens bear numbers that refer to catalog numbers of those institutions.

SYSTEMATIC PALEONTOLOGY

Genus **Monodiexodina** Sosnina, 1956

Monodiexodina linearis (Dunbar and Skinner)

Plate 2, figures 11-13

Schwagerina linearis Dunbar and Skinner, 1937, Texas Univ. Bull. 3701, p. 637, pl. 63, figs. 1-7.

Description.—Elongate subcylindrical tests that commonly reach 9 mm. in length and 1.8 mm. in diameter in 7 volutions.

The proloculi are of medium outside diameter, 0.15 to 0.20 mm., in specimens examined from the Leonard Formation. The volutions are low, and successive ones lengthen markedly along the axis to establish the general shape of the test by the third volution.

The thin keriotheca of the wall thickens from 0.02 mm. in the proloculus to 0.07 mm. in the seventh volution. The septa are nearly planar in their upper half but the lower half is folded into numerous long tubular projections that extend in front of a septum to connect with the adjacent septa where the succeeding tubular projections arise.

The tunnel is narrow in the first three or four volutions; the tunnel angle ranges between 20 and 25 degrees but in later volutions it expands to 50 degrees or more. Resorption of the tips of the septal folds in the fifth and later volutions forms low cuniculi which are well displayed in oblique tangential sections. Secondary deposits are common and tend to fill the axis in the early portion of the test (Pl. 2, figs. 11, 13). Septal folds are commonly thickened, particularly near the poles, by secondary deposits in later volutions.

Remarks.—Specimens of *Monodiexodina linearis* from the Leonard Formation agree closely with the syntypes from the Lenox Hills Formation, Wolfcampian Series, that underlies the Leonard Formation in the western Glass Mountains and fall within the range of variation of the species as represented there.

M. linearis is similar to a number of species that have been variously placed in *Parafusulina, Schwagerina,* and more recently in *Monodiexodina. Schwagerina paralinearis* Thorsteinsson from Grinnell Peninsula has less secondary deposits and apparently lacks cuniculi in comparison to *Monodiexodina linearis. Parafusulina alaskensis* Dunbar from Kuiu Island has higher volutions and little secondary deposition, and *Schwagerina prolongata* (Berry) from Bolivia has less axial deposits and may have cuniculi (see Dunbar and Newell, 1946, pl. 1, fig. 4). *Parafusulina shiptoni* Dunbar from the Karakoram and *P. wanneri* (Schu-

MEASUREMENTS OF
MONODIEXODINA LINEARIS
YPM SPECIMENS

	Volution	21844	21845	21846
	0	.06	.07	.08
	1	.12	.12	.15
Radius	2	.20	.18	.25
vector	3	.30	.28	.35
(mm.)	4	.40	.38	.45
	5	.55	.50	.60
	6	.75	.68	.80
	7	....	....	1.05?
	1	.35	.20	.35
Half	2	.65	.45	.65
length	3	1.15	.60	1.05
(mm.)	4	1.60	.90	1.80
	5	2.55	1.20	2.70
	6	3.80	1.80	3.70
	7	....	....	5.00?
	1	2.9	1.7	2.3
	2	3.2	2.5	2.6
Form	3	3.8	2.1	3.0
ratio	4	4.0	2.4	4.0
	5	4.6	2.4	4.5
	6	5.1	2.6	4.6
	7	....	....	....
	0	.03	.02	.03
	1	.04	.02	.02
	2	.04	.02	.02
Wall	3	.04	.02	.03
thickness	4	.04	.03	.03
(mm.)	5	.06	.03	.05
	6	.06	.04	.05
	7	....	....	....
	1	25	20	30
	2	25	20	30
Tunnel	3	25	20	30
angle	4	25	20	45
(°)	5	25	25	50
	6	....	....	....
	7	....	....	....

bert) from Timor are slightly larger and have more extensively developed and higher septal folds and cuniculi, and *Monodiexodina wanneri* var. *sutschanica* (Doutkevitch) on which the genus *Monodiexodina* was erected has more axial deposits and a greater extension of chambers along the axis than *M. linearis*. The occurrence of *M. linearis* in the lower 200 feet of the Leonard Formation extends the zone of this species from the upper part of the Wolfcampian Series into the Leonardian Series.

Occurrence.—In the Leonard Formation, *M. linearis* occurs in medium-grained calcarenite 20 to 200 feet above the base of the formation. Localities: 7A-3, 6D-1, 6D-12, loc. 8?.

Type material.—Syntypes are from the Lenox Hills Formation, Wolfcampian Series, at the west end of Leonard Mountain and at the south flank of the Hess Ranch horst (Dunbar and Skinner, 1937).

Genus **Schubertella** Staff and Wedekind, 1910

Schubertella muellerriedi Thompson and Miller

Plate 6, figures 8, 9

Schubertella muellerriedi THOMPSON and MILLER, 1944, Jour. Paleontology, v. 18, p. 488, pl. 79, figs. 5-11. —KLING, 1960, Jour. Paleontology, v. 34, p. 647, pl. 79, figs. 1-6.

Description.—Test is small, having an ellipsoidal outline, and reaches 1.8 mm. in length and 1.0 mm. in diameter in 7 volutions.

The proloculus is small, about 0.04 mm. outside diameter, and the initial volutions have an "endothyroid" mode of coiling and axes that are greatly inclined to the axes of later volutions. The third and later volutions are coiled around the same axis and have an ellipsoidal outline (Pl. 6, figs. 8, 9).

The wall in the next to last volution is composed of three layers: a dark line and a translucent layer immediately below, probably the tectum, about 0.005 mm. thick; beneath this a dark layer, 0.02 mm. thick, that has numerous vertical and evenly spaced lines and probably is a diaphanotheca; above the dark line at the top of the tectum there is an outer tectorium, 0.002 mm. thick, that merges with the tabular chomata and thicker deposits on the lateral slopes. The septa are nearly planar and have evenly spaced septal pores 0.01 mm. in diameter and about 0.05 mm. apart.

The tunnel in the fusiform part of the test is straight and gradually increases in width, the tunnel angle increasing from 25 degrees to 60 degrees in the third to sixth volution. Strong tabular chomata line the tunnel and merge with the outer tectorium. Other secondary deposits are not known.

Remarks.—Specimens of *Schubertella muellerriedi* from the Glass Mountains agree closely in size, shape, type of chomata, and many other diagnostic features with the type specimens of *S. muellerriedi* from Chiapas, Mexico (Thompson and Miller, 1944), and with specimens described by Kling (1960) from Guatemala. The Glass Mountains specimens, however, show different wall structures from those reported in the specimens from Central America, in *S. kingi* Dunbar and Skinner and *S. melonica* Dunbar and Skinner from the Glass Mountains, and in the type species, *S. transitoria* Staff and Wedekind, from Spitzbergen. This difference in the wall structure in specimens of *S. muellerriedi* from the Glass Mountains may be less significant than it at first appears because the wall in the smaller fusulinids commonly recrystallizes during lithification of the limestones. Thompson and Miller (1944, p. 488) reported that the wall in *S. muellerriedi* is thin and composed of a tectum and a very thin lower layer that is observed only in the middle part of the test in the

MEASUREMENTS OF
SCHUBERTELLA MUELLERRIEDI
YPM SPECIMENS

	Volution	21873	21875
	0	?	.03
Radius	1	.05	.04
vector	2	.10	.08
(mm.)	3	.12	.12
	4	.25	.20
	5	.40	.32
	6	.51	.42
	1	.08	.04
Half	2	.15	.08
length	3	.30	.20
(mm.)	4	.50	.40
	5	.70	.60
	6	.90	.80
	1	1.6	1.0
Form	2	1.5	1.0
ratio	3	2.5	1.7
	4	2.0	2.0
	5	1.8	1.9
	6	1.8	1.9
	0	....	.01
Wall	1	.02	.02
thickness	2	.02	.02
(mm.)	3	.03	.03
	4	.03	.03
	5	.03	.03
	6	.04	.03
	1	30	?
Tunnel	2	25	20
angle	3	25	20
(°)	4	35	20
	5	60	45
	6	....	....

fusiform volutions. Kling (1960, p. 647) stated that the wall in specimens that he examined was composed of a relatively thin tectum and a thicker, translucent diaphanotheca which was difficult to observe but which was traceable across the width of a chamber in the fusiform part of the test. Thompson (1948, p. 34) mentioned that one feature of the genus *Schubertella* was a two-layered wall composed of a tectum and a lower transparent layer. If the specimens of *S. muellerriedi* from the Leonard Formation, Glass Mountains, having a more completely preserved wall structure are representative of the species, then the evolutionary stage of this species appears to lie between the type species of *Schubertella* and species of the more complex genus *Yangchienia*. *Yangchienia* is larger in size than *Schubertella* and has extremely massive chomata and a wall composed of a tectum, a lower transparent layer, a basal dense layer, and two layers (possibly two stages of deposition of the outer tectorium) above the tectum.

S. muellerriedi is larger and has a more ellipsoidal outline than *S. kingi* Dunbar and Skinner from the Hueco Mountains, Texas, and is more elongate than the closely similar species *S. melonica* Dunbar and Skinner from the upper part of the Leonard Formation in the eastern part of the Glass Mountains.

Occurrence.—*S. muellerriedi* is common in only three collections, Locality 12, from the basal limestone of member B in the northern part of the Lenox Hills, 5-12B on Leonard Mountain, and 6-6 in the Lenox Hills.

Type Locality.—In the Paseo Hondo Formation, Chiapas, Mexico, 3½ miles east of Portales.

Genus **Paraschwagerina** Dunbar and Skinner, 1936

Paraschwagerina sp. A

Plate 2, figure 6

Discussion.—From the uppermost limestone beds of the Lenox Hills Formation at Leonard Mountain (collection 1) and for 4 or 5 miles to the northeast, this distinctive species marks a persistent zone at the top of the Wolfcampian Series. Its most common occurrence is in poorly sorted calcarenite made of broken fusulinid tests, crinoidal debris, and fine sand-size calcareous matrix. It is associated with *Schwagerina* sp. A and *S. dispensa* Ross.

The first 2 or 3 volutions are elongate, coiling from a small proloculus to form a distinctive early growth stage. The succeeding volution has a marked inflation which remains nearly constant in all of the mature volutions. Slight polar knobs are common in later volutions. The keriothecal wall becomes thick (0.13 mm.) in later volutions and the broadly rounded septal folds overlap one another even in the midplane of the test. Secondary deposits are apparent in the axial region of the early volutions but are lacking elsewhere in the test.

This species is most closely comparable to *Paraschwagerina roveloi* Thompson and Miller (1944) from the La Vanilla Limestone of Chiapas, Mexico, from which it differs in having much less closely folded septa and in being distinctly more elongate. *P. plena* Ross (1959) now is known to occur only in the uppermost limestone beds of the Lenox Hills Formation (rather than in the basal limestone of the Leonard Formation) in the Lenox Hills, and it differs from *P.* sp. A in having much greater inflation and a subglobose shape.

Nearly all the specimens of *P.* sp. A are broken or crushed and thus the species is not formally named. However, the best preserved specimen (Pl. 2, fig. 6) shows clearly the diagnostic features of the species

MEASUREMENTS OF
PARASCHWAGERINA SP. A
YPM SPECIMEN 21843

Volution	Radius vector (mm.)	Half length (mm.)	Form ratio
0	.03	....	....
1	.08	.25	3.1
2	.18	.55	3.1
3	.30	.95	3.2
4	.70	1.65	2.4
5	1.05	2.55	2.4
6	1.50	4.20	2.8

Volution	Wall thickness (mm.)	Tunnel angle (°)
0	.01	....
1	.01	30
2	.01	30
3	.03	25
4	.06	25
5	.09	25
6	.13	....

Genus **Schwagerina** Möller, 1877,
emend. Dunbar and Skinner, 1936

Schwagerina crassitectoria Dunbar and Skinner
Plate 1, figures 15, 16

Schwagerina crassitectoria DUNBAR and SKINNER, 1937, Texas Univ. Bull. 3701, p. 641, pl. 65, figs. 1-15. —THOMPSON, 1954, Kansas Contr. Paleontology, Protozoa, Art. 5, pl. 35, figs. 10-13.—ROSS, 1960a, Cushman Found. Foram. Research, Contr., v. 11, p. 123, pl. 17, figs. 1-9. (Not *S. crassitectoria* KNIGHT, 1956, Jour. Paleontology, v. 30, p. 779, pl. 83, figs. 13, 14.)

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

Description.—Tests commonly reach 9 mm. in length and 3.5 mm. in diameter in 7 volutions. Specimens from the Leonard Formation in the western part of the Glass Mountains have the same shape, same thin walls in their early volutions, and same high and regular septal folds with secondary deposits as do specimens from the Hess Member of the Leonard Formation in the eastern part of the Glass Mountains (Ross, 1960a, p. 123).

Proloculi are commonly large, averaging 0.2 mm. outside diameter, and may be aspherical (Pl. 1, fig. 16). The first half volution in these specimens is low but later volutions increase uniformly in height with a proportional increase in test length.

The wall is thin in early volutions and increases gradually to about 0.9 mm. in the sixth volution. The high, regularly fluted, widely spaced septal folds slope forward to the floor of the chamber (Pl. 1, fig. 16). The tunnel widens irregularly in succeeding volutions (see Measurements). Secondary deposits are heaviest in the axial region and in the septal folds adjacent to the tunnel. Pseudochomata commonly are well displayed (Pl. 1, fig. 16) as thickenings at the base of the septa at the sides of the tunnel.

MEASUREMENTS OF
SCHWAGERINA CRASSITECTORIA
YPM SPECIMENS

	Volution	21832	21833	number of septa
Radius vector (mm.)	0	.10?	.15	
	1	.18	.35	
	2	.23	.55	
	3	.35	.75	
	4	.50	1.05	
	5	.75	1.3	
	6	1.00	....	
	7	1.25	....	
Half length (mm.)	1	.15		10
	2	.30		15
	3	.50		26
	4	1.05		24
	5	1.60		25
	6	2.45		....
	7	3.30		....
Form ratio	1	1.5?		
	2	1.3		
	3	1.4		
	4	2.1		
	5	2.1		
	6	2.4		
	7	2.6		
Wall thickness (mm.)	0	?	.03	
	1	.03	.03	
	2	.03	.05	
	3	.04	.06	
	4	.04	.07	
	5	.06	.07	
	6	.07	....	
	7	.09	....	
Tunnel angle (°)	1	?		
	2	35		
	3	35		
	4	40		
	5	35		
	6	35		
	7	....		

Remarks.—Schwagerina crassitectoria is less globose than *S. guembeli* Dunbar and Skinner and lacks the cuniculi distinctive of *Parafusulina australis* Thompson and Miller. Size, shape, distribution of secondary deposits, and thin wall of *Schwagerina crassitectoria* separate it from most other described species of

Schwagerina. S. guembeli var. *pseudoregularis* Dunbar and Skinner falls within the range of variation of *S. crassitectoria* and is considered a junior synonym (Ross, 1960a, p. 124).

Specimens of *S. crassitectoria* are rare in the Leonard Formation of the western part of the Glass Mountains but do represent a part of the zone of *S. crassitectoria* extensively developed in the lower 210 feet of the Hess Member of the Leonard Formation in the eastern part of the Glass Mountains.

Occurrence.—Specimens discussed here are from a single collection in calcilutite 245 feet above the base of the Leonard Formation in the Lenox Hills. Locality 6A-25X.

Type locality.—In Hess Member of the Leonard Formation, 1½ miles west of Gap Tank about 100 feet above the top of the shales of the Lenox Hills Formation, Wolfcampian Series.

Schwagerina dugoutensis Ross n. sp.

Plate 3, figures 5-10

Description.—This thickly fusiform species attains a length of 12 to 13 mm. and a diameter of 4 to 4.5 mm. in 7 to 8 volutions. The lateral slopes are often straight and approach the poles at a fairly consistent angle throughout the test while the central portion of the shell is parallel to the axis of coiling. In many specimens, the axial fillings are distinctive and commonly completely fill most of the early volutions away from the midplane (Pl. 3, fig. 10).

The proloculus is small, averaging 0.12 mm. in outside diameter, and is nearly spherical. Early whorls have form ratios of 2.1 to 2.4, but later whorls show a gradual increase in this proportion. The chambers are nearly the same height from the center of the shell to the poles. The wall is thin (0.007 mm.) in the proloculus and early whorls, but it gradually increases to 0.09 or 0.10 mm. in thickness in the outer two volutions. The tectum is well defined in chambers having secondary deposits but the coarse keriotheca is apparently filled by these secondary deposits and so is seen best in the mid-portions of the shell (Pl. 3, fig. 10).

The septal folds reach to the top of the chambers, are closely spaced and have nearly straight sides and flat tops. Adjacent septa overlap only in the lateral portions of the shell. The septal folds are often completely obscured or greatly thickened by secondary deposits, except in the last volution.

The tunnel is narrow and well defined where it cuts the folded septa in thin section but lacks chomata.

Remarks.—*Schwagerina dugoutensis* is closely similar to *S. compacta* (White) and is probably a younger species in the same lineage. It differs from *S. compacta* in being larger, in having low- and thin-walled early volutions, and in having thick septal deposits throughout the test.

MEASUREMENTS OF *SCHWAGERINA DUGOUTENSIS*

	YPM SPECIMEN				
	Volution	20621	20622	20623	20620
	0	.05	.07	.08	.07
Radius vector (mm.)	1	.15	.12	.18	.12
	2	.25	.28	.27	.22
	3	.42	.48	.45	.40
	4	.70	.72	.70	.65
	5	.97	.98	.95	.88
	6	1.30	1.32	1.30	1.29
	7	1.70	1.70	1.70	....
	8	2.20	2.10	....	....
Half length (mm.)	1	.30	.30	.40	.30
	2	.60	.60	.75	.70
	3	1.10	1.10	1.10	1.20
	4	1.90	1.70	1.80	1.80
	5	2.70	2.40	2.50	2.30
	6	3.70	3.30	3.60	3.20
	7	5.50	4.50	....	....
	8	6.50	....	....	....
Form ratio	1	2.0	2.5	2.1	2.5
	2	2.4	2.1	2.6	3.2
	3	2.6	2.3	2.5	3.0
	4	2.7	2.3	2.6	2.8
	5	2.8	2.4	2.6	2.6
	6	2.9	2.5	2.8	2.5
	7	3.2	2.6	....	....
	8	3.0	....	....	....
Tunnel angle (°)	1	15	20	20	15
	2	20	15	15	16
	3	20	15	17	17
	4	20	20	20	20
	5	20	20	20	20
	6	20	15	25	....
	7	20	17	....	....
	8	....	....	....	....
Wall thickness (mm.)	0	.007	.006	.008	.007
	1	.009	.009	.007	.01
	2	.01	.01	.008	.01
	3	.02	.015	.009	.02
	4	.04	.04	.02	.06
	5	.07	.05	.03	.07
	6	.08	.08	.07	.09
	7	.09	.10	....	....
	8	....	....	....	....

S. diversiformis Dunbar and Skinner is similar but is more loosely coiled in the early whorls, has a marked increase in chamber height away from the midplane of the shell, concave lateral slopes, and less axial fillings. *S. compacta* is also similar to *S. thompsoni* Needham but is larger and has heavier axial fillings.

Occurrence.—*S. dugoutensis* appears to mark a zone in the lower 40 feet of the Leonard Formation in the western Glass Mountains. It is particularly common in shaly lenses at the base of the basal conglomeratic limestone of the formation. Localities: 7A-3, 7B-21, 6A-2, 6A-4, 6A-5, 5-12B, loc. 2, 5, 15?

Type material.—Holotype YPM 20621, Yale Peabody Museum, illustrated Pl. 3, fig. 10; from a shaly bed at the base of the Leonard Formation at the southwest end of Dugout Mountain, locality 2.

Schwagerina guembeli Dunbar and Skinner

Plate 1, figures 1-3

Schwagerina guembeli DUNBAR and SKINNER, 1937, Texas Univ. Bull. 3701, p. 639, pl. 61, figs. 1-13.—ROSS, 1960a, Cushman Found. Foram. Research, Contr., v. 11, p. 124, pl. 17, figs. 10-13, pl. 18, figs. 1-6. (Not *S. guembeli* KNIGHT, 1956, Jour. Paleontology, v. 30, p. 778, pl. 83, figs. 7-10.)

Description.—Tests commonly attain lengths of 10 mm. and diameters of 4 mm. in 8 volutions. Specimens from the Leonard Formation in the western part of the Glass Mountains have the same shape, mode of coiling and septal folding, and distribution of secondary deposits as do specimens from the Hess Member of the Leonard Formation of the eastern Glass Mountains (Ross, 1960a, p. 124).

Proloculi are large in specimens from the western part of the Glass Mountains, averaging about 0.25 mm. outside diameter. The initial volution is high and succeeding volutions gradually increase in height. The characteristic flattened shape of the mid-region of the test is attained by the second volution. Commonly, the form ratio gradually increases from about 2.0 in the first volution to 2.5 in the sixth.

The keriothecal wall is commonly very thin in the first 2 or 3 volutions and only in the fourth and later volutions does it increase markedly in thickness. The thin septa are folded into high regular folds that have flattened crests except in the last volution where the folds become more widely spaced.

The tunnel follows a regular path, is of narrow to medium width in the early volutions and expands gradually in later volutions (see Measurements) where its path becomes difficult to trace because it cuts few septal folds. Rudimentary chomata girth the proloculus, and pseudochomata may form at the base of the septa in volutions where secondary deposition is marked. Secondary deposits tend to fill the axis and the interior of septal folds in the first 2 to 3 volutions, and they heavily coat the crests of folds adjacent to the tunnel in all but the last volution (Pl. 1, figs. 2, 3).

Remarks.—*Schwagerina guembeli* differs from the closely similar *S. crassitectoria* Dunbar and Skinner in shape and distribution of axial deposits, and it differs from *S. gruperaensis* Thompson and Miller in being smaller per volution and smaller in mature size. Specimens of *S. guembeli* are rare in the Leonard Formation of the western part of the Glass Mountains

MEASUREMENTS OF
SCHWAGERINA GUEMBELI
YPM SPECIMENS

	Volution	21818	21819	21817	
Radius vector (mm.)	0	.12	.14	.13	
	1	.20	.20	.25	
	2	.30	.35	.45	
	3	.50	.55	.65	
	4	.70	.85	1.00	
	5	.95	1.20	1.30	
	6	1.25	1.50	....	
Half length (mm.)	1	.30	.35	10	number of septa
	2	.65	.65	23	
	3	1.00	1.00	23	
	4	1.40	1.60	25	
	5	1.90	2.50	23	
	6	2.60	3.50	....	
Form ratio	1	1.5	1.8		
	2	2.1	1.9		
	3	2.0	1.9		
	4	2.0	1.9		
	5	2.0	2.1		
	6	2.1	2.3		
Wall thickness (mm.)	0	.02	.02	.03	
	1	.02	.02	.02	
	2	.04	.03	.04	
	3	.04	.05	.05	
	4	.05	.07	.05	
	5	.08	.08	.08	
	6	.08	.08	....	
Tunnel angle (°)	1	25	25		
	2	25	25		
	3	25	25		
	4	30	30		
	5	....	45?		
	6	....	....		

but their occurrence here represents the extension of the zone of *S. guembeli* to southwest of the Hess Ranch house.

Occurrence.—Specimens discussed here are from 3 collections in calcilutite, 10 to 50 feet above the coarse conglomeratic limestone forming the base of the Leonard Formation, and one free specimen that was associated with other specimens of Leonardian fusulinids. Localities: 5-2, 7A-11X, loc. 4 (float), 9.

Type locality.—One and one-half miles west of Gap Tank, eastern part of the Glass Mountains, Hess Member, Leonard Formation, about 150 feet above the top of the shales of the Lenox Hills Formation (Wolfcampian Series).

Schwagerina hawkinsi Dunbar and Skinner

Plate 4, figures 1-6

Schwagerina hawkinsi DUNBAR and SKINNER, 1937, Texas Univ. Bull. 3701, p. 632, pl. 59, figs. 1-9.

Description.—Large globose to subglobose tests that commonly attain 18 mm. in length and 6.5 mm. in diameter in 8½ to 9 volutions.

Proloculus is large, 0.4 mm. outside diameter, and the first one to two volutions are low (Pl. 4, figs. 1, 6). Succeeding volutions become higher and by the third or fourth volution the test attains a subglobose or globose shape that it retains in later volutions. The poles commonly become pointed.

MEASUREMENTS OF
SCHWAGERINA HAWKINSI
YPM SPECIMENS

	Volution	21852	21854	21855	21857
	0	.18	.18	.18	.15
	1	.30	.32	.45	.25
Radius	2	.55	.50	.65	.50
vector	3	.75	.80	.85	.75
(mm.)	4	1.15	1.15	1.05	.95
	5	1.50	1.55	1.35	1.30
	6	1.95	1.95	1.70	1.65
	7	2.45	....	2.05	2.05
	8	2.80	....	2.60	....
	1	.45	.65	.45	.50
	2	.90	.95	.65	1.05
Half	3	1.30	1.30	.90	1.60
length	4	1.80	1.90	1.25	2.10
(mm.)	5	2.50	2.35	1.70	2.90
	6	3.75	2.40	2.40	3.80
	7	5.50	....	3.35	4.90
	8	6.90	....	4.40	....
	1	1.3	2.0	1.0	2.0
	2	1.6	1.9	1.0	2.1
Form	3	1.9	1.6	1.1	2.1
ratio	4	1.6	1.7	1.2	2.2
	5	1.7	1.5	1.3	2.2
	6	1.9	1.2	1.4	2.3
	7	2.3	....	1.6	2.4
	8	2.5	....	1.7	....
	0	.10	.07	.05	.03
	1	.10	.05	.04	.03
Wall	2	.08	.06	.04	.04
thickness	3	.07	.05	.05	.04
(mm.)	4	.10	.07	.05	.06
	5	.10	.09	.07	.05
	6	.12	.08	.08	.08
	7	.12	....	.12	.08
	8	.12	....	.12	....
	1	20	10	5	10
	2	15	10	5	10
Tunnel	3	10	10	5	10
angle	4	10	10	5	15
(°)	5	11	15	10	10
	6	15	....	10	20
	7	15	....	10	20
	8	....	....	10	....

The keriotheca is thick and has coarse alveoli that are well displayed in the fourth and later volutions. The septa are complexly fluted into high, regular folds reaching to the top of the chambers and overlapping onto previous septal folds (Pl. 4, fig. 1).

The narrow tunnel is well outlined and follows an irregular path. Secondary deposits occur as heavy coatings on septa and are particularly common in all but the last volution. These coatings are generally heaviest near the tunnel.

Remarks.—*Schwagerina hawkinsi* has more regularly folded and thicker septa and heavier secondary deposits than *S. nelsoni* Dunbar and Skinner, and lacks the inflated growth stage common in that species. *S. hessensis* Dunbar and Skinner has a less ventricose shape, less regularly folded septa, and is more loosely coiled. *S. gruperaensis* Thompson and Miller is smaller and has heavier secondary deposits particularly near the tunnel, and *S. figueroai* Thompson and Miller is more loosely coiled and has heavy secondary deposits only adjacent to the tunnel. *S. hawkinsi* is similar in size and general shape to *S. globosa* (Schellwien and Dyhrenfurth) from the Lower Permian of Russia and east Asia but differs from that species in having lower chambers, secondary deposits, and commonly a longer axis.

S. hawkinsi is a distinctive species, not known outside of the western part of the Glass Mountains, and is abundant in conglomerate beds in the lower 100 feet of the Leonard Formation in the western part of the Glass Mountains. Abraded specimens have been found above the basal 100 feet of the Leonard Formation at only one locality (6-4C) 420 feet above the base of the formation.

Occurrence.—In conglomeratic limestones, commonly associated with attached brachiopods, large crinoids, and *S. hessensis*. Localities: 6-4C, 6A-4, 6A-7, 6A-8, 7A-3, 7A-5, 7B-18, loc. 3 (Float), 13, 15 (float).

Lectotype.—Here designated as specimen illustrated by Dunbar and Skinner (1937, Pl. 59, fig. 4), YPM 14955, from the base of the Leonard Formation, Dugout Mountain.

Schwagerina hessensis Dunbar and Skinner

Plate 1, figures 8, 9, 11-13, 17; plate 2, figures 5, 7-10

Schwagerina hessensis DUNBAR and SKINNER, 1937, Texas Univ. Bull. 3701, p. 630, pl. 58, figs. 1-11.

Description.—Fusiform tests of medium size that commonly reach 9 to 10 mm. in length and 3.5 mm. in diameter in 6 or 7 volutions.

Proloculi vary greatly in outside diameter, 0.2 to 0.4 mm. in specimens examined, and the volutions coil loosely. The test attains a characteristic fusiform shape that becomes progressively more elongate.

The thick, coarsely alveolar keriotheca thins markedly toward the poles. The septa are fluted into high, regular folds that reach to the top of the chambers. Folds lap onto the folds of the preceding septum from the poles to high on the lateral slopes.

The tunnel is well outlined, of medium width, and closely follows the midplane of the test. Secondary deposits are of two types; thickenings deposited in the axes of the septal folds and false walls that are particularly common in most of the chambers. Chomata or rudimentary chomata are lacking in the test.

Remarks.—Schwagerina hessensis differs from *S. hawkinsi* in having a fusiform shape, less secondary deposits, and a wider straighter tunnel.

From other common species of *Schwagerina* such as *S. diversiformis* Dunbar and Skinner and *S. huecoensis* (Dunbar and Skinner), *S. hessensis* differs in its combination of fusiform shape, thick, coarsely alveolar wall, open coiling, and lack of heavy secondary deposits. It differs in shape, ontogeny, and thickness of its wall from *S. nelsoni* Dunbar and Skinner.

MEASUREMENTS OF *SCHWAGERINA HESSENSIS*

YPM SPECIMENS

	Volution	21842	21838	21840
	0	.14	.10	.15
	1	.30	.20	.25
Radius	2	.55	.40	.45
vector	3	.85	.65	.80
(mm.)	4	1.25	.95	1.20
	5	1.60	1.25	1.60
	6	....	....	....
	1	.50	.40	.30
Half	2	.85	.75	.90
length	3	1.60	1.50	1.80
(mm.)	4	3.15	2.40	2.80
	5	4.10	3.40?	4.70
	6	....	....	....
	1	1.7	2.0	1.2
	2	1.5	1.9	2.0
Form	3	1.9	2.3	2.2
ratio	4	1.4	2.5	2.3
	5	2.6	2.7?	2.9
	6	....	....	....
	0	.03	.02	.03
	1	.04	.04	.03
Wall	2	.09	.07	.07
thickness	3	.14	.08	.10
(mm.)	4	.15	.13	.14
	5	....	....	.14
	6	....	....	....
	1	15	20	25
Tunnel	2	25	20	25
angle	3	25	25	25
(°)	4	30	28	25
	5	....	....	....
	6	....	....	....

S. hessensis is distributed widely in the lower 350 feet of the Leonard Formation in the western part of the Glass Mountains where it forms a readily recognizable zone. It has not been reported outside the Glass Mountains. *S. hessensis* is closely similar to *S. vulgaris* (Schellwien and Dyhrenfurth) from the Lower Permian of Russia and apparently differs from that species in having lower chambers and more highly fluted septa.

Occurrence.—S. hessensis is common in coarse calcarenite and occasionally in conglomeratic limestone. It is associated with *S. hawkinsi* and *Parafusulina leonardensis* Ross n. sp. Localities: 6-4B, 6A-4, 6A-7, 6A-34, 6C-1C, 6D-1, 7A-3, 7A-11X, Loc. 4, 6, 7?, 8, and 10.

Lectotype.—Here designated as specimen illustrated by Dunbar and Skinner (1937, Pl. 58, fig. 11), YPM 14948, from the base of the Leonard Limestone, Dugout Mountain.

Schwagerina sp. A

Plate 1, figures 10, 14

Discussion.—Two specimens of *Schwagerina* sp. A found in a collection from the upper part of the Lenox Hills Formation are of particular interest because they apparently represent a rare species, or perhaps two rare species, that appears to be ancestral to species common in the Leonard Formation. The stratigraphic significance of these specimens is difficult to assess because of their limited occurrence.

The two specimens illustrated have subventricose outlines, a thick keriotheca, thin broadly rounded septal folds, and lack false walls. In such features as their thick walls and general distribution of secondary deposits, they are similar to *S. hessensis* Dunbar and Skinner but they differ from this species in the shape and folding of the septa. The specimen, shown in Plate 1, fig. 10, apparently represents a possible ancestor to *S. hessensis*. The specimen, illustrated in Plate 1, fig. 14, is perhaps more closely similar to *S. huecoensis* (Dunbar and Skinner) from the lower part of Hueco Limestone in the Hueco Mountains, Texas, although that species is larger than *S.* sp. A, has higher and more intensely folded septa, and a crenulated wall. The more elongate specimen (Pl. 1, fig. 14) may represent an intermediate step toward such species as *S. dugoutensis* Ross n. sp. which, however, has more angular poles and more angular septal folds.

Occurrence.—S. sp. A was found at one locality in the upper part of the Lenox Hills Formation a few feet stratigraphically below the Leonard Formation at the top of the northeast ridge of Leonard Mountain, Locality 1, where it is associated with *Paraschwagerina* sp. A.

MEASUREMENTS OF *SCHWAGERINA* SP. A

YPM SPECIMENS

	Volution	21830	21831
	0	.10	.20
	1	.20	.35
Radius	2	.35	.50
vector	3	.60	.75
(mm.)	4	.85	1.05
	5	1.20	1.40
	6	....	1.70
	1	.60	.60
Half	2	.85	1.15
length	3	1.50	1.95
(mm.)	4	2.30	2.95
	5	3.20	4.00
	6	....	5.20
	1	3.0	1.7
	2	2.4	2.3
Form	3	2.5	2.1
ratio	4	2.7	2.8
	5	2.7	2.8
	6	....	3.1
	0	.02	.03
	1	.03	.05
Wall	2	.05	.07
thickness	3	.06	.09
(mm.)	4	.09	.12
	5	.09	.13
	6	....	.10
	1	25	30
Tunnel	2	25	30
angle	3	25	30
(°)	4	30	50
	5	....	....
	6	....	....

Genus **Parafusulina** Dunbar and Skinner, 1931

Parafusulina allisonensis Ross

Plate 2, figures 1-4

Parafusulina allisonensis Ross, 1960a, Cushman Found. Foram. Research, Contr., v. 11, p. 126, pl. 19, figs. 1-9.

Description.—Fusiform tests that commonly reach 8.5 to 9 mm. in length and 2.6 to 2.9 mm. in diameter in 7 to 7½ volutions.

Proloculi in specimens examined are of medium size, average about 0.25 mm. outside diameter. The first volution is low and globose and succeeding volutions gradually increase in height and become proportionally longer; a form ratio of 3.0 is common in the sixth volution. The general shape of the test is established by the second or third volution.

The wall is composed of a thin tectum and a medium to coarsely alveolar keriotheca. It is thin in the proloculus and the first two volutions, 0.01 mm. thick, but gradually increases to 0.10 mm. in later volutions. The wall thins abruptly at the polar extremities. The septa are intensely folded into regularly spaced folds that increase in height away from the midplane. The folds have gently rounded crests. Folds of adjacent septa meet at their bases where resorption results in low cuniculi in the outer two volutions.

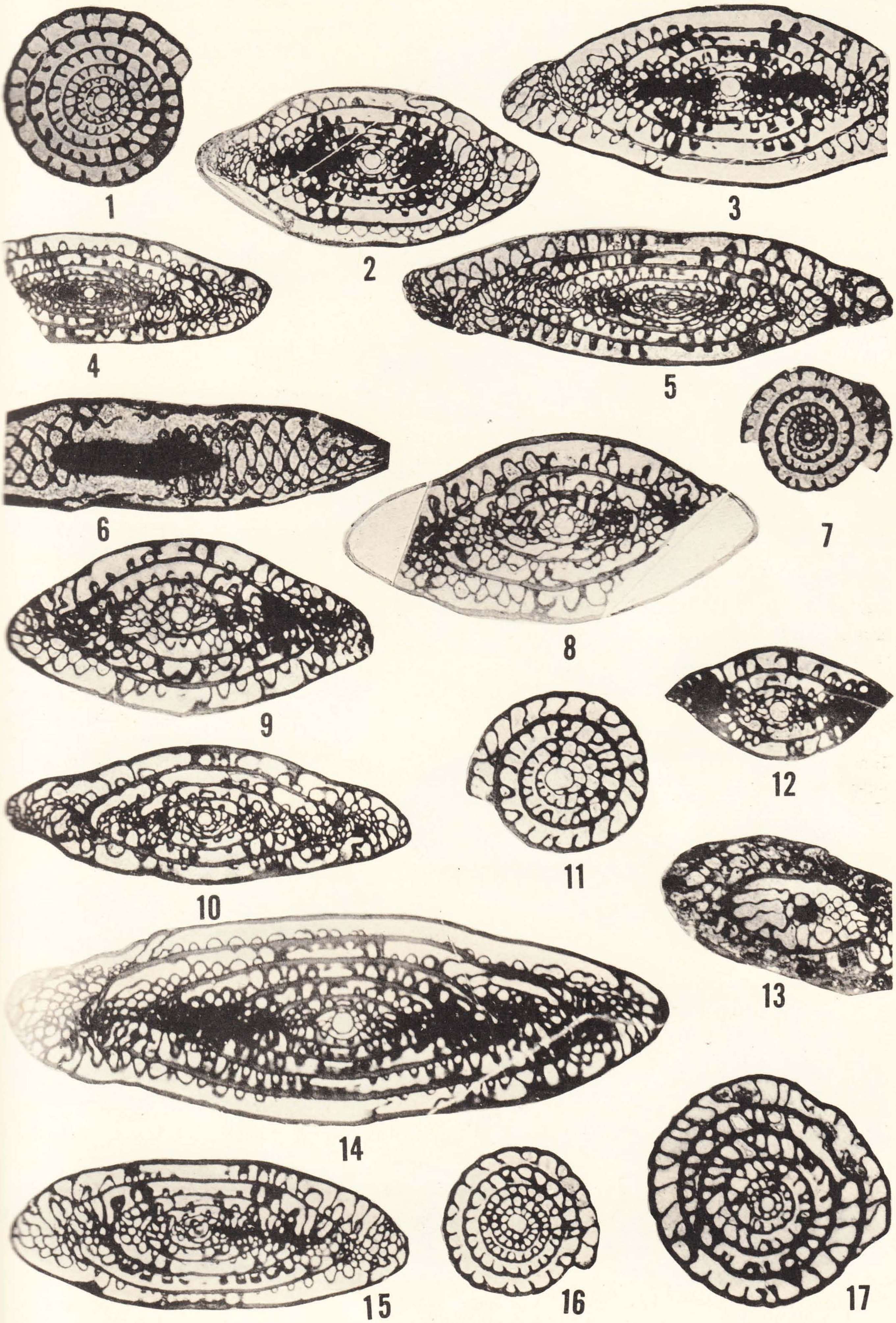
The tunnel is of medium width in the inner volutions and widens in later volutions where it is difficult to trace because it cuts few of the widely spaced septa. The path of the tunnel is slightly irregular (Pl. 2, fig. 4). Rudimentary chomata ring the proloculus but are lacking in the coiled part of the test. Secondary deposits are common in the axial portion of the test and may coat the crests of septal folds in a few volutions (Pl. 1, figs. 3, 4).

Remarks.—Specimens of *Parafusulina allisonensis* from the western part of the Glass Mountains show

EXPLANATION OF PLATE 1

All figures × 10

Figs.		Page
1-3.	*Schwagerina guembeli* Dunbar and Skinner, collection 7A-11X (float), 20 feet above top of basal limestone of the Leonard Formation, member A, Dugout Mountain .... 1. Sagittal section, YPM 21817. 2, 3. Axial sections, YPM 21818 and YPM 21819.	11
4-7.	*Parafusulina spissisepta* Ross, collection 6-4A, base of the first limestone member of the Leonard Formation, member B, Lenox Hills .... 4, 5. Axial sections, YPM 21820 and YPM 21821. 6. Tangential section showing low but well developed cuniculi, YPM 21822. 7. Sagittal section, YPM 21823.	18
8, 9, 11-13, 17.	*Schwagerina hessensis* Dunbar and Skinner, basal limestone of the Leonard Formation, member A, in the Lenox Hills .... 8, 9, 12. Axial sections, collection 18, YPM 21824, 21825, and 21826. 11, 17. Sagittal sections, collection 18, YPM 21827 and 21828. 13. Tangential section, collection 18, YPM 21829.	12
10, 14.	*Schwagerina* sp. A, upper limestone of the Lenox Hills Formation, northeasternmost knob on Leonard Mountain, locality 1 .... 10, 14. Axial sections, YPM 21830 and 21831.	13
15, 16.	*Schwagerina crassitectoria* Dunbar and Skinner, collection 6A-25X, float from about 40 feet below the first limestone member of the Leonard Formation, member A, Lenox Hills 15. Axial section, YPM 21832. 16, Sagittal section, YPM 21833.	9



Ross: Fusulinids from the Permian of Texas

Ross: Fusulinids from the Permian of Texas

MEASUREMENTS OF
PARAFUSULINA ALLISONENSIS
YPM SPECIMENS

	Volution	21834	21836	21837
	0	.12	.14	.13
	1	.25	.22	.25
Radius	2	.40	.30	.35
Vector	3	.60	.40	.50
(mm.)	4	.80	.55	.75
	5	1.10	.85	1.00
	6	1.35	.95	1.30
	7	....	1.20	....
	1	.50	.35	.35
	2	1.10	.65	.65
Half	3	1.70	1.00	1.30
length	4	2.70	1.55	2.60
(mm.)	5	4.20	2.70	3.40
	6	5.20	3.60	4.30
	7	....	4.60	....
	1	2.0	1.6	1.4
	2	2.8	2.2	1.9
Form	3	2.8	2.5	2.6
ratio	4	3.4	2.9	3.5
	5	3.8	3.2	3.4
	6	3.8	3.8	3.3
	7	....	3.8	....
	0	.03	.01	.02
	1	.05	.01	.04
Wall	2	.07	.01	.04
thickness	3	.08	.03	.07
(mm.)	4	.08	.04	.08
	5	.10	.07	.11
	6	.10	.09	.10
	7	..	.11	....
	1	30	20	25
	2	30	20	25
Tunnel	3	35	30	30
angle	4	40	35	35
(°)	5	....	45	40
	6	....	60	....
	7	....	....	....

slightly less axial deposition than do the syntypes from the Hess Member of the Leonard Formation in the eastern part of the Glass Mountains but in other aspects they appear identical. *P. allisonensis* differs from *P. nancei* Thompson and Miller from Venezuela in having less extended poles, a smaller size, and axial deposits scattered along the axes rather than concentrated in the early volutions. *P. skinneri* Dunbar frcm Sonora, Mexico, is larger, has more irregular and higher septal folds, and has secondary deposits scattered throughout the test. *P. bakeri* Dunbar and Skinner is larger, has higher and more regular septal folds, and a different ontogeny in the early volutions.

Occurrence.—*P. allisonensis* is found in collections 7-6A, 7A-11X, 7B-21, loc. 6. In the western part of the Glass Mountains, this species occurs in well sorted calcilutite, commonly having very fine calcareous sand, from 50 to 400 feet above the base of the formation. These beds appear to represent part of the zone of *P. allisonensis* as recognized in the Hess Member in the eastern part of the Glass Mountains (Ross, 1960a).

Type Locality.—840 feet above the base of the Hess Member of the Leonard Formation near the Allison Ranch house, eastern part of the Glass Mountains.

Parafusulina durhami Thompson and Miller

Plate 6, figures 1-7

Parafusulina durhami THOMPSON and MILLER, 1949, Jour. Paleontology, v. 23, p. 15, pl. 3, figs. 3-7, pl. 5, figs. 9, 11, 12.

Description.—Large, elongate tests that commonly reach 14 mm. in length and 3.5 mm. in diameter in 8 volutions.

Proloculi are of medium size, averaging 0.25 mm. outside diameter, and may be aspherical (Pl. 6, fig. 3). The first three volutions are low and succeeding volutions increase gradually in height. The chambers heighten toward the poles giving the test a fusiform shape after the fourth volution. The poles are sharply rounded from tapering lateral slopes. The axis of coiling may be curved.

EXPLANATION OF PLATE 2

All figures × 10

FIGS.		PAGE
1-4.	*Parafusulina allisonensis* Ross, lower part of the Leonard Formation, members A and B, Dugout Mountain .... 1, 3, 4. Axial sections, collection 7B-21, YPM 21834, 21836, and 21837. 2. Sagittal section, collection 7-6A, YPM 21835.	14
5, 7-10.	*Schwagerina hessensis* Dunbar and Skinner, lower part of Leonard Formation, members A and B, Dugout Mountain and the Lenox Hills .... 5. Axial section, collection 6A-5, YPM 21838. 7. Axial section, collection 7A-3, YPM 21839. 8. Axial section, collection 6, YPM 21840. 9. Axial section, collection 7A-3, YPM 21841. 10. Axial section, collection 6-4B, YPM 21842.	12
6.	*Paraschwagerina* sp. A, upper limestone beds of the Lenox Hills Formation, northeastern knob on Leonard Mountain .... 6. Axial section, collection 1, YPM 21843.	8
11-13.	*Monodiexodina linearis* (Dunbar and Skinner), lower part of Leonard Formation, members A and B .... 11. Axial section, collection 6D-12, YPM 21844. 12, 13. Axial sections, collection 7A-5, YPM 21845 and 21846.	6

The wall is thin throughout the test, reaching a thickness of about 0.07 mm. in the seventh volution, and alveoli are prominently displayed. The septa are strongly folded into high regular folds that reach to the top of the chambers. Opposing folds of adjacent septa meet and are resorbed to form low cuniculi (Pl. 6, fig. 4).

The tunnel is of medium width and follows a slightly irregular path. The tunnel angle increases gradually from 25 degrees in the first volution to 35 degrees in the fifth volution. Chomata are lacking. Secondary deposits occur only in the axial region of the first 4 to 4½ volutions.

Remarks.—These specimens from the Glass Mountains agree closely in all aspects with the syntypes described by Thompson and Miller from Colombia. *Parafusulina durhami* is closely similar to *P. leonardensis* Ross n. sp. which occurs below it in the lower part of the Leonard Formation. From *P. leonardensis,* it differs in having more regular and more closely spaced septal folds and secondary deposits restricted to the axial region of the first 4½ volutions. *P. durhami* differs from *P. guatemalaensis* Dunbar from Central America in having higher chambers, more regularly spaced and more intensely folded septa, and in having secondary deposits only in the early volutions.

P. durhami is similar to *P. tschussovensis* Rauser-Chernoussova from the Artinskian Series of the southern Ural Mountains but differs from that species in having more volutions and lower chambers although both species have nearly the same size and form ratio. *Schwagerina hyperborea* (Salter) from the Canadian Arctic is probably a primitive species of *Parafusulina* having low cuniculi (see Thorsteinsson, 1960, pl. 6, fig. 1) and it is similar to *P. durhami* in size and shape but has higher chambers, less closely spaced septal folds, and more extensive axial deposits. *P. belcheri* Thorsteinsson lacks axial deposits, is more stubby in outline, and has more loosely folded septa.

Occurrence.—*P. durhami* is abundant in two collections from the Glass Mountains high in the Leonard Formation about 100 feet beneath the base of the Word Formation. Localities: 5-30 in the type section

MEASUREMENTS OF
PARAFUSULINA DURHAMI
YPM SPECIMENS

	Volution	21866	21867	21870	21871
	0	.13	.16	.10	.12
	1	.22	.20	.18	.18
Radius	2	.35	.35	.30	.25
vector	3	.50	.50	.45	.40
(mm.)	4	.70	.70	.65	.60
	5	1.00	.95	.90	.80
	6	1.40	1.25	1.20	1.20
	7	1.70	....	1.60	1.45
	1	.50	.40	.50	.45
	2	.90	.90	.90	.95
Half	3	1.40	1.40	1.40	1.85
length	4	2.40	2.40	2.05	2.50
(mm.)	5	3.80	4.50	3.10	3.50
	6	5.30	6.00	4.10	5.20
	7	6.20	....	5.70	6.80
	1	2.3	2.0	2.8	2.5
	2	2.6	2.6	3.0	3.8
Form	3	2.9	2.8	3.1	4.6
ratio	4	3.4	3.4	3.1	4.2
	5	3.8	4.7	3.4	4.4
	6	3.8	4.8	3.4	4.3
	7	3.7	....	3.6	4.7
	0	.03	.02	.02	.02
	1	.03	.02	.03	.02
Wall	2	.04	.03	.03	.03
thickness	3	.05	.04	.04	.03
(mm.)	4	.05	.04	.05	.04
	5	.07	.04	.05	.07
	6	.08	.07	.07	.07
	7	.09	....	.08	.06
	1	20	25	25	20
	2	20	30	25	20
Tunnel	3	30	35	30	25
angle	4	40	35	40	30
(°)	5	40	40	35	35
	6	40	....	40	....
	7	....	....	....	....

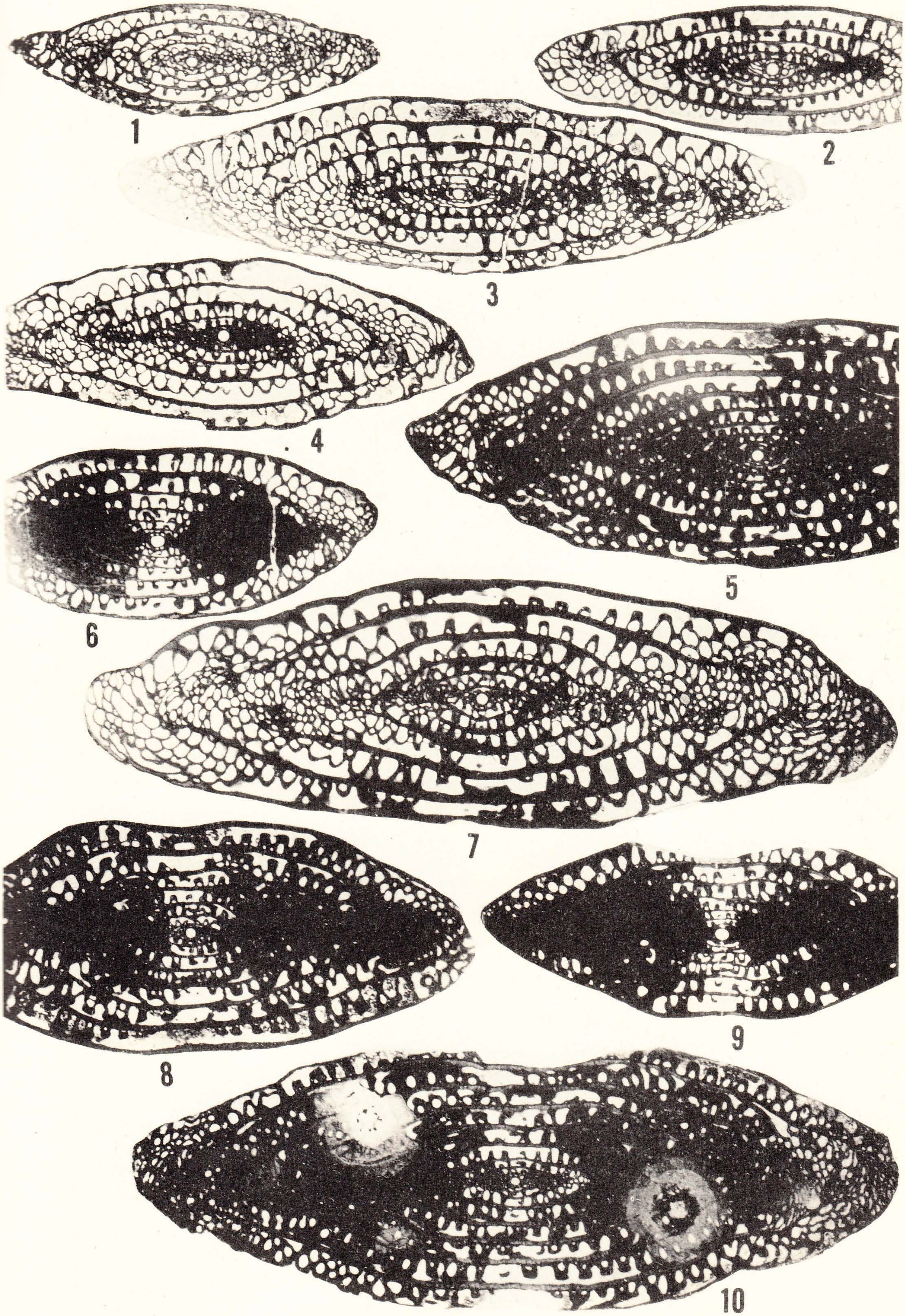
EXPLANATION OF PLATE 3

All figures × 10

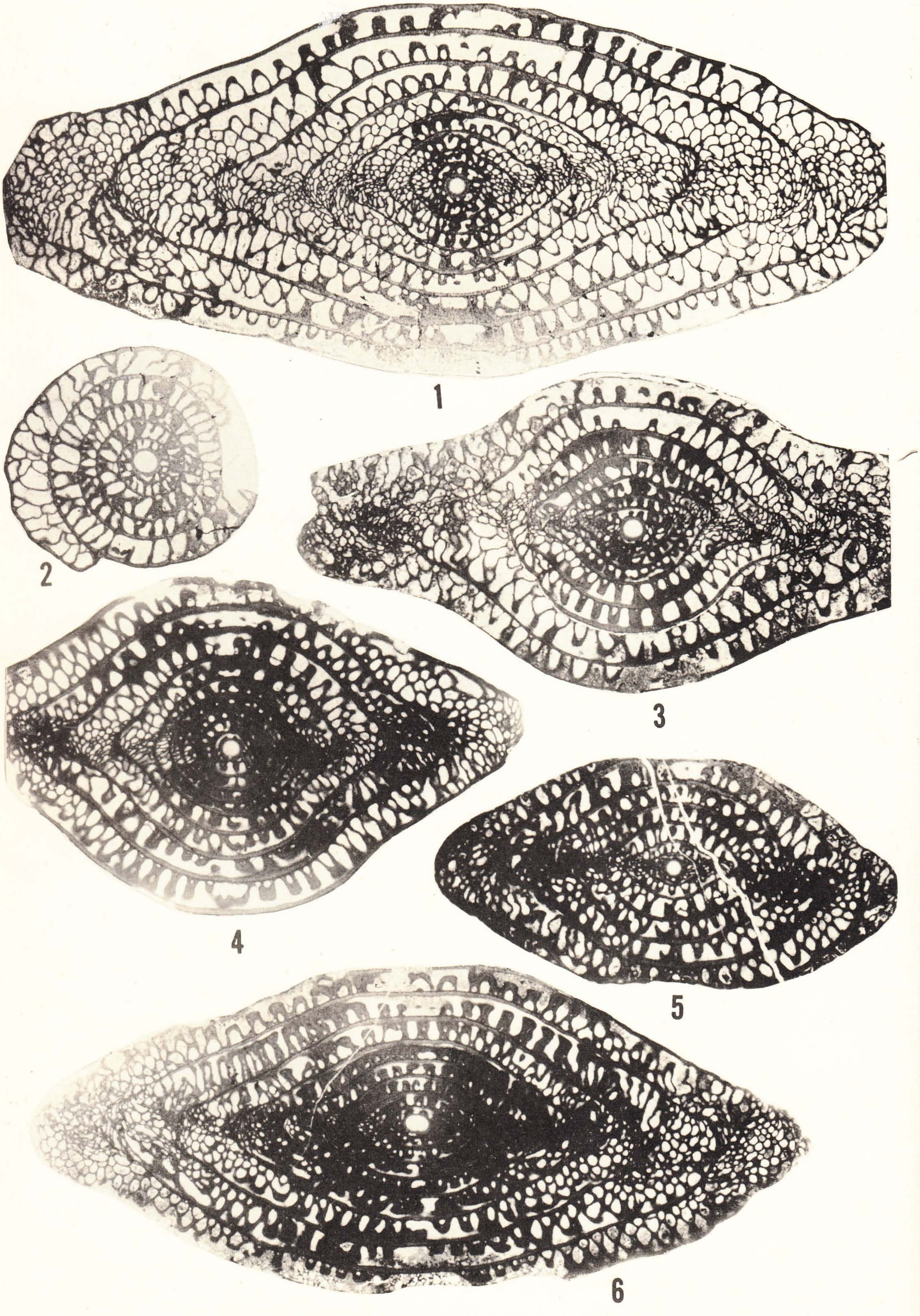
FIGS. PAGE

1-4. *Parafusulina spissisepta* Ross, from member B and near top of "sponge reef" horizon, Leonard Formation, north of the Wolf Camp Hills 18
1. Axial section, collection USNM 714u, USNM 139577. 2. Axial section, collection 6-4A, YPM 21847. 3, 4. Axial sections, collection 13, YPM 20658 and YPM 20657.

5-10. *Schwagerina dugoutensis* Ross, n. sp., from member A, Leonard Formation, Dugout Mountain and Lenox Hills 10
5. Axial section, collection 6A-4, YPM 21850. 6. Axial section, collection 16, YPM 20620. 7. Axial section, collection 6A-5, YPM 21851. 8. Axial section, collection 2, YPM 20622. 9. Axial section, collection 2, YPM 20623. 10. Axial section of holotype, collection 2, YPM 20621. Specimens lacking secondary deposits, as in Fig. 7, are rare, but specimens having thick secondary deposits, as in Figs. 5, 8, and 10, are common.



Ross: Fusulinids from the Permian of Texas



Ross: Fusulinids from the Permian of Texas

of the Leonard Formation, loc. 14 at Split Tank east of the Old Word Ranch house, and loc. 17 at Clay Slide.

Syntypes.—From limestone on a hill at the north side of Quebrada Manaure, about 4.5 kilometers east of the village of Manaure, Department de Magdalena, Colombia (Thompson and Miller, 1949).

Parafusulina leonardensis Ross n. sp.

Plate 5, figures 1-8

Description.—Large subcylindrical tests that attain lengths of 14 to 15 mm. and diameters of 3.0 to 3.5 mm. in 6 to 7 volutions.

Proloculi in specimens examined range from 0.18 to 4.8 mm. outside diameter. The early volutions are low and the succeeding volutions increase gradually in height to the last volution. The form ratio increases from about 3 in early volutions to 4 in later volutions (see Measurements). Succeeding half volutions overlap irregularly and commonly form bluntly rounded poles (Pl. 5, figs. 2, 4, 5).

The wall is formed of a dark tectum and a coarsely alveolar keriotheca. The septa are intensely folded into high, regularly spaced folds that have flattened crests. Only in the polar extremities do the folds become irregular. The tunnel follows a straight path and is narrow in the first four volutions where the tunnel angle averages about 20 degrees. In later volutions, the tunnel may become irregular in its path and is wider, the tunnel angle being commonly 40 degrees in the sixth volution. Cuniculi are well displayed in the outer 2 or 3 volutions (Pl. 5, figs. 3). Chomata are lacking. Secondary deposits are common and vary greatly between specimens (Pl. 5, figs. 1, 2, 4-6, 8). Deposits are heaviest in the axial region and may coat the septa and also occasionally the proloculi.

Remarks.—*Parafusulina leonardensis* is similar to a number of early species of *Parafusulina* from which it is commonly difficult to separate. Perhaps the most closely similar species is *P. guatemalaensis* Dunbar (Dunbar, 1939b, p. 347, and Kling, 1960, p. 649) which differs from *P. leonardensis* in being more elongate, in having axial deposits only in the inner 3½ volutions, and in having wider cuniculi. *P. bosei* var. *attenuata* has more tapered lateral slopes and more extensively developed cuniculi in earlier volutions. *P. splendens* Dunbar and Skinner has more closely spaced septal folds and higher but less elongate chambers.

P. bakeri Dunbar and Skinner differs from *P. leonardensis* in having a larger proloculus, a more ventricose test, and only minor amounts of secondary deposits. *P. bakeri* is reported by Dunbar and Skinner from two localities near the base of the Leonard Formation at the southern end of Dugout Mountain and at the southern tip of the hill just west of Iron Moun-

MEASUREMENTS OF
PARAFUSULINA LEONARDENSIS
YPM SPECIMENS

	Volution	21858	21859	21862	21865
	0	.21	.12	.11	.09
	1	.40	.20	.18	.15
Radius	2	.55	.30	.30	.25
vector	3	.70	.50	.40	.35
(mm.)	4	.90	.70	.60	.55
	5	1.20	.80	.75	.70
	6	1.45?	1.25	.85	.95
	7	....	1.55	1.20	1.25
	1	1.0	.70	.40	.40
	2	1.50	1.40	.90	.80
Half	3	2.30	2.10	1.30	1.40
length	4	3.40	2.80	2.10	1.90
(mm.)	5	4.90	4.10	2.90	2.50
	6	6.70	5.30	4.00	3.70
	7	....	6.60	6.10	4.60
	1	2.5	3.5	2.2	2.7
	2	2.7	3.6	3.0	3.2
Form	3	3.3	4.2	3.2	4.0
ratio	4	3.8	4.0	3.5	3.5
	5	4.1	5.1	3.9	3.6
	6	4.6?	4.2	4.7	3.9
	7	....	4.3	5.1	3.8
	0	.02	.03	.02	.02
	1	.02	.03	.02	.03
Wall	2	.03	.03	.02	.03
thickness	3	.03	.05	.02	.05
(mm.)	4	.04	.04	.04	.06
	5	.07	.06	.06	.07
	6	.07	.08	.08	.08
	7	....	.07	.08	.08
	1	30	30	15	25
	2	35	25	20	20
Tunnel	3	40	30	25	20
angle	4	40	30	30	30
(°)	5	40	35	35	30
	6	....	45	35	35
	7	....	....	....	....

EXPLANATION OF PLATE 4

All figures × 10

Figs.		Page
1-6.	*Schwagerina hawkinsi* Dunbar and Skinner, members A and B, Leonard Formation	11

1. Axial section, collection 6A-4, YPM 21852. 2. Sagittal section, collection 19, YPM 21853. 3. Axial section, collection 7B-18, YPM 21854. 4. Axial section, collection 6A-4, YPM 21855. 5. Axial section, rounded and abraded specimen, collection 6-4C, YPM 21856. 6. Axial section, collection 6A-4, YPM 21857.

tain. Although both these localities were examined and collected in detail, no additional specimens of *P. bakeri* were found. *P. durhami* Thompson and Miller differs from *P. leonardensis* in having more regular and more closely spaced septal folds and secondary deposits restricted to the axial region of the first four and one-half volutions. *P. leonardensis* is smaller per volution and is more elongate than *P. skinneri* Dunbar from Sonora although both species are closely similar in many other features. *P. kaerimizensis* (Ozawa) from Japan has more tapered poles.

P. leonardensis takes its name from Leonard Mountain where the holotype was collected.

Occurrence.—*P. leonardensis* is widely distributed in the lower 600 feet of the Leonard Formation in poorly sorted calcarenites. Localities: 5-3, 5-5, 5-12A, 5-12B, 6-2, 6-6, 6A-7, 6A-8, 6A-12, 6A-17, 6A-19, 6B-23, 6B-40, 6C-1B, 6C-1C, 6C-3A, 6C-3X (float), 6D-2, 7-2A, 7-2B, 7A-3, loc. 9.

Holotype.—YPM 21862, from collection 5-12B, 380 feet above the base of the Leonard Formation on the north side of Leonard Mountain.

Parafusulina spissisepta Ross

Plate 1, figures 4-7; plate 3, figures 1-4

Parafusulina spissisepta Ross, 1960a, Cushman Found. Foram. Research, Contr., v. 11, p. 127, pl. 18, figs. 7-13.

Description.—Fusiform tests commonly reach 11 mm. in length and 2.8 mm. in diameter in 6 volutions.

Proloculi in specimens examined are of medium size, about 0.15 mm. outside diameter, and the first two to three volutions are low and elongate. Succeeding volutions have a marked increase in height, particularly near the poles (Pl. 1, fig. 5). The shape of the test is nearly constant after the first volution. The poles are subacute.

The wall is composed of a tectum and a thin, finely alveolar kerioetheca that tapers gradually toward the poles. The septa are intensely folded into high, regular, open folds that extend to the top of the chambers. Opposing folds of adjacent septa overlap and low cuniculi are common in the outer volution.

The straight tunnel is of medium width in the first three volutions; the tunnel angle is 20 to 30 degrees, and gradually widens in later volutions where it may reach 40 degrees. Secondary deposits coat the septal folds in the axial region and adjacent to the tunnel but these deposits are not extensive. False walls are rare or lacking.

MEASUREMENTS OF
PARAFUSULINA SPISSISEPTA
YPM SPECIMENS

	Volution	21820	21821	20658
	0	.06	.05	.08
	1	.12	.09	.15
Radius	2	.15	.14	.30
vector	3	.25	.25	.50
(mm.)	4	.40	.40	.80
	5	.55	.60	1.15
	6	.80	.80	1.50
	7	....	1.10	....
	1	.20	.25	.70
	2	.40	.40	1.25
Half	3	.65	.70	2.00
length	4	1.00	1.20	2.80
(mm.)	5	1.70	1.90	4.10
	6	2.60	2.90	5.60
	7	....	4.10	....
	1	1.7	2.8	4.5
	2	2.6	2.9	4.2
Form	3	2.6	2.8	4.0
ratio	4	2.5	3.0	3.5
	5	3.1	3.2	3.5
	6	3.2	3.6	3.7
	7	....	3.7	....
	0	.02	.02	.02
	1	.02	.02	.02
Wall	2	.03	.02	.03
thickness	3	.04	.03	.04
(mm.)	4	.06	.05	.06
	5	.08	.07	.07
	6	.07	.06	.08
	7	....	.08	....
	1	20	20	30
	2	20	25	25
Tunnel	3	25	25	35
angle	4	20	30	40
(°)	5	25	30	55
	6	....	40	..
	7	....	....	..

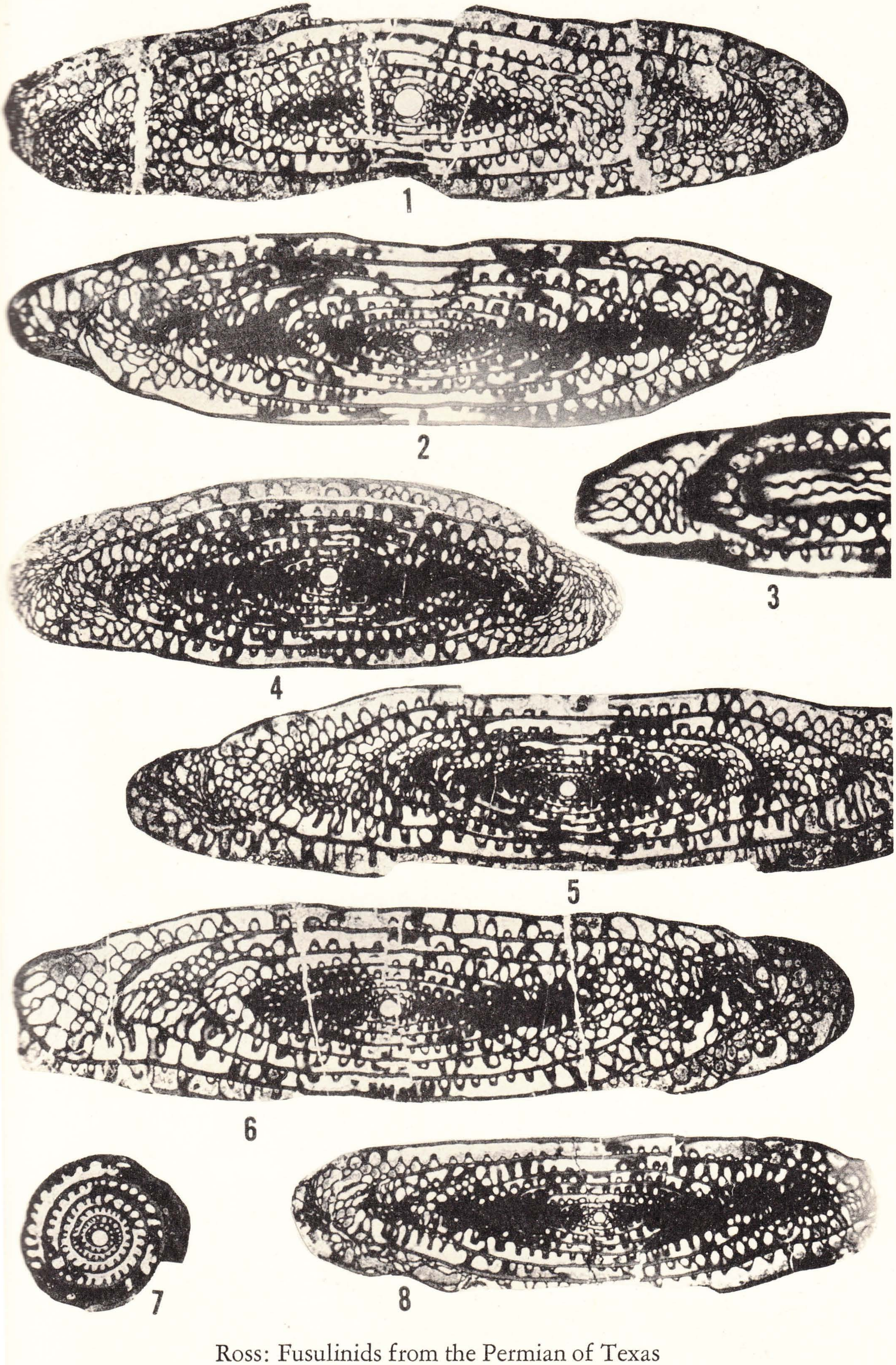
EXPLANATION OF PLATE 5

All figures × 10

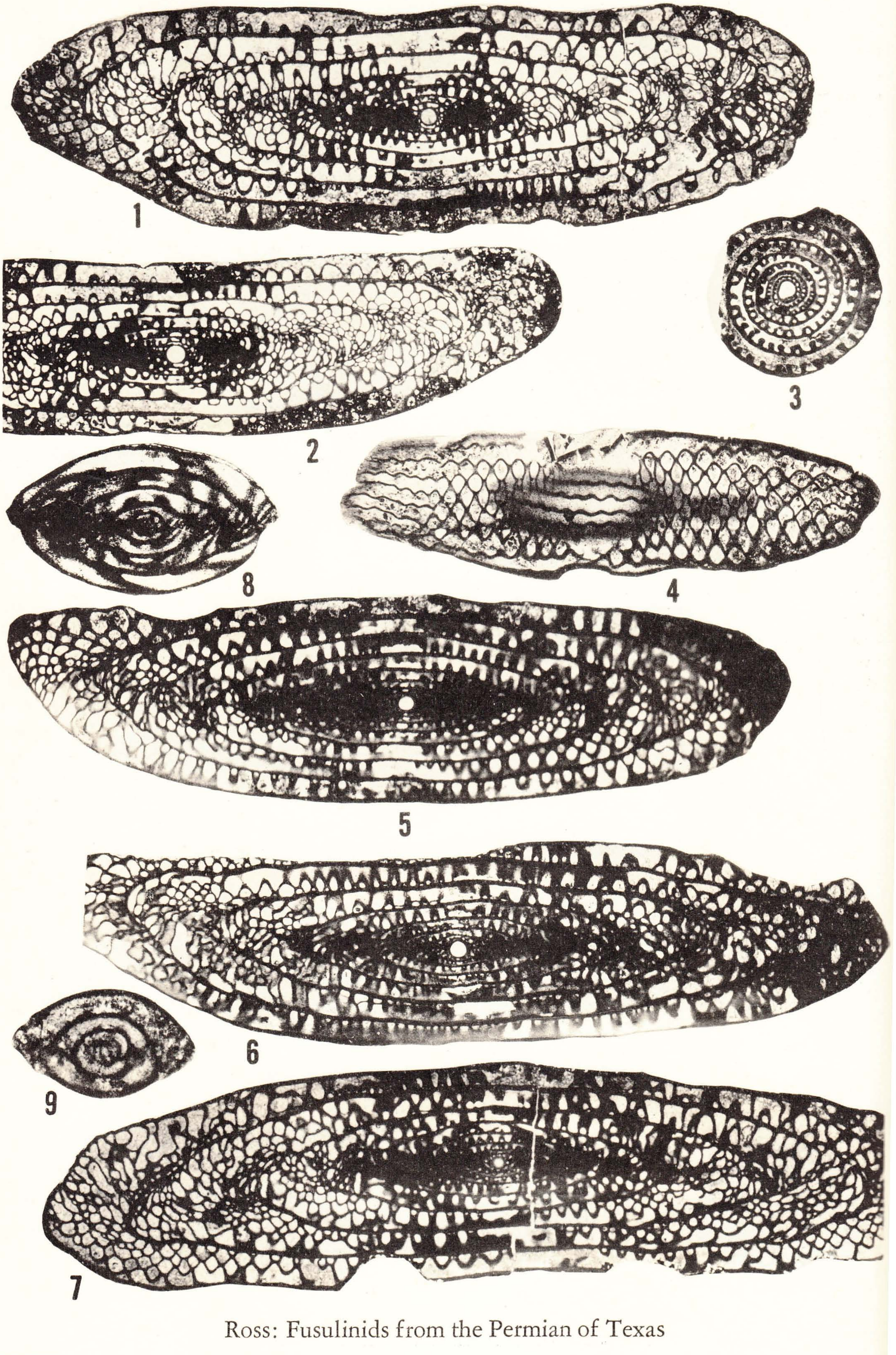
FIGS. PAGE

1-8. *Parafusulina leonardensis* Ross n. sp., from members A and B, Leonard Formation, Leonard Mountain and Lenox Hills 17

1, 6. Axial sections, collection 6C-3X, YPM 21858 and YPM 21863. 2. Axial section, collection 6B-40, YPM 21859. 3. Tangential section, collection 6B-40, YPM 21860. 4. Axial section, collection 6C-3A, YPM 21861. 5. Axial section of holotype, collection 5-12B, YPM 21862. 7. Sagittal section, collection 6B-40, YPM 21864. 8. Axial section, collection 5-3, YPM 21865.



Ross: Fusulinids from the Permian of Texas



Ross: Fusulinids from the Permian of Texas

Remarks.—Specimens of *Parafusulina spissisepta* from the western part of the Glass Mountains compare closely with the syntypes described from the eastern part of the Glass Mountains. The amount of secondary deposition on the septal folds tends to be less although specimens from a few feet above the type locality (Pl. 3, figs. 3, 4) also have fewer secondarily thickened septa.

P. spissisepta is not closely similar to other described primitive species of *Parafusulina.* It differs from *P. leonardensis* Ross n. sp. and *P. allisonensis* Ross in having compact early volutions and a different shape. *P. bakeri* Dunbar and Skinner has less tightly coiled early volutions and a different shape and septal folding, and *P. nancei* Thompson and Miller from northern South America is more elongate and has a different distribution of secondary deposits. *P. spissisepta* has a similar shape to *Schwagerina aculeata* Thompson and Hazzard from the Bird Spring Formation of southern California but differs from that species in possessing low cuniculi and more regularly folded septa.

Occurrence.—Parafusulina spissisepta is most common in the complex lenses of poorly sorted calcarenite that form most of the first to fourth limestone members of the Leonard Formation as designated by P. B. King (1931, 1937) at Dugout Mountain and in the Lenox Hills. Its stratigraphic range there is at least 150 feet. Localities: 6-4A, 6A-34, 6C-1C, 6D-2, 7-2B, locality 7, USNM locality 714u. Type locality is in the Hess fossil bed in the eastern part of the Glass Mountains.

MISCELLANEOUS COLLECTING LOCALITIES

Lenox Hills Formation

1. Top of northeastern knoll of Leonard Mountain, 0.8 mile NNE of BM 5860. (YPM collection 6683-75). *Schwagerina* sp. A, *Paraschwagerina* sp. A.

Leonard Formation

2. Southwest end of Dugout Mountain, 0.4 mile N 83° W of Section 7B, base of member A. (YPM collection 6683-14). *Schwagerina dugoutensis.*
3. Loose specimens just below basal limestone of the Leonard Formation on a shaly slope of the Lenox Hills Formation, 0.2 mile SW of the summit of Dugout Mountain. (YPM collection 6683-18). *Schwagerina hawkinsi, S. diversiformis* Dunbar and Skinner.
4. West of Section 7B about 0.8 mile, loose specimens at the top of a tightly folded anticline in the Gaptank Formation. (YPM collection 6683-24). *Schwagerina guembeli, S. hessensis?*
5. Slump block, north end of the Lenox Hills, 0.5 mile S 30° W of Hill 5021. (YPM 6683-25). *Schwagerina dugoutensis, S. hessensis.*
6. 50 feet below top of member A, 0.9 mile, N 40° E of the summit of Dugout Mountain. (YPM collection 6683-72). *Parafusulina allisonensis.*
7. Northwest end of the main escarpment of the eastern Glass Mountains opposite the center of the Hess Ranch horst, bed 7 of P. B. King's (1931) measured Section 22. (YPM collection 6683-82). *Schwagerina crassitectoria, S. guembeli, S. hessensis?*
8. 20 feet above the base of member A, 0.5 mile north of Section 6A, Lenox Hills. (YPM collection 6683-83). *Schwagerina hessensis, Monodiexodina linearis.*
9. 25 feet above base of member B, above Section 6A, Lenox Hills. (YPM collection 8863-84). *Parafusulina leonardensis.*
10. 65 to 100 feet above the base of the Leonard Formation, 0.8 mile west of Iron Mountain (Hill 5420). (YPM collection 6683-10-15 and 10-16). *Parafusulina leonardensis, Schwagerina hessensis.*
11. 0.9 mile N 70° W of Hill 5816, on the northern flank of the Hess Ranch horst, just above the basal limestone ledge of the Leonard Formation. (YPM collection 6753-9). *Schwagerina guembeli.*
12. 15 feet above the base of member B, 0.3 mile S 42° W of Hill 5021, northern part of the Lenox Hills. (YPM collection 6527-7). *Schubertella muellerriedi.*
13. 1.8 miles NW of Wolf Camp Hills, 150 feet above the base of the Hess fossil bed. (Dunbar collection 7-5-3, 1950). *Parafusulina spissisepta.*
14. 100 feet below top of Leonard Formation at Split Tank, 1.7 miles N 50° E of the Old Word Ranch

EXPLANATION OF PLATE 6

FIGS. PAGE

1-7. *Parafusulina durhami* Thompson and Miller, member C. Leonard Formation, Leonard Mountain and Split Tank, × 10 15

1, 2, 7. Axial sections, collection 5-30, YPM 21866, 21867, and 21872. 3. Sagittal section, collection 14, YPM 21868. 4. Tangential section, collection 14, YPM 21869. 5, 6. Axial sections, collection 14, YPM 21870 and 21871.

8, 9. *Schubertella muellerriedi* Thompson and Miller, basal limestone of member B, Leonard Formation, north part of Lenox Hills 7

8. Axial section of mature specimen, collection 12, YPM 21873, × 25. 9. Axial section of an immature specimen, collection 12, YPM 21874, × 50.

house. (Dunbar collection 7-23-1, 1941). *Parafusulina durhami.*

15. Loose specimens of covered slope below the base of the Leonard Formation, 0.9 miles west of BM 5860, Leonard Mountain. (YPM collection 6683-11-7X). *Schwagerina hawkinsi, S. dugoutensis?, Parafusulina allisonensis? Triticites* spp.
16. Top of Leonard Mountain at the base of small knob topped by BM 5860. (YPM 6683-12-19). *Parafusulina leonardensis.*
17. 40 to 100 feet below top of the Leonard Formation, 0.4 mile south of Hill 4910 at Clay Slide, about 2.5 miles west of Iron Mountain. (Dunbar collection 11-6-6, 1949). *Parafusulina durhami.*
18. Near top of basal conglomeratic limestone of member A, 0.3 mile S 42° W of Hill 5021, northern part of the Lenox Hills. (Dunbar collection 7-1-2, 1950). *Schwagerina hessensis.*
19. 5 to 15 feet above bed 4 of Section 6A, near the center of the Lenox Hills. (Dunbar collection 7-21-1, 1941). *Schwagerina hawkinsi.*

U.S.N.M. 714u. Near the top of the lowest limestone bed of member B, 0.35 mile, N 60° E of Hill 4801 at the southern end of the Lenox Hills. *Parafusulina spissisepta.*

U.S.N.M. 718p. Top of the conglomeratic limestone ledge at the base of member A, probably the same bed as bed 4 of Section 6B. *Parafusulina leonardensis.*

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CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH
VOLUME XIII, PART 1, JANUARY, 1962

237. *DYMIA* N. K. BYKOVA, NEW NAME FOR *CANDELA* N. K. BYKOVA, 1958, NOT HERRMANNSEN, 1846

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Dymia N. K. Bykova, new name, is proposed for the foraminiferal genus *Candela* N. K. Bykova, Mikrofauna SSSR, Sbornik 9, Trudy Vses. Neft. Nauchno-Issledov. Geologorazved. Instituta (VNIGRI), Vyp. 115, p. 70, 1958, type species: *Trifarina labrum* Subbotina, 1953; not *Candela* Herrmannsen, 1846, Ind. Gen. Malac., v. 1, p. 166 (Mollusca).

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REVIEW

CONTRIBUCION AL ESTUDIO DE LAS GLOBIGERINIDEA DE LA REGION CARIBE-ANTILLANA (PALEOCENE-RECIENTE), by PEDRO J. BERMÚDEZ: *in* Boletín de Geología, Publicación Especial No. 3; Memoria Tercer Congreso Geológico Venezolano, Tomo 3, Caracas, 1960, pp. 1119-1393, Laminas 1-20. Published: June, 1961.

A large portion of the Tertiary to Recent planktonic Foraminifera were originally described from the Caribbean-Antillean and Gulf Coast regions. Many of these Foraminifera have subsequently become valuable stratigraphic markers that can be used not only for local but also for world-wide stratigraphic correlation. Bermúdez' monographic study of the Globigerinidea in the Caribbean-Antillean region is, therefore, a very welcome contribution in that it summarizes the present knowledge of the Cenozoic planktonic Foraminifera.

Bermúdez describes all the Cenozoic genera and species belonging to the superfamily Globigerinidea that are on record from the Caribbean-Antillean region. Of the 234 species and varieties, 28 are introduced as new. Stratigraphic distributions are briefly discussed and separate faunal lists are presented for the Paleocene, Lower Eocene, Middle and Upper Eocene, Oligocene, Oligo-Miocene, Miocene, Pliocene-Pleistocene and Recent. For convenient reference, the stratigrapher would have wished in addition the inclusion of a chart showing the stratigraphic distribution of all the species discussed.

The photographic figures are arranged in stereoscopic pairs. It is regrettable that not all species could be included for a complete record. Furthermore, it is unfortunate that the pairs are too close together to be viewed by stereoscope, and that many are much inferior in quality to the excellent original photographs. In most cases, however, satisfactory stereoscopic pictures result in simply bringing the pairs together by naked eye.

A number of micropaleontologists in recent years have independently proposed new classifications on generic and suprageneric levels for the planktonic Foraminifera. Bermúdez' taxonomic treatment again deviates in some cases from any of the earlier ones. He introduces, for example, the new subfamily Globigerinitinae that includes the genera *Globigerinita* (with *Catapsydrax* and *Tinophodella* as synonyms), *Globigerinatella, Globigerinoita* and *Globigerinatheka.*

This variety of classifications certainly shows the lively interest and the importance paleontologists today attribute to the planktonic Foraminifera. As a result, there now exist such wide differences of opinion on the criteria to be used for classification that it is difficult to foresee a generally accepted solution in the near future. With each new proposal the overall taxonomic picture is becoming necessarily more and more complex.

Many stratigraphers and paleontologists, especially those in the economic field, must find it increasingly difficult to keep pace with these frequently proposed changes and to decide which system to adopt. As a result, some of them may become reluctant to continue using, or to introduce, planktonic Foraminifera for biostratigraphic zonation and correlation. They should always remain aware, however, that, with the frequent changes on a generic or suprageneric level, the species as such and its stratigraphic significance remains the same; for example, whether *"dissimilis"* is attributed to *Globigerina* by one paleontologist, to *Catapsydrax* by a second, to *Globigerinita* by a third, and so on, in no way alters the specific definition of *"dissimilis"* nor its value as a stratigraphic index fossil.

The extensive synonymy lists that accompany Bermúdez' species descriptions greatly aid in solving many questions concerning such changes on supraspecific levels. They constitute, therefore, a valuable part of the monograph. The publication will be found indispensable not only by paleontologists working on Caribbean-Antillean Cenozoic planktonic Foraminifera but also by those studying them in other parts of the world.

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CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH
VOLUME XIII, PART 1, JANUARY, 1962

RECENT LITERATURE ON THE FORAMINIFERA

Below are given some of the more recent works on the Foraminifera that have come to hand.

ALEXANDROWICZ, STEFAN. Stratigraphic section of the Lower Tortonian at Czechowice, near Gliwice (the Upper Silesian Basin) (English summary of Polish text).—Poland Instyt. Geol., Biul. 155, 1960, p. 5-70, text figs. 1-7 (map, columnar section, graphs, correl. charts), tables 1-6.—Lists of species and quantitative analyses of four assemblages from different facies.

ALEXANDROWICZ, STEFAN, and ODRZYWOLSKA-BIENKOWA, EWA. Marine deposits of the Lower Tortonian at Ledziny (the Upper Silesian Basin) (English summary of Polish text).—Poland Instyt. Geol., Biul. 155, 1960, p. 71-106, text figs. 1-5 (map, columnar sections, geol. section, range and abund. chart), tables 1, 2.—Many species listed, with their abundance recorded in a series of 12 samples, in which series 5 different assemblages are recognized.

AOKI, NAOAKI. Foraminifera from the Imozawagawa Formation in Sendai, Japan.—Trans. Proc. Pal. Soc. Japan, n. ser., No. 41, April 10, 1961, p. 15-20, pl. 3, table 1.—A small fauna of 16 species, none new (but with abundant specimens per weight of sediment), interpreted as of middle or late Pliocene age and a littoral brackish environment.

BIEDA, FRANCISZEK. Nummulite fauna in the Tatra Eocene (English summary of Polish text).—Poland Instyt. Geol., Biul. 141, 1960, p. 5-31, pls. 1-3.—Four zones based on earliest appearances of 4 index species of *Nummulites*.

BIELECKA, WANDA. Micropaleontological stratigraphy of the Lower Malm in the vicinity of Chrzanow (southern Poland).—Poland Instyt. Geol. Prace, tome 31, 1960, p. 1-155, pls. 1-10 (drawings of fossils), 11-15 (distrib. and abund. charts, correl. chart, range and abund. chart).—Six foraminiferal zones, covering the interval between upper Callovian and Argovian-Rauracian?, are recognized in and correlated between 4 boreholes and a quarry outcrop. Foraminifera zonal boundaries roughly agree with those of the ammonite zones. Seventy-nine species (3 new) are included, most of them described and illustrated.

Upper Jurassic microfauna in bore-hole Piekary (near Poznan) (English summary of Polish text).—Poland Instyt. Geol., Kwart. Geol., v. 4, No. 2, 1960, p. 417-424, text fig. 1 (distrib. and abund. chart).

Micropaleontological stratigraphy of Upper Jurassic sediments of Poland, excluding the Carpathians (English summary of Polish text).—Poland Instyt. Geol., Kwart. Geol., v. 4, No. 4, 1960, p. 949-963, table 1 (range and occurrence chart).—Occurrences and ranges of many species are recorded from 8 Polish areas.

BOGDANOVICH, A. K. Novye Dannye o Stratigraficheskom i Prostranstvennom Raspredelenii Majkopskoj Microfauny Severnogo Kavkaza.—Paleogenovye Otlozhenij Juga Evropeiskoj Chasti SSSR, Akad. Nauk SSSR, 1960, p. 245-276, pls. 1-5, 1 correl. table.—Includes descriptions and illustrations of 27 species (17 new) from the Oligocene and lower and middle Miocene of northern Kavkaza.

BOGUSH, O. I., and UPHEREV, O. V. Layers with *Endothyra communis* in Karatau and in the western spurs of the Talass Alatau (in Russian with English summary).—Bull. Moscow Soc. Naturalists, Geol. Ser., v. 36, No. 3, 1961, p. 89-101, tables 1, 2.—Useful in tracing the Devonian-Carboniferous boundary.

BOILLOT, GILBERT, and LE CALVEZ, YOLANDE. Étude de l'Éocène au large de Roscoff (Finistère) et au Sud de la Manche occidentale.—Revue Geogr Phys. et Geol. Dyn., ser. 2, v. 4, fasc. 1, Jan.-March 1961, p. 15-30, text figs. 1-9 (maps, diagrams, drawings of fossils), 1 plate of photographs, tables 1, 2.—From submarine outcrops of Eocene limestone off northern Brittany, a large fauna of Foraminifera is recorded, with a few critical species illustrated.

BOLTOVSKOY, ESTEBAN. Linea de la convergencia subantartica en el Atlantico sur y su determinacion usando los indicadores biologicos Foraminiferos.—Argentina Serv. Hidrografia Naval, Publ. H.1018, March 1961, p. 1-35, 1 pl. (drawings), 1 map.—Six planktonic species (2 including forma) are discussed as to their usefulness in recognition of Antarctic waters off Argentina.

Los Foraminiferos de los sedimentos Cuaternario en los alrededores de Puerto Quequen (Provincia de Buenos Aires).—Rev. Asoc. Geol. Argentina v. 14, Nos. 3-4, 1961, p. 251-277, 1 distrib. and abund. table.—Quantitative analysis of Foraminifera from 4 Pleistocene and 4 Holocene samples indicates more or less equivalent ecologic conditions but a lower temperature during Pleistocene. Systematic catalog includes over 50 species, subspecies, and forma.

CHERNOVA, E. I. Biostratigrafija (po Foraminiferam) Srednekamennougol'nykhOtlozhennij Saratovskogo Pravoberezh'ja.—Akad. Nauk SSSR, Geol. Instit., v. 5, 1961, p. 261-286, pl. 1, text figs. 1-4 (columnar sections showing occurrences of species, correl. diagram, graphs).—Fusulinid zones in Middle Carboniferous, and descriptions and illustrations of 7 species, 2 new and 2 indeterminate.

CHIJI, MANZO. Neogene biostratigraphy of the Toyama sedimentary basin, Japan Sea coast (in Japanese with English summary).—Bull. Osaka Mus. Nat. Hist., No. 14, May 1961, p. 1-88, pl. 1, text figs. 1-12 (maps, section, columnar section), tables 1-24 (distrib. tables, correl. tables, stratigraphic tables, range chart).—Four Foraminifera zones, 2 with local subzones, are recognized, the boundary between Tertiary f_3 and Tertiary g possibly coinciding with one of the zonal boundaries. Ranges of 141 species and subspecies in the 4 zones are charted. Four new species are described. Distribution and abundance of species in local parts of the basin are documented on numerous tables.

Foraminifera from the Asahiyama shellbed, Himi City, Toyama Prefecture.—Prof. Jiro Makiyama Mem. Vol., July 1961, p. 229-238, pls. 1, 2, text figs. 1, 2 (map, drawings).—Listing and notes on 56 species and subspecies from Pleistocene terrace sediments. A few are illustrated and 1 new *Buccella* is described.

CHRISTODOULOU, GEORGIOS. Geologische und mikropaläontologische Untersuchungen auf der Insel Karpathos (Dodekanes).—Palaeontographica, Abt. A, Band 115, lieferung 1-6, Dec. 1960, p. 1-143, pls. 1-16, text figs. 1-22 (sections, photomicrographs, photos).—Illustrated systematic catalog includes nearly 350 species and subspecies, 16 species and 10 subspecies new, from the lower Pliocene.

Die Foraminiferen des marinen Neogens (Astien) von Attika (German summary of Greek text).—Institute for Geol. and Subsurface Research, Athens, v. 7, No. 1, 1961, p. 1-47, 1 pl., 1 map.—Systematic catalog including 89 species and subspecies, one *Lagena* new.

CORMINBOEUF, PAUL. Tests isolés de *Globotruncana mayaroensis* Bolli, *Rugoglobigerina, Trinitella* et Heterohelicidae dans le Maestrichtien des Alpettes.—Eclogae Geol. Helvetiae, v. 54, No. 1, July 1, 1961, p. 107-122, pls. 1, 2, text fig. 1 (map).—A planktonic fauna of 25 species and subspecies, none new, is listed, and 10 are illustrated.

DAIN, L. G. Nekotorye Vidy Foraminifer Melovykh Otlozhenij Shumikhinskogo Rajona Cheljabinskoj Oblasti.—Mikrofauna SSSR, Sbornik 12, Russia Vses. neft. nauchno-issl. geol. instit. (VNIGRI), Trudy, Biul. 170, 1961, p. 4-37, pls. 1, 2, tables 1, 2.—Describes and illustrates 9 species (7 new) from the Cretaceous of the Cheliabinsk district.

DALMATSKAJA, I. I. Stratigrafija i Foraminifery Srednekamennougol'nykh Otlozhenij Gor'kovskogo i Ul'janovskogo Novolzh'ja.—Akad. Nauk SSSR, Geol. Instit., v. 5, 1961, p. 7-54, pls. 1, 2, 1 occurrence table.—Eight fusulinid zones in the Middle Carboniferous. Descriptions and illustrations of 5 new species and 3 new varieties.

DELOFFRE, R. Sur la découverte d'un nouveau lituolidé du Crétacé Inférieur des Basses-Pyrénées: *Pseudochoffatella cuvillieri* n. gen., n. sp.—Revue de Micropaléontologie, v. 4, No. 2, Sept. 1961, p. 105-107, pl. 1.

DIDON, JEAN; DURAND DELGA, MICHEL; FONTBOTÉ, JOSÉ MARIA; MAGNÉ, JEAN; and PEYRE, YVES. El Oligoceno superior del Betico de Malaga (Andalucia).—Notas y Comunic. Instit. Geol. Min. España, No. 61, 1961, p. 115-130, 1 pl., text figs. 1-3 (map, geol. sections), tables 1, 2.—Age determined from Foraminifera and occurrence of species recorded in 9 samples.

DIZER, ATIFE. Le genre *Fabiania* et quelques autres Foraminifères l'accompagnant dans le Nummulitique de Kizilcahamam (NW Ankara).—Revue de Micropaléontologie, v. 4, No. 2, Sept. 1961, p. 80-84, pls. 1, 2.—Descriptions and illustrations of 2 species of *Fabiania* (one new and the other with a new variety) from the Lutetian. Accompanying species are listed.

ECKERT, R., HAY, W. W., LORENZ, G., and VOGT, P. The magnetic separator as a tool in micropaleontology.—Jour. Paleontology, v. 35, No. 4, July 1961, p. 876-877.

FUJIWARA, TAKAYO. Organic constituents in some fusulinid tests (in Japanese with English summary).—Misc. Repts. Research Instit. Natural Resources, Tokyo, Nos. 54-55, March 25, 1961, p. 2-6.—Amino acids and amino-sugars found in isolated specimens.

FUNNELL, B. M. The Palaeogene and early Pleistocene of Norfolk, *in* The geology of Norfolk (edited by G. P. Larwood and B. M. Funnell).—Trans. Norfolk and Norwich Naturalists' Soc., v. 19, pt. 6, Sept. 1961, p. 340-364, pl. 1 (map), figs. 10-14 (map, columnar section, charts), tables 4, 5.—Includes quantitative analysis of Foraminifera from several horizons and localities in the Butleyan(?) and Icenian Crags (early Pleistocene).

GAWOR-BIEDOWA, EUGENIA, and WITWICKA, EMILIA. Micropalaeontological stratigraphy of Upper Albian and Upper Cretaceous in Poland excluding the Carpathians (English summary of Polish text).—Poland Instyt. Geol., Kwart. Geol., v. 4, No. 4, 1960, p. 974-990, table 1 (range and occurrence chart).—Occurrences and ranges of many stratigraphically important species are recorded between Albian and Dano-Paleocene.

GEROCH, STANISLAW. Microfaunal assemblages from the Cretaceous and Palaeogene Silesian unit in the Beskid Slaski Mts. (Silesian Carpathians) (English summary of Polish text).—Poland Instyt. Geol., Biul. 153, 1960, p. 7-138, pls. 1-13, text figs. 1, 2 (maps), tables 1-4.—Six zones differentiated on the basis of Foraminifera species are recognized between Valanginian and Eocene. Restricted ranges are indicated for 25 species, and many species are illustrated. A new variety of *Hormosina ovulum* is described.

GORDON, WILLIAM ANTHONY. The age of the middle Tertiary rocks of north-western Puerto Rico.—Trans. 2nd Caribb. Geol. Conf., Univ. Puerto Rico, Jan. 4-9, 1959, p. 87-90.—Correlation with the *Orbulina*-surface and by means of orbitoids suggests Aquitanian and Tortonian as probable lower and upper limits.

Foraminifera from the 4CPR Oil Test Well near Arecibo, Puerto Rico.—Oil and gas possibilities of northern Puerto Rico, Puerto Rico Mining Commission, San Juan, 1961, p. 25-40, pls. 1-3, distrib. chart, 1 graph.—A rich assemblage from a 5500-ft. section of middle Tertiary rocks is recorded (104 species) and a few species are illustrated. A new *Rotalia* is described. Amphisteginids are predominant nearly throughout with globigerinids becoming abundant near top and bottom of the section. Depth is interpreted between 0 and 60 fms.

GUCIK, STEFAN, and MORGIEL, JANINA. The microfauna from the Krosno beds in Leszczawa Gorna, south of Przemysl (Carpathians) (English summary of Polish text).—Poland Instyt. Geol., Kwart. Geol., v. 4, No. 2, 1960, p. 484-494, pls. 1, 2, text figs. 1, 2 (map, columnar section), table 1. —The major affinities of the listed assemblage are with the Oligocene.

HILTERMANN, HEINRICH. Fortschritte der Mikropaläontologie in Deutschland mit einer Bibliographie für das Jahr 1960.—Paläont. Zeitschr., v. 35, Nos. 3/4, Aug. 1961, p. 209-230.

HOFKER, J. Die Foraminiferen-Fauna der Gruben Hemmoor und Basbeck.—Paläont. Zeitschr., v. 35, Nos. 3/4, Aug. 1961, p. 123-145, text figs. 1-11 (drawings, tables), 4 occurrence tables, correl. chart.—Foraminifera listed from a well section of lower and upper Maestrichtian age, with notes on 5 significant species.

Globigerina pseudobulloides Plummer dans le Paléocène inférieur de Tunisie.—Revue de Micropaléontologie, v. 4, No. 2, Sept. 1961, p. 69-71, 5 drawings.—A zone previously interpreted as Cretaceous-Tertiary transition beds is now interpreted as lower Paleocene. Age determination is based on detailed wall structure (progressively more like a honeycomb) of *Globigerina pseudobulloides*.

HOYT, JOHN H., and CHRONIC, JOHN. Wolfcampian fusulinids from Ingleside formation, Owl Canyon, Colorado.—Jour. Paleontology, v. 35, No. 5, p. 1089, fig. 1.

JARTHEVA, M. V. Nummulity Paleogenovykh Otlozhenij Severo-Vostochnogo Sklona Ukrainskogo Kristallicheskogo Massiva.—Paleogenovye Otlozhenij Juga Evropeiskoj Chasti SSSR, Akad. Nauk SSSR, 1960, p. 143-164, pls. 1-4, text figs. 1, 2 (map, geol. section).—Five species (1 new) and 2 varieties (1 new).

Nummulity Paleogena Depressij Ukrainskogo Kristallocheskogo Massiva (Dnepropetrovskaja Oblast').—Paleogenovye Otlozhenij Juga Evropeiskoj Chasti SSSR, Akad. Nauk SSSR, 1960, p. 165-172, pls. 1, 2.—Describes a new variety of *N. incrassatus* de la Harpe.

JURKIEWICZ, HENRYK. Contribution to cognizance of microfauna of Krosno beds (English summary of Polish text).—Poland Instyt. Geol., Kwart. Geol., v. 5, No. 1, 1961, p. 196-206, pl. 1, text fig. 1 (columnar sections), tables 1, 1a.—Foraminifera listed from beds interpreted as upper Eocene and Oligocene.

KAPTARENKO-CHERNOUSOVA, O. K. Lentikulinini Jurs'kikh Vidkladiv Dniprovs'ko-Doneth'koi Zapadini ta Okrain Donbasu.—Akad. Nauk Ukrain. RSR, Kiev, Instyt. geol. Nauk Trudy, ser. strat. i paleo., vyp. 36, 1961, p. 1-102, pls. 1-15.—Illustrated catalog includes 102 species (27 new) and 4 varieties (2 new) of Jurassic lenticulinids.

On the evolution of Jurassic Trocholins (English summary of Russian text).—Dopovidi Akad. Nauk Ukrain. RSR, Kiev, 1961, No. 6, p. 806-811, figs. 1-5.—Three species of the *Trocholina nidiformis* lineage, 2 new, one each from upper Bajocian, middle Callovian, and lower Oxfordian, becoming progressively more complex in number of convolutions, number of pillars, and height of coiling.

KIPRIJANOVA, F. V. Novye Vidy Foraminifer iz Verkhnego Mela Vostochnogo Sklona Srednego Urala.—Akad. Nauk SSSR, Ural. fil., Sverdlovsk, Gorno-geol. instit., Trudy, vyp. 46, 1960, Voprosy geol. Urala, ch. 3, p. 117-133, pls. 1, 2.—Ten Upper Cretaceous species, 8 new.

KIPRIJANOVA, F. V., and PAPULOV, G. N. K Voprosu o Stratigraficheskom Znachenii Vida *Gaudryina filiformis* Berthelin Dlja Melovykh Otlozhenij Vostochnogo Sklona Urala i Zaural'ja.—Akad

Nauk SSSR, Ural. fil., Sverdlovsk, Gorno-geol. instit., Trudy, vyp. 46, 1960, Voprosy geol. Urala, ch. 3, p. 111-116, text figs. 1-3.

DE KLASZ, I., MARIE, P., and RÉRAT, D. Deux nouvelles espèces du genre *Gabonella* (Foraminifère) du Crétacé du Gabon (Afrique Équatoriale).—Revue de Micropaléontologie, v. 4, No. 2, Sept. 1961, p. 77-79, text figs. 1, 2 (map, drawings).—In upper Cenomanian and Turonian, thus extending the stratigraphic range of the genus.

KOPIK, JANUSZ. Micropalaeontological characteristic of Lias and lower Dogger in Poland (English summary of Polish text).—Poland Instyt. Geol., Kwart. Geol., v. 4, No. 4, 1960, p. 921-935, tables 1-3 (range and occurrence charts).—Occurrences and ranges of many species are recorded.

KRAEVA, E. JA. Foraminiferovye Kompleksy Verkhneeothenovykh i Oligothenovykh Otlozhenij Prichernomorskoj Vpadiny (Zapadnaja Chast').—Paleogenovye Otlozhenij Juga Evropeiskoj Chasti SSSR, Akad. Nauk SSSR, 1960, p. 230-244, 1 pl., occurrence table.—Four species (3 new) and 3 new varieties from upper Eocene and Oligocene.

KÜPPER, INGE. Alttertiäre Foraminiferenfaunen in Flyschgesteinen aus dem Untergrund des nördlichen Inneralpinen Wiener Beckens (Österreich).—Jahrbuch Geol. Bundesanstalt, Jahrgang 1961, Band 104, heft 1, July 1961, p. 239-271, pls. 15-18 (fossil plates, occurrence tables, electric logs).—*Globorotalia aragonensis* and *G. acuta* zones are recognized in the subsurface, the former zone called upper Paleocene (lower Ilerdian) and the latter lower Eocene or uppermost Paleocene. These and other planktonics and nummulites are illustrated and their occurrence plotted in 28 wells.

LATHKOVA, V. E., ORLOVA, I. N., CHERNOVA, E. I., and RAUZER-CHERNOUSOVA, D. M. Stratigrafija Srednekamennougol'nykh Otlozhenij Saratovskogo Zavolzh'ja.—Akad. Nauk SSSR, Geol. Instit., v. 5, 1961, p. 287-296, text fig. 1 (columnar section).—Fusulinid zones in Middle Carboniferous.

LISZKOWA, JANINA, and NOWAK, WIESLAW. The Subsilesian series in the Bielsko Carpathians (The Frydek Subsilesian series) (English summary of Polish text).—Poland Instyt. Geol., Kwart. Geol., v. 4, No. 2, 1960, p. 510-529, pls. 1-7, text fig. 1 (columnar section), table 1.—Includes list of species and photographs of assemblages ranging in age from Cenomanian? to early Eocene.

LITEANU, E., and BANDRABUR, T. Recherches géologiques dans la région Danubienne entre la rivière de l'Arges et la vallée de la Mostistea (French summary of Rumanian text).—Acad. Repub. Pop. Romîne, Sect. Geol. si Geog., Studii si cercetari de Geol., tom. 5, no. 4, 1960, p. 655-681, text figs. 1-6 (diagrams, maps), tables 1, 2.—Cretaceous Foraminifera listed.

LOEBLICH, ALFRED R., JR., and TAPPAN, HELEN. Remarks on the systematics of the Sarkodina (Protozoa), renamed homonyms and new and validated genera.—Proc. Biol. Soc. Washington, v. 74, Aug. 11, 1961, p. 213-234.—In the Foraminifera, 5 new genera are erected and 1 given a new name. One homonym is re-named, and a new suborder and a new subfamily are named.

The status of *Hagenowella* Cushman, 1933, and a new genus *Hagenowina*.—Proc. Biol. Soc. Washington, v. 74, Aug. 11, 1961, p. 241-244.—*Hagenowella* is a synonym of *Arenobulimina* because its type species lacks internal partitions. *Hagenowina* (type species *Valvulina quadribullata* von Hagenow) is named to replace it.

LONGINELLI, A., and TONGIORGI, E. Frequenza degli individui destrogiri in diverse popolazioni di *Rotalia beccarii* Linneo.—Boll. Soc. Pal. Ital., v. 1, No. 1, 1960, p. 5-16, text figs. 1-3 (graphs).—Statistical analysis of right and left coiling, as correlatable with paleotemperatures and thus also with sea depth, suggests that left coiling in *R. beccarii* is favored by colder habitats. Influences other than water temperature on the variation in coiling ratios are discussed. Study is based on 45 samples from Recent marine and lagoonal sediments and Upper Tertiary and Quaternary strata.

LORIGA, C. Foraminiferi del Permiano superiore delle Dolomiti (Val Gardena, Val Badia, Bal Marebbe).—Boll. Soc. Pal. Ital., v. 1, No. 1, 1960, p. 33-73, pls. 3-7, text figs. 1-14, tables 1, 2.—Descriptions and illustrations of 33 species and subspecies, 5 species and 1 subspecies new and 10 species indeterminate.

MALAPRIS, MADELEINE, and RAT, PIERRE. Données sur les Rosalines du Cénomanien et du Turonien de Côte-d'Or.—Revue de Micropaléontologie, v. 4, No. 2, Sept. 1961, p. 85-98, pls. 1-3, text figs. 1-8 (map, geol. sections, drawings, range chart), 1 table.—Two zones in the Cenomanian and one in the Turonian are based on planktonics, with the critical species illustrated and described.

MCGILL, PETER C., and LORANGER, D. M. Micropalaeontological (Foraminifera) zonation of the Sans Sault group, lower Mackenzie River area, *in* Geology of the Arctic (G. O. Raasch, ed.).—First Internat. Symposium Arctic Geology Proc., Calgary, 1960, v. 1, 1961, p. 515-531, text figs. 1-6 (map, cross section, occurrence table, photos of specimens).—Correlation between 3 sections of Albian age by means of smaller Foraminifera, with 7 diagnostic tops recognized. Fifteen species (12 new) are described and illustrated.

MORIKAWA, ROKURO, and TAKAOKA, YOCHINARI. Two new species of the *Parafusulina yabei* type from Tomuro, Totigi Prefecture, Central Japan.—Trans. Proc. Pal. Soc. Japan, n. ser., No. 41, April 10, 1961, p. 33-40, pls. 7, 8, tables 1, 2.

MOURA, ARMANDO REIS. Foraminiferos das areias de praia e dos calcarenitos da Ilha de Porto Santo (with English summary).—Publ. Mus. e Lab. Min. e Geol. da Univ. Coimbra e do Centro Estudos Geol., No. 51, 1961, p. 63-82, pls. 1-5, distrib. table.—Illustrated catalog of 20 species (none new) from shore sands and calcarenites from Porto Santo, one of the Madeira Islands.

OLAUSSON, ERIC. Studies of Deep-Sea Cores.—Repts. Swedish Deep-Sea Exped., v. 8, Sediment Cores from the Mediterranean Sea and the Red Sea, No. 6, Feb. 1961, p. 337-391, text figs. 1-5 (graphs, maps, drawing, occurrence diagrams, correl. diagrams), tables 1-8.—Study based on 15 cores in the eastern Mediterranean with 5 alternating warmer and colder time-units correlated between the cores. Abnormal accumulations of Foraminifera (i.e., floods of *Globigerina eggeri* to the near exclusion of other species) in some sapropelitic muds are interpreted as resulting not from climatic fluctuations but possibly from poisoning of deep-dwelling plankton by water rich in H_2S.

Remarks on some Cenozoic core sequences from the Central Pacific, with a discussion of the role of Coccolithophorids and Foraminifera in carbonate deposition.—Medd. Oceanografiska Institutet Göteborg, No. 29, March 21, 1961, p. 1-35, text figs. 1-5 (graphs, maps), table 1.—Includes discussion of age boundaries and carbonate content in 2 cores, one reaching into the Miocene and the other into the Eocene, raised from below the present critical depth for solubility of $CaCO_3$.

PAGHIDA, NATALIA. La microfaune du Tortonien de la rive droite du Prouth (R.P.R.).—Anal. Stiintifice, Univ. "Al. I. Cuza" Jassy (n. ser.), Sect. 2, tom. 6, fasc. 2, 1960, p. 345-354, pls. 1 (section), 2, 3 (assemblages), 1 comparative occurrence table.—Lists of species and photographs of assemblages.

PAPP, ADOLF. Nummuliten aus Poljsica (Slovenian).—Geol., Razprave in Porocila, Ljubljana, kn. 5, 1959, p. 31-36, text figs. 1, 2.

PAZDROWA, OLGA. Micropalaeontological characteristic of Vesulian and Bathonian of Polish Lowland (English summary of Polish text).—Poland Instyt. Geol., Kwart. Geol., v. 4, No. 4, 1960, p. 936-948, table 1 (range and occurrence chart).—Occurrences and ranges of species are recorded from 8 localities.

PESSAGNO, E. A., JR. Preliminary note on the Geology of the Ponce-Coama area, Puerto Rico.—Trans. Second Caribb. Geol. Conf., 1960, p. 83-86.—Lists of Foraminifera from Upper Cretaceous and Eocene formations.

POKORNY, VLADIMIR. Contribution to the microstratigraphical division of the "Hustopece marls" in the vicinity of Trkmanec and Zajeci (Zdanice unit, southern Moravia, Czechoslovakia) (English summary of Czech text).—Casopis pro Mineralogii a Geologii, Prague, roc. 6, No. 3, 1961, p. 305-315, text figs. 1-11 (drawings), table 1 (correl. chart).—Three units are distinguished, the lower unit correlatable by planktonics with 2 zones from the lower part of the Cipero section in Trinidad.

POREBSKA-SZOTOWA, WANDA. The microfauna profile of the Miocene at Leki Dolne (Subcarpathians) and attempt of its stratigraphical division (English summary of Polish text).—Poland Instyt. Geol., Kwart. Geol., v. 4, No. 1, 1960, p. 125-145, pls. 1-3, text figs. 1-3 (distrib. and abund. charts).—Three microfauna zones distinguished in the borehole section.

RAUZER-CHERNOUSOVA, D. M. Srednekamennougol'nye Otlozhennja Vozhgal'skogo Rajona.—Akad. Nauk SSSR, Geol. Instit., v. 5, 1961, p. 55-79, text fig. 1 (columnar section), tables 1, 2.—Seven fusulinid zones in the Middle Carboniferous.

Biostratigraficheskoe Raschlenenie po Foraminiferam Srednekamennougol'nykh Otlozhenij Samarskoj Luki i Srednego Zavolzh'ja.—Akad. Nauk SSSR, Geol. Instit., v. 5, 1961, p. 149-212, pls. 1, 2, text figs. 1, 2 (columnar sections and occurrences of species), 1 table.—Fusulinid zones and occurrences of many species.

Nekotorye Srednekamennougol'nye Fuzulinidy Prikam'ja i Povolzh'ja.—Akad. Nauk SSSR, Geol Instit., v. 5, 1961, p. 213-217, pl. 1.—Descriptions and illustrations of 3 species, 2 subspecies, and 1 variety, all new.

RAUZER-CHERNOUSOVA, D. M., and SAFONOVA, T. P. Stratigrafija Srednekamennoul'nykh Otlozhenij Permskogo Prikam'ja.—Akad. Nauk SSSR, Geol. Instit., v. 5, 1961, p. 80-148, pls. 1-3, text figs. 1-4 (map, columnar sections showing correlation and occurrences of species), 1 table.—Fusulinid zones and occurrences of many species.

REISS, Z. Lower Cretaceous microfacies and microfossils from Galilee.—Bull. Research Council Israel, Sec. G, Geo-Sciences, v. 10G, Nos. 1-4, July 1961, p. 223-242, photomicrographs, map, facies diagram, columnar section.—A composite section extending from Neocomian to lower Cenomanian, generalized from surface exposures and correlated with a subsurface section from southern Israel having different facies. Larger Foraminifera illustrated in section. *Hensonella* and *Iraquia* are restricted to Galilee by facies shifts.

REITLINGER, E. A. Stratigrafija Srednekamennougol'nykh Otlozhenij Razreza Skv. No. 1 Krasnoj Poljany v Srednem Zavolzh'e.—Akad. Nauk SSSR, Geol. Instit., v. 5, 1961, p. 218-260, pls. 1-4, text figs. 1, 2 (columnar section, outline drawings), tables 1, 2.—Fusulinid zones and occurrences of many species. Descriptions and illustrations of 11 species, 4 subspecies, 5 varieties, and 2 formas, all new except 1 species.

ROA MORALES, PEDRO, and OTTMANN, FRANCOIS. Première étude topographique et géologique du Golfe de Cariaco, province de l'Oriente (Vénézuela).—Revue Geogr. Phys. et Geol. Dyn., ser. 2, v. 4, fasc. 1, Jan.-March 1961, p. 31-37, text figs. 1-6 (maps), 1 table.—Occurrence of a globigerine-pteropod ooze at depths less than 100 meters, a result of up-welling waters in a tectonic trough with constricted opening.

SAIDOVA, H. M. Stratigraphy of sediments and palaeogeography of the north-eastern Pacific according to the bottom Foraminifers (English summary of Russian text).—Mezhdunarodnyj Geol. Kongress, XXI Sess., Doklady Sovetsk. Geol., 1960, p. 59-68, tables 1-5.—In light of knowledge about living foram inhabitants of sea floors near the lower limit of foram existence, bathyal and abyssal assemblages are interpreted in and 7 horizons recognized and correlated between 4 long cores. Sinkings and upheavals of the sea floor during the Holocene and subdivisions of the Pleistocene are interpreted from the foram horizons in the cores, and possibly tied in with resultant transgressions and regressions of seas on the continental shelf and formation of the Bering isthmus.

The quantitative distribution of bottom Foraminifera in Antarctica (in Russian).—Doklady Akad. Nauk SSSR, tom 139, No. 4, 1961, p. 967-969, text figs. 1-3 (maps, graph).

SCHOLL, D. W., and SAINSBURY, C. L. Marine geology and bathymetry of the Chukchi shelf off the Ogotoruk Creek area, northwest Alaska—*in* Geology of the Arctic (G. O. Raasch, ed.).—First Internat. Symposium Arctic Geology Proc., Calgary, 1960, v. 1, 1961, p. 718-732, figs. 1-10, tables 1-3.—Quantitative record of 26 species of Foraminifera in bottom sediments between 20 and 50 feet.

SEIGLIE, G. A. Contribucion al estudio de las microfacies de Pinar del Rio.—Rev. Soc. Cubana Ingen., Nos. 3-4, March-April 1961, p. 5-27, pls. 1-9, chart.—Thin-section photographs illustrate microfacies between Bathonian and Tortonian.

SEMIKHATOVA, E. N. Znachenie Foraminifer v Izuchenii Srednekamennougol'nykh Otlozhenij Oblasti Dono-Medvedithkikh Dislokathij.—Akad. Nauk SSSR, Geol. Instit., v. 5, 1961, p. 297-356, pls. 1, 2, text figs. 1-12 (columnar sections showing correlation and occurrences of species, graphs), tables 1-5.—Occurrence of many Middle Carboniferous fusulinid species and descriptions and illustrations of 3 species, 3 subspecies, and 1 variety, all new.

STUCKEY, CHARLES W., JR. A correlation of the Gulf Coast Jackson.—Trans. Gulf Coast Assoc. Geol. Soc., v. 10, 1960, p. 285-298, text figs. 1-5 (map, correl. charts).—Includes a correlation chart indicating change in Foraminifera composition to be expected from shallower to deeper parts of paleo-stratigraphic zones.

SUBBOTINA, N. N. Pelagicheskie Foraminifery Paleogenovykh Otlozhenij Juga SSSR.—Paleogenovye Otlozhenij Juga Evropeiskoj Chasti SSSR, Akad. Nauk SSSR, 1960, p. 24-36, text figs. 1-4 (stratigraphic charts).—In 4 stratigraphic charts spanning the interval between Maestrichtian and lower Oligocene, zoned with letters a to k, are shown the lineages, evolution, and stratigraphic ranges of species in 4 groups: globigerinids, truncorotaliids, acarininids, and globorotaliids. Forty-five species are illustrated on the charts.

SZTEJN, JANINA. Micropaleontological stratigraphy of the Lower Cretaceous in Poland excluding the Carpathians (English summary of Polish text).—Poland Instyt. Geol., Kwart. Geol., v. 4, No. 4, 1960, p. 964-973, table 1 (range and occurrence chart).—Occurrences and ranges of 34 selected species of Foraminifera are recorded between Infravalanginian and Hauterivian.

URBANIAK, JADWIGA. Miocene stratigraphy of the vicinity of Szynwald near Tarnow (Carpathian Foreland) (English summary of Polish text).—Poland Instyt. Geol., Biul. 141, 1960, p. 205-235, pls. 17-20, text figs. 1-4 (maps, profiles, photographs), tables 1, 2.—Lists and photographs of smaller Foraminifera assemblages from middle and lower Tortonian.

VANCEA, A., and UNGUREANU, LARISA. Corrélation entre les dépôts Mio-Pliocènes du Bassin Transylvain, fondée sur la microfaune (French summary of Rumanian text).—Acad. Repub. Pop. Romîne, Sect. Geol. si Geog., Studii si cercetari de Geol., tom. 5, no. 4, 1960, p. 613-626.—Foraminifera in many faunal lists.

VASSILENKO, V. P. Foraminifery Verkhnego Mela Poluostrova Mangyshlaka.—Russia Vses. neft. nauchno-issl. geol. instit., Trudy, vyp. 171, 1961, p. 1-487, pls. 1-41, figs. 2-40 (evolution diagrams, drawings, columnar sections, distrib. tables), tables 1-15 (range and occurrence charts).—Illustrated catalog includes 109 species (31 new), 6 subspecies (4 new), 15 varieties (9 new) and 3 forma from the Upper Cretaceous of the Mangishlak Peninsula in the northeastern part of the Caspian Sea.

VENGLINSKI, I. V. Rozvitok Dejakikh rebristikh miliolid z miothenovikh vidkladiv Zakarpattia.—Geol. Zhurnal, Kiev, tom 21, vyp. 3, 1961, p. 97-101, text figs. 1-12 (in stratig. chart).—*Quinqueloculina karreriella* Venglinski var. *articulata* nov., in which the final chamber is partially or wholly uncoiled, is described from the lowermost Sarmatian.

VOLOSHINOVA, N. A., and BUDASHEVA, A. I. Lituolidy i Trokhamminidy iz Tretichnykh Otlozhenij Ostrova Sakhalina i Poluostrova Kamchatki.—Mikrofauna SSSR, Sbornik 12, Russia Vses. neft. nauchno-issl. geol. instit. (VNIGRI), Trudy, Biul. 170, 1961, p. 169-233, pls. 1-19, tables 1, 2 (range charts).—Illustrated catalog includes 51 species (29 new) and 1 new subspecies in 12 genera of lituolids and trochamminids with their ranges between upper Eocene and upper Miocene indicated. *Circus* gen. nov. (type species *C. multicameratus* sp. nov.) is erected in the Lituolidae.

WOLFENDEN, E. B. The geology and mineral resources of the Lower Rajang valley and adjoining areas, Sarawak.—Borneo (British Territories), Geol. Survey Dept., Memoir 11, 1960, p. 1-167, pls. 1-39 (photographs, photomicrographs), text figs. 1-15 (maps, sections), tables 1-26, geol. map. —Occurrences of many genera and species of Foraminifera, some age-determining, are recorded from Upper Cretaceous to Pliocene strata.

WOODRING, W. P. Oligocene and Miocene in the Caribbean region.—Trans. Second Caribb. Geol. Conf., 1960, p. 27-32, text fig. 1 (correl. table).—Bolli's lowering of the Oligocene-Miocene boundary to the top of the *Globorotalia kugleri* zone brings age assignments based on Foraminifera into essential agreement with those based on mollusks. Two subdivisions of the Oligocene and 5 of the Miocene are recognizable, and correlation of several Caribbean formations with the Foraminifera zonation is indicated.

ZAPPI, LILIANA. Il Pliocene di Castel Verrua.—Atti Soc. Ital. Sci. Nat. e Mus. Civ. Storia Nat. Milano v. 100, fasc. 1-2, March-June 1961, p. 73-204, pls 9-14 (map, assemblage photographs, faunal composition graphs), text figs. 1, 2 (geol. section graph), tables 1, 2.—Systematic catalog includes 155 species and subspecies, none new, many illustrated in faunal assemblages from 4 of the 15 samples studied.

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