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213. THE DISTINCTION BETWEEN *OPERCULINA* AND *OPERCULINELLA*

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ABSTRACT

Cole (1959) placed **Operculinella** and **Operculinoides** in the synonymy of **Operculina.** Nagappa (1959) takes a closely similar view. In our experience there is little practical difficulty in distinguishing two genera: **Operculina** which includes laxispiral, compressed, evolute forms and **Operculinella** which includes involute and partially involute species that increase in whorl height throughout the growth of the test but typically have more tightly coiled spires than **Operculina.** Cole includes more than one species in **Operculina ammonoides;** speciation is discussed and it is shown that gradation between fully evolute and partially involute species is not firmly proven. The existence of possible senior synonyms of **Operculinella** and **Operculinoides** will be discussed elsewhere.

INTRODUCTION

Over a period of many years we have had the opportunity to examine large collections of small fossil nummuloid foraminifera and we are familiar with the extensive collections of Recent specimens of this group in the British Museum (Natural History). We are in the habit of determining material as seen in whole specimens, orientated and skew sections. Ovey (1938) and Cole (1959) have placed *Operculinella* and *Operculinoides* in the synonymy of *Operculina,* and Nagappa (1959) has come to a similar conclusion. We strongly dissent. The traditional distinction between the evolute, complanate, laxispiral specimens of *Operculina* and the involute or partially involute, usually tightly coiled forms typified by *Operculinella* or *Operculinoides* is both useful and easy to apply. We are furthermore dissatisfied with the specific distinctions used by Cole.

The Linnean system of classification has its primary value as a code. Specimens are named according to their morphological resemblance in certain defined respects to type specimens. The morphological distinctions must be selected to minimise practical difficulty and to fit as well as possible with biological factors such as interbreeding groups, but it is a mistake to attempt to embody all known facts, not to mention hypotheses, in the classification. A name is required for the labelling of specimens and reference to similar specimens in published works. Where morphological confusions and very gross phyletic inconsistencies exist, the nomenclature must be amended. However, there is far too much tendency at present to alter the nomenclature in an attempt to create a degree of precision that defeats its own object and makes the Linnean system inefficient as a code.

Cole (1959) has most carefully redescribed and refigured a suite of living and Neogene species of Nummulitinae. Four of these species have been discussed, figured and recorded in a formidable list of works and it would be presumptuous to attempt a precise synonymy. The forms figured by Cole (1959) represent seven distinct species. In many cases we do not agree with the names that he applied to them. Our determinations are:—

Operculina complanata (Defrance), 1822

Lenticulites complanata DEFRANCE, 1822.

Operculina complanata (DEFRANCE); COLE, 1959, pl. 31, figs. 3, 4.

The characters shown by the figures cited above are characteristic of this species, notably the very lax spire and the comparatively large megalosphere, measuring about 0.35 mm. in diameter. Cole's pl. 29 fig. 16 may be this species but his pl. 31 fig. 2 has a small megalosphere and in this feature, the shape of the septa and the pace of the spire, the specimen agrees with the most laxispiral variants of *Operculina gaymardi.* Brady (1884) and other authors have also included specimens of *O. gaymardi* under the name *O. complanata.* The species are indeed very similar except in megalosphere size and in the production of closely coiled variants, which do not occur in *O. complanata.* Neither species has substantial alar prolongations but *O. complanata* is the less involute, with the lateral chamber walls attached closely below the marginal cord of the previous whorl.

Operculina gaymardi Deshayes, 1832 (*ex* d'Orbigny)

Operculina gaimardi D'ORBIGNY, 1826, *nomen nudum,* p. 115.

Operculina gaymardi D'ORBIGNY; *in* DESHAYES, 1832, p. 667.

Operculina gaymardi D'ORBIGNY; FORNASINI, (1903) 1904, pl. 14, figs. 4, 4a.

Operculina sp. CARPENTER, (1859) 1860, pl. 3, figs. 6, 7, 8, 9, 11, 12; pl. 4, figs. 8, 10; pl. 5, figs. 1, 3; pl. 6, fig. 3.

Operculina bartschi CUSHMAN subspecies *ornata* CUSHMAN, 1921, pl. 74, figs. 2a, b.

Operculina bartschi CUSHMAN; COLE, 1959, pl. 28, fig. 16.

Operculina ammonoides (GRONOVIUS); COLE, 1959, pl. 28, fig. 10; pl. 29, figs. 4, 5; pl. 31, fig. 5.

Operculina complanata (DEFRANCE); COLE, 1959, pl. 31, fig. 2.

These references are selected to illustrate typical specimens of this species. The varieties of *O. bartschi,* as described by Cushman (1921), show that the strongly operculiniform specimens vary in the degree of development of ornament; septal sutures being simple, limbate or beaded, and pustulation developing sporadically between the sutures. The degree of compression of the test is always great, although variable. Brady (1884) figured a suite of specimens of this species under the incorrect name *Operculina complanata.* The specimens figured by Carpenter (1860) show great variation in the pace of the spire, the more closely coiled specimens grading into *Operculina ammonoides.* The test of *O. gaymardi* is strictly evolute. This implies that the chamber cavities have no alar prolongations other than the exceedingly short ones that are inevitable if the chamber walls are to be attached to the chambers of the previous whorl just below the marginal cord. The term "involute" does not apply to the layers of shell material, which in theory each completely envelopes the previous test. In this species these laminae are thin or incomplete in the later stages of growth and leave much of the test remote from the terminal chamber uncovered.

Some authors have confused this species with *Operculina granulosa* Leymerie, 1846, but this is a distinct species of Lower Tertiary age.

Operculina ammonoides (Gronovius), 1781

Nautilus ammonoides GRONOVIUS, 1781, p. 282, pl. XIX, fig. 5, 6.

Operculina sp. CARPENTER, 1859 (1860), pl. III, figs. 1, 2.

Operculina (Operculinella) venosa (FICHTEL and MOLL), 1798; YABE and HANZAWA, 1925, pl. V, figs. 3, 5, 6, 7, 8, 9, 12, 13, 14; pl. VI, figs. 1-5; pl. VII, figs. 3-6.

Operculina ammonoides (GRONOVIUS); CHAPMAN and PARR, 1938, pl. XVII, fig. 12, Gronovius' type figures; pl. XVII, figs. 13-16, text fig. 5.

Operculina ammonoides (GRONOVIUS); HANZAWA, 1939; pl. XV, figs. 1, 2.

Operculina ammonoides (GRONOVIUS); COLE, 1959, pl. 28, figs. 4, 5, 6, 7; pl. 29, figs. 3, 12, 7; pl. 30, fig. 3; pl. 31, figs. 6, 7.

Again, these references are selected to illustrate the most typical forms of the species. The type figures show a tightly coiled, entirely evolute test with beaded septal sutures and a polar group of pustules. The figures quoted show that somewhat less tightly coiled specimens are commonly found, and Carpenter (1860) demonstrated complete gradation between this species and *Operculina gaymardi.* This involves nothing more than change in rate of opening of the spire and the inevitable adjustments such as lessened curvature of the septa, crowding of pustules, and the comparatively large size of the marginal cord becoming more obvious. In both species the lateral chamber walls are pinched in below the marginal cord and in *O. ammonoides* this gives a very characteristic shape to the chambers when seen in axial section.

Hanzawa (1939) and Cole (1959) included in *Operculina ammonoides* involute and partially involute specimens like those of *Operculinella cumingii* figured by Carpenter, 1860, Pl. V, figs. 13, 14. They are here regarded as typical *Operculinella venosa.*

Some authors (e. g., Chapman and Parr, 1938) regarded *Operculina ammonoides* and *Operculina gaymardi* as synonymous, but they tended to use the species *Operculina bartschi* for the more laxispiral specimens, although the type figure of *Operculina gaymardi* is strongly laxispiral.

Operculina hanzawai sp. nov.

Operculina (Operculinella) venosa (FICHTEL and MOLL); HANZAWA, 1925, pl. V, figs. 15, 16, 17, 18; pl. VII, figs. 7, 8.

Operculina ammonoides (GRONOVIUS); COLE, 1959, pl. 28, fig. 3; pl. 29, fig. 9; pl. 30, fig. 4.

Description.—The megalospheric test has from three to four whorls that are tightly coiled for this genus, but the height is roughly double in successive whorls. The septa are gently curved and their sutures are finely beaded. The marginal cord is inflated. The chambers are widest at their inner ends, falling away only slightly into the broad umbilicus, which has small polar bosses in it. The early whorls are evolute but the chambers of the last whorl develop considerable alar prolongations.

The holotype (Cole, 1959, pl. 28, fig. 3) measures, according to Cole, 1.98 mm. diameter and 1.6 mm. in thickness. Cole quotes the following measurements of a paratype (pl. 30, fig. 4). Diameter 1.6 mm.; thickness 1.35 mm.; diameter of megalosphere 0.065 mm.; diameter of second chamber 0.03 x 0.07 mm.; distance across both chambers 0.115 mm.; whorls 3; chambers in 1st whorl 9, chambers in 3rd whorl 16; total number of chambers 37.

Type locality.—Nakoshi, Haneji-mura, Okinawa-jima; fossil; late Tertiary.

Remarks.—This species is highly anomalous in that the early whorls are evolute and the last one partially evolute. It has here been placed in *Operculina* but further study may indicate that a new genus should be proposed. The general resemblance to *Operculina ammonoides* is very considerable and it seems to be only a rather distinctive variant of that species, in which case a generic distinction would be quite unsuitable.

This is a form that might be claimed to link *O. ammonoides* with *Operculinella venosa.* The increased development of alar prolongations of the chambers in the later whorls is, however, characteristic of neither species and cannot be satisfactory evidence of gradation between these species.

Operculinella venosa (Fichtel and Moll), 1798

Nautilus venosus FICHTEL and MOLL, 1798, p. 59, pl. VIII, figs. e-h.

Amphistegina cumingii CARPENTER, 1859 (1860), pl. V, figs. 13, 14.

Operculina ammonoides (GRONOVIUS); HANZAWA, 1939, pl. XV, figs. 4, 5.

Operculina ammonoides (GRONOVIUS); COLE, 1959, pl. 28, figs. 1, 2, 8, 9, 11, 15; pl. 29, figs. 6, 8, 10; pl. 30, figs. 2, 5, 6, 7, 8.

These references are selected to illustrate most typical forms.

The test is lenticular and involute, sometimes with the alar prolongations of the chambers of the last whorl short and almost evolute. The poles are flattened, at a distinct angle to the obtuse return of the chamber walls to the margin. There are no pustules, and even when partially evolute there is only a feeble spiral groove. The spire is tightly coiled. The marginal cord is small and inconspicuous. In axial section the chamber walls are comparatively thin but more regularly covering the previous chambers and the poles than in *Operculina ammonoides.* The axial section contrasts with that species very strongly.

Operculinella cumingi (Carpenter), 1859 (1860)

Amphistegina cumingii CARPENTER, 1859 (1860), pl. V, figs. 16, 17.

Operculinella cumingii (CARPENTER); HANZAWA, 1939, pl. XV, figs. 6, 7, 8, 9; pl. XVI, figs. 1, 2, 3, 9.

Operculina venosa (FICHTEL and MOLL); COLE, 1959, pl. 28, figs. 12, 13, 14, 17, 18; pl. 29, figs. 1, 2, 11, 13, 14; pl. 30, figs. 1, 9, 10; pl. 31, fig. 1.

These references are selected to illustrate the most typical forms.

The juvenile test is smoothly lenticular, almost subglobose, with a subacute margin. The last whorl has a sharp increase in height and forms a highly compressed, pseudevolute or partially evolute flange. The septal filaments are highly curved and usually strongly retrorse at the margin; they are limbate, particularly near the poles. There is no pustulation. The alar prolongations of the chambers are variable in length, but a sufficient proportion reach the axis of coiling to prevent the formation of axial plugs. In axial section the chamber walls are comparatively thick and their lamination is rather obvious. The axial section has flowing lines that are not very different from those of *Operculinella venosa* but contrast with those of *Operculina ammonoides.* Whorl height in the terminal flange increases rapidly.

Operculinella cf. **O. striatoreticulata** (Rutten), 1928

Operculina ammonoides (GRONOVIUS); COLE, 1959, pl. 29, fig. 15.

The single axial section available is insufficient for precise determination to be attempted. It is strikingly different from all others figured by Cole (1959), and has enormous alar prolongations of the chambers. It most closely resembles *O. striatoreticulata,* but also has a strong resemblance to axial sections of *Operculinella willcoxi* (Heilprin, 1882).

DISCUSSION

Using typical specimens of the five species, *Operculina gaymardi, O. ammonoides, O. hanzawai, Operculinella venosa* and *O. cumingi,* measurements by Chapman and Parr (1938), Hanzawa (1939) and Cole (1959) show that in characters such as the size of the nucleoconch, the number of whorls, and degree of dimorphism, no significant differences can be established. The specimen of "*Operculina bartschi*" recorded by Chapman and Parr (1938) as having a megalosphere 0.231 mm. diameter is probably a specimen of *Operculina complanata* that has been misdetermined, for the remainder of all species average about 0.05 mm. diameter with considerable variation from 0.03 to 0.08 mm. The adult size is not notably affected by the dimorphism and it is not correlated with any of the variable characters. Microspheric tests have 3½ to 4½ whorls and megalospheric ones 2½ to 3 whorls. The adult size is correlated with the laxity of the spire, varying from 7 mm. to 2 mm. The microspheric test has about 30 chambers in the last whorl, the megalospheric test has about 20. *Operculinella cumingi* is exceptional, the corresponding numbers being about 22 and 17. Complete gradation between *Operculina gaymardi* and *O. ammonoides* is well established and generally recognised; see *Operculina* sp. Carpenter, 1860. Intermediates are common. These species certainly cannot be separated generically since their specific independence is in question, but one resembles *Operculina* while the other resembles *Assilina.* The latter name is nowadays reserved for Paleocene and Eocene species which form a distinct lineage, so it is convenient to assign both Recent species to *Operculina.*

The variable degree of involution of the last whorl of *Operculinella venosa* has caused confusion with *Operculina ammonoides.* The axial sections of these species, however, usually remain very distinctly different. *O. ammonoides* shows an inflated marginal cord, thicker chamber walls, and a rounded shape of the lateral chamber walls. *O. venosa* has a thinner marginal cord, thinner chamber walls; also flattened polar regions, with the return to the margin at an obtuse angle to them. *O. ammonoides* has evolute chambers, while all but the last whorl of chambers of *O. venosa* are strongly involute. *Operculina hanzawai* appears at first sight to be an intermediate form, but the increased degree of involution of the last whorl is anomalous whichever species is considered; it cannot be claimed that it indicates gradation between them. *O. hanzawai* is evolute in the earlier whorls and most closely resembles *O. ammonoides*. Specimens of *Operculinella venosa* from Samoa (Yabe and Hanzawa, 1925, pl. 5, figs. 15, 16, 17; pl. 7, figs. 1, 2) are unusual in that the axial section has some resemblance to that of *O. cumingi,* except that the marginal cord is stronger, more like that of *Operculina ammonoides,* and there is no terminal flange. This is suggestive of a recombination of characters of *O. ammonoides, Operculinella venosa* and *O. cumingi.* Typical specimens of the two latter species have not been recorded from this population, however. *Operculina* sp. (Hanzawa, 1939, pl. 15, figs. 9a, b) is in some respects intermediate between *Operculinella venosa* and *O. cumingi,* having a terminal flange and thick chamber walls but less limbate, less flexuous, filaments. We regard this as more probably a variant of *O. cumingi* than an intermediate form. *O. cumingi* usually appears to be sharply distinct from the similar living species, being distinguished from them by the terminal flange, by the flexuous, limbate filaments and by the slightly different septal count.

We have seen that a case can be made for regarding *Operculina gaymardi, O. ammonoides, O. hanzawai, Operculinella venosa* and *O. cumingi* as a single species in which local communities show different but fairly constant linkage of variations of certain characters. On the other hand, it is only in the case of *Operculina gaymardi* and *O. ammonoides* that intergradation is normally found, and even then the end forms are so distinctive that the use of two names is convenient. The existence of intermediate specimens between *Operculina ammonoides-gaymardi, O. hanzawai, Operculinella venosa* and *O. cumingi* is not firmly established, nor is there proof of continuous variation between evolute and partially involute species. We find no practical difficulty in classifying specimens, using the five species in question.

GENERIC CLASSIFICATION

Operculina d'Orbigny, 1826, type species *Lenticulites complanata* Defrance, 1822, designated by Cushman in 1914, was originally described as having the spire visible on both sides, i.e., the test had evolute chambers. This feature, combined with a lax spire, compressed shape and lack of secondary septation, is very widely recognized as establishing this genus. Davies (1945) and Bannink (1948) have tried to define *Operculina* by the rate of increase of height of the spire, but if *Operculina ammonoides* is to be included, a rigid definition becomes impossible. This affects the distinction from *Assilina,* not from *Operculinella.*

Operculinella Yabe, 1918, has as type species *Amphistegina cumingii* Carpenter, 1859. By definition it differs from *Nummulites* by the "operculine or heterostegine" terminal flange. The very compressed flange of *Operculinella cumingi* is unusual among the Nummulitinae and the definition has been widely interpreted to mean that the height of the spire increases throughout growth, in distinction from *Nummulites,* where low girontic whorls are typically present. Distinction from *Operculina* by the presence of strongly involute chambers in the earlier whorls was assumed. Cole (1959) has shown that the chambers of the terminal flange in *Operculinella cumingi* are usually strongly involute, although the type figures show that evolute terminal chambers do occur. *Operculinoides* Hanzawa, 1937, was proposed for species showing no evolute chambers, with type species *Nummulites willcoxi* Heilprin, 1882. Cole (1958) showed that there is insufficient difference between *Operculinella* and *Operculinoides* for generic distinction. He preferred to use *Operculinoides,* but *Operculinella* is obviously the senior name and the one of these two that should be conserved. Its actual validity is doubtful, however, and the possible prior synonyms will be discussed elsewhere. The genus represented by *Operculinella* is, however, an important one. The numerous small nummuloid species that occur in the Tertiary and Quaternary can be classified rapidly as evolute or at least partially involute with a negligible proportion of cases of real difficulty. To ignore this traditional distinction would increase the number of species of *Operculina* to the point where, as in *Nummulites,* they become very difficult to comprehend. The distinction forms a useful step in the taxonomic procedure that we would be very reluctant to abandon.

Eames, Banner, Blow and Clarke (1960) used *Palaeonummulites* Schubert, 1908, as a senior synonym of *Operculinella.* This is a nomenclatural problem distinct from that discussed here, which is the desirability of maintaining a generic distinction from *Operculina.*

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Analysis of Records by Cole 1959

Locality 1. *Albatross* stn. D 5141; 6° 09′ 00″ N, 120° 58′ 00″ E; depth 29 fathoms; Recent.

Operculina gaymardi, pl. 28, fig. 16;

Operculinella cumingi, pl. 28, fig. 18; pl. 31, fig. 1.

Locality 2. *Albatross* stn. D 5142; 6° 06′ 10″ N, 121° 02′ 40″ E; depth 21 fathoms; Recent.

Operculinella cumingi, pl. 28, figs. 12, 13, 14, 17; pl. 29, figs. 1, 2, 11, 13, 14; pl. 30, figs. 1, 9, 10.

Locality 3. Espiritu Santo, New Hebrides; Recent.
Operculina ammonoides, pl. 28, figs. 5, 7; pl. 29, fig. 12.
Operculinella venosa, pl. 28, figs. 1, 8, 11; pl. 29, figs. 6, 8, 10; pl. 30, figs. 2, 6, 7.

Locality 4. Stn. IS-F-310a-56, Ishigaki-Shima, Yaeyama-gunto, Ryûkyû-retto; Fossil.
Operculina gaymardi, pl. 28, fig. 10; pl. 29, figs. 4, 5; pl. 31, fig. 5.
Operculina ammonoides, pl. 28, fig. 4; pl. 29, fig. 3; pl. 30, fig. 3.
Operculinella venosa, pl. 28, figs. 2, 9, 15; pl. 30, figs. 5, 8.
Operculinella cf. *O. striatoreticulata,* pl. 29, fig. 15.

Locality 5. Stn. 1S-M-149-56 Ishigaki-Shima, Yaeyama-gunto, Ryûkyû-retto; Fossil.
Operculina complanata, pl. 31, figs. 3, 4.

Locality 6. Nakoshi, Haneji-mura, Okinawa-jima; Fossil.
Operculina hanzawai, pl. 28, fig. 3; pl. 29, fig. 9; pl. 30, fig. 4.

Locality 7. Djaing Langit, Tabalong District, S. E. Borneo; Fossil.
Operculina ammonoides, pl. 28, fig. 6, pl. 29, fig. 7; pl. 31, figs. 6, 7.

Locality 8. L 444, Oneata, Lau Islands, Fiji; Fossil.
Operculina gaymardi, pl. 29, fig. 16; pl. 31, fig. 2.

Operculina complanata	Loc. 5.
O. gaymardi	Locs. 1, 4, 8.
O. ammonoides	Locs. 3, 4, 7.
O. hanzawai	Loc. 6.
Operculinella cumingi	Locs. 1, 2,
O. venosa	Locs. 3, 4.
O. cf. *O. striatoreticulata*	Loc. 4.

BIBLIOGRAPHY

BAGG, R. M., 1908, Foraminifera collected near the Hawaiian Islands by the steamer *Albatross* in 1902: Proc. U. S. Nat. Mus., v. 34, pp. 166-7.

BANNINCK, D. D., 1948, Een monographie van het genus *Operculina* d'Orbigny, 1826: Thesis, Leiden, pp. 1-159, pls. 1-19.

BRADY, H. B., 1884, Foraminifera: Rept. Sci. Res. Voyage *Challenger,* Zool., v. 9, p. 749, pl. 112, figs. 11-13, text fig. 22.

CARPENTER, W. B., 1859 (1860), III. Researches on the Foraminifera: Philos. Trans. Roy. Soc. London, v. 149, pp. 32-35, pl. 5, figs. 13-17; pl. 6, figs. 5-6.

———, 1862, Introduction to the study of Foraminifera: Ray Soc. London, pp. 1-319, pls. 1-22.

CHAPMAN, F., 1895, On some Foraminifera obtained by the Royal Indian Marine Survey's S. S. *Investigator* from the Arabian Sea near the Laccadive Islands: Proc. Zool. Soc. London, pp. 4-55.

———, 1913, Description of new and rare fossils obtained by deep boring in the Mallee, Pt. 1. Plantae and Rhizopoda to Brachiopoda: Proc. Roy. Soc. Victoria, v. 26, pp. 165-191, pls. 16-19.

———, and PARR, W. J., 1938, Australian and New Zealand species of the foraminiferal genera *Operculina* and *Operculinella*: Proc. Roy. Soc. Victoria, v. 50, pt. 1, n. s., pp. 279-299, pls. 16, 17.

COLE, W. S., 1958, Names of and variation in certain American larger Foraminifera, particularly the camerinids: Bull. Am. Paleontology, v. 38, no. 171, pp. 219-233, pls. 26-29.

———, 1959, Names of and variation in certain Indo-Pacific camerinids: Bull. Am. Paleontology, v. 39, no. 181, pp. 349-371, pls. 28-31.

CRESPIN, I., 1936, The larger Foraminifera of the Lower Miocene of Victoria: Pal. Bull., no. 2 (Dept. of the Interior, Canberra, Australia), pp. 1-15, 2 pls.

CUSHMAN, J. A., 1921, Foraminifera of the Philippine and adjacent seas: U. S. Nat. Mus. Bull., v. 4, no. 100, pp. 1-608, 100 pls.

———, 1924, Samoan Foraminifera: Carnegie Inst., Washington, Publ. 342, pp. 1-75, 25 pls.

———, 1931, The Foraminifera of the Atlantic Ocean: U. S. Nat. Mus. Bull., v. 104, no. 8, pp. 1-179, 26 pls.

———, 1948, Foraminifera, their classification and economic use: 4th ed., Cambridge, Massachusetts, pp. 1-605, 55 pls.

DAVIES, L. M., 1945, Classification of spiral Foraminifera: Nature, v. 155, p. 81, 1 text fig.

DEFRANCE, M. J. L., 1822, Mineralogie et géologie; Dictionnaire des Sciences naturelles: Paris, v. 25, pp. 1-485.

DESHAYES, G. P., 1832, Encyclopédie méthodique; Histoire naturelle des vers: v. 3, Paris.

EAMES, F. E., BANNER, F. T., BLOW, W. H., and CLARK, W. J., 1960, Mid-Tertiary stratigraphical paleontology: Nature, v. 185, no. 4711, pp. 447-448.

FICHTEL, L. VON, and MOLL, J. P. C. VON, 1798, Testacea microscopica aliaque minuta, etc., Wien, 24 pls.

FORNASINI, C. (1903) 1904, Illustrazione di specie Orbignyane di "Nummulitidae" institute nel 1826: Bol. Soc. geol. ital., v. 22, pp. 395-398, pl. 14.

GALLOWAY, J. J., 1933, A manual of Foraminifera: Bloomington, Indiana, pp. 1-483, 42 pls.

GLAESSNER, M. F., 1945, Principles of micropalaeontology: Melbourne, pp. 1-296, 14 pls.

GRONOVIUS, L. T., 1781, Zoophyracium gronovianum exhitens animalia quadrupeda, etc.: Leyden, fasc. 3, pp. 241-380, pls. 18-20.

HANZAWA, S., 1939, Revision of "*Nummulites*" *cumingi* (Carpenter): Jap. Jour. Geol. and Geogr., v. 16, no. 3-4, pp. 225-232, 2 pls.

HEILPRIN, A., 1882, On the occurrence of nummulitic deposits in Florida, and the association of *Nummulites* with a fresh-water fauna: Acad. Nat. Sci. Philadelphia, Proc., v. 34, pp. 189-193.

HOFKER, J., 1927, The Foraminifera of the Siboga Expedition: Pt. 1, pp. 61-66.

———, 1932, Foraminifera of the Malay Archipelago: Vidensk Medd. fra Dansk naturh. Foren., v. 93, pp. 71-167, 35 text figs.

LADD, H. S., and HOFFMEISTER, J. E., 1945, The geology of Lau, Fiji: B. P. Bishop Mus. Bull., v. 181, pp. 1-399, 62 pls.

LEYMERIE, A., 1846, Mémoire sur le terrain a *Nummulites* (épicretacé) des Corbières et de la Montagne Noire: Mém. Soc. Géol. France, ser. 2, v. 1, p. 337, pls. 12-17.

MILLETT, F. W., 1904, XL Rept. on the Recent fauna of the Malay Archipelago: Jour. Roy. Micros. Soc., pt. 17, pp. 605-606.

NAGAPPA, Y., 1959, Note on *Operculinoides* Hanzawa 1935: Palaeontology, v. 2, pt. 1, pp. 156-160, pls. 21-23.

ORBIGNY, A. D', 1826, Tableau méthodique de la classe des céphalopodes: Ann. Sci. Nat., v. 7, pp. 245-314, pls. 10-17.

OVEY, C. D., 1938, On some East Africa Neogene Foraminifera: Monogr. Geol. Dept. Hunter Mus., Glasgow: v. 5, pp. 98-105, pls. 10-11.

PARKER, W. K., and JONES, T. R., 1857, Description of some Foraminifera from the coast of Norway: Ann. Mag. Nat. Hist., ser. 2, v. 19, p. 285, pl. 11, figs. 3-4.

———, and ———, 1865, On some Foraminifera from the North Atlantic and Arctic oceans: Philos. Trans. Roy. Soc. London, v. 155, p. 398, pl. 14, fig. 44; pl. 17, figs. 62-63.

POKORNY, V., 1958, Grundzüge der zoologischen mikropaläontologie: Berlin, Band 1, pp. 1-582.

SCHROETER, J. S., 1783, Einleitung in die Conchylienkenntniss nach Linné: Band 1, pp. 1-860, 3 pls.

SCHUBERT, R. J., 1908, Zur Geologie des österreichischen velebit: Geol. Reichsanst. Jahrb., Wien, v. 58, pp. 345-386, pl. 16.

SIGAL, J., 1952, Ordre des Foraminifères: *in* Piveteau, J., Traité de Paleontologie, Paris, Tome I, pp. 133-301.

SILVESTRI, S., 1907, Considerazione palaeontologiche e morphologiche sui generi *Operculina, Heterostegina, Cycloclypeus*: Boll. Soc. geol. ital., v. 26, pp. 29-62, pl. 2.

WILLIAMSON, W. C., 1858, Monograph of the Recent Foraminifera of Great Britain: Ray Soc. London, pp. 1-107, 7 pls.

YABE, H., 1918, Notes on the *Operculina*-rocks from Japan with remarks on "*Nummulites*" *cumingii*: Tohoku Imp. Univ. Sci. Rep., ser. 2 (geol.), v. 4, no. 3, pp. 107-126, pl. 17.

———, and HANZAWA, S., 1925, A geological problem concerning the raised coral reefs of the Riukiu Island and Taiwan: Sci. Rept. Tohoku Univ., v. 7, no. 2, pp. 49-51, pl. 5, figs. 1-27, etc.

CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH
VOLUME XI, PART 4, OCTOBER, 1960

214. *LACOSTEINA PAYNEI,* A NEW SPECIES FROM THE UPPER CRETACEOUS OF CALIFORNIA

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and
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ABSTRACT

The new species, **Lacosteina paynei**, is described. It is found in the uppermost concretionary sandstone of the Uhalde formation and the Dosados member of the Moreno formation, and is of Maastrichtian age; it is the first reported occurrence of the genus in California.

INTRODUCTION

Lacosteina, a genus from the late Upper Cretaceous, was identified during a microscopic examination of augered samples from the lowest member (Dosados) of the Moreno Formation and the uppermost sandstone unit of the Panoche Group (Fig. 1). Both units are in Fresno County, California, and are currently accepted as Maastrichtian in age. The species herein described as new — *Lacosteina paynei* Graham and Clark — is significant because it extends the geographic range of the genus from isolated occurrences in Morocco (Marie, 1945, p. 295), the Sinai Peninsula (Said and Kenawy, 1956, p. 143), the Kyzyl-Kum region, U.S.S.R. (Bykova and Subbotina, 1959, p. 336-337), and northern Alaska (Tappan, 1960, p. 289) to California. Moreover, it is found in strata that may be of the same age as or younger than those at the type locality of the genotype *Lacosteina gouskovi* Marie.[1]

The foraminifer ranges through 265 feet of strata, including a bed, 25 feet thick, of fine-grained, grey, friable, concretionary sandstone at the top of the Panoche and the 240 feet of the sandstone and shale (Dosados member) of the Moreno. No specimens of *Lacosteina paynei* were observed in the basal part of the Tierra Loma member (shale) of the Moreno, which is stratigraphically higher than the Dosados, nor in that part of the Uhalde formation (Panoche Group) below the concretionary sandstone. Associated with specimens of this distinctive species are several other taxa of Foraminifera, some of which are diagnostic of Goudkoff's "D-1 zone" of the California Cretaceous (Goudkoff, 1945, p. 968): *Bolivina incrassata* Reuss, *Bulimina petroleana* Cushman and Hedberg, *B. prolixa* Cushman and Parker, *B. trihedra* Cushman, *Gavelinella* sp. (= *Valvulineria cretacea* (Carsey) of California workers), *"Globigerinella" aspera* (Ehrenberg), *Globotruncana arca* (Cushman), *Heterohelix globulosa* (Ehrenberg), *Pseudoguembelina excolata* (Cushman), *Rugoglobigerina rugosa* (Plummer), *Siphogenerinoides clarki* var. *costifera* Cushman and Goudkoff, and *S. whitei* Church.

The aforementioned concretionary sandstone is at the same stratigraphic level as that at LSJU Locality 2251, approximately 7.2 miles to the southeast in the NE ¼ sec. 12, T. 15 S., R. 11 E. (Payne, 1951, pl. 1, fig. 6). At this latter locality, *Baculites columna* Morton, an ammonite "very possibly referable to the Lower Maestrichtian" has been identified by Matsumoto (1959, pt. 1, p. 163; 1960, p. 44; pl. 1).

The writers wish to thank the Shell Companies

1. Marie (1945, p. 298) states that **Lacosteina gouskovi** occurs in the Campanian of Morocco; however, Hofker (1959, p. 113) reports that it is found in the Maastrichtian, not Campanian, but does not cite his evidence.

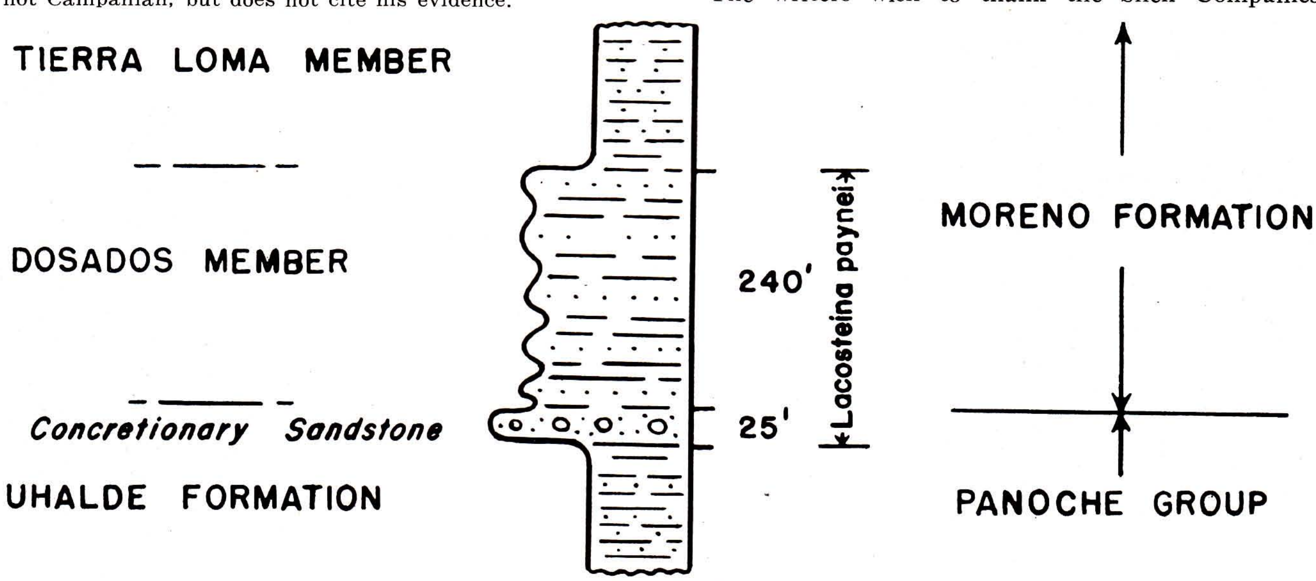

FIGURE 1
Stratigraphic section along Television Hill Road in NW ¼ sec. 3, T. 14 S., R. 11 E., Panoche Valley Quadrangle, Fresno County, California, showing biostratigraphic range of *Lacosteina paynei* n. sp. (see Payne, 1960, figs. 2-5).

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DESCRIPTION OF SPECIES

Family Uncertain

Genus **Lacosteina** Marie, 1945

Lacosteina paynei Graham and Clark, n. sp.

Plate 16, figures 1-5

Test. — small, slightly fusiform, subtriangular in transverse section, sides concave; planispiral coil with central callus and rounded periphery; triserial upper part 3 to 4 times wider than thickness of coil. *Wall.* — smooth, finely perforate. *Chambers.* — those of initial coil uniformly triangular in shape, 4 to 10 visible and gradually increasing in size; those of triserial portion inflated and arranged in 3 to 5 whorls, becoming lobate and progressively larger toward distal end. *Sutures.* — straight to gently curved, limbate, slightly depressed in initial coil; those in triserial portion also depressed. *Aperture.* — spatuliform, attenuated end extending to basal suture, excentric. *Dimensions.* — *Holotype*: length — 0.266 mm.; maximum width — 0.110 mm.; diameter of initial coil — 0.104 mm.; thickness of initial coil — 0.039 mm. *Paratypes*: (range) length — 0.208 to 0.266 mm.; maximum width — 0.110 mm.; diameter of initial coil — 0.065 to 0.078 mm.; thickness of initial coil — 0.035 to 0.039 mm.

Remarks. — *Lacosteina paynei* is distinguished from *L. gouskovi* Marie (1945, p. 296, text-figs. 1-6) from the Upper Cretaceous of Morocco in having lobed chambers in the adult portion of the test, in having a rounded periphery in the initial coil, in being subtriangular in transverse section, and in possessing a buliminid-like adult chamber arrangement. Recrystallization of the tests does not permit observation of microstructures such as those described for *L. gouskovi* by Marie (*ibid.*, p. 297) and by Hofker (1959, p. 113). We are uncertain as to the family allocation of *Lacosteina.* Marie (*ibid.*, p. 296) believes that it represents the most primitive genus of the family Buliminidae, whereas Hofker (*ibid.*, p. 114) is of the opinion that it "is not a primitive *Bulimina* but a highly developed and aberrant species related to *Conorboides* or an allied genus."

The species is dedicated to Max B. Payne of the Norris Oil Company, Bakersfield, California, in recognition of his contributions to Cretaceous stratigraphy in California.

Occurrence. — Specimens are rare in both the Dosados member (sandstone and shale) of the Moreno and in the upper concretionary sandstone bed of the Uhalde Formation (Panoche Group), as exposed in a road cut in the NW ¼ sec. 3, T. 14 S., R. 11 E., M.D.B. and M., Panoche Valley Quadrangle, California (L.S.J.U. locality no. M - 625).

Types. — Holotype (fig. 5), Stanford Univ. Paleo. Type Coll. No. 9145, from 5 feet below top of the Upper Cretaceous (Maastrichtian) Uhalde Formation. Paratypes (figs. 1-4), Stanford Univ. Paleo. Type Coll. Nos. 9146, 9147, 9148, and 9149, from 80 feet below top of the Upper Cretaceous (Maastrichtian) Dosados member of the Moreno Formation.

Camera lucida drawings are by Perfecto M. Mary, staff artist, School of Mineral Sciences, Stanford University.

REFERENCES

BYKOVA, N. K., and SUBBOTINA, N. N., 1959, Suborder Heterohelicida: *in* Osnovy Paleontologii, edited by D. M. Rausser-Chernousova and A. V. Fursenko, General Pt., Protozoa, 12 d. Akad. Nauk., S.S.S.R., 482 p., 7 pls., 6 text-figs.

GOUDKOFF, P. P., 1945, Stratigraphic relations of Upper Cretaceous in Great Valley, California: Am. Assoc. Petroleum Geologists Bull., vol. 29, no. 7, p. 956-1007, 17 figs., 2 tables.

HOFKER, JAN, 1959, The genera *Eponides, Lacosteina, Nuttalides, Planorbulina,* and *Halkyardia*: Contr. Cushman Found. Foram. Research, vol. 10, pt. 4, p. 111-118, 27 text-figs.

MARIE, PIERRE, 1945, Sur un foraminifère nouveau du Crétacé supérieur marocain: *Lacosteina gouskovi* nov. gen. et nov. sp.: Bull. Soc. Géol. France, sér. 5, tome 13 (1943), p. 295-298, 6 text-figs.

MATSUMOTO, TATSURO, 1959-1960, Upper Cretaceous Ammonites of California: Parts I-III - Mem. Fac. Sci., Kyushu Univ., ser. D, Geol. vol. 8, no. 4 (Part I, 1959, p. 91-171, text-figs. 1-85, pls. 30-45; Part II, Special vol. I, 1959, 172 p., 80 text-figs., 41 pls.; Part III, Special vol. II, 1960, 204 p., 20 text-figs., 2 pls.)

PAYNE, M. B., 1951, Type Moreno formation and overlying Eocene strata on the west side of the San Joaquin Valley, Fresno and Merced counties, California: State of California, Dept. Nat. Res., Special Rept. 9, 29 p., 5 pls., 11 figs.

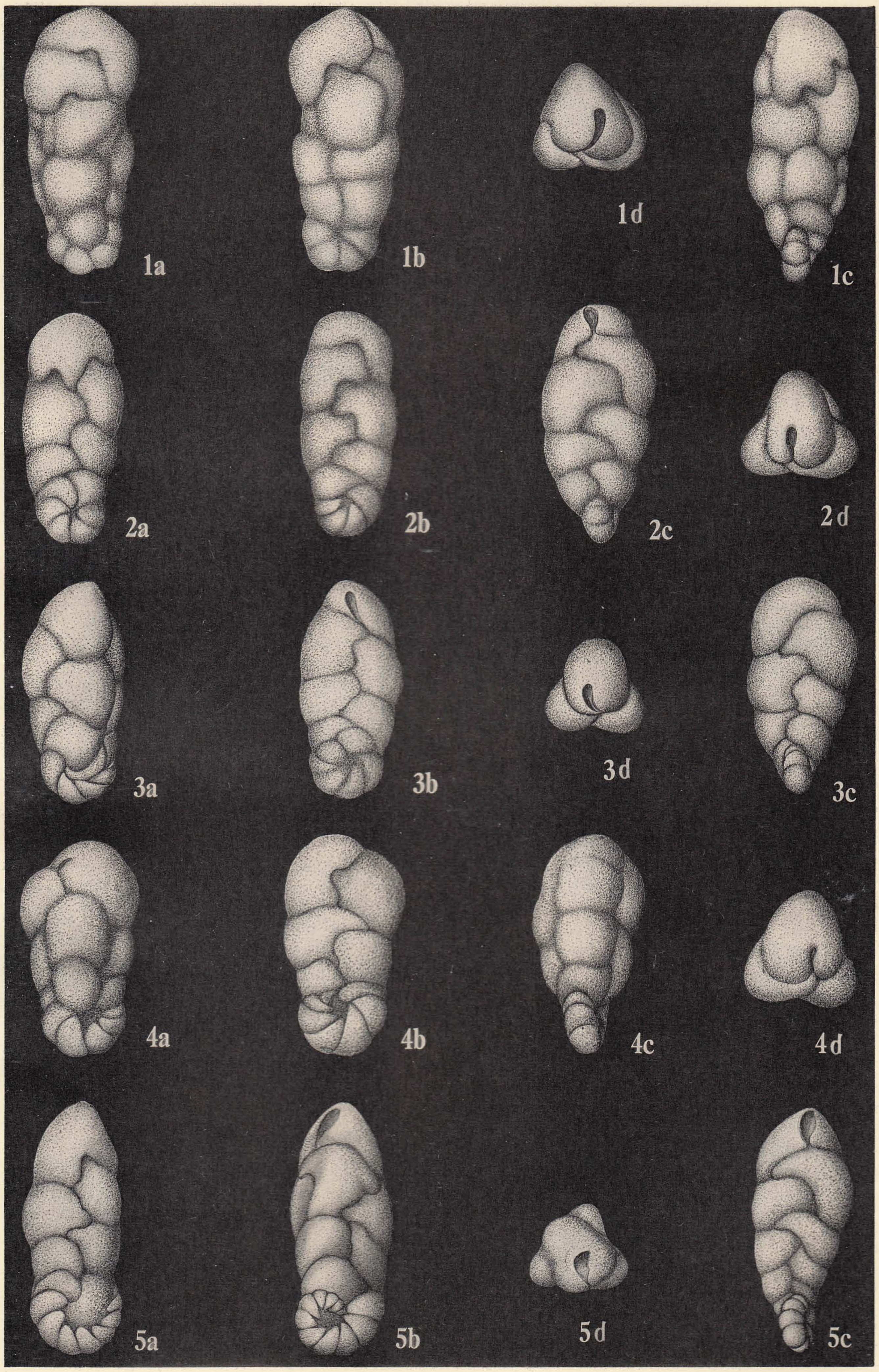
———, 1960, *in* Type Panoche, Panoche Hills area, Fresno County, California: Pacific Section S.E.P.M., Guidebook 1960 Spring Field Trip, 12 p., 6 figs.

SAID, RUSHDI, and KENAWY, ABBAS, 1956, Upper Cretaceous and Lower Tertiary Foraminifera from northern Sinai, Egypt: Micropaleontology, vol. 2, no. 2, p. 105-173, 7 pls., 6 text-figs.

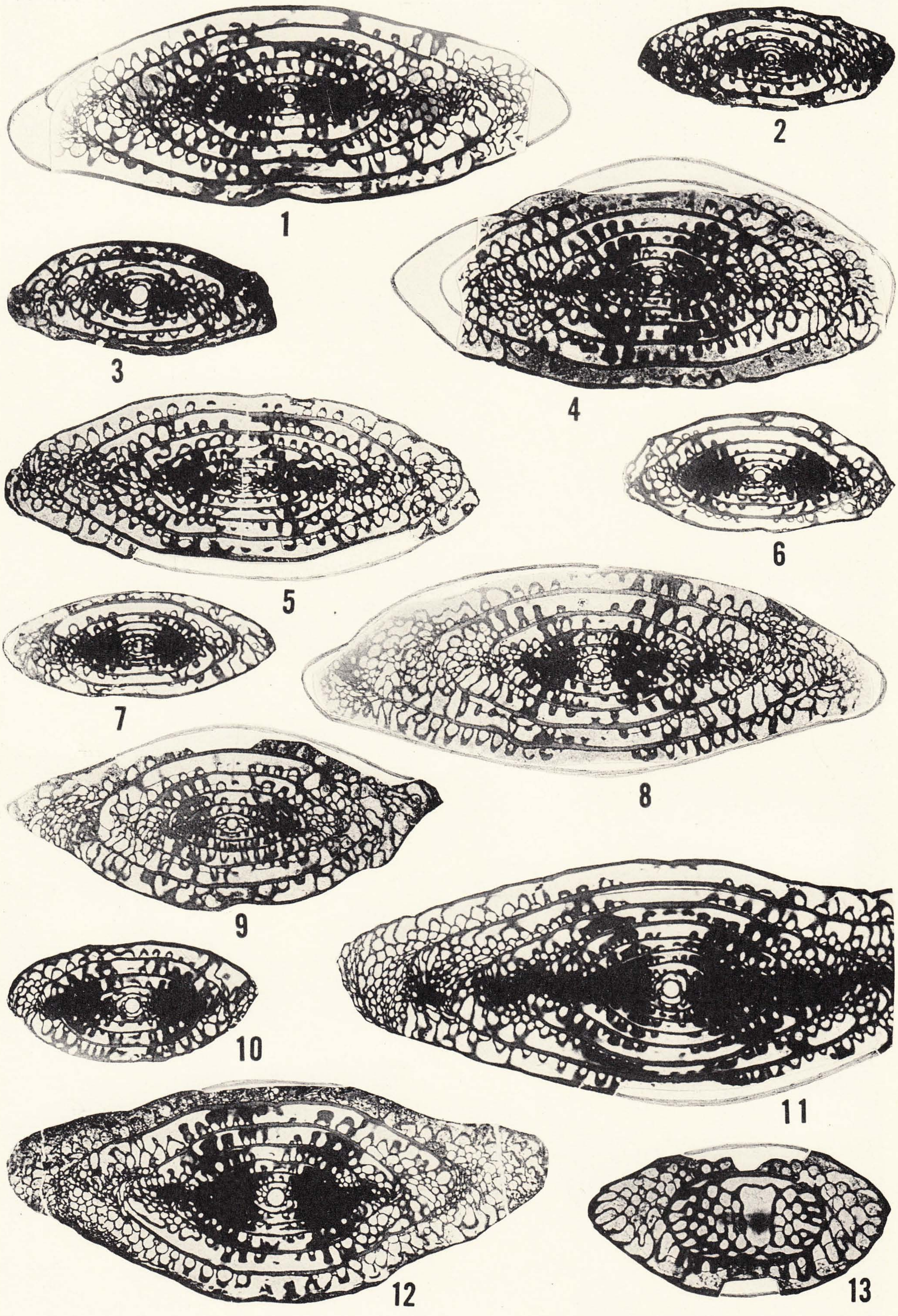
TAPPAN, HELEN, 1960, Cretaceous biostratigraphy of northern Alaska: Am. Assoc. Petroleum Geologists Bull., vol. 44, no. 3, pt. 1, p. 273-297, 7 figs., 2 pls.

EXPLANATION OF PLATE 16

FIGS.		PAGE
1-5.	*Lacosteina paynei* Graham and Clark, n. sp. × 150 (approx.) .... From the Upper Cretaceous (Maastrichtian) of Fresno County, California (L.S.J.U. Loc. no. M-625). Figs. 1-4 paratypes, Fig. 5 holotype. Views: a-b, opposite sides; c, inner periphery; d, summit.	116



Graham and Clark: *Lacosteina paynei,* Upper Cretaceous, California



Ross: Permian fusulinids from Texas

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215. FUSULINIDS FROM THE HESS MEMBER OF THE LEONARD FORMATION, LEONARD SERIES (PERMIAN), GLASS MOUNTAINS, TEXAS

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ABSTRACT

Five fusulinid zones are recognizable in the Hess member of the Leonard formation in the eastern Glass Mountains. These zones are useful for correlation and contain two species of **Schwagerina**, previously described, and five species of **Parafusulina** which are new. The assemblage of **Schwagerina crassitectoria** Dunbar and Skinner and **S. guembeli** Dunbar and Skinner forms the lowest zone, **Parafusulina allisonensis** n. sp. forms the second zone, **P. deltoides** n. sp. and **Parafusulina** sp. A form the third zone, **P. spissisepta** n. sp. forms the fourth zone which includes the upper Hess fossil bed of P. B. King (1931), and the assemblage of **P. brooksensis** n. sp. and **P. vidriensis** n. sp. forms the fifth and highest zone of the Hess member. The distribution of these species of fusulinids in these zones is closely related to the types of limestones.

A possible species of **Eoverbeekina** found near the base of the Hess member in the double ledge may be one of the earliest occurrences of a member of an Asian fusulinid fauna to be reported from the standard Permian section.

INTRODUCTION

The Wolfcamp and Leonard Series, the lower two standard series of the Permian for North America, are well exposed in the Glass Mountains of western Texas. The Wolfcamp Series has been the subject of several papers, field trips, and stratigraphic discussions, but the overlying Leonard Series has escaped the close attention that it rightly deserves and is known from a few reports which bring forth only the major relations of this important series.

The Leonard Series in its type area in the Glass Mountains is a complex sequence, about 2000 feet thick, formed of several intertonguing lithologies and its faunas for the most part remain undescribed. The Marathon orogenic belt immediately south of the Glass Mountains was only mildly active during Leonard time as the major episodes of thrusting, intensive folding, and the associated deposition of thick conglomeratic deltas such as those in the Wolfcamp Series had already ended. The shallow water Leonard deposits of the Glass Mountains change facies as they thicken northward into the Val Verde geosyncline and the Delaware basin.

The Leonard faunas in the eastern facies, or Hess member, are more poorly documented than those in the western, or siliceous shale facies, where, however, only the fauna from a few beds has been studied in detail. This paper is concerned with the fusulinid zones of the Hess member in the eastern Glass Mountains and the description and lithologic association of the fusulinid species in these faunal zones.

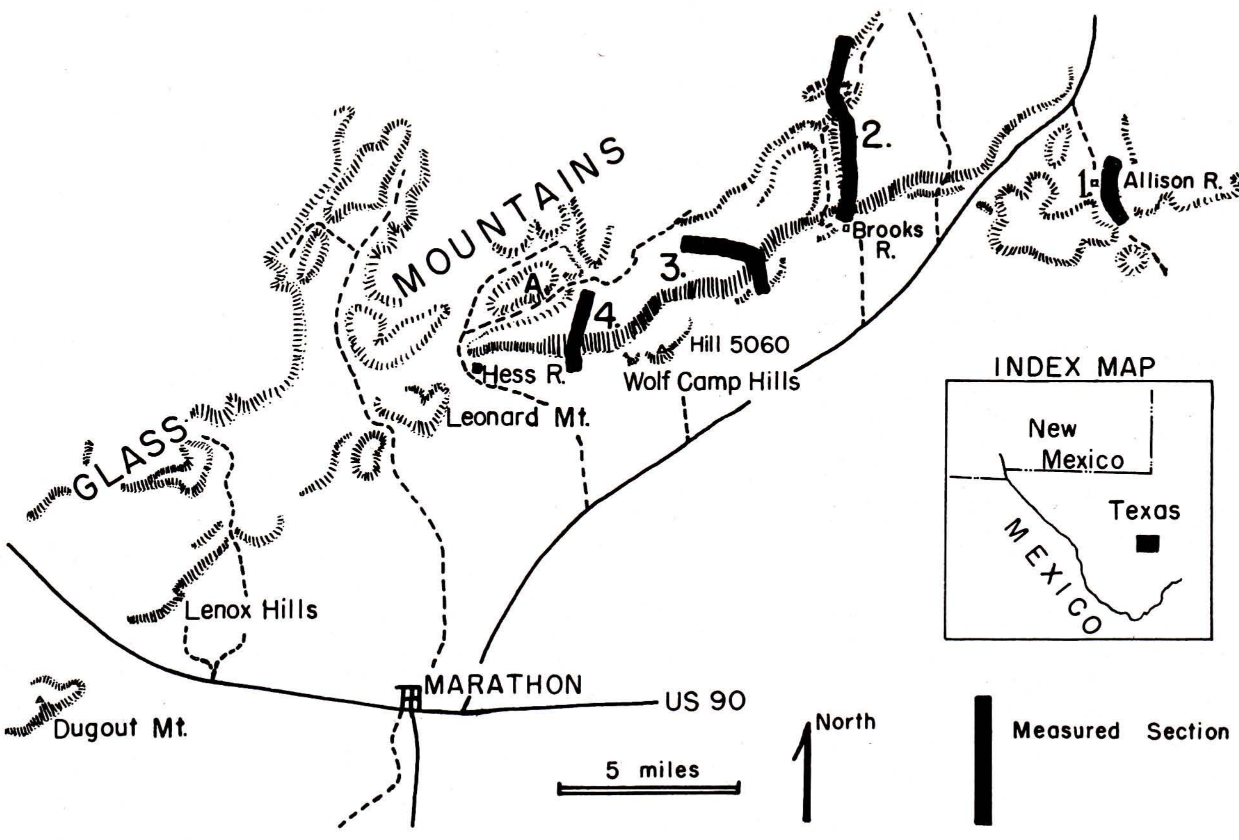
In the four measured sections of the Hess member (text figs. 1 and 2), there is a marked change in the total amount of limestone and the impurities in the limestone beds from east to west. Section 1 at the Allison Ranch is dominantly shale and sandstone and to the west in sections 2 and 3 the shale beds thin and pass into silty and clayey limestone. Section 4, about 4 miles to the west of section 3, has little shale or siltstone in its lower part and here the limestone beds contain little clay or silt. The Glass Mountains escarpment increases in height westward as progressively higher limestone beds form the crest. This increase in resistance to erosion toward the west is largely the result of thinning or disappearance of shale in the lower part of the sequence.

The Leonard formation, named by Udden, Baker,

EXPLANATION OF PLATE 17

All figures × 10

FIGS.		PAGE
1-9.	*Schwagerina crassitectoria* Dunbar and Skinner, lower part of the Hess member .... 1. Axial section, collection 2-3A, YPM 21181. 2. Axial section, immature specimen, collection 3-(10)A, YPM 21189. 3. Axial section, immature specimen, collection 3-(10)A, YPM 21190. 4. Axial section, collection 1-7, YPM 21183. 5. Axial section, collection 1-13, YPM 21184. 6. Axial section, immature specimen, collection 3-(10)A, YPM 21187. 7. Axial section, immature specimen, collection 3-(10)A, YPM 21188. 8. Axial section, collection 1-7, YPM 21186. 9. Axial section, collection 1-10, YPM 21185.	123
10-13.	*Schwagerina guembeli* Dunbar and Skinner, lower part of the Hess member .... 10. Axial section, immature specimen, collection 3-(10)A, YPM 21191. 11. Axial section, collection 4-16A, YPM 21208. 12. Axial section, collection 1-12, YPM 21210. 13. Tangential section, collection 1-21, YPM 21212.	124

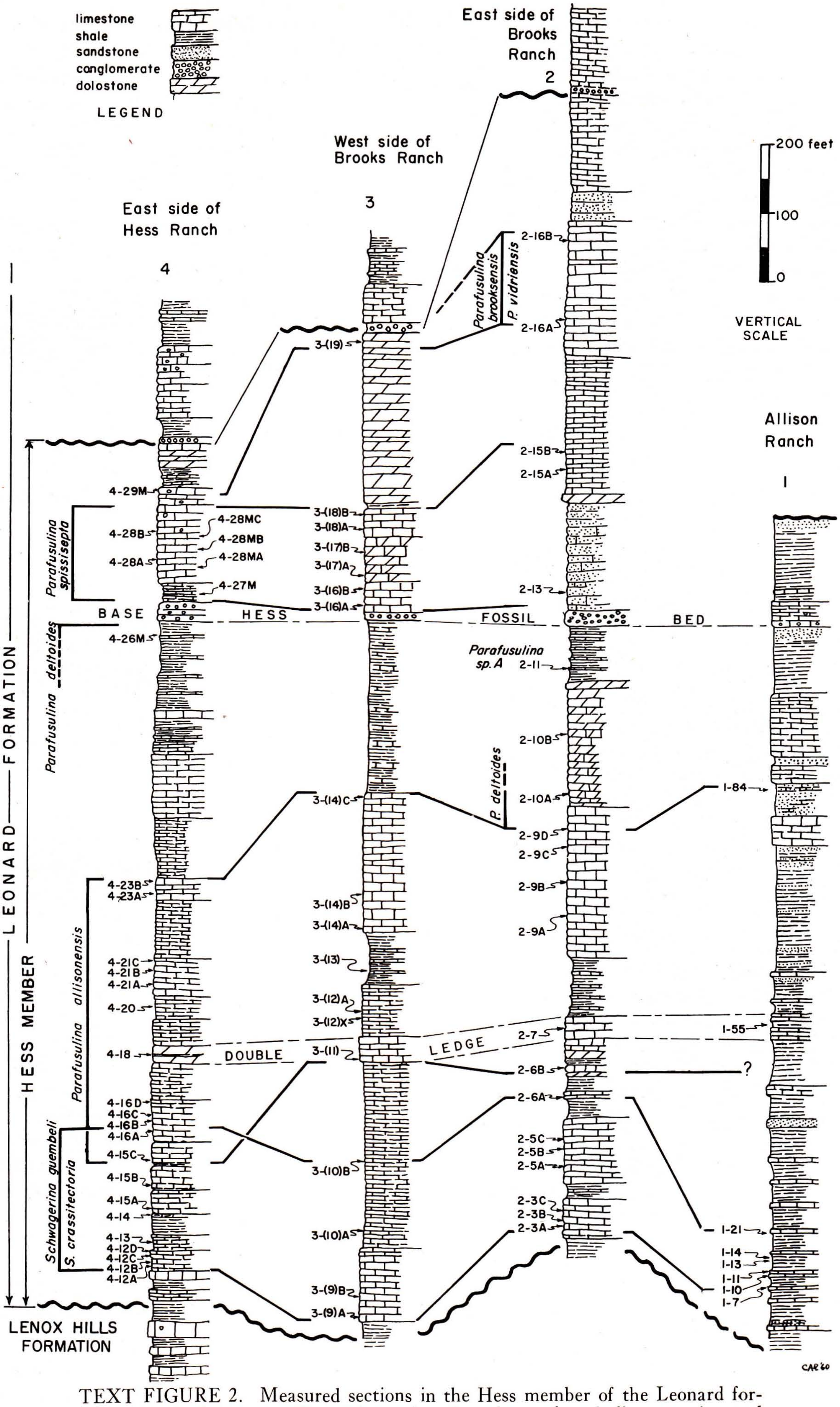


TEXT FIGURE 1. Index map of the Glass Mountains, Texas: Section 1, east of the Allison Ranch house; Section 2, north of the Brooks Ranch house; Section 3, about 3 miles southwest of the Brooks Ranch house (remeasurement of P. B. King's section 26, 1931); and Section 4, 3 miles east of the Hess Ranch house. Symbol A locates the Hess Ranch horst.

and Böse (1916, p. 51), originally included about 1800 feet of beds in its type section on and to the north of Leonard Mountain. Udden, Baker, and Böse also included in the Leonard formation the beds exposed in the eastern Glass Mountains escarpment. The following year, Udden (1917, p. 43-46) separated the beds forming the eastern escarpment of the Glass Mountains into the Hess formation and considered them unconformably overlain by strata of the type Leonard formation. According to Udden (1917, p. 43), the Hess formation unconformably overlay older beds below, and behind the Wolf Camp Hills it began with a basal conglomerate (40 feet) succeeded by shale and thin limestone beds (200 feet) above which were about 1900 feet of thin limestone beds forming the main escarpment. He (Udden, 1917, p. 45) expressed doubt as to the extent of the Hess formation west of Leonard Mountain although he showed a considerable outcrop belt on his geologic map. Böse (1919, p. 16, 17) traced the conglomerate at the base of the Hess formation as defined by Udden (1917) and carried the Hess formation across the base of the western escarpment of the Glass Mountains. He showed that an important angular unconformity existed at the base of the Hess formation and that this unconformity did not lie at the base of the Permian sequence, but rather within the lower part of the Permian.

King and King (1928, p. 126, 127) and P. B. King (1931, p. 57) showed that the lower part of Udden's (1917) type Leonard formation on Leonard Mountain was in part equivalent to the Hess formation in the eastern Glass Mountains escarpment and redefined the Leonard formation to exclude beds they considered to belong to the Hess formation. They essentially restricted the siliceous shale beds in the western Glass Mountains to the Leonard formation and the limestone sequence in the eastern Glass Mountains to the Hess formation. In addition, they (King and King, 1928, p. 126) found faunal evidence that supported placing the lower part of the Hess formation, discussed by Böse in the western Glass Mountain, in the Wolfcamp formation. P. B. King (1931, p. 56) and R. E. King (1931) also considered much of the strata in the Hess Ranch horst as Wolfcamp equivalents although Udden and Böse had regarded these strata as part of the Hess formation.

In all of these studies, the lateral change of facies in the Hess and Leonard formations had been mentioned although not studied in detail. The sequence on Leonard Mountain, which is complicated by slumped tierra blocks, igneous intrusives, and dolomitization of limestone beds, and the sequence in the high escarpment about two miles northeast of the Hess Ranch House were studied in more detail by P. B. King (1932). He found (1932, p. 338-341) that the Permian strata abruptly changed from shale and thin limestone



TEXT FIGURE 2. Measured sections in the Hess member of the Leonard formation in the eastern Glass Mountains. Sample numbers indicate section and bed numbers, letters indicate position within a bed.

beds at the western end of Leonard Mountain into reefy lenticular limestone on the eastern side of the mountain and that slightly higher in the section east of the Hess Ranch house similar reefy limestone beds lensed eastward into fine grained, thin bedded limestone of the Hess formation. As a result of these observations, King (1932, p. 353, 354) concluded that the Leonard and Hess formations were for the most part lateral equivalents. In 1934, P. B. King (p. 730) proposed to call the entire sequence above the Wolfcamp formation and below the Word formation the Leonard formation and to restrict the name Hess to the thin bedded limestones in the eastern Glass Mountains which he gave member rank.

Again, in 1937 (p. 98) and 1942 (p. 650), P. B. King discussed the stratigraphy of the Leonard formation in the Glass Mountains and showed that a narrow band of reefy limestone lay between the siliceous shale beds in the west and the thin bedded limestones of the Hess member in the east (King, 1937, p. 98). This reef lithology is commonly referred to as the sponge reef horizon. The top of the Hess member was more clearly defined by P. B. King (1942, p. 652, 653) as the beds beneath a persistent chert pebble conglomerate high in the formation in the eastern Glass Mountains which to King suggested an unconformity.

Ross (1959, p. 299-301) redefined and divided the Wolfcamp Series into two formations, the Neal Ranch and Lenox Hills formations, which have distinct fusulinid faunas and which are separated by a regional unconformity, the same unconformity that Udden (1917) found at the base of the Hess formation in the eastern Glass Mountains and which Böse (1919) had traced across the base of the western Glass Mountains escarpment. Thus the base of the Hess member was raised above the position indicated in previous publications.

STRATIGRAPHY

The lower formation of the Wolfcamp Series (Ross, 1959), the Neal Ranch formation, has its type locality in the Wolf Camp Hills one-quarter of one mile west of Hill 5060 and is the upper shale and limestone sequence of Udden's original Wolfcamp formation (1917). The upper formation, the Lenox Hills formation, lies above the regional unconformity and has its type section in the Lenox Hills, one-quarter of one mile north of the Slick-Urschel no. 1 Mary Decie well site 7 miles, north 70 degrees west, of Marathon, Texas. This formation includes the beds called the Wolfcamp formation by P. B. King and R. E. King (1928, 1931) throughout the western Glass Mountains and can be traced into the lower 250 to 300 feet of the original Leonard formation (Udden, *et al.*, 1916) in the eastern Glass Mountains. Thus Ross (1959, p. 299-301) raised the base of the Leonard formation in the eastern part of the Glass Mountains to exclude strata equivalent to the Lenox Hills formation, that is, the upper part of the Wolfcamp Series.

The base of the Hess member of the Leonard formation rests with erosional unconformity on the Lenox Hills formation throughout most of the eastern Glass Mountains. The upper part of the Lenox Hills formation in the eastern Glass Mountains is mainly shale with some interbedded limestone which increases in amount to the west. Shale from the top of this underlying formation was eroded and redeposited during initial deposition of the Hess member. The lower five to twenty feet of the Hess member are composed of shale and thin limestone beds which resemble the underlying shales of the Lenox Hills formation, although separated by an erosional unconformity which can be seen in one or two road cuts where this shale sequence is well exposed.

The thin bedded limestones in the lower 200 feet of the Hess member in the eastern Glass Mountains are silty biomicrosparites (terminology of Folk, 1959) and biomicrites although a few of the more fossiliferous beds in section 4 are biosparite tonguing into the sequence from the west. Above these beds are 400 feet of limestone which is alternately biosparite, generally having abundant algal fragments and smaller Foraminifera, and biomicrosparite. In beds that P. B. King (1931) referred to as the upper Hess fossil horizon (or *Perrinites compressus* horizon) and in the succeeding 200 feet of limestone, the limestone is biosparite having many fossils cemented by a mozaic of coarse sparry calcite. Algae are particularly abundant and smaller Foraminifera of many kinds are common. The succeeding 400 feet, to the base of the typical Leonard or siliceous shale facies, is mostly limestone which is recrystallized biosparite or biomicrosparite.

In the eastern part of the Glass Mountains, tongues of shale, siltstone, and sandstone increase in thickness and become more common. Many of these clastic tongues have cyclic repetitions of beds and the highest and also the thickest, 200 feet, of these tongues lies beneath the Hess fossil bed and has shale, siltstone, and thin silty limestone beds repeated in 5 or 6 cycles.

Two key beds have proven to be traceable for considerable distances across the eastern Glass Mountains. The lower key bed is the double ledge of P. B. King (1931) which can be traced almost continuously from section 4, bed 18, eastward to section 2, bed 7, and is probably the same as section 1, bed 55. It has a characteristic microfauna of a large staffelloid, the alga *Mizza,* and an abundance of smaller Foraminifera. The upper key bed is the conglomerate at the base of the upper Hess fossil horizon which can be traced from section 4, bed 27, into section 2, bed 13, and is probably equivalent to the algal limestone near the top of section 1.

Chert pebbles are common in the upper several hundred feet of the Hess member and generally are scattered throughout the limestone. The top of the Hess member is drawn at the base of the first chert pebble conglomerate bed. The chert pebble conglomerate beds used to define the top of the Hess member apparently represent local concentration of pebbles and are not at the same stratigraphic position in each of the measured sections.

FUSULINID FAUNA

In many beds of the Hess member, fossils are abundant but are commonly of only a few kinds. The distinctive Hess fossil bed contains the most varied fauna in the Hess member. P. B. King (1931) termed this marker bed the *Perrinites compressus* horizon. However, Miller and Furnish (1940, p. 148) studied the cephalopods from this horizon and found that the only species of *Perrinites* present was *P. hilli* (Smith). The brachiopods from this horizon were described by R. E. King (1931). From a few localities in the lower part of the Hess member, gastropods (Yochelson, 1956 and Batten, 1958), ostracods (Kellett, 1943), and fusulinids (Dunbar and Skinner, 1937) have been studied.

Of the fusulinids from the Hess member, only *Schwagerina guembeli* Dunbar and Skinner, *S. guembeli* var. *pseudoregularis* Dunbar and Skinner, *S. crassitectoria* Dunbar and Skinner, *Staffella lacunosa* Dunbar and Skinner, and *Schubertella melonica* Dunbar and Skinner have previously been described by Dunbar and Skinner (1937) based on collections from 7 localities. Of these species, *Staffella lacunosa* and *Schubertella melonica* have long stratigraphic ranges and apparently are common throughout the Hess member. However, they are restricted to certain lithologies and this suggests a close facies control of their distribution.

In the eastern Glass Mountains, five fusulinid zones are well represented in the Hess member of the Leonard formation (text fig. 2). The lowest zone, about 200 feet thick, contains the association of *Schwagerina crassitectoria* and *S. guembeli.* This is followed by a zone about 400 feet thick having *Parafusulina allisonensis* n. sp. The third zone contains *P. deltoides* n. sp. which extends through about 300 feet of strata to the base of the Hess fossil bed. The fourth zone includes the Hess fossil bed and about 200 feet of beds above, including the "sponge reef" limestone, and is characterized by *P. spissisepta* n. sp. The fifth and highest zone contains *P. brooksensis* n. sp. and *P. vidriensis* n. sp. and is about 400 feet thick. The highest part of the Hess member, 250 feet thick in section 2, has beds of recrystallized limestone in which fossils are rare or present only in relict outlines.

Two interesting features emerge from a study of the fusulinid faunas and the rock types in which they occur. A comparison of lithologies and fusulinid species suggests a close control by facies of the distribution of species. Similar facies reappearing at different levels in the sequence contain different species and this suggests that the ranges of the species in a particular facies are fairly accurate guides to their total biochron.

Schwagerina guembeli and *S. crassitectoria* from the lower 210 feet of the Leonard formation form a persistent zone across the eastern escarpment of the Glass Mountains (text fig. 2). In the lowermost beds, *S. guembeli* and *S. crassitectoria* are closely similar morphologically and usually occur in the same bed. However, higher in their stratigraphic ranges they become markedly distinct, *S. guembeli* becoming very large and rotund and *S. crassitectoria* becoming more elongate and having simpler axial deposits, and generally these two species are no longer associated in the same beds. *S. guembeli* in the upper part of its range is most common in biosparite and biomicrosparite and *S. crassitectoria* in the upper part of its range is most common in biomicrosparite. This suggests that these two closely related species gradually evolved so that in their later stratigraphic range they became adapted to slightly different environments and this was accompanied by morphological changes. Similar lines of divergence are known when the geographic ranges of closely related Recent species having overlapping ecological tolerances are brought together. The slight change in morphology of *S. crassitectoria* suggests that it retained essentially the same ecological tolerances, whereas the significant morphological changes in *S. guembeli* suggest its ecological tolerances shifted with time. In the eastern Glass Mountains, *S. guembeli* has a slightly higher stratigraphic range which in section 4 overlaps with the lower part of the range of *Parafusulina allisonensis* n. sp.

Parafusulina allisonensis n. sp. is the common species in the biosparite and biomicrosparite beds for about 400 feet above the zone of *Schwagerina guembeli.* These limestones differ slightly from those in the lower part of the sequence in having little silt and clay and in having abundant algal fragments and smaller Foraminifera in most beds. The species changes only slightly through this sequence although axial deposits are more common and heavier in specimens from the dominantly limestone sequence in the west (sections 3 and 4) than in specimens in the eastern sections (section 1 and 2). In general the amount of axial deposits in this species decreases in specimens from successively higher beds. This perhaps reflects an evolutionary trend, but such a trend could easily be a result of environmental factors.

In the succeeding 300 to 400 feet, that is, as high as the conglomerate at the base of the Hess fossil bed, the limestone beds contain *Parafusulina deltoides* n. sp. and *Parafusulina* sp. A. These limestone beds intertongue with cyclothems of shale, siltstone, and sandstone, and apparently represent a third environment of deposition in the lower part of the Hess member. The limestone beds are clayey biomicrite similar to those having *S. crassitectoria* in the lowest part of the sequence. Fusulinids are rare in most of these higher limestone beds and the environment must have been unfavorable to them.

In the Hess fossil bed and in the overlying 200 feet of strata, the lithology and faunas change abruptly from those in the beds below. This upper part of the Hess member is characterized by *Parafusulina spissisepta* n. sp. which is abundant in the biosparite. These limestone beds are greatly recrystallized and they are suggestive of a fossil hash which was later well cemented by sparry calcite.

Smaller Foraminifera, and fragments of bryozoans and brachiopods form the major part of the rock and all are rounded and surrounded by algal rims suggesting strong current action and shallow water during their deposition.

The highest fusulinid zone extends for about 400 feet above the *Parafusulina spissisepta* zone. Here *P. brooksensis* n. sp. and *P. vidriensis* n. sp. occur scattered throughout several beds. The limestone beds containing these two species are biosparites and fossiliferous oosparites and were probably originally deposited as sand size calcite fragments in shallow water. *Schubertella* and *Staffella* are common and algal fragments and smaller Foraminifera are abundant in these limestones. The range of the two species of *Parafusulina* is considerably higher in section 2 and seems to be above the lithologic base of the siliceous shale facies in section 3 (text fig. 2).

CORRELATIONS

The fusulinid faunas from the Hess member of the eastern Glass Mountains are a very different faunal association from any described fusulinid faunas from western North America. Leonardian fusulinids are probably the least well known of the Permian fusulinid faunas not only in the standard section but also in the rest of the western hemisphere. The species of *Schwagerina* and the primitive species of *Parafusulina* described by Dunbar and Skinner (1937) from the Bone Spring limestone in the Sierra Diablo, west Texas, are closely similar in stage of evolution but they are not the same species as these from the eastern Glass Mountains. The limestone beds in the Bone Spring limestone and in the Hess member are lithologically different and as the species in the Hess member seem to show considerable environmental preference, the Bone Spring fusulinids probably represent another facies fauna of approximately equivalent age.

From the Arcturus formation of eastern Nevada, Knight (1956) described several species which in general features are similar to those in the Hess member in the eastern Glass Mountains. The species described by Knight (1956) are of about the same evolutionary stage, that is, they are primitive species of *Parafusulina* having low cuniculi and subpointed poles and their association with *Schwagerina* suggests a middle Leonard age.

Several papers have described primitive species of *Parafusulina* from Mexico. Of these papers, Dunbar (1939a) described *Parafusulina skinneri* Dunbar from the Paleozoic beds near El Tigre, Sonora, and this species shows similarities with *P. allisonensis* n. sp. in general stage of evolution. *Parafusulina guatemalaensis* Dunbar (1939b) from the "Karbonkalk" of Guatemala is similar to *P. brooksensis* n. sp. in many features and the two species appear to be of closely similar age.

The fusulinids described by Thompson and Miller (1944) from Chiapas, Mexico, have several closely related, if not identical, species to those in the Hess member of the eastern Glass Mountains. In the Paseo Hondo formation, the primitive *Parafusulina australis* Thompson and Miller is closely similar to *Schwagerina crassitectoria* Dunbar and Skinner and *Schwagerina* sp. A Thompson and Miller is perhaps the same as *Parafusulina allisonensis* n. sp. In the eastern Glass Mountains, the double ledge (of King, 1931) and equivalent strata to the east (collections 3-(11), 2-6, 1-55) contain a large nearly spherical staffelloid that dominates the fauna. This species is about 3 mm. in diameter and compares closely with a species described by Thompson and Miller (1944, p. 492) as *Eoverbeekina americana* Thompson and Miller from massive limestone beds in the Paseo Hondo formation. If this is a species of *Eoverbeekina,* its occurrence in the double ledge in the Glass Mountains places the genus *Eoverbeekina* low in the Leonard Series and represents the lowest known occurrence of the typical Asian fusulinid faunas in the standard section. *Yabeina texana* Skinner and Wilde (1955), *Codonofusiella* (Dunbar and Skinner, 1937), and *Rauserella* (Dunbar, 1944) are reported from high in the Guadalupe Series and represent another occurrence of the Asian fusulinid faunas in the North America standard section.

The faunal similarity of the Paseo Hondo fusulinid fauna and the Hess member fauna supports the correlation that the Paseo Hondo formation is of Leonard age as suggested by Thompson and Miller (1944, p. 486). In addition, *Paraschwagerina roveloi* Thompson and Miller and *Schwagerina* sp. B Thompson and Miller from the underlying La Vainilla limestone are closely similar to *Paraschwagerina plena* Ross and *Schwagerina nelsoni* Dunbar and Skinner from the Lenox Hills formation which underlies the Hess member in the eastern Glass Mountains.

Outside of the Western Hemisphere, species of *Parafusulina* very similar in size and evolutionary development to the primitive species of *Parafusulina* in the Hess member are locally well known and appear to mark a faunal zone of approximately the same age throughout most of the early Artinskian strata of the Eastern Hemisphere. These primitive species of the

Eastern Hemisphere *Parafusulina* fauna are more closely allied morphologically to the species of *Parafusulina* in the Leonard Series, and particularly those in the Hess member, than they are to the more advanced species of *Parafusulina* in the overlying Word formation of the Guadalupe Series.

In Japan, China, Indochina, Indonesia, and the southern Urals of Russia, a number of closely similar primitive species of *Parafusulina* have been described. Many of these are similar to *P. allisonensis* n. sp., *P. deltoides* n. sp., *P. brooksensis* n. sp., and *P. vidriensis* n. sp. from the Hess member. Thus the subzone of *Parafusulina kaerimizensis* (Ozawa) of Toriyama (1958) in southwestern Honshu, Japan, the Chihsia limestone near Nanking, China, described by Chen (1934), various local formations in northern China reported by Lee (1927), and the gray limestone reported by Deprat (1913) in Cammon, Indochina, are all approximately this same age. Verbeek and Fennema (1896) report what is probably a primitive *Parafusulina, Fusulina granum avenae* Roemer, from the high plateau of Padang, Sumatra, and Reichel (1940) described a number of primitive species of *Parafusulina* from the Artinskian of Karakorum. From the Ural region of Russia, Rauser-Chernoussova (1935) reports a number of primitive species of *Parafusulina* such as *P. lutugini* (Schellwien) and *P. tschussovensis* Rauser-Chernoussova from the lower part of the Artinskian Series. Also the aberrant *Pseudoschwagerina tumida* Licharew from the lower part of the Artinskian Series (Licharew, *et al.*, 1939) is closely similar to *P. stanislavi* Dunbar from the lower part of the Bone Spring limestone, of Leonard age, in the Sierra Diablo of western Texas (Dunbar, 1953).

In Asia, these faunas of primitive species of *Parafusulina* are associated with early representatives of *Verbeekina, Neoschwagerina,* and *Pseudodoliolina*. If these primitive species of *Parafusulina* form a reliable zone for correlation, the occurrence of these neoschwagerinid faunas in this zone suggests that *Verbeekina, Neoschwagerina,* and *Pseudodoliolina* have stratigraphic ranges reaching well down into strata equivalent to the Leonard Series. The occurrence of a species possibly belonging to *Eoverbeekina* in the lower part of the Leonard Series both in the Glass Mountains and in southern Mexico tends to support such a correlation.

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Repository.—The type specimens are housed in Peabody Museum, Yale University, and bear numbers prefixed with YPM which refer to the catalog numbers of that institution.

SYSTEMATIC PALEONTOLOGY

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

Schwagerina crassitectoria Dunbar and Skinner

Plate 17, figures 1-9

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. [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.—This species commonly reaches a length of 9.0 mm. and a diameter of 3.5 mm. in 7 volutions. The thin walls of the early whorls, high and regular septal folds having secondary deposits, and thick fusiform shape are distinctive of this species (Pl. 17, figs. 1, 4, 5, and 8).

In specimens examined, the proloculi are small, averaging 0.12 mm. outside diameter. The first 2 to 3 volutions are low and long, the next 1 or 2 volutions increase in height but they show only slight increase in length. The succeeding volutions gradually extend along the axis of coiling to reach form ratios of 2.5 to 2.7 in mature specimens. The poles are evenly rounded.

The keriothecal wall is thin in the proloculus, 0.007 to 0.01 mm. thick, and in the first 2 whorls thickens to only 0.02 mm. The wall in succeeding whorls gradually increases in thickness to 0.11 mm. in the last volution. Away from the mid plane the thickness of the wall decreases near the poles to about one-half its thickness at the mid plane.

The septa are fluted into high regular folds extending across the entire chamber. The folds are loosely spaced and have rounded crests in axial section (Pl. 17, figs. 1, 4, 5 and 8).

The tunnel angle ranges between 15 degrees and 40 degrees in early whorls and increases irregularly in succeeding volutions to reach 40 degrees to 50 degrees in the fifth or sixth volution. The path of the tunnel deviates as much as 10 degrees from the mid plane of the test. Chomata are rudimentary on the outside of the proloculus and are lacking in the volutions of the test. Secondary deposits commonly coat the septal folds along the axis of coiling but they do not completely fill the septal folds except in the first 2 or 3 volutions. False walls occur in a few of the later volutions (Pl. 17, figs. 1, 5) but are not common features in tests.

TABLE OF MEASUREMENTS
YPM SPECIMENS

	Volution	21181	21183	21184	21185	21186
Radius vector (mm.)	0	.06	.04	.06	.07	.11
	1	.12	.12	.17	.15	.16
	2	.23	.26	.28	.30	.31
	3	.48	.45	.46	.50	.55
	4	.71	.70	.65	.80	.84
	5	1.02	1.00	.90	1.15	1.20
	6	1.32	1.40	1.25	....	1.60
	7	1.75	1.70	....	....	....
Half length (mm.)	1	.25	.35	.30	.38	.37
	2	.64	.70	.62	.75	.70
	3	1.05	.92	1.05	1.15	1.12
	4	1.52	1.42	1.55	1.80	1.70
	5	2.25	2.00	2.15	2.42	2.70
	6	3.35	3.20	3.10	....	3.80
	7	4.70	4.20?	3.90	....	....
Form ratio	1	2.1	2.9	1.8	2.5	2.3
	2	2.8	2.7	2.2	2.5	2.3
	3	2.2	2.0	2.3	2.3	2.2
	4	2.1	2.0	2.4	2.2	2.0
	5	2.2	2.0	2.4	2.2	2.3
	6	2.5	2.3	2.5	....	2.4
	7	2.7	2.5?	....	....	....
Wall thickness (mm.)	0	.011	.007	.007	.01	.007
	1	.01	.02	.007	.01	.009
	2	.02	.01	.01	.02	.02
	3	.03	.02	.02	.02	.04
	4	.04	.04	.04	.04	.08
	5	.07	.07	.06	.07	.09
	6	.11	.09	.09	....	.10
	7	.11	.11	....	....	....
Tunnel angle (°)	1	40	25	30	25	15
	2	40	25	35	25	20
	3	35	30	40	30	25
	4	35	30	40	25	35
	5	45	35	40	....	40
	6	50	40	....	....	....

Remarks.—In collections from the lower part of the range of *Schwagerina crassitectoria,* this species and *S. guembeli* Dunbar and Skinner are closely similar and gradational forms between the two species are common (compare Pl. 17, fig. 1 and Pl. 18, fig. 5, from collection 2-3A). Near the top of its range, *S. crassitectoria* is smaller and thinner than *S. guembeli. S. crassitectoria* differs from *S. elkoensis* Thompson and Hansen in having axial deposits and fewer chambers per volution and differs from *S. diversiformis* Dunbar and Skinner in size, septal folding, and shape. *S. lineanoda* Ross is more cylindrical and smaller than *S. crassitectoria. S. guembeli* var. *pseudoregularis* falls within the range of variation found in hypodigms of *S. crassitectoria* and is considered a synonym of *S. crassitectoria.*

Occurrence.—*Schwagerina crassitectoria* is found in the following localities (see text fig. 2): 1-7, 1-10, 1-11, 1-13, 1-14; 2-3A, 2-3B, 2-3C, 2-5B; 3-(10)A; 4-12D, 4-13, 4-14. In the eastern part of the Glass Mountains this species has a stratigraphic range of about 130 feet.

Schwagerina guembeli Dunbar and Skinner

Plate 17, figures 10-13; plate 18, figures 1-6

Schwagerina guembeli Dunbar and Skinner, 1937, Texas Univ. Bull. 3701, p. 639, pl. 61, figs. 1-13. [Not *S. guembeli* Knight, 1956, Jour. Paleontology, v. 30, p. 778, pl. 83, figs. 7-10.]

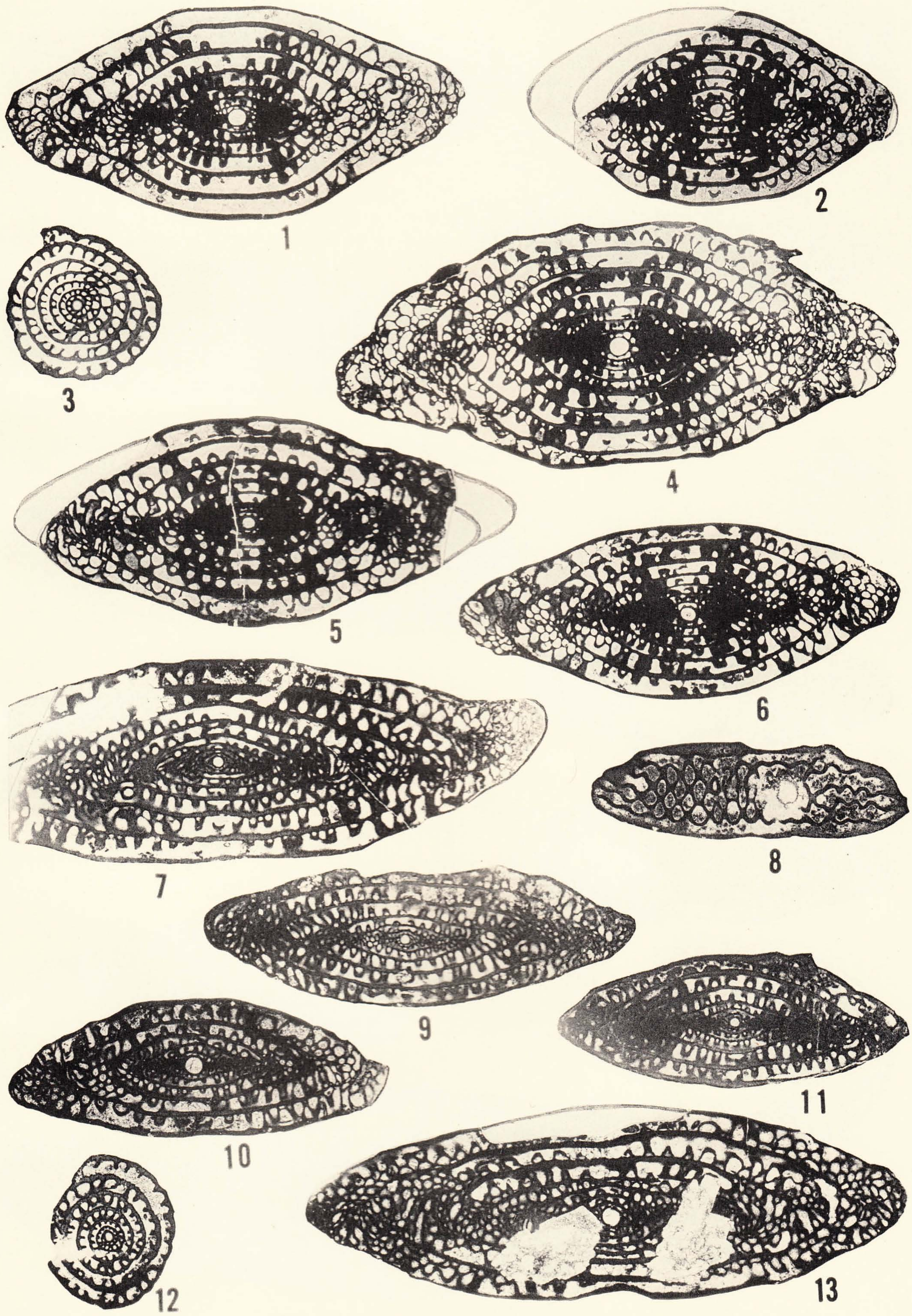
Description.—This large thick fusiform species commonly attains a length of 10.0 mm. and a diameter of 4.0 mm. in 8 volutions. The heavy secondary thickenings on either side of the narrow tunnel and the high chambers throughout the test are distinctive features of the species.

The proloculi are large and spherical and, in specimens examined, range between 0.24 and 0.32 mm. outside diameter. As shown in Plate 17, figures 11, 12, the initial volution is high and succeeding volutions continue to increase in height. The chambers in each succeeding whorl widen along the axis of coiling and commonly reach form ratios of 2.5 in the sixth or seventh volution. The shape of the test, consistent in specimens examined, flattens slightly across the mid plane and has long tapering shoulders which meet at the bluntly rounded poles.

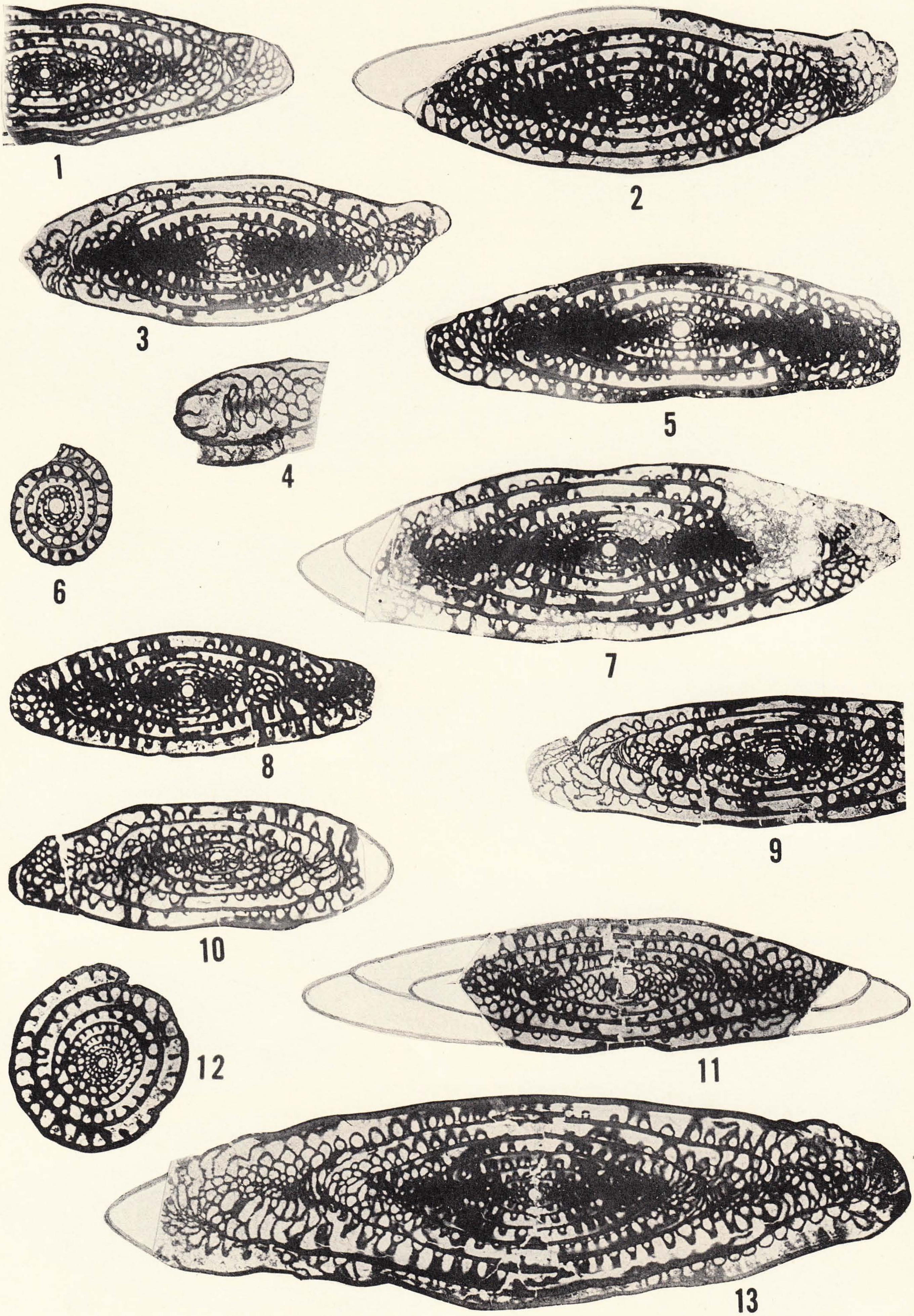
The keriothecal wall increases in thickness from a minimum of 0.007 mm. in the proloculus to 0.10 to 0.11 mm. in the sixth or seventh volution. The wall

EXPLANATION OF PLATE 18
All figures × 10

Figs.		Page
1-6.	*Schwagerina guembeli* Dunbar and Skinner, lower part of the Hess member	124
	1. Axial section, collection 4-13A, YPM 21209. 2. Axial section, collection 2-5C, YPM 21211. 3. Sagittal section, collection 3-(10)A, YPM 21213. 4. Axial section, collection 3-(9)B, YPM 21214. 5. Axial section, collection 2-3A, YPM 21182. 6. Axial section, collection 3-(9)B, YPM 21207.	
7-13.	*Parafusulina spissisepta* n. sp., upper part of the Hess member	127
	7. Axial section of holotype, collection 3-(17)A, YPM 21192. 8. Tangential section showing cuniculi near tunnel, collection 3-(16)B, YPM 21198. 9. Axial section, collection 4-28MA, YPM 21194. 10. Axial section, collection 3-(17)B, YPM 21193. 11. Axial section, collection 3-(16)B, YPM 21196. 12. Sagittal section, collection 3-(16)A, YPM 21197. 13. Axial section, collection 3-(17)A, YPM 21195.	



Ross: Permian fusulinids from Texas



Ross: Permian fusulinids from Texas

remains of constant thickness from the mid plane to the polar extremities. (Pl. 17, fig. 12).

The septa are strongly and regularly folded throughout the shell. As seen in axial sections the symmetrical folds are commonly slightly flattened at their crests. The basal margins of the folds may touch those of adjacent septa but resorption does not occur and cuniculi are lacking.

In most specimens the straight tunnel is narrow, the tunnel angle gradually increasing from 15 or 20 degrees in the first whorl to 30 or 35 degrees in the fifth or sixth whorl. The septa are resorbed for about one-third the chamber height to form the tunnel. Chomata are lacking in the volutions and only rudimentary chomata are common on the outer surface of the proloculus. Secondary deposits coat the septal folds and occur irregularly along the axis of coiling. Most of the secondary material is deposited on the septa adjacent to the tunnel. False walls may be present in chambers which lack secondary deposits on the septal folds (Pl. 18, figs. 1, 4).

Remarks.—*S. guembeli* is similar to *S. crassitectoria* Dunbar and Skinner, particularly in the lower part of their ranges. *S. guembeli* becomes progressively larger and thicker toward the top of its range where it can be distinguished easily from the higher forms of *S. crassitectoria*. *S. guembeli* is closely similar to *S. gruperaensis* Thompson and Miller from Chiapas, Mexico, but differs in being smaller per volution and smaller in mature size.

Occurrence.—*Schwagerina guembeli* is found in collections 1-7, 1-10, 1-14, 1-21; 2-3A, 2-3B, 2-5C, 2-6A; 3-(9)A, 3-(9)B, 3-(10)A, 3-(10)B; 4-12A, 4-13, 4-15A, and 4-16A (see text fig. 2). Sections 2 and 4 have this species through 210 feet of strata which is apparently its maximum stratigraphic range in the eastern Glass Mountains.

TABLE OF MEASUREMENTS
YPM SPECIMENS

	Volution	21207	21208	21209	21210	21211
Radius vector (mm.)	0	.15	.15	.13	.16	.12
	1	.20	.26	.26	.24	.24
	2	.35	.43	.41	.40	.42
	3	.48	.61	.63	.58	.65
	4	.65	.80	.95	.88	.90
	5	.90	1.08	1.30	1.23	1.15
	6	1.18	1.37	1.65	1.56	1.45
	7	1.45	1.68	....	....	....
	8	....	2.05	....	....	....
Half length (mm.)	1	.42	.30	.45	.40	.30
	2	.78	.70	.85	.80	.65
	3	1.05	1.15	1.22	1.25	.95
	4	1.45	1.55	1.55	1.65	1.40
	5	2.05	2.32	2.45	2.40	1.95
	6	2.80	3.20	3.50	3.35	2.55
	7	3.60	4.10	....	....	....
	8	....	5.20	....	....	....
Form ratio	1	2.1	1.2	1.7	1.7	1.2
	2	2.2	1.6	2.1	2.0	1.5
	3	2.2	1.9	1.9	2.2	1.5
	4	2.2	1.9	1.6	1.9	1.6
	5	2.3	2.2	1.9	1.9	1.7
	6	2.4	2.3	2.1	2.1	1.8
	7	2.5	2.4	....	....	....
	8	....	2.5	....	....	....
Wall thickness (mm.)	0	.01	.01	.007	.01	.01
	1	.01	.02	.01	.01	.05
	2	.02	.03	.02	.02	.06
	3	.02	.03	.04	.03	.05
	4	.04	.03	.08	.05	.07
	5	.08	.07	.09	.07	.08
	6	.10	.10	.11	.08	.09
	7	.10	.09	....	....	....
	8	....	.10	....	....	....
Tunnel angle (°)	1	25	20	25	15	15
	2	25	20	25	20	15
	3	25	20	30	25	20
	4	25	25	30	25	20
	5	25	30	30	25	25
	6	30	40	35	....	....
	7	....	40	....	....	....

EXPLANATION OF PLATE 19

All figures × 10

FIGS. PAGE

1-9. *Parafusulina allisonensis* n. sp., middle part of the Hess member 126
1. Axial section, collection 4-23B, YPM 21204. 2. Axial section of holotype, collection 1-84, YPM 21202. 3. Axial section, collection 2-9C, YPM 21201. 4. Tangential section showing low cuniculi near tunnel, collection 1-84, YPM 21243. 5. Axial section, collection 3-(14)A, YPM 21199. 6. Sagittal section, collection 4-23B, YPM 21205. 7. Axial section, collection 3-(13)A, YPM 21200. 8. Axial section, collection 1-84, YPM 21203. 9. Axial section, collection 1-84, YPM 21206.

10, 11. *Parafusulina* sp. A, middle part of the Hess member 131
10. Axial section, collection 2-11A, YPM 21215. 11. Axial section, collection 2-11A, YPM 21216.

12, 13. *Parafusulina deltoides* n. sp., middle part of the Hess member 126
12. Sagittal section, collection 2-10A, YPM 21217. 13. Axial section of holotype, collection 2-10A, YPM 21218.

Genus **Parafusulina** Dunbar and Skinner, 1931

Parafusulina allisonensis n. sp.

Plate 19, figures 1-9

Description.—This fusiform species commonly reaches 8.0 mm. in length and 2.6 mm. in diameter in seven volutions. The regularly folded septa, medium axial deposits, and low cuniculi are distinctive in this species.

In specimens examined, the proloculi range between 0.14 mm. and 0.28 mm. outside diameter and are spherical. The first one or two volutions are globose but the length gradually increases in successive whorls and the form ratio commonly reaches 3.0 by the sixth volution. The general shape of the shell is established by the second or third volution in which the shoulders are convex and the evenly rounded poles become increasingly pointed as each additional volution is added.

The wall is composed of a tectum and coarsely alveolar keriotheca and increases in thickness from 0.01 mm. in the proloculus to 0.10 mm. in the sixth or seventh volution. It is of constant thickness from the mid plane to the polar extremities where it thins abruptly. The septa are highly fluted in regular folds (Pl. 19, fig. 2) which increase in height away from the mid plane. The folds are symmetrical and gently rounded at their crests. Folds of adjacent septa meet at their base and resorption results in low cuniculi in the outer one or two volutions near the tunnel (Pl. 19, fig. 4).

The tunnel is of medium width, the tunnel angle commonly increasing from 20 degrees in early volutions to 35 to 40 degrees in the fifth or sixth whorl. The tunnel is irregular and it deviates slightly from the mid plane. (Pl. 19, figs. 5, 7). Rudimentary chomata ring the proloculus but are lacking in the volutions of the test. Secondary deposits commonly fill the axial portions of the tests and coat the septa in adjacent regions. In shells which have only minor axial deposits (Pl. 19, fig. 2) false walls are common but are only minor features.

Remarks.—*Parafusulina allisonensis* n. sp. develops low cuniculi in its outer one or two whorls and is most similar to *P. nancei* Thompson and Miller from Venezuela. It differs from *P. nancei* in having greater axial deposits toward the poles and less extended polar extremities. *P. skinneri* Dunbar is larger, has more irregularly and higher septal folds, and has a different distribution of secondary deposits than *P. allisonensis*. *P. guatemalaensis* Dunbar is larger and has irregular secondary deposits. *P. retusa* Knight and *P. apiculata* Knight have different shapes and ontogeny. *P. bakeri* Dunbar and Skinner is larger, lacks axial deposits, and has higher and more regularly folded septa.

The species takes its name from the type locality, the Allison Ranch.

Occurrence.—*Parafusulina allisonensis* is found in collections 1-84, 2-6B, 2-9A, 2-9C, 2-9D; 3-(11), 3-(12)A, 3-(12)X, 3-(13)A, 3-(14)A, 3-(14)B, 3-(14)C; 4-15C, 4-16B, 4-16C, 4-20A, 4-21A, 4-21B, and 4-23B (see text fig. 2). *P. allisonensis* has a stratigraphic range of over 350 feet in Section 4 and over 390 feet in Section 3, suggesting a maximum range of about 400 feet in the eastern Glass Mountains. The holotype, YPM 21202, is from collection 1-84, 840 feet above the base of the Hess member, Leonard formation.

TABLE OF MEASUREMENTS
YPM SPECIMENS

	Volution	21199	21200	21201	21202	21203	21204	21205	number of septa
Radius vector (mm.)	0	.12	.12	.14	.10	.10	.07	.11	
	1	.18	.20	.22	.22	.18	.13	.21	
	2	.31	.30	.38	.31	.28	.20	.30	
	3	.48	.41	.56	.50	.40	.28	.50	
	4	.69	.61	.78	.72	.55	.43	.75	
	5	.90	.84	.95	.95	.80	.60	....	
	6	1.10?	1.10	1.20	1.25	1.05	.85	....	
	7	....	1.32	....	....	....	1.05	....	
Half length (mm.)	1	.50	.25	.38	.40	.32	.22		9
	2	.87	.50	.75	.78	.65	.44		17
	3	1.24	.80	1.10	1.15	.95	.68		18
	4	1.90	1.60	1.85	1.55	1.55	1.10		22
	5	2.70	2.20	2.45	2.60	2.50	1.70		28?
	6	3.90	2.80	3.55	3.50	3.20	2.75		....
	7	....	4.00	....	....	....	3.50		....
Form ratio	1	2.8	1.2	1.7	1.8	1.8	1.7		
	2	2.8	1.7	2.0	2.3	2.3	2.2		
	3	2.6	2.0	2.0	2.3	2.4	2.4		
	4	2.8	2.6	2.4	2.2	2.7	2.6		
	5	3.0	2.6	2.6	2.7	3.1	2.8		
	6	3.5	2.5	2.8	2.8	3.0	3.2		
	7	....	3.0	....	....	....	3.3		
Wall thickness (mm.)	0	.02	.02	.01	.01	.01	.01		
	1	.01	.03	.01	.03	.02	.02		
	2	.03	.02	.04	.05	.03	.03		
	3	.05	.05	.06	.08	.04	.04		
	4	.08	.07	.07	.07	.04	.04		
	5	.07	.09	.04	.08	.09	.08		
	6	....	.10	.08	.09	.09	.10		
	7	....	.11	....	....	....	.09		
Tunnel Angle (°)	1	25	25	25	20	20	20		
	2	25	25	25	25	25	20		
	3	25	30	25	25	25	25		
	4	25	30	30	30	30	25		
	5	....	35	40	40	35	30		
	6	....	40	....	....	....	30		

Parafusulina deltoides n. sp.

Plate 19, figures 12, 13; plate 20, figures 1-5

Description.—This large, elongate species commonly reaches 11 mm. in length and 3.2 mm. in diameter. The extended polar regions and the conical shaped secondary deposits in the early whorls are distinctive.

In specimens measured, the proloculus ranges between 0.14 and 0.30 mm. outside diameter. The initial whorls are low and long in specimens having large proloculi but are notably higher in specimens having smaller proloculi (Pl. 20, figs. 3, 4). After reaching a diameter of 1.5 mm., the tests having small proloculi extend their polar regions and have similar form ratios in mature specimens as specimens having larger proloculi. The poles are rounded to slightly pointed.

The wall is composed of a tectum and a coarsely alveolar keriotheca. The thickness of the wall increases gradually from 0.01 mm. in the proloculus to 0.10 mm. in the sixth volution. The wall is thickest near the mid plane of the test and tapers gradually toward the poles.

The septa are fluted into high, closely spaced folds across the entire chamber. The folds have steep sides and the crests are commonly flattened giving a rectangular outline to folds in axial sections. Opposing folds of adjacent septa join at their basal margins where they are resorbed to form cuniculi in the third or fourth volution (Pl. 20, fig. 2).

TABLE OF MEASUREMENTS
YPM SPECIMENS

	Volution	21220	21218	21219	21221	21222	21217	
	0	.15	.06	.12	.07	.13	.07	
	1	.30	.22	.18	.20	.23	.15	
Radius	2	.48	.41	.28	.28	.40	.25	
vector	3	.87	.65	.44	.38	.65	.40	
(mm.)	4	1.05	.91	.65	.56	.88	.58	
	5	....	1.20	.90	.83	1.20	.80	
	6	....	1.50	1.25	1.00	....	1.10	
	7	....	....	1.60	....	....	1.40	
	1	.60	.55	.25	.25	.40	10	number of septa
	2	1.10	1.20	.55	.50	.85	20	
Half	3	2.70	1.90	.90	.82	1.50	25	
length	4	4.10	2.60	1.45	1.10	2.40	25	
(mm.)	5	....	3.40	2.25	1.80	3.30?	29	
	6	....	5.40	3.05	3.15	....	25	
	7	....	....	4.40	....	....	29	
	1	2.0	2.5	1.4	1.2	1.7		
	2	2.3	2.9	2.0	1.8	2.1		
Form	3	3.1	2.9	2.0	2.2	2.3		
ratio	4	3.9	2.9	2.2	2.0	2.7		
	5	....	2.8	2.5	2.2	2.8		
	6	....	3.6	2.4	3.2	....		
	7	....	....	2.7	....	....		
	0	.01	.01	.01	.01	.01		
	1	.03	.02	.02	.01	.02		
Wall	2	.04	.03	.03	.03	.03		
thickness	3	.08	.04	.04	.04	.04		
(mm.)	4	.09	.08	.06	.04	.08		
	5	....	.08	.07	.07	.11		
	6	....	.10	.09	.08	....		
	7	....	....	.09	....	....		
	1	30	20	20	20	20		
Tunnel	2	30	20	20	20	23		
angle	3	35	10	20	20	32		
(°)	4	....	25	30	25	45		
	5	....	35	35	40	....		
	6	....	....	40	....	....		

The tunnel is wide and slightly irregular, deviating 5 to 10 degrees out of the mid plane of the test (Pl. 20, figs. 1, 4). The tunnel angle increases from 20 degrees in the first two or three whorls to 40 degrees or more in later whorls. Rudimentary chomata girth the proloculus but are lacking in the whorls. Secondary deposits commonly fill the chambers in the early volutions, particularly in the axial region. The septal folds are coated by secondary deposits throughout the remainder of the test except in the polar extremities of the outer two volutions. False walls are common and may occur in chambers having thickened septa.

Remarks.—Parafusulina deltoides n. sp. is similar to *P. australis* Thompson and Miller in shape and distribution of axial deposits but differs in having a larger size and more regularly folded septa. *P. allisonensis* n. sp. has a different pattern of septal folds, is smaller per volution, and has secondary deposits along the length of the axis. *P. deltoides* differs from *P. primigenia* n. sp. in lacking tightly coiled early whorls and in having a different shape. *P. deltoides* is closely similar to *P. skinneri* Dunbar from Sonora, Mexico, but differs from that species in having more rounded lateral slopes and more pointed poles. *P. guatamalaensis* Dunbar is more elongate than *P. deltoides*.

The species takes its name from the Latin, *deltoides*, meaning delta shaped, and refers to the outline of the axial deposits as seen in thin section.

Occurrence.—Parafusulina deltoides is known from collections 2-9D, 2-10A, and 4-26M (see text fig. 2) and seems to be restricted to about 70 feet of strata in Section 2, but occurs about 200 feet higher in one collection in Section 4, indicating a total stratigraphic range of nearly 300 feet. The holotype, YPM 21218, is from collection 2-10A, 640 feet above the base of the Hess member, Leonard formation.

Parafusulina spissisepta n. sp.

Plate 18, figures 7-13

Description.—This species commonly attains a length of 10.00 mm. and a diameter of 3.2 mm. in 8 or 9 volutions. The tightly coiled initial whorls, high flattened septal folds, and thick, coarsely alveolar wall are distinctive features.

In specimens examined, the proloculi are spherical and range in size between 0.12 and 0.30 mm. outside diameter. The first two or three volutions are low and commonly have form ratios of about 2.2. Successive volutions increase in height and become progressively longer. The shell attains form ratios of 3.0 by the fifth or sixth volution. The gently convex flanks of the test meet to form bluntly pointed poles. The general shape of the test is established in the first or second volutions (Pl. 18, fig. 7).

The wall is composed of a thin tectum and a coarsely alveolar keriotheca. The wall of the proloculus is thick, commonly 0.02 mm., and in successive volutions it commonly increases rapidly to 0.08 mm. by the third or fourth volution. Toward the poles the wall thins to about one-half its maximum thickness.

The septa are regularly fluted into high even folds extending across the entire chamber. In axial sections the crests of the folds are flattened and the sides are steep, giving the folds a rectangular outline. In the early chambers the folds are closely spaced but they become more widely spaced in later volutions. Septal folds touch folds of adjacent septa in the outer two or three volutions but they overlap only in the polar extremities.

The tunnel is straight and narrow, the tunnel angle of most specimens increasing from 10 to 20 degrees in early whorls to 30 to 35 degrees in the fifth or sixth volution. Secondary deposits are common as thick coatings on septa (Pl. 18, fig. 7) but they do not completely fill the folds. Low cuniculi are common in the outer 2 or 3 whorls (Pl. 18, figs. 7, 11). False walls are rare or lacking.

Remarks.—*Parafusulina spissisepta* n. sp. develops low, primitive cuniculi in its outer two or three whorls and is not particularly similar to any other described primitive *Parafusulina*. *P. sonoranensis* Dunbar and *P. imlayi* Dunbar lack the compact early whorls, the thick secondary deposits on septal folds, and the distinctive shape of *P. spissisepta*. *P. splendens* Dunbar and Skinner has a different shape, ontogeny, and distribution of axial deposits. *P. bakeri* Dunbar and Skinner has less tightly coiled early whorls and a different shape and septal folding.

P. nancei Thompson and Miller has a more elongate shape and different distribution of axial deposits than *P. spissisepta*. *P. spissisepta* has the general shape of *Schwagerina aculeata* Thompson and Hazzard but differs in having cuniculi and more regularly folded septa than *S. aculeata*.

The species takes its name from the Latin, *spissisepta*, meaning having numerous septa, and refers to the closely spaced septa in this species.

Occurrence.—*Parafusulina spissisepta* is known from collections 2-13A, 2-15A, 2-15B; 3-(16)B, 3-(17)A, 3-(17)B, 3-(18)A, 3-(18)B; 4-28A, 4-28B, 4-27M, 4-28MA, 4-28MB, and 4-28MC (see text fig. 2). This species is characteristic of a zone about 250 feet thick in and above the Hess fossil bed in the eastern Glass Mountains. The holotype, YPM 21192, is from collection 3-(17)A, 1090 feet above the base of the Hess member, Leonard formation.

TABLE OF MEASUREMENTS
YPM SPECIMENS

	Volution	21192	21193	21194	21195	21196	21197
Radius vector (mm.)	0	.08	.14	.07	.15	.06	.08
	1	.13	.23	.12	.30	.18	.15
	2	.20	.38	.21	.45	.30	.20
	3	.28	.55	.40	.58	.50	.48
	4	.42	.78	.65	.72	.75	.70
	5	.65	1.10	.90	.98	1.00	.95
	6	.91	1.40?	1.25?	1.30	....	1.20±
	7	1.25	....	....	....	....	....
	8	1.60	....	....	....	....	....
Half length (mm.)	1	.28	.50	.28	.50	.28	10 (number of septa)
	2	.49	1.05	.70	.90	.55	15
	3	.75	1.55	1.10	1.45	1.00	18
	4	1.15	2.30	2.00	2.05	1.65	25
	5	2.00	3.20	2.75	3.25	2.25	24
	6	2.75	....	3.80	4.40	....	29
	7	3.85	....	....	....	....	....
	8	5.00	....	....	....	....	...
Form ratio	1	2.2	2.2	2.3	1.7	1.6	
	2	2.4	2.8	3.3	2.0	1.8	
	3	2.7	2.8	2.7	2.5	2.0	
	4	2.7	3.0	3.1	2.8	2.2	
	5	3.1	2.9	3.1	3.2	2.3	
	6	3.1	....	3.0	3.4	....	
	7	3.1	....	....	....	....	
	8	3.1	....	....	....	....	
Wall tickness (mm.)	0	.01	.02	.02	.03	.01	
	1	.02	.03	.02	.04	.02	
	2	.03	.04	.03	.05	.03	
	3	.03	.08	.04	.08	.05	
	4	.04	.09	.06	.10	.08	
	5	.06	.09	.06	.10	.09	
	6	.08	....	.08	.11	....	
	7	.12	....	....	....	....	
	8	.09	....	....	....	....	
Tunnel angle (°)	1	25	20	10	30	15	
	2	25	20	15	30	15	
	3	25	20	10	30	20	
	4	25	25	15	35	15	
	5	30	....	....	35	....	
	6	35	....	....	....	....	

EXPLANATION OF PLATE 20
All figures × 10

FIGS. PAGE

1-5. *Parafusulina deltoides* n. sp., middle part of the Hess member 126

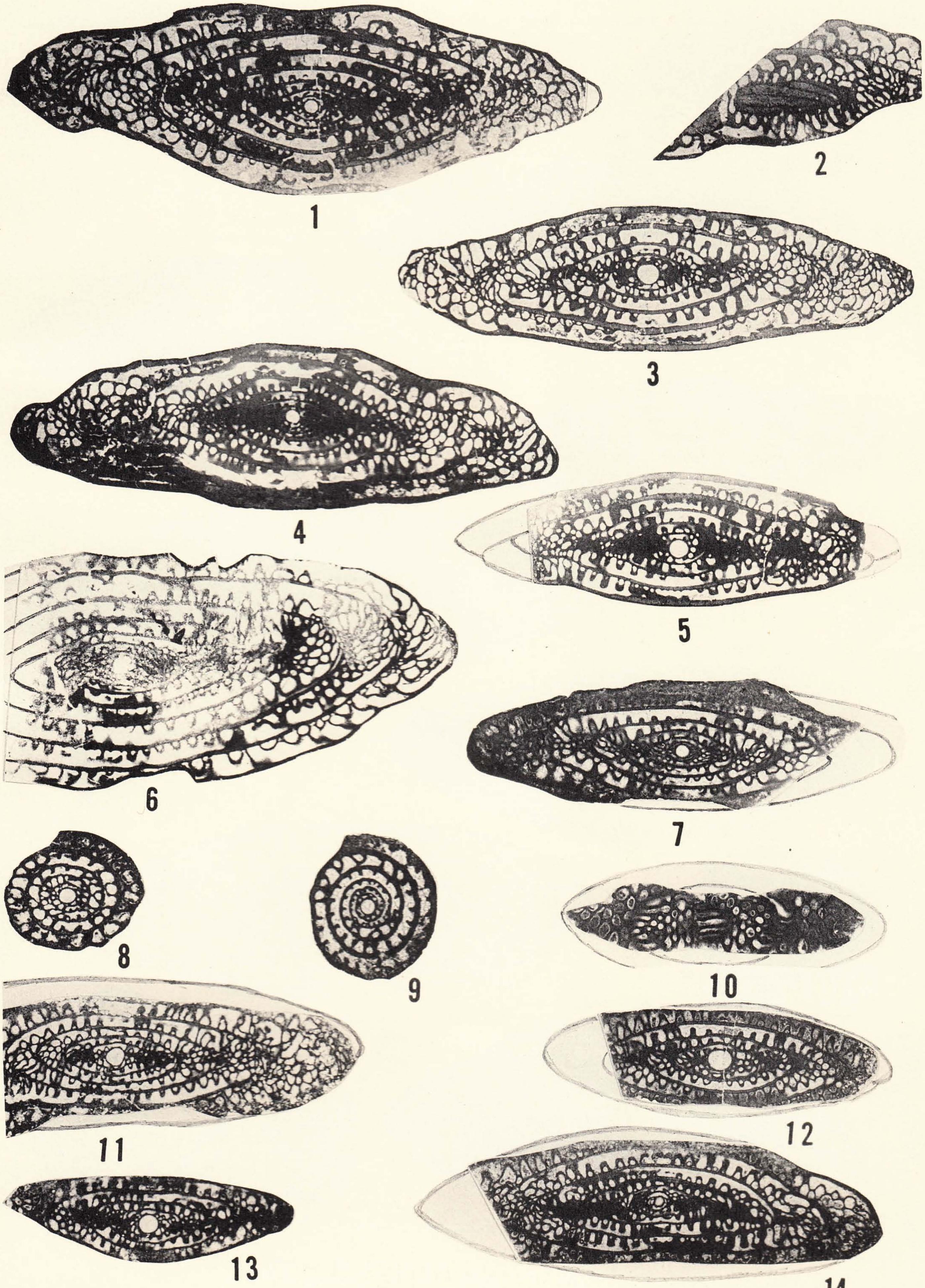
1. Axial section of specimen having a large proloculus, collection 2-10A, YPM 21219. 2. Tangential section showing cuniculi, collection 2-10A, YPM 21232. 3, Axial section, collection 2-10A, YPM 21220. 4. Axial section, collection 2-10A, YPM 21221. 5. Axial section, collection 2-10A, YPM 21222.

6. *Parafusulina* sp. A, middle part of the Hess member 131

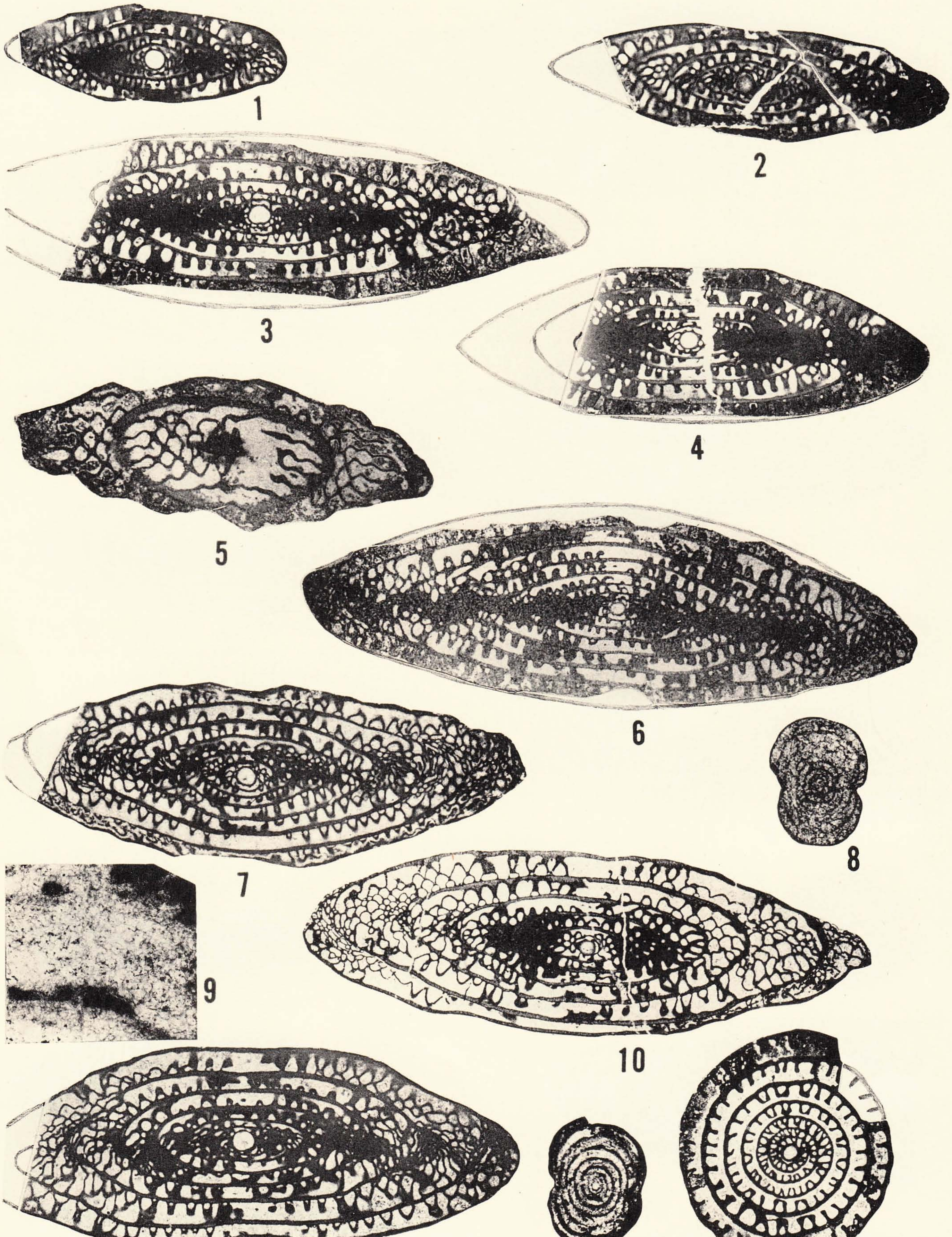
6. Axial section, collection 2-11A, YPM 21223.

7-14. *Parafusulina brooksensis* n. sp., upper part of the Hess member 129

7. Axial section, collection 2-16B, YPM 21224. 8. Sagittal section, collection 2-16B, YPM 21225. 9. Sagittal section, collection 2-16B, YPM 21226. 10. Tangential section showing low cuniculi, collection 3-(19)A, YPM 21231. 11. Axial section, collection 2-16B, YPM 21227. 12. Axial section, collection 3-(19)A, YPM 21228. 13. Axial section, collection 2-16B, YPM 21229. 14. Axial section, collection 2-16B, YPM 21230.



Ross: Permian fusulinids from Texas



Ross: Permian fusulinids from Texas

Parafusulina brooksensis n. sp

Plate 20, figures 7-14; plate 21, figures 1-4, 6

Description.—This small elongate species commonly reaches 8 mm. in length and 2.2 mm. in diameter in five or six volutions. The bluntly pointed poles, tapering lateral slopes and the axial and septal deposits are distinctive.

In specimens examined, the proloculi range between 0.18 and 0.36 mm. outside diameter and are generally spherical. The initial volution is low and long, generally having a form ratio between 2.2 and 2.6. Succeeding volutions increase proportionately more in length than height and mature tests of five or more volutions have form ratios of 3.5 (Pl. 21, figs. 3, 6). The height of the chambers increases between the second and third volution giving the test a "zoned" appearance.

The wall is composed of a tectum and a thin but coarsely alveolar keriotheca. The wall thickens gradually from 0.01 mm. in the proloculus to 0.07 mm. in the fifth or sixth whorl.

The septa are strongly fluted into high, regular folds across the entire chamber. The folds have steep sides and nearly flat crests and appear rectangular in axial sections (Pl. 21, figs. 3, 4, 6). Septal folds commonly touch folds of adjacent septa near their basal margin but do not overlap except in the polar extremities.

The tunnel is narrow and its path deviates 5 to 10 degrees out of the mid plane in the early whorls (Pl. 21, figs. 3, 6). The tunnel angle ranges between 20 and 35 degrees and shows only a general trend toward increasing in later volutions. The proloculus commonly has rudimentary chomata, but chomata are lacking in the coiled portion of the test. Cuniculi, found in the outer one or two whorls, are low (Pl. 20, fig. 10). Secondary deposits are common features in most mature tests and coat the septal folds and fill the axis. False walls are lacking.

TABLE OF MEASUREMENTS
YPM SPECIMENS

	Volution	21236	21224	21228	21237	21235	21226	number of septa
Radius vector (mm.)	0	.12	.10	.18	.09	.12	.10	
	1	.22	.18	.25	.18	.25	.20	
	2	.35	.25	.40	.29	.33	.35	
	3	.51	.38	.60	.46	.55	.55	
	4	.80	.55	.75	.65	.85	.80	
	5	1.10	.75	....	.90	1.15	1.10	
	6	....	1.00	....	1.20	....	....	
	7	....	....	....	1.40	....	....	
Half length (mm.)	1	.52	.25	.65	.40	.55		10
	2	1.00	.50	1.20	.85	.90		20
	3	1.65	.85	1.90	1.50	1.50		18
	4	2.35	1.30	2.60	2.30	2.60		17
	5	3.20	2.15	....	3.10	4.00		24
	6	....	3.35	....	4.00	....		....
	7	....	....	....	5.00?	....		....
Form ratio	1	2.4	1.4	2.6	2.2	2.2		
	2	2.8	2.0	3.0	2.9	2.7		
	3	3.2	2.2	3.2	3.3	2.7		
	4	2.9	2.4	3.5	3.5	3.1		
	5	2.9	2.9	....	3.5	3.5		
	6	....	3.4	....	3.3	....		
	7	....	....	....	3.6?	....		
Wall thickness (mm.)	0	.01	.01	.02	.01	.02		
	1	.02	.01	.03	.01	.02		
	2	.03	.02	.04	.02	.03		
	3	.04	.03	.05	.04	.04		
	4	.06	.04	?	.04	.05		
	5	.07	.05	....	.07	.07		
	6	....	?	....	.08	....		
	7	....	....	....	....	....		
Tunnel angle (°)	1	25	20	30	30	20		
	2	25	25	40	20	25		
	3	20	30	30	20	35		
	4	20	35	....	25	30		
	5	....	30	....	30	....		
	6	....	....	....	....	....		

EXPLANATION OF PLATE 21

All figures × 10 (except figure 9)

FIGS. PAGE

1-4, 6. *Parafusulina brooksensis* n. sp., upper part of the Hess member 129

1. Axial section, collection 3-(19)A, YPM 21233. 2. Axial section, collection 3-(19)A, YPM 21234. 3. Axial section, collection 2-16B, YPM 21235. 4. Axial section, collection 2-16A, YPM 21236. 6. Axial section of holotype, collection 2-16B, YPM 21237.

5, 7, 10, 11, 13. *Parafusulina vidriensis* n. sp., upper part of the Hess member 130

5. Tangential section, collection 2-16B, YPM 21238. 7, Axial section, collection 2-16B, YPM 21239. 10. Axial section, collection 2-16A, YPM 21240. 11. Axial section of holotype, collection 2-16A, YPM 21241. 13. Sagittal section, collection 2-16A, YPM 21242.

8, 9, 12. *Eoverbeekina*? aff. *E. americana* Thompson and Miller, Double ledge of the lower part of the Hess member 131

8. Axial section, collection 1-55, YPM 21245. 9. Enlarged view of basal foramina of figure 12, collection 1-55, YPM 21244, × 100. 12. Axial section, collection 1-55, YPM 21244.

Remarks.—Few species of primitive *Parafusulina* have been described and it is difficult to compare *P. brooksensis* n. sp. with other species. *P. gracilis* (Meek) and *P. linearis* (Dunbar and Skinner) are both much more elongate and differ considerably in ontogeny from *P. brooksensis* and probably belong to different phylogenetic lineages. *P. australis* Thompson and Miller is thicker and has a different pattern of septal folds. *P. vidriensis* n. sp. is thicker, less tightly coiled, and has a different ontogeny and distribution of secondary deposits from *P. brooksensis*. *P. deltoides* has a different shape and ontogeny. *P. brooksensis* is closely similar to *P. guatemalaensis* Dunbar from Central America but differs from that species in having more pointed poles and a less elongate shape. It differs from *P. skinneri* Dunbar from Sonora, Mexico, which is larger and has less regularly folded septa.

Occurrence.—*Parafusulina brooksensis* is found in collections 2-16A, 2-16B, and 3-(19) (see text fig. 2). This species and *P. vidriensis* n. sp. form the highest fusulinid zone in the Hess member of the eastern Glass Mountains and have a stratigraphic range of at least 200 feet. The holotype, YPM 21237, is from collection 2-16B, 1450 feet above the base of the Hess member, Leonard formation.

Parafusulina vidriensis n. sp.

Plate 21, figures 5, 7, 10, 11, 13

Description.—This species reaches 9 mm. in length and 3 mm. in diameter in six volutions. The septal folds commonly overlap folds of adjacent septa across the mid region of the test, the volutions are loosely coiled, and secondary deposits are common in the early whorls.

In specimens examined, the proloculi range between 0.2 and 0.3 mm. outside diameter and are subspherical. The early volutions are long and form ratios of 3.0 are common in many specimens. Succeeding volutions are loosely coiled and form ratios change only slightly (YPM specimens 21240 and 21241). The poles are broadly rounded and the test thickly fusiform throughout.

The wall is composed of a tectum and a thin, coarsely alveolar keriotheca. The thickness of the wall increases from less than 0.01 mm. in the proloculus to 0.08 mm. in the fourth and later volutions. Between the third and fourth volutions the wall commonly doubles its thickness.

The septa are closely fluted into high folds which have broadly rounded crests in axial sections. Folds of adjacent septa commonly overlap one another across the length of the test (Pl. 21, fig. 10). The septa are thin and closely spaced in the first three volutions but become considerably thicker and more widely spaced in later volutions, changing with the increase in wall thickness. Cuniculi are common in the outer two volutions and occur down the lateral slopes of the test (Pl. 21, fig. 5).

The tunnel is of medium width and follows a straight path in the mid plane of the test. The tunnel angle increases from 25 degrees in the first volution to 35 degrees in the fifth volution in the holotype, YPM specimen 21241. Rudimentary chomata ring the proloculus but are lacking in the coiled part of the test. Secondary deposits line the septal folds particularly along the lateral slopes near the tunnel and commonly fill the folds in the axial portions of the first two or three volutions (Pl. 21, figs. 10, 11). False walls are lacking.

TABLE OF MEASUREMENTS
YPM SPECIMENS

	Volution	21239	21240	21241	21242	
Radius vector (mm.)	0	.12	.10	.15	.11	
	1	.20	.20	.20	.25	
	2	.31	.35	.30	.43	
	3	.47	.55	.50	.62	
	4	.65	.80	.75	.90	
	5	.90	1.15	1.00	1.25	
	6	1.15	1.40	1.40	1.60	
Half length (mm.)	1	.25	.65	.60	8	number of septa
	2	.70	1.10	1.00	25	
	3	1.10	1.90	1.50	35	
	4	1.75	2.60	2.00	33	
	5	2.60	3.90	2.80	33	
	6	3.35	4.50	3.80	35	
Form ratio	1	1.2	3.3	3.0		
	2	2.3	3.1	3.3		
	3	2.3	3.4	3.0		
	4	2.7	3.3	2.7		
	5	2.9	3.4	2.8		
	6	2.9	3.2	2.7		
Wall thickness (mm.)	0	.01	.02	.01		
	1	.02	.01	.02		
	2	.03	.02	.02		
	3	.04	.03	.04		
	4	.05	.07	.05		
	5	.08	.08	.07		
	6	.08	.06	.09		
Tunnel angle (°)	1	35	30	25		
	2	30	25	25		
	3	30	25	25		
	4	35	30	20		
	5	40	....	35		
	6	....	....	....		

Remarks.—*Parafusulina vidriensis* n. sp. differs from *P. deltoides* n. sp. in shape and ontogeny and from *P. brooksensis* n. sp. in size, ontogeny, and distribution of axial deposits. *P. spissisepta* n. sp. has more tightly coiled early whorls and *P. allisonensis* n. sp. is more elongate than *P. vidriensis*. *P. australis* Thompson and Miller is smaller per volution and has a different growth pattern in mature whorls. *P. apiculata* Knight and *P. shaksgamensis* var. *crassimarginata* Knight are similar but differ in shape particularly in the mature whorls. *P. vidriensis* is less elongate than *P. skinneri* Dunbar from Sonora, Mexico, and *P. guatemalaensis* Dunbar from Guatemala.

This species takes its name from the Sierra Vidrio, the Spanish name for the Glass Mountains.

Occurrence.—Parafusulina vidriensis is known from collections 2-16A, 2-16B, and 4-29M (see text fig. 2). This species and *P. brooksensis* n. sp. form the highest fusulinid zone in the Hess member in the eastern Glass Mountains. The holotype, YPM 21241, is from collection 2-16A, 1350 feet above the base of the Hess member, Leonard formation.

Parafusulina sp. A

Plate 19, figures 10, 11; plate 20, figure 6

Description.—This large fusiform species commonly attains a length of 9.5 mm. and a diameter of 3.0 mm. in six volutions. The high and closely spaced septal folds, the open coiled pattern, and lack of secondary deposits are distinctive.

This species is known from one small collection (2-11A) and the large individuals are partially dolomitized. In specimens examined, the proloculus is 0.15 to 0.30 mm. outside diameter. The early whorls are low and long and form ratios of 2.5 are common. Chamber height increases markedly after the second or third volution and also the length of the test increases giving mature tests of six volutions form ratios of 3.0. Tests are fusiform and the general outline is attained within the first 2 or 3 volutions (Pl. 19, figs. 10, 11).

The wall is composed of a tectum and a keriotheca. It is 0.007 mm. thick in the proloculus and gradually increases to 0.08 mm. in the fifth or sixth volution.

The septa are strongly fluted into high regular folds which extend across the entire chamber. Opposing folds of adjacent septa are resorbed where they meet near the base of the chambers to form cuniculi in the fourth and later volutions.

The tunnel is narrow and irregular, deviating 5 to 10 degrees away from the mid plane of the test. Rudimentary chomata ring the proloculus but are lacking in the coiled portion of the test. Secondary deposits are lacking.

Remarks.—Parafusulina sp. A is similar to *P. allisonensis* n. sp. in general shape but is larger, has more open coiling and lacks secondary deposits. *P. spissisepta* n. sp. has more closely coiled early volutions and *P. deltoides* n. sp. has a different shape and distinctive secondary deposits in contrast to *Parafusulina* sp. A. *P. sapperi* (Staff) from Central America has greater development of cuniculi and axial deposits than *Parafusulina* sp. A.

Although known from only one collection and a few thin sections, this species is distinct from other species of *Parafusulina* found in the Hess member. As the species comes from a horizon from which few other fusulinid species are known, it may be an important guide species to the upper part of the middle Hess succession.

TABLE OF MEASUREMENTS
YPM SPECIMENS

	Volution	21215	21216	21223
Radius vector (mm.)	0	.08	.14	.12
	1	.18	.22	.22
	2	.26	.38	.38
	3	.44	.55	.52
	4	.61	.75	.70
	5	.86	1.00	1.05
	6	....	....	1.50
Half length (mm.)	1	.30	.40	.50
	2	.75	.85	.95
	3	1.10	1.40	1.50
	4	1.70	2.30	2.25
	5	2.55	3.40	3.35
	6	....	....	4.20
Form ratio	1	1.7	1.8	2.3
	2	2.9	2.2	2.5
	3	2.5	2.5	2.9
	4	2.8	3.1	3.2
	5	3.0	3.4	3.2
	6	....	....	2.8
Wall thickness (mm.)	0	.007	.007	....
	1	.007	.01	.03
	2	.02	.05	.05
	3	.02	.07	.07
	4	.03	.08	.09
	5	.04	.09	.10
	6	....	....	.10
Tunnel angle (°)	1	30	25	35
	2	30	25	40
	3	35	30	40
	4	40	40	45
	5	....	....	50

Occurrence.—Parafusulina sp. A is known from only one collection, 2-11A (see text fig. 2), 60 feet beneath the base of the upper Hess fossil bed on the Brooks Ranch. The lithologic change from a dense dolomitic limestone in bed 10 to shale and thin bedded limestones in bed 11 suggests that the distribution of *Parafusulina* sp. A may be closely controlled by facies.

Genus **Eoverbeekina** Lee, 1933

Eoverbeekina? aff. **E. americana** Thompson and Miller

Plate 21, figures 8, 9, 12

?*Eoverbeekina americana* THOMPSON and MILLER, 1944, Jour. Paleontology, v. 18, p. 492, pl. 80, figs. 3-6, pl. 83, figs. 3-7.

Description.—This small, subspherical species attains a length of 1.1 mm. and a diameter of 2.8 mm.

in seven to eight volutions. The poles are slightly indented.

The proloculus is large for species of this genus, about 0.06 mm. outside diameter. The early whorls are high and have broadly rounded peripheries and this shape is characteristic throughout the rest of the test. The form ratios decrease slightly in later volutions as the poles become more indented.

The preservation of the tests in specimens examined is poor and the wall structure is recrystallized to clear calcite. However, there are suggestions of a two layer wall with the addition of an outer tectorium in the inner whorls of several specimens.

In the first four volutions the tunnel is lined by low, asymmetrical chomata. In these early volutions the tunnel is wide and well defined. The later volutions clearly show the development of multiple foramina at the base of the septa (Pl. 21, fig. 9). Parachomata are possibly present but the features observed may be the result of thickening at the base of the septa which may not connect adjacent septa to form true parachomata. Thus these specimens are apparently intermediate in morphology between *Staffella* and *Eoverbeekina.*

TABLE OF MEASUREMENTS
YPM SPECIMENS

	Volution	21244	21245	21246
	0	.03	.02	.03
	1	.08	.08	.18
	2	.18	.16	.29
Radius	3	.29	.24	.43
vector	4	.41	?	.65
(mm.)	5	.58	?	.90
	6	.75	?	1.10
	7	.92	.95	1.40
	8	....	1.10	....
	1	.08	.05	....
	2	.15	.11	....
Half	3	.25	.20	....
length	4	.35	.25	....
(mm.)	5	.45	?	....
	6	.58	?	....
	7	.65	.45	....
	8	....	.55	....
	1	1.0	.6	....
	2	.8	.7	....
	3	.7	.8	....
Form	4	.8	?	....
ratio	5	.8	?	....
	6	.8	?	....
	7	.7	.5	....
	8	....	.5	....

Remarks.—These specimens from the Hess member are similar in size and general development of the test to *Eoverbeekina americana* Thompson and Miller from the Paseo Hondo formation in southern Mexico. The specimens from the Hess member differ from those described by Thompson and Miller in having slightly greater inflation of their chambers and more indented poles. In these specimens as in other species placed in *Eoverbeekina,* including the type species *E. intermedia* Lee, the parachomata are poorly developed or may be lacking.

Occurrence.—*Eoverbeekina*? aff. *E. americana* Thompson and Miller is known in collections from the double ledge and equivalent beds; 1-55, 2-7, 3-11, 4-15?, and 4-18.

REFERENCES CITED

BATTEN, R. L., 1958, Pleurotomariacea, Portlockiellidae, Phymatopleuridae, and Eotomariidae; Permian Gastropoda of the southwestern United States: Am. Mus. Nat. History, Bull., v. 114, art. 2, p. 159-246.

BÖSE, EMIL, 1919 (1917), The Permo-Carboniferous ammonoids of the Glass Mountains and their stratigraphic significance: Texas Univ. Bull. 1762, 241 p.

CHEN, S., 1934, Fusulinidae of south China. Pt. 1: Palaeontologia Sinica, ser. B, v. 4, fasc. 2, 185 p.

DEPRAT, J., 1913, Étude des Fusulinidés de Chine et d'Indochine et classification des calcaires à Fusulinidés (II Memoire). Les Fusulinidés des calcaires carboniferiens et permiens du Tonkin, du Laos et du Nord-Annam: Serv. géol. de l'Indochine, Mém., v. 2, fasc. 1, p. 1-74.

DUNBAR, C. O., 1939a, Permian fusulines from Sonora: Geol. Soc. America Bull., v. 50, p. 1745-1760.

———, 1939b, Permian fusulines from Central America: Jour. Paleontology, v. 13, p. 344-348.

———, 1944, *in* KING, R. E., *et al.,* Geology and paleontology of the Permian area northwest of Las Delicias, southwestern Coahuila, Mexico: Geol. Soc. America, Special Paper 52, Pt. 2, p. 35-48.

———, 1953, A zone of *Pseudoschwagerina* low in the Leonard Series in the Sierra Diablo, Trans-Pecos Texas: Am. Jour. Sci., v. 251, p. 798-813.

———, and SKINNER, J. W., 1937, The geology of Texas, v. 3, Pt. 2, Permian Fusulinidae of Texas: Texas Univ. Bull. 3701, p. 517-825.

FOLK, R. L., 1959, Practical petrographic classification of limestones: Am. Assoc. Petroleum Geologists Bull., v. 43, p. 1-38.

KELLETT, BETTY, 1943, Permian ostracodes: Jour. Paleontology, v. 17, p. 615-628.

KING, P. B., 1931, The geology of the Glass Mountains, Texas; Pt. 1: Texas Univ. Bull. 3038, 167 p.

———, 1932, Limestone reefs in the Leonard and Hess formation of Trans-Pecos Texas: Am. Jour. Sci., v. 24, 5th ser., p. 337-354.

———, 1934, Permian stratigraphy of Trans-Pecos Texas: Geol. Soc. America Bull., v. 45, p. 697-797.

———, 1937, Geology of the Marathon règion, Texas: U. S. Geol. Survey, Prof. Paper 187, 148 p.

———, 1942, Permian of west Texas and southwestern New Mexico: Am. Assoc. Petroleum Geologists Bull., v. 26, p. 533-763.

———, and KING, R. E., 1928, The Pennsylvanian and Permian stratigraphy of the Glass Mountains: Texas Univ. Bull. 2801, p. 109-146.

KING, R. E., 1931, The geology of the Glass Mountains, Pt. 2: Texas Univ. Bull. 3042, 245 p.

KNIGHT, R. L., 1956, Permian fusulines from Nevada: Jour. Paleontology, v. 30, p. 773-792.

LEE, J. S., 1927, Fusulinidae of south China: Palaeontologia Sinica, Geol. Survey China, ser. B, v. 4, fasc. 1, 123 p.

LICHAREW, BORIS, *et al.*, 1939, The Atlas of the leading forms of the fossil fauna U.S.S.R., Permian Fusulinidae: Central Geol. Prosp. Inst., v. 6, p. 32-47.

MILLER, A. K., and FURNISH, W. M., 1940, Permian ammonoids of the Guadalupe Mountain region and adjacent areas: Geol. Soc. America, Special Paper 26, 242 p.

RAUSER-CHERNOUSSOVA, D. M., 1935, On the Lower Permian age of the sediments with *Pseudofusulina lutugini* (Schellwien) on the western slope of the Urals: Soc. naturalistes Moscou, Bull., Sec. Géol., v. 13, p. 129-154.

REICHEL, MANFRED, 1940, Die Paläzoischen Faunen von 1935. 1. Unterpermische Fusuliniden aus dem Karakorum und dem Aghil-Gebirge: Wissensch. Ergeb. Niederl. Expeditionen Karakorum, Band 3, Paläontologie, tiel 2, p. 89-118.

ROSS, C. A., 1959, The Wolfcamp Series (Permian) and new species of fusulinids, Glass Mountains, Texas: Jour. Wash. Acad. Sci., v. 49, p. 299-316.

SKINNER, J. W. and WILDE, G. L., 1955, New fusulinids from the Permian of west Texas: Jour. Paleontology, v. 29, p. 796-803.

THOMPSON, M. L. and HANSEN, A. N., 1954, *in* Thompson, M. L., American Wolfcamp fusulinids: Kans. Univ. Paleont. Contr., Protozoa, art. 5, p. 27, 64.

———, and HAZZARD, J. C., 1946, *in* Thompson, M. L., Wheeler, H. E., and Hazzard, J. C., Permian fusulines of California: Geol. Soc. America Mem. 17, p. 37-53.

——— and MILLER, A. K., 1944, The Permian of southernmost Mexico and its fusulinid faunas: Jour. Paleontology, v. 18, p. 481-504.

——— and ———, 1949, Permian fusulinids and cephalopods from the vicinity of the Maracaibo Basin in northern South America: Jour. Paleontology, v. 23, p. 1-24.

TORIYAMA, RYUZO, 1958, Geology of Akiyoshi; Pt. 3, Fusulinids of Akiyoshi: Kyushu Univ. Mem., Faculty Sci., ser. D, Geology, v. 7, 264 p.

UDDEN, J. A., 1917, Notes of the geology of the Glass Mountains: Texas Univ. Bull. 1753, p. 3-59.

———, BAKER, C. L., and BÖSE, EMIL, 1916, Review of the geology of Texas: Texas Univ. Bull. 44, 164 p.

VERBEEK, R. D. M., and FENNEMA, R., 1896, Description géologique de Java et de Madoura, Amsterdam, v. 1, pl. 1, v. 2, p. 1134.

YOCHELSON, E. L., 1956, Euomphalacea, Trochonematacea, Pseudophoracea, Anomphalacea, Craspedostomatacea, and Platyceratacea, Pt. 1; Permian Gastropoda of the southwestern United States: Am. Mus. Nat. History, Bull., v. 110, art. 3, p. 173-276.

CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH
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RECENT LITERATURE ON THE FORAMINIFERA

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

AGIP MINERARIA. Microfacies italiane (dal carbonifero al miocene medio).—AGIP Mineraria, 1959, p. 1-35, pls. 1-145, map.—Several hundred photographs of thin sections illustrate various microfacies including both larger and smaller Foraminifera and associated organisms. Indexes to age and to genera and species.

ASANO, KIYOSHI. The Foraminifera from the Adjacent Seas of Japan, collected by the S. S. Soyo-maru, 1922-1930. Part 5. Nonionidae.—Sci. Repts. Tohoku Univ., 2nd Ser. (Geol.), Spec. Vol. No. 4 (Professor Shoshiro Hanzawa Memorial Vol.), May 1960, p. 189-201, pls. 21, 22.—Eighteen species and 3 varieties, none new.

AYALA-CASTANARES, AGUSTIN. **Orbitolina morelensis** sp. nov. de la formacion Morelos del Cretacico Inferior (Albiano) en la region de Huetamo, Michoacan, Mexico.—Univ. Nac. Autonoma Mexico, Paleontologia Mexicana No. 6, May 9, 1960, p. 1-16, pls. 1-3, text figs. 1-7 (map, graphs), 1 table.

BANDY, ORVILLE L. Planktonic foraminiferal criteria for paleoclimatic zonation.—Sci. Repts. Tohoku Univ., 2nd Ser. (Geol.), Spec. Vol. No. 4 (Professor Shoshiro Hanzawa Memorial Vol.), May 1960, p. 1-8, text figs. 1, 2.—Compared with the general limits of modern tropical marine faunas (marked approximately by the 20°C isotherm), there have been 2 prominent warming cycles (one in Upper Cretaceous and one in later Paleocene and lower Eocene) and one minor one (in later Eocene) as indicated by the geographic extension of certain planktonic Foraminifera, chiefly keeled globorotaloids. Planktonic species useful for temperature zonation in modern seas are listed.

BELJAEVA, N. V. Distribution of Foraminifera in the western part of the Bering Sea (in Russian).—Akad. Nauk SSSR, Instit. Okean., Trudy, tom 32, 1960, p. 158-170, text figs. 1-8 (maps), table 1.—Western part of Bering Sea is divided into 6 shelf areas and 3 slope areas. Presence of 41 species is recorded in these 9 areas, based on about 60 samples. Individual distribution and abundance patterns are plotted for 4 of the species.

BERGQUIST, HARLAN R. Occurrence of Foraminifera and conodonts in upper Paleozoic and Triassic rocks, northern Alaska.—Jour. Paleontology, v. 34, No. 3, May 1960, p. 596-601, text fig. 1 (map).—First Alaska records of late Paleozoic Foraminifera (a few indeterminate species of agglutinate genera), and listing of Triassic Foraminifera.

BIZON, G. Révision de quelques espèces-types de Foraminifères du Lias du Bassin Parisien de la collection Terquem.—Revue de Micropaléontologie, v. 3, No. 1, June 1960, p. 3-18, pls. 1-4.—Descriptions and illustrations (photographs) of 21 type specimens (6 holotypes, 15 lectotypes), 10 with new generic assignments and one given a new name. Another species is not described as its 2 individuals belong in synonymy with 2 other species.

BOLTOVSKOY, ESTEBAN. The Malvin Current (a study on the basis of the investigation of Foraminifera).—Argentina Servicio de Hidrografia Naval, Publ. H 1015, 1959, p. 1-96, pls. 1-3, 2 maps.—Eight benthonic species and 4 planktonic species, typical of Malvin current waters, are illustrated. The inner boundary of the current is defined as well as the northernmost point reached. Foraminifera content of the current waters suggests origin of the current is in the Malvin Islands rather than Tierra del Fuego.

BONNET, LOUIS. Nouveaux Thecamoebiens du Sol (II).—Bull. Soc. Hist. Nat. Toulouse, t. 94, fasc. 3-4, 1959, p. 407-412, text figs. 1-17.—Six species, 2 varieties, and 1 forma.

BUKALOVA, G. V. Rotaliidy i Epistominidy Aptskikh i Al'bskikh Otlozhenij Levoberezh'ja r. Laby (Severo-Zapadiyj Kavkaz).—Moscow Vses. nauchno-issl. geol. neft. instit., Trudy, vyp. 16, Pal, Sbornik 3, 1960, p. 209-219, pls. 1, 2.—Eleven species, 4 new, from Aptian and Albian formations.

Buliminidy i Ellipsoidinidy Al'bskikh Otlozhenij Mezhdurech'ja Beloj i Kubani (Severnoe Predkavkaz'e).—Moscow Vses. nauchno-issl. geol. neft. instit., Trudy, vyp. 16, Pal. Sbornik 3, 1960, p. 225-231, pl. 1.—Seven species, 5 new, of Albian age.

CARALP, MICHELLE, and JULIUS, CHARLES. Répartition stratigraphique de trois Nonionidae dans le Miocène Aquitain.—Revue de Micropaléontologie, v. 3, No. 1, June 1960, p. 65-69, pl. 1.—Three species of **Nonion** (1 new) related in an evolutionary line are characteristic of Aquitanian, Burdigalian, and Helvetian respectively.

CHANG, LI-SHO. Tertiary biostratigraphy of Taiwan with special reference to smaller Foraminifera and its bearing on the Tertiary geohistory of Taiwan.—Proc. Geol. Soc. China, No. 3, April 1960, p. 7-30, text figs. 1, 2 (map, graph), tables 1-8.—Descriptions and correlation of zonules and subzonules based on larger and smaller Foraminifera in eastern and western Taiwan. Four zonules are correlated with Tertiary **a** to **e**; 5 zonules (including 5 subzonules) in western Taiwan and 5 zonules in eastern Taiwan are correlated with Tertiary **f** to **h** and certain ones with each other. Ranges of 50 diagnostic and dominant species are indicated.

CIFELLI, RICHARD. Variation of English Bathonian Lagenidae and its phylogenetic significance.—Jour. Paleontology, v. 34, No. 3, May 1960, p. 556-569, text figs. 1-6.—Morphologic instability, characteristic of organisms in the early stage of their evolutionary development, is present among the Bathonian lagenids. Transitional forms between distinct types in a single assemblage indicate that characters generally accepted as of generic importance exist within single species. Identical structural types in distinct lineages suggest polyphyletic origin of many lagenid genera.

CITA, MARIA BIANCA, and ROSSI, DANIELE. Prima segnalazione di Aptiano-Albiano nelle Dolomiti.—Accad. Naz. Lincei, Rend. Classe Sci. fis., matemat.

e nat., ser. 8, v. 27, fasc. 6, Dec. 1959, p. 405-411, text figs. 1 (map), 2 (outline drawings).—Foraminifera in thin section.

CITA, M. B., and SILVA, I. PREMOLI. **Globigerina bollii**, nuovi specie del Langhiano delle Langhe.—Riv. Ital. Pal. Stratig., v. 66, No. 1, 1960, p. 119-126, pl. 13, text figs. 1-4.—A zone marker for the type Langhian (lower Miocene).

COLE, W. STORRS. Variability in embryonic chambers of **Lepidocyclina**.—Micropaleontology, v. 6, No. 2, April 1960, p. 133-144, pls. 1-4, table 1.—Embryonic chambers of **Lepidocyclina (Pliolepidina) pustulosa** vary from bilocular to multilocular; those of **L. (Eulepidina) radiata** vary from nephrolepidine, eulepidine, and trybliolepidine to multilepidine. Multiple embryonic chambers may result through development of a multiple fission cyst, such as is known in **Patellina corrugata**, in which the cyst walls are too thick to permit dissociation of gamonts. Eight synonyms of **L. radiata** are listed. **Lepidocyclina** is tentatively divisible into 4 subgenera.

Problems of the geographic and stratigraphic distribution of certain Tertiary larger Foraminifera.—Sci. Repts. Tohoku University, 2nd Ser. (Geol.), Spec. Vol. No. 4 (Professor Shoshiro Hanzawa Memorial Vol.), May 1960, p. 9-18, table 1.—Fourteen genera and subgenera occur both in the Americas and the Indonesia-central Pacific region but do not have identical ranges in both areas. Twenty-two more genera and subgenera are restricted; 11 to the Americas and 11 to the Indonesia-central Pacific region. Evolution and dispersal of **Lepidocyclina** from America to Indonesia is outlined. Dispersal of benthonic Foraminifera is probably accomplished by entanglement in some kind of floating mass and would probably be slow, erratic, and discontinuous.

COLOM, G. Notas micropaleontológicas y ecológicas sobre algunas formaciones continentales españolas.—Madrid Instit. Invest. Geol. "Lucas Mallada," v. 15, Nos. 41-44, 1959, p. 93-106, text figs. 1-7.—Mainly brackish species (in **Streblus** and **Discorinopsis**) associated with non-marine forms (Chara, gastropods, and ostracodes) in several late Tertiary and Quaternary formations.

COMASCHI CARIA, IDA. I microfossili del Miocene di Fangario (Cagliari).—Boll. Soc. Geol. Ital., v. 78, fasc. 1, 1959 (1960), p. 45-56, pls. 1, 2.—Lists of Foraminifera indicating Helvetian age.

CRESPIN, IRENE. Some Recent Foraminifera from Vestfold Hills, Antarctica.—Sci. Repts. Tohoku Univ., 2nd Ser. (Geol.), Spec. Vol. No. 4 (Professor Shoshiro Hanzawa Memorial Vol.), May 1960, p. 19-31, pls. 1-3, text fig. 1 (map).—Twenty-three species (6 new) from elevated marine terraces around lakes, formerly fjords, that had been isolated by falling sea level.

CUMMINGS, ROBERT H. Recent advances in micropaleontology.—Liverpool and Manchester Geol. Jour., v. 2, pt. 2, 1960, p. 288-310, text figs. 1-3 (graphs).—Decline in volume and changing trends in research during period 1948-1958.

CZIHAK, GERHARD, and GRELL, KARL G. Zur Determination der Zellkerne bei der Foraminifere **Rotaliella heterocaryotica**.—Naturwissenschaften, 47 Jahrg., heft 9, 1960, p. 211, 212, text figs. 1a-c.

DABAGJAN, N. V. Foraminifery Verkhneehothenovykh Otlozhenij Rakhovsko-Peninskoj Zony Karpat.—Kiev. Ukrain. nauchno-issl. geol.-razved. instit., Trudy, vyp. 1, 1959, p. 130-138, pls. 1-4.—Four species (3 new) and 1 variety from the upper Eocene.

DOUGLASS, RAYMOND C. The foraminiferal genus **Orbitolina** in North America.—U. S. Geol. Survey Prof. Paper 333, June 2, 1960, p. 1-52, pls. 1-17, text figs. 1-32 (maps, correl. table, diagrams, graphs), tables 1-9.—This important monographic study includes 10 species, all but 3 new. The American specimens fall into 8 species: **O. texana** and the 7 new species, and their stratigraphic usefulness is demonstrated. Two European species, **O. lenticulata** (type species of the genus) and **O. concava**, are restudied using modern techniques. Detailed morphology of the genus is described, diagrammatically represented, and illustrated by thin section photographs. Glossary of special terms and annotated bibliography are included.

ESPITALIÉ, J., and SIGAL, J. Microfaunes du Domérien du Jura Méridional et du Détroit de Rodez.—Revue de Micropaléontologie, v. 3, No. 1, June 1960, p. 52-59, pls. 1-3.—Comparison between 2 equivalent faunas, with both illustrated. One new species.

FERNET, PAULE. Étude micropaléontologique du Jurassique du Forage de Saint-Félix (Charente).—Revue de Micropaléontologie, v. 3, No. 1, June 1960, p. 19-30, pls. 1, 2, text figs. 1, 2 (map, range and abundance chart).—Range and abundance of a few species of Foraminifera in Callovian, upper Oxfordian, and lower Kimeridgian of a well boring, in association with ostracodes.

FEYLING-HANSSEN, ROLF W. Marine fossils from the Late-Pleistocene of Sør-Odal (in Norwegian with English summary).—Norges Geol. Undersökelse, Nr. 205, Arbok 1958 (1959), p. 79-83, 1 map.—Impoverished fauna suggests marine conditions diluted by fresh water in northern extension of sea.

GIANNINI, E., and TAVANI, G. Una nuova specie di **Cibicides** del Terziario.—Atti Soc. Toscana Sci. Nat., Mem., ser. A, v. 66, fasc. 2, Anno 1959 (1960), p. 418-421, pls. 1, 2.—**C. bellincionii**, from the Miocene and Pliocene of Tuscany and Po valley, is described and its variability illustrated by excellent photographs.

VAN GINKEL, A. C. The Casavegas section and its fusulinid fauna.—Leidse Geol. Meded., deel 24, afl. 2, 1959 (Feb. 1, 1960), p. 705-720, text figs. 1-5.—Three zones are recognized and serve as a means of local subdivision in the Spanish area.

GLAESSNER, M. F. Upper Cretaceous larger Foraminifera from New Guinea.—Sci. Repts. Tohoku Univ., 2nd Ser. (Geol.), Spec. Vol. No. 4 (Professor Shoshiro Hanzawa Memorial Vol.), May 1960, p. 37-44, pl. 6, text fig. 1 (map).—Campanian age indicated by **Pseudorbitoides israelskii** and **Orbitoides tissoti** in association with **Globotruncana stuarti**.

GORBENKO, V. F. Novye Vidy Foraminifer iz Otlozhenij Verkhnego Mela Severo-Zapadnoj Okrainy Donethkogo Bassejna.—Izvest. Vyssh. Uchebnykh Zaved., Geol. i Razved., No. 1, 1960, p. 67-76, text figs. 1-7.—Seven species, 6 new, of Late Cretaceous age. **Pseudospiroplectinata** gen. n. (type species **P. plana** n. sp.).

GREY, ROBERTO R. Philippine guide Foraminifera for the fieldmen.—The Philippine Geologist, v. 14, No. 1, March 1960, p. 9-16, text figs. 1-13.—Generic descriptions, with generalized diagrams, for 13 genera of larger Foraminifera having more or less restricted ranges.

HABAROVA, T. N. Foraminifery Jurskikh Otlozhenij Saratovskoj Oblasti **in** Stratigrafija i Fauna Jurskikh i Melovykh Otlozhenij Saratovskogo Povolzh'ja.—Russia Vses. neft. nauchno-issl. geol.-razved. instit., Trudy, vyp. 137, 1959, p. 461-501, pls. 1-9.—Forty-eight Jurassic species, 12 new.

HARRINGTON, GEORGE L. A Recent foraminiferal faunule from Honshu, Japan.—Sci. Repts. Tohoku Univ., 2nd Ser. (Geol.), Spec. Vol. No. 4 (Professor Shoshiro Hanzawa Memorial Vol.), May 1960, p. 45-55, text fig. 1 (map).—Sixty-four species and varieties, none new, from a fine-grained beach sand.

HATAE, NOBUHIRO. On the **Nummulites** Zone of the Islands of Amakusa, Kyushu, Japan (in Japanese with English abstract).—Sci. Repts. Tohoku Univ., 2nd Ser. (Geol.), Spec. Vol. No. 4 (Professor Shoshiro Hanzawa Memorial Vol.), May 1960, p. 411-423, text figs. 1-26 (columnar sections, map, photographs).

HOFKER, J. Foraminifera from the Cretaceous of South Limburg, Netherlands. XLVII. Buliminae of the Maestrichtian Tuff Chalk.—Natuurhist. Maandblad, 49e Jahrg., Nos. 1-2, Feb. 26, 1960, p. 15-19, text figs. 1-15.—Nine species of Danian age.

XLVIII. **Globigerina daubjergensis** Brönnimann and the age of Me and Lower Paleocene above the upper Md in the quarry Curfs, near Houthem, and the age of the Cr 4 below the Ma.—Natuurhist. Maandblad, 49e Jahrg., Nos. 3-4, April 29, 1960, p. 34-41, pls. 1-4.—Correlation of Maestrichtian Tuff Chalk of Holland with the type Danian of Denmark is supported by identical planktonic assemblages and by comparable developmental series of **Globigerina daubjergensis** across the Cretaceous-Danian boundary.

The type localities of the Maestrichtian (Maestrichtian Chalk Tuff) and of the Montian (Tuffeau de Ciply, Calcaire de Mons, Lagunar, and Lacustre Montian).—Jour. Paleontology, v. 34, No. 3, May 1960, p. 584-588, text fig. 1, table 1.—The major planktonic faunal break between Cretaceous and Tertiary types occurs at the base of the Maestrichtian Chalk Tuff in Holland and is similar to the break beneath the Danian in Denmark, suggesting equivalence of the two. A few significant species are illustrated from Holland.

HUANG, TUN-YOW. The Foraminifera from the Liuchiuhsu mudstone of Liuchiuhsu off the southwestern coast of Taiwan.—Proc. Geol. Soc. China, No. 3, April 1960, p. 59-66, pls. 1, 2, text figs. 1, 2 (map, section), table 1.—Pliocene faunule of 98 species, planktonic specimens predominating, suggesting moderately deep water environment.

IGÔ, HISAYOSHI. **Yabeina** from the Ômi Limestone, Niigata Prefecture, Central Japan.—Sci. Repts. Tohoku Univ., 2nd Ser. (Geol.), Spec. Vol. No. 4 (Professor Shoshiro Hanzawa Memorial Vol.), May 1960, p. 335-343, pl. 36.—Illustrations and description of **Y. hayasakai** Ozawa.

KAWANO, MICHIHIRO. Some fusulinids from the Aratani conglomerate in the northeastern part of Yamaguchi City.—Sci. Repts. Tohoku Univ., 2nd Ser. (Geol.), Spec. Vol. No. 4 (Professor Shoshiro Hanzawa Memorial Vol.), May 1960, p. 223-230, pls. 24, 25, tables 1-3.—Three species (2 new) and one new subspecies.

KHLOPONIN, K. L. Paleogen Rakhovsko-Peninskoj Zony Vostochnykh Karpat.—Kiev. Ukrain. nauchno-issl. geol.-razved. instit., Trudy, vyp. 1, 1959, p. 39-56, pls. 1-4, text figs. 1, 2 (maps).—Concerning micro- and megalospheric generations in 3 species of **Nummulites.**

KRASHENINNIKOV, V. A. Foraminifery **in** Atlas Srednemiotsenovoi fauny Severnogo Kavkaza i Kryma (edited by B. P. ZHIZHCHENKO).—Vses. nauchno-issl. instit., Trudy, 1959, p. 15-103, pls. 1-14, text figs. 2-6.—Seventy-nine species and varieties, 19 species and 1 variety new, described and illustrated from the middle Miocene of northern Kavkaza and Crimea.

KÜPPER, INGE. Miogypsinen aus Britisch West-Afrika (Cameroon).—Sci. Repts. Tohoku Univ., 2nd Ser. (Geol.), Spec. Vol. No. 4 (Professor Shoshiro Hanzawa Memorial Vol.), May 1960, p. 56-69, pls. 7-9, text figs. 1-3 (maps, graph), tables 1-3.—Five species, one new, of lower Burdigalian age.

MARIE, PIERRE. Sur le Crétacé Supérieur Marin des Martigues (Bouches-du-Rhône).—84e Congrès des Soc. Savantes de Paris et de Départments, Sec. des Sci., 1959, p. 449-496, 6 text figs. (columnar sections, map, sections, distrib. table).—Record of about 50 species in about 60 samples.

MANGIN, MICHÈLE. Révision des Miliolidés de la collection Terquem du "Pliocène Supérieur" de l'Ile de Rhodes.—Revue de Micropaléontologie, v. 3, No. 1, June 1960, p. 37-51, pls. 1, 2, 1 table.—Of 33 miliolid species described by Terquem, types were not found or were unusable for 16, 3 others were considered invalid, and 3 were found to belong in previously described species. Two others are given new names, and 2 are placed in different genera. Two are recognized from their figures even though types were not found. Altogether, 31 species are recorded from the Isle of Rhodes, 1 new and 3 given new names, and most are illustrated.

MEISL, STEFAN. Eine neue **Gaudryina** aus dem nordwestdeutschen Eozän (Foram.).—Geol. Jahrb., Band 76, April 1959, p. 411-419, pls. 19, 20.—**Gaudryina (Pseudogaudryina) hiltermanni** n. sp. and **trigonalis** n. subsp., both of Ypresian-Lutetian age.

MOSKVINA, M. M. (ed.). Atlas Verkhnemelovoj Fauny Severnogo Kavkaza i Kryma.—Vses. nauchno-issl. instit., Trudy, 1959. [Foraminifera, p. 87-129, pls. 1-15, text figs. 2-6, table 6.]—Systematic illustrated catalog includes 93 species, none new, with ranges indicated between upper Albian and Paleocene.

MURATA, SHIGEO, and SUGAHARA, MICHITOSHI. Some Paleogene Foraminifera from the vicinity of Ariake-Bay, Kyushu.—Sci. Repts. Tohoku Univ., 2nd Ser. (Geol.), Spec. Vol. No. 4 (Professor Shoshiro Hanzawa Memorial Vol.), May 1960, p. 297-300, pl. 32.—Four species, 3 new, of agglutinated Foraminifera.

NEUMANN, MADELEINE, and DAMOTTE, RENÉE. **Abrardia**, nouveau genre du Crétacé Supérieur d'Aquitaine.—Revue de Micropaléontologie, v. 3, No. 1, June 1960, p. 60-64, pl. 1, text figs. 1-3.—**Dictyoconus mosae** Hofker is genotype of **Abrardia.**

NOGAMI, YASUO. Fusulinids from the Maizuru Zone, southwest Japan. Part 2. Derived Fusulinids.—Mem. College Sci., Univ. Kyoto, ser. B, v. 26, No. 2, Nov. 1959, p. 67-82, pl. 1, text fig. 1 (map).—Ten species, 6 indeterminate, from limestone pebbles in conglomerates.

OBREGON DE LA PARRA, J. Foraminiferos de la formacion La Peña.—Bol. Asoc. Mexicana Geol. Petr., v. 11, Nos. 3-4, 1959, p. 135-153, pls. 1-5, text figs. 1, 2 (map, range and abundance chart).—Thirty-eight species (18 new and 2 indeterminate) from the Cretaceous.

OVECHKIN, N. K. (ed.). Structure Géologique de l'U.R.S.S. Tome 1: Stratigraphie. Fasc. 5: Cénozoïque.—Russia Vses. geol. instit., 1958, (French translation from Russian), Paris, 1959, p. 655-735, 2 correl. charts.—Correlation charts from Carpathians to Kamchatka include smaller and larger Foraminifera as marker fossils in Paleogene part of section.

PAPI, F., and TAVANI, G. Sulla presenza di alcuni Foraminiferi nell'acqua di una sorgenta delle Terme di Montecatini.—Atti Soc. Toscana Sci. Nat., ser. B, v. 66, Anno 1959 (1960), p. 1-9, text figs. 1-3.—**Miliammina fusca** and **Rotalia beccarii** adapted to life in a mineral spring, interpreted as a relict fauna of marine origin.

PAPP, ADOLF. Das Vorkommen von **Miogypsina** in Mitteleuropa und dessen Bedeutung für die Tertiär-stratigraphie.—Mitteil. Geol. Gesellschaft Wien, Band 51, 1958 (1960), p. 219-227, text figs. 1-4.—**Miogypsina gunteri-M. tani** of middle Aquitanian age and **M. intermedia** of upper Burdigalian age.

PARKER, FRANCES L. Living planktonic Foraminifera from the equatorial and southeast Pacific.—Sci. Repts. Tohoku Univ., 2nd Ser. (Geol.), Spec. Vol. No. 4, (Professor Shoshiro Hanzawa Memorial Vol.), May 1960, p. 71-82, text figs. 1-20 (maps), table 1.—Abundance (as percentage of total fauna) and distribution pattern are plotted on maps for the 16 major species found in 81 plankton tows. Species are grouped as to areas where found, possibly controlled by surface temperatures. Largest populations are found in regions richest in nutrients. Daytime tows richer than night tows indicate dependence of planktonic Foraminifera on plant life of the euphotic zone, possibly symbiosis with the plant life that is observed in the Foraminifera protoplasm.

PHLEGER, FRED B. Foraminiferal populations in Laguna Madre, Texas.—Sci. Repts. Tohoku Univ., 2nd Ser. (Geol.), Spec. Vol. No. 4, (Professor Shoshiro Hanzawa Memorial Vol.), May 1960, p. 83-91, text figs. 1-9 (maps), table 1.—Quantitative study made in coastal lagoon behind a barrier island reveals large populations, mostly dominated by miliolids on sandy substrate but with **Elphidium** and **Streblus beccarii** variants where the sediment is silt and clay. Live-total ratios indicate the barrier is the major source of sediment.

PISCHVANOVA, L. S. Markirujushchie Gorizonty Planktonnykh Foraminifer v Miothenovykh Otlozhenijakh Predkarpatskogo Pragiba.—Kiev. Ukrain. nauchno-issl. geol.-razved. instit., Trudy, vyp. 1, 1959, p. 3-27, pls. 1-8.—Nineteen species (6 new) and 3 varieties (1 new).

POIGNANT, ARMELLE. Aperçu sur la microfaune de l'Éocène Supérieur du Médoc.—Revue de Micropaléontologie, v. 3, No. 1, June 1960, p. 31-36, pls. 1, 2.—Two species of **Lituonella**, one new.

REYMENT, R. A. The foraminiferal genera **Afrobolivina** gen. nov. and **Bolivina** in the Upper Cretaceous and lower Tertiary of West Africa.—Acta Univ. Stockholm., Stockholm Contrib. in Geol., v. 3, 1959, p. 1-59, pls. 1-7, text figs. 1-13, table 1, map.—Ten species, all but 3 new, with restricted stratigraphic ranges. Two new species in **Afrobolivina** gen. nov. (type species **A. afra** sp. nov.) and the remainder in **Bolivina** s.s. and **Bolivina (Loxostomoides). Bolivinoides** is identical with **Bolivina. Loxostomum** should be removed from Bolivininae. **Afrobolivina** is distinguished by vertical partitions within the chambers.

RUIZ DE GAONA, MAXIMO. Los más antiguos cordelados de Eurasia.—Madrid Instit. Invest. Geol. "Lucas Mallada," v. 15, Nos. 41-44, 1959, p. 325-328.—**Discocyclina seunesi** Douvillé in Spain.

SABOL, JOSEPH WILLIAM. An emendation of the description of **Nodosaria catesbyi**, d'Orbigny.—Jour. Paleontology, v. 34, No. 3, May 1960, p. 594.—Specimens from Yorktown (upper Miocene) material noted having as many as 4 chambers.

SAIDOVA, K. M. Distribution of Foraminifera in the bottom sediments of the Okhotsk Sea (in Russian).—Akad. Nauk SSSR, Instit. Okean., Trudy, tom 32, 1960, p. 96-157, text figs. 1-28 (maps, diagrams), table 1.—For 83 species, data as to depth range, temperature, salinity, oxygen content, and bottom type are given, with their occurrence recorded in 21 areas of the Okhotsk Sea. Individual distribution and abundance patterns in the Okhotsk Sea are plotted for 20 of the more important species.

SCHUTZKAJA, E. K. Foraminifery Verkhnego Paleothena Jugo-Zapadnogo Kryma (Bakhchisarajskij Rajon).—Moscow Vses. nauchno-issl. geol. neft. instit., Trudy, vyp. 16, Pal. Sbornik 3, 1960, p. 235-259, pls. 1-5.—Twenty-six species, 5 new, from upper Paleocene.

SEIBOLD, EUGEN, and SEIBOLD, ILSE. Foraminiferen der Bank- und Schwamm-Fazies im unteren Malm Süddeutschlands.—Neues Jahrb. Geol. Paleont., Abh., Band 109, heft 3, Feb. 1960, p. 309-438, pls. 7, 8, text figs. 1-22.—About 135 species and subspecies (14 species and 2 subspecies new and 1 new name) described and illustrated. Three neotypes are designated. A few species are facies-dependent; 31 favor bank-facies and 14 favor sponge-facies.

STANLEY, D. J. Stratigraphy and Foraminifera of lower Tertiary Vidoño shale, near Puerto la Cruz, Venezuela.—Bull. Amer. Assoc. Petr. Geol., v. 44, No. 5, May 1960, p. 616-627, figs. 1, 2 (map, columnar section), tables 1, 2.—Distribution and abundance of 86 species plotted in a 140-foot section which is correlated approximately by benthonic species with 2 other areas in Venezuela and 1 in Trinidad. Two planktonic zones are recognized and the section is interpreted as of Paleocene (Landenian) and lower Eocene (Ypresian) age. Black shales in the lower part indicate low-oxygen conditions. Fauna of upper part of section indicates incursion of the sea into a partly restricted basin.

TAI, YOSHIRO. Miocene smaller Foraminifera from the Funo and Saijô Basins, Hiroshima Prefecture, West Japan.—Sci. Repts. Tohoku Univ., 2nd Ser. (Geol.), Spec. Vol. No. 4 (Professor Shoshiro Hanzawa Memorial Vol.), May 1960, p. 231-235, text figs. 1 (map), table 1.—Fauna listed is interpreted as of Vindobonian age and as deposited in the middle to outer neritic zone.

TAKAYANAGI, YOKICHI. Annotated bibliography of the Cretaceous Foraminifera from Japan.—Sci. Repts. Tohoku Univ., 2nd Ser. (Geol.), Spec. Vol. No. 4 (Professor Shoshiro Hanzawa Memorial Vol.), May 1960, p. 309-315.

THOMPSON, M. L. Stratigraphic distribution of American Pennsylvanian Fusulinid Foraminifera.—Sci. Repts. Tohoku Univ., 2nd Ser. (Geol.), Spec. Vol. No. 4 (Professor Shoshiro Hanzawa Memorial Vol.), May 1960, p. 109-116, text figs. 1, 2 (range chart, correl. chart).—Ranges indicated for 23 genera in 5 fusulinid zones in the Pennsylvanian system.

TODD, RUTH. Some observations on the distribution of **Calcarina** and **Baculogypsina** in the Pacific.—Sci. Repts. Tohoku Univ., 2nd Ser. (Geol.), Spec. Vol. No. 4 (Professor Shoshiro Hanzawa Memorial Vol.), May 1960, p. 100-108, pl. 10, text fig. 1 (map), tables 1, 2. —Two common reef-dwelling species appeared in the late Tertiary and are now restricted to the western tropical Pacific.

TODD, RUTH, and LOW, DORIS. Smaller Foraminifera from Eniwetok drill holes.—U. S. Geol. Survey Prof. Paper 260-X, Aug. 10, 1960, p. 799-861, pls. 255-264, text figs. 256-259 (map, range chart, correl. diagrams), tables 1-7.—Two holes, about 22 miles apart on opposite sides of the atoll, were drilled to the basement rock at 4,200 and 4,600 feet. Miocene was penetrated at about 510 feet (Tertiary **g**, **f**, and **e**), lower Oligocene (Tertiary **c**) at 2,180 feet, and upper Eocene (Tertiary **b**) at 2,770 feet. Shallow-water deposition is indicated throughout the shorter hole and the upper part of the longer hole while deeper-water and outer slope deposition is indicated for the lower part of the longer hole. Tentative correlations of several zones based on smaller Foraminifera are made between these two holes and the Bikini holes. About 270 species are recorded; many are described and illustrated; 7 are new.

UJIIÉ, H., and OSHIMA, K. Statistical characters of two **Miogypsina** assemblages from the Mizunami district, Gifu Prefecture—Restudy of the Japanese Miogypsinids, Part 1.—Sci. Repts. Tokyo Kyoiku Daigaku, sec. C, vol. 7, No. 62, March 25, 1960, p. 105-116, pl. 6, 7 text figs.—According to Drooger's method of age determination based on nepionic acceleration, the 2 assemblages are lower? or middle Burdigalian and uppermost Burdigalian.

UJIIÉ, H., and WATANABE, H. The Poronai Foraminifera of the northern Ishikari coal-field, Hokkaido.—Sci. Repts. Tokyo Kyoiku Daigaku, sec. C, vol. 7, No. 63, March 25, 1960, p. 117-136, pls. 1-3, text figs. 1-4 (maps, sections), tables 1-4.—About 50 species (4 new but only 2 of them described here) from the Poronai formation which is correlated approximately with the Narizian stage of California. **Poronaia** n. gen. (type species **Plectina poronaiensis** Asano) is erected.

VOLOSHINOVA, N. A. Genus **Buccella** Andersen and its species from the Neogene of Sakhalin (in Russian).—Mikrofauna SSSR, Sbornik 11, Trudy VNIGRI, Vyp. 153, 1960, p. 265-288, pls. 1-8, text fig. 1 (range and abundance chart).—Fourteen species, all but 3 new, and 2 new subspecies from the upper Miocene and Pliocene.

ZAV'JALOVA, E. A. O Foraminiferakh Turnejskogo Jarusa L'vovskoj Mul'dy.—Kiev. Ukrain. nauchno-issl. geol.-razved. instit., Trudy, vyp. 1, 1959, p. 174-179, pls. 1-3.—Four Paleozoic species.

RUTH TODD