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63. SOME PLIOCENE FORAMINIFERA FROM A PORTION OF THE LOS ANGELES BASIN, CALIFORNIA

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ABSTRACT—Ninety-two species and varieties of Foraminifera are described and figured from lower and upper Pliocene strata along an outcrop on Fourth and Flower Streets, Los Angeles, California. A stratigraphic thickness of some 325 feet consisting of southward dipping massive siltstones and thin conglomeratic lenses is exposed at this locality. One new species and two new varieties are described. Lithologic, faunal, and ecologic data are presented and discussed. Significant points covered are: description of rock types and possible mode of deposition, specific composition and stratigraphic distribution of the fauna, and ecologic implications indicated by comparison with Recent forms. Charts and tables illustrating the relative abundance and stratigraphic distribution within the section are based on a count of 7280 specimens.

INTRODUCTION

Pliocene foraminiferal assemblages of the Repetto and Pico formations of the Los Angeles Basin have been studied extensively because of their stratigraphic value in the petroleum industry. Paradoxically, however, aside from several brief specific studies no faunal analysis has ever been published or presented. This paper, by no means complete or exhaustive, invites attention to this distinctive foraminiferal fauna.

The lithological and faunal contents analyzed herein were obtained from University of Southern California (USC) locality 106 located on Fourth and Flower Streets in the downtown area of the city of Los Angeles, California (fig. 1). Aims of this paper are fivefold: (1) to figure and describe the fauna, (2) to determine and indicate the stratigraphic ranges and relative abundance of diagnostic species, (3) to describe the lithology, (4) to attempt a reconstruction of the depositional environment of the sediments at this particular outcrop, and (5) to determine the ecological conditions at the time of the faunas internment.

It was originally planned to sample the locality by establishing substations every 2 feet stratigraphically and to then divide the section into 10 foot intervals, each containing 5 mixed samples. In the Pico this gave admirable results, but in the Repetto less nearly perfect results were attained. In the latter formation several stations yielded poor foraminiferal concentrates and stations 1 and 2 produced completely negative results both times they were sampled and processed. Furthermore, it was not possible to maintain continuity of 2 foot substation interval in the Repetto because leached zones occur at and near the base of the exposed formation. Hence the station stratigraphic interval for the Repetto averages 20 feet, whereas that of the Pico averages 10 feet as originally planned. In the Pico only station 12 proved to be barren (fig. 1). Despite the difference between the station intervals of the lower and upper Pliocene, it is felt that adequate coverage was accomplished.

The collecting of samples and the pursuance of other necessary field and laboratory work was carried on during the summer of 1949. The figures were drawn by the author, using a camera lucida for outlining the structures. Approximately one academic year was spent in the analysis of the fauna and the preparation of this paper.

By necessity, any project of this type is made possible and aided by the assistance and cooperation of a number of individuals and agencies. This study is no exception and first to be mentioned are H. L. Driver and W. H. Holman of the Standard Oil Company of California, who not only suggested the locality but its possibilities as well. R. W. Crouch and W. Elliot of the Richfield Oil Corporation kindly assisted with identifications. W. H. Easton and K. O. Emery of the University of Southern California furnished valuable assistance and helpful suggestions. Finally it is a pleasure to acknowledge the aid and encouragement given by O. L. Bandy of the University of Southern California during the planning and preparation of this study.

HISTORICAL REVIEW

General

Nomenclaturally the marine Pliocene formations of the Los Angeles area have undergone an evolution that more or less parallels the stratigraphic and paleontological developments in the basin. Eldridge and Arnold (1907, p. 22) mapped the northern portion of the basin Pliocene in the vicinity of the old Los Angeles City oil field as Fernando. Subsequently Kew (1924, p. 70) raised the Fernando to group status and added

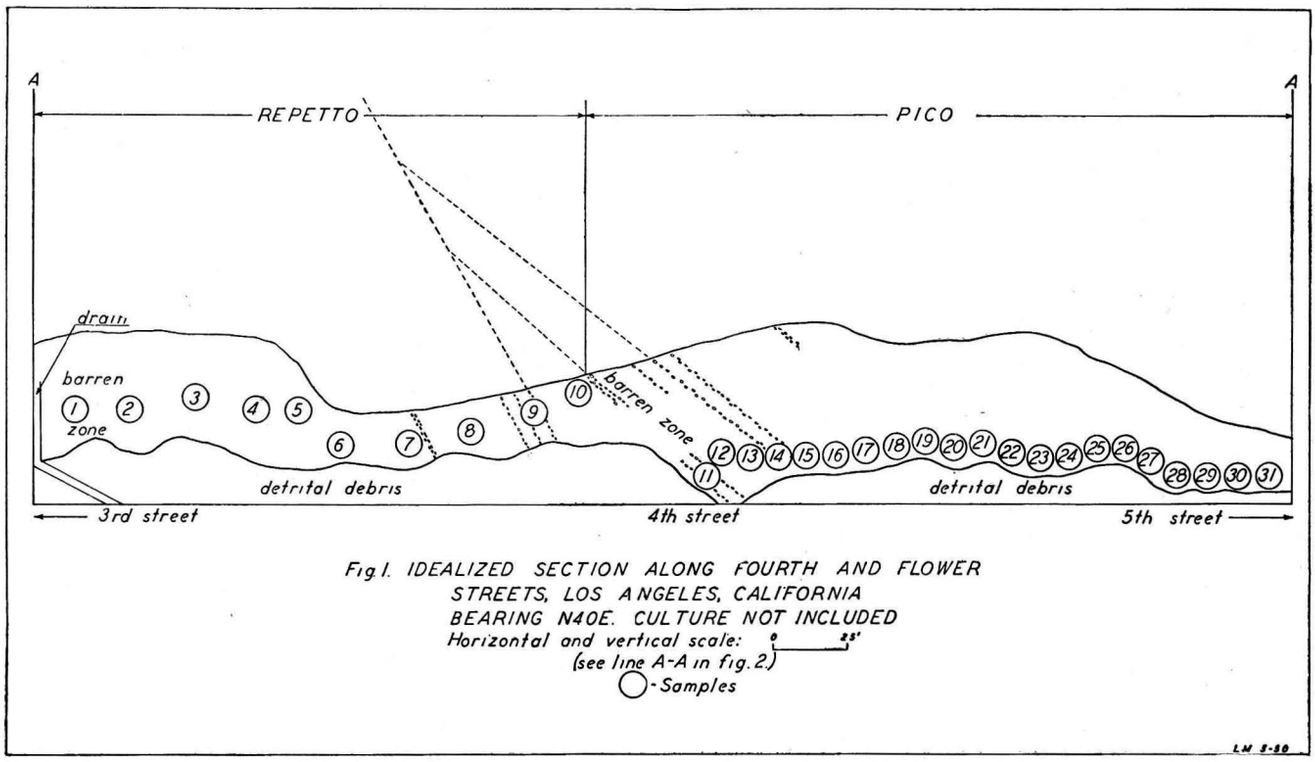


Fig I. IDEALIZED SECTION ALONG FOURTH AND FLOWER STREETS, LOS ANGELES, CALIFORNIA BEARING N40E. CULTURE NOT INCLUDED
Horizontal and vertical scale: 0 25'
(see line A-A in fig. 2.)
○ - Samples

the Pico and Saugus formations, the latter having their type sections in the Ventura basin. In 1930 the Society of Economic Paleontologists and Mineralogists established the name Repetto for the lower Pliocene and limited the use of the Pico to the upper Pliocene. This latter development resulted from the confusion in terminology arising from more extensive and detailed work of micropaleontologists that revealed two distinct faunal facies in the basin (Wissler, 1943, p. 212). Reed (1932, p. 31) first defined the Repetto formation in print.

Table No. 1 Nomenclatural Development of the Los Angeles Basin Pliocene

Eldridge and Arnold, 1907	Kew, 1924	S.E.P.M., 1930	Reed, 1932
Fernando	Saugus	Pico	Pico
	Pico	Repetto	Repetto

Fourth and Flower Streets Locality

The Pliocene locality described in this paper has received considerable attention from various workers in past years. Eldridge and Arnold (1907) presented maps and cross-sections as well as detailed discussions of the area near the Elysian anticline, of which the Fourth and Flower Streets locality forms part of the southern limb. H. L. Driver, A. Ferrando, and W. H. Holman (1931) in an unpublished report, described the lithology and micropaleontology of part of the immediate vicinity. In 1932 Soper and Grant described and mapped in detail a portion of the downtown section of Los Angeles including the area under consideration. Edwards (1934) investigated the inferred environments of Pliocene conglomerates including the conglomeratic lenses at the locality. Finally Wissler (1943) refers to the Fourth and Flower Streets area in his analysis of the producing zones of the Los Angeles basin.

STRATIGRAPHY

Inasmuch as the stratigraphy of the area has been described previously by Soper and Grant (1932) it is discussed only briefly herein. The Los Angeles valley area is structurally a deep basin-like depression similar to the present-day deep-water basins on the continental shelf of southern California. The valley floor is somewhat synclinal in structure with subordinate folds. Its substructure to great depths is composed of strata of Pliocene age capped by wash and terrace material of Pleistocene age. The total thickness of sediments is in excess of 10,000 feet or about 2 miles (Reed, 1933, p. 228). The locality discussed herein lies in the northern portion of the Los Angeles basin. In this section of the city of Los Angeles the oldest beds are the Puente shales of upper Miocene age. Conformably overlying a conspicuous white band of diatomaceous shale that marks the uppermost Miocene are the Pliocene series. Overlying unconformably and partly concealing both Miocene and Pliocene formations are Pleistocene gravels and alluvium.

Although in the general vicinity Pliocene strata have been assigned an estimated thickness of 1,000 feet (Soper and Grant, 1932, p. 1048), at Fourth and Flower Streets only several hundred feet are well ex-

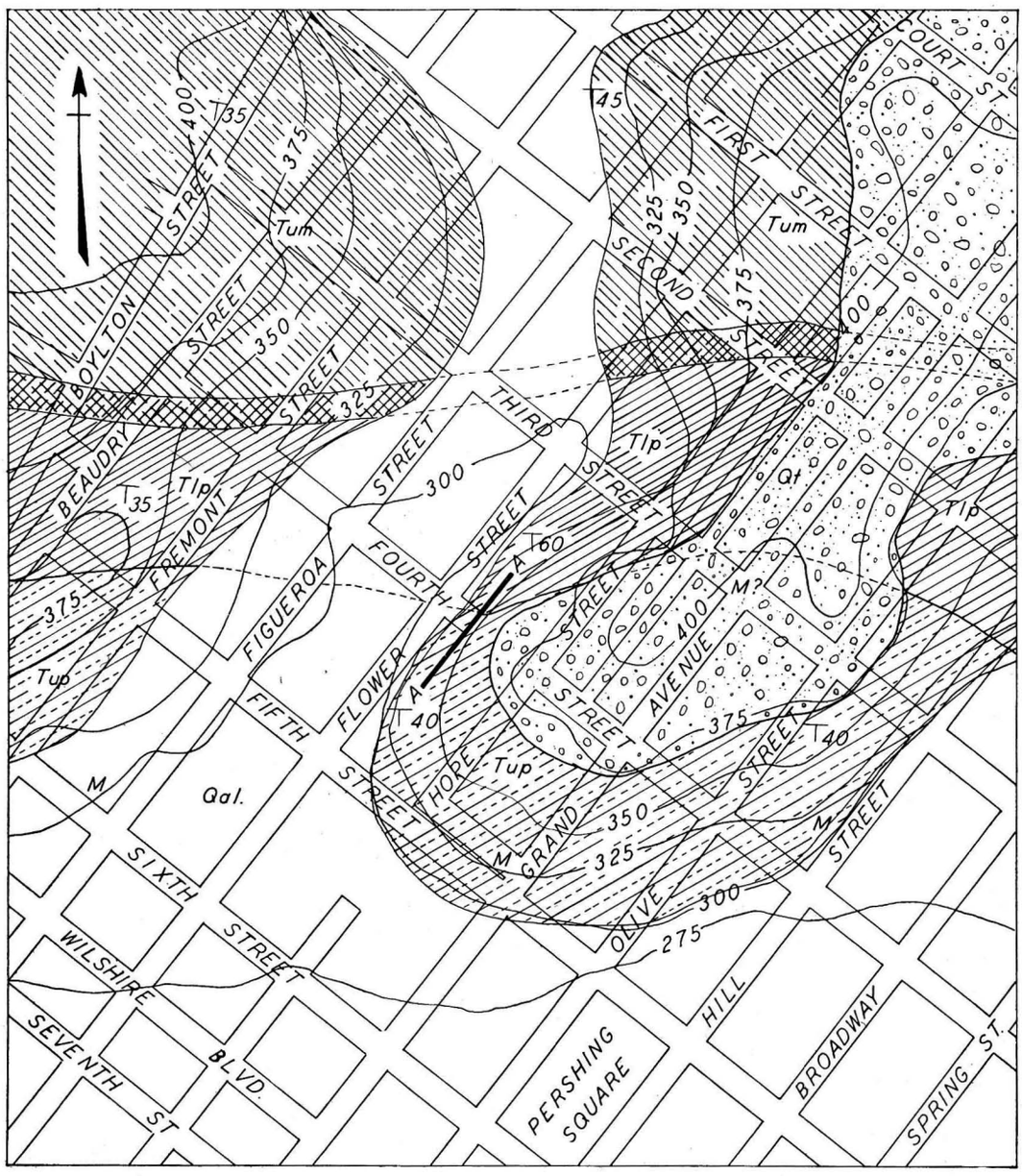
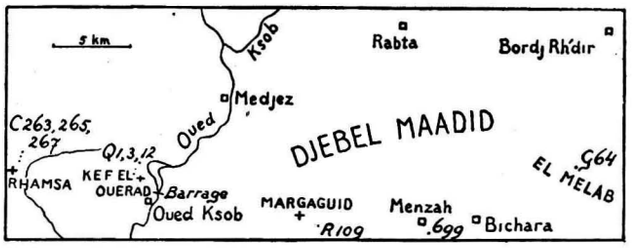


Fig. 2. GEOLOGIC MAP OF A PORTION OF THE DOWNTOWN AREA OF LOS ANGELES, CALIFORNIA

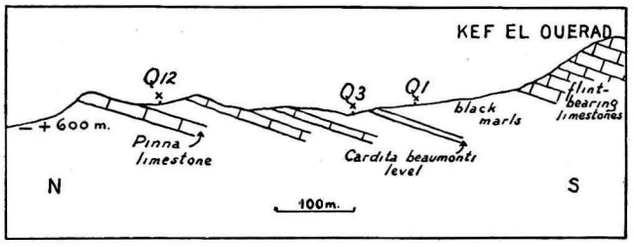
(Contouring after U.S.G.S. topographic map of L.A.; Geology modified from Soper and Grant) LM 5-50



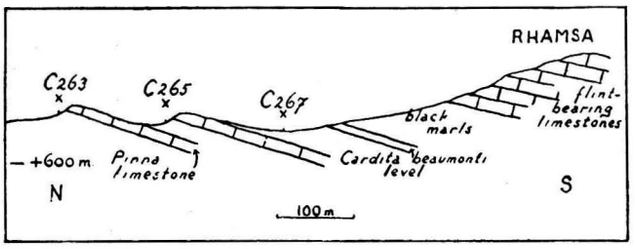
Text Fig. 1: Sample Localities, Hodna Basin, Algeria

especially by SAVORNIN (lit. 3) and FLANDRIN (lit. 2). During the geological mapping it was found, however, that a study of the detailed stratigraphy of these layers is severely hampered by the occurrence of lateral facies changes. In the region along and to the west of Oued Ksob two fairly constant levels could be mapped, which fortunately, are situated respectively near the base and close to the top of this complex. In the lower part of the sequence a thick, light-coloured limestone occurs, in which, in addition to other ill-preserved fossils, numerous fragments of *Pinna* sp. were observed. In the upper portion of the 80 meters' complex a thin, fossiliferous, yellowish, marly zone with numerous *Cardita beaumonti* d'Archiac was encountered, lying at the base of a series of dark gypsiferous clays, which in turn are overlain by the topographically protruding complex of Eocene (Ypresian) limestones with silex.

In two sections on the northern slopes of Rhamsa and of Kef el Ouerad, three samples of each of the sections contained smaller Foraminifera and a few larger ones. Their exact stratigraphic position has been marked on the accompanying drawings (Text figs. 2 and 3). Sample 699 has been taken from a level, slightly above that of *Cardita beaumonti,* in the



Text Fig. 2: Stratigraphic Section: Localities Q 1, Q 3, and Q 12 Dano-Montian, Kef el Ouerad, Algeria



Text Fig. 3: Stratigraphic Section: Localities C 263, C 265, and C 267 Dano-Montian, Rhamsa, Algeria

southern Djebel Maadid near Oued Menzah. Sample G 64 is a composite one, derived from beds directly below, in and slightly above this same horizon, in the isolated outcrop of these strata of El Melab, south of Bordj Rh'dir. The exact stratigraphical position of sample R 109 is unknown.

The megafauna of the higher part of the sequence involved, in and some distance below the level, marked by the abundance of *Cardita beaumonti,* is characterized by *Cardita beaumonti* d'Archiac, *Roudaireia drui* Munier-Chalmas and *Exogyra overwegi* von Buch. Moreover, especially near the Rhamsa, numerous, mainly fragmentary oysters, were encountered in several horizons throughout the section, even some meters below the *Pinna*-limestone. These strongly variable oysters may all be considered to belong to a single species, most likely *Alectryonia aucapitainei* (Coquand).

The three first mentioned species of these mollusks in the higher part of the Cretaceous-Tertiary transitional strata are now generally considered to characterize the North African Danian. *Alectryonia aucapitainei* is considered by SAVORNIN to be restricted to the Danian in the vicinity of Oued Ksob. It should be remarked, however, that the age of the layers, dealt with here, is evaluated differently by SAVORNIN and FLANDRIN. As far as can be concluded from his general description, SAVORNIN places the complex between the *Pinna*-limestone and the *Cardita beaumonti*-level nearly entirely in the Danian; the latter horizon, however, he considers to be Montian. On the other hand, FLANDRIN places the majority of our section in the Uppermost Maestrichtian, whereas he considers the Danian to range from about 25 meters below to 35 meters above the *Cardita beaumonti*-horizon. The upper limit of FLANDRIN's Danian is evidently based on the occurrence of some oyster-beds, which contain a. o. *Alectryonia villei* (Coquand), near the top of the dark gypsiferous clays. This *A. villei* is generally considered to be a typical Cretaceous species, occurring abundantly in the Campanian and the Maestrichtian of this part of North Africa. Unfortunately, the oysters, collected during our mapping survey, are too poorly preserved to allow a specific determination, but some fragments from these oyster-beds were observed, which, indeed, strongly resemble the well-known Cretaceous species.

The stratigraphical problems concerning our strata, are not yet satisfactorily solved. It is therefore thought recommendable at present either to name these beds simply "Cretaceous-Tertiary transitional strata" or possibly to use the name Dano-Montian, introduced by FLANDRIN (lit. 2) and SIGAL (lit. 4). The writer is inclined to place the larger part of or even the entire section in the Danian, as in none of his samples a typical Maestrichtian microfauna was encountered. On the other hand, however, no criterions are available to separate the Danian from the Paleocene.

The microfaunal assemblages of the samples have a rather different aspect with respect to associations, known from other localities of the Algerian Cretaceous-Tertiary transitional sediments (lit. 1 and 4). The latter have a more cosmopolitan character and compare better with several described fauna of America, as for instance the Midway of Texas, and also with those from the Caucasus and Sweden. This difference in faunal composition may be explained by assuming that the corresponding sediments along the northern border of the Hodna Basin were deposited under rather extreme, i. e. comparatively shallow, and possibly partly brackish water conditions. The lateral facies changes of the individual layers, the numerous oyster-beds and the gypsum content of many of the samples support this opinion. Further evidence is found in several of the species which were reported as shallow water forms elsewhere or which may be anticipated as such. The occurrence of many of the species with numerous individuals of relatively small, but constant, size in samples with a rather low number of species, together with the comparatively high amount of new species, may also point to the former existence of some special environmental influence during sedimentation.

The established stratigraphical ranges of earlier described species in our samples indicate a dominance of Danian-Paleocene forms. Only three of the determined species have so far been recorded from Upper Senonian strata only: *Loxostomum plaitum, Siphogenerinoides parva* and *Omphalocyclus macropora.* Especially the latter is an important species of the European Uppermost Cretaceous (excluding Danian), for instance of the Maestrichtian at its type-locality Maastricht. REY (in FLANDRIN, lit. 2, p. 155), however, reports this species from the Algerian Danian. Only three species are probably restricted, as far as known, to the Eocene: *Nonion acutidorsatus, Gümbelitria triserialis* and *Globorotalia wilcoxensis* var. *acuta.* The majority of the other earlier described 25 species are known from, and in many cases restricted to, Danian, Paleocene or Danian-Paleocene. Comparing the foraminiferal associations from the Hodna region with those of about the same age in the neighbourhood of Constantine (lit. 1 and 4), a somewhat better correlation is indicated with the fauna of the Velasco shale and Tabasco formations of Mexico and with the Lizard Springs marls of Trinidad. Relations exist also with the fauna of the Paleocene of El-Guss-Abu-Said, Egypt, and of the Netherlands. It has been pointed out already that distinct Maestrichtian markers are absent in our material, but the conclusion herefrom is weakened by the scarcity of pelagic species, though those that are present, point to levels, younger than Upper Senonian.

When combining our individual samples to a tentative single stratigraphical sequence, no distinct zoning is observed from the vertical distribution of the spe-

	C 263	Q 12	C 265	C 267	Q 3	G 64	699	Q 1
Haplophragmoides eggeri Cushman	×						×	
Trochammina bradyi (Schwager)		×			×		×	×
Nodosaria bacillum Defrance					×		×	
Vaginulina legumen (Linné)					×	×		
Nonion acutidorsatus Dam	×	×	×			×	×	
Nonionella insecta (Schwager)	×	×						
Gümbelina morsei Kline	×					×	×	
Bulimina trigonalis Dam	×				×			
Virgulina troosteri Drooger n. sp.	×	×					×	×
Valvulineria koenigswaldi Drooger n. sp.	×					×	×	×
Valvulineria palmi Drooger n. sp.	aff.	×						
Rotalia sigali Drooger n. sp.			×	×				
Globigerina voluta White	×	×	×		×	×		
Cibicides praecursorius (Schwager) and vars.	×	×	×	×				
Anomalina midwayensis (Plummer) and vars.					×	×		
Anomalina newmanae ksobensis Drooger n. var.						×	×	×
Virgulina cruysi Drooger and new var.						×	×	

Table 1: Distribution Chart of some of the Dano-Montian Hodna Mountains Beds in Algeria with tentative stratigraphic sequence of localities indicated on Text figs. 1, 2, and 3.

cies. This negative result is probably mainly due to a lack of sufficient data. Possibly the middle of the "section" (C 265 and C 267) represents an intercalation of sediments, deposited under extremely aberrant environmental conditions. Although this may have been of local importance only, it may explain the interrupted occurrences of some, otherwise common species, as for instance *Virgulina troosteri* and *Valvulineria koenigswaldi*.

The author is gratefully indebted to H. Cruys, Q. A. Palm and Th. Raven, who collected part of the samples, and to G. Bétier, Directeur du Service de la Carte géologique de l'Algérie, who allowed a substantial grant for making the drawings. Many thanks are due to H. E. Thalmann for valuable assistance in correcting the English, to P. Marks for his helpful criticism and the drawing of the figures, and to J. H. van Dijk for the making of the photographs.

DESCRIPTION OF THE SPECIES

Family AMMODISCIDAE
Genus **Ammodiscoides** Cushman, 1909
Ammodiscoides turbinatus Cushman

Ammodiscoides turbinatus CUSHMAN, 1909, Proc. U. S. Nat. Museum, vol. 36, no. 1676, p. 423, pl. 33, f. 1-6; CUSHMAN and STAINFORTH, 1946, Cushman Lab. Foram. Res., Spec. Publ. 18, p. 15, pl. 1, f. 28, 29.

As far as known this species evidently has a long stratigraphical range: Upper Cretaceous to Recent.

Occurrence—Rare in C 263.

Family LITUOLIDAE
Genus **Haplophragmoides** Cushman, 1910
Haplophragmoides eggeri Cushman
Plate 15, figure 1

Haplophragmoides eggeri CUSHMAN, 1926, Bull. Am. Ass. Petr. Geol., vol. 10, p. 583, pl. 15, f. 1; CUSHMAN and JARVIS, 1932, Proc. U. S. Nat. Museum, Bull. 80, art. 14, p. 12, pl. 3, f. 2; GALLOWAY and MORREY, 1932, Journ. of Pal., vol. 5, p. 333, pl. 37, f. 6; GLAESSNER, 1937, Probl. Paleont., Moscow Univ., vols. 2-3, p. 361, pl. 1, f. 10.

Remarks—Many of the Algerian specimens, considered to belong to this species, have been somewhat distorted, resulting in rather varying external appearances of the test, because of different directions of distortion for the separate specimens. In some individuals the sutures appear strongly limbate (see Pl. 15, fig. 1).

Occurrence—Few in 699 and R 109, rare in C 263.

Originally described from the Velasco shale of Mexico. Reported from Uppermost Cretaceous (about Danian) deposits in Mexico and Trinidad and from the Paleocene of the Caucasus.

Family TEXTULARIIDAE
Genus **Spiroplectammina** Cushman, 1927
Spiroplectammina raveni Drooger, n. sp.
Plate 15, figures 2a-3b

Description—Test minute, about 1½ times as long as broad, gradually tapering to the broadly rounded initial end, compressed, early portion distinctly coiled, later part biserial with inter-fingering chambers; periphery sharp, slightly keeled and often indented; chambers distinct, in the biserial portion about twice as broad as high; sutures strongly limbate, occasionally raised in the early portion, in the adult usually slightly depressed and somewhat curved, forming an angle with the median line of about 70 degrees in their inner portion; wall arenaceous, rather roughly finished; aperture a narrow slit at the base of the final chamber. Maximum observed length 0.25 mm.

Remarks—Except for its much smaller size *S. raveni* differs from *S. richardi* Martin (1943, Publ. Stanford Univ., Univ. Ser., Geol. Sci., vol. 3, no. 3, p. 104, pl. 5, f. 3) from the Eocene-Paleocene Lodo formation of California by its strongly limbate sutures, which show a different arrangement near the median line, whereas the early coiled stage is relatively better developed in the Algerian species.

Occurrence—Rare in Q 1.

Genus **Textularia** Defrance, 1824
Textularia plummerae Lalicker
Plate 15, figures 4a-5

Textularia cocaena PLUMMER (non Gümbel), 1926, Univ. Texas Bull. 2644, p. 67, pl. 3, f. 2.

Textularia plummerae LALICKER, 1935, Contrib. Cushman Lab. Foram. Res., vol. 11, p. 50, pl. 6, f. 10; GLAESSNER, 1937, Probl. Paleont., Moscow Univ., vols. 2-3, p. 364.

Remarks—Typical specimens are rare in our material, but many others were found with obviously the same features, but in which the test is strongly compressed, probably due to collapse of the chamber walls (see Pl. 15, fig. 5). In these specimens the sutures appear as somewhat limbate and often slightly elevated ridges.

The Algerian specimens differ from *T. plummerae* in being of much smaller size (maximum length 0.35 mm.). Megalospheric specimens resemble best those pictured by Lalicker; microspheric ones are closest to the specimen pictured by Plummer.

Occurrence—Few in Q 1.

T. plummerae has been reported from the Upper Midway of Texas and the Paleocene of the Causasus.

Family VERNEUILINIDAE
Genus **Gaudryina** Orbigny, 1839
Gaudryina laevigata Franke var. **pyramidata** Cushman
Plate 15, figure 6

Gaudryina laevigata Franke var. *pyramidata* CUSH-

MAN, 1926, Bull. Am. Ass. Petr. Geol., vol. 10, p. 587, pl. 16, f. 8; CUSHMAN and JARVIS, 1928, Contrib. Cushman Lab. Foram. Res., vol. 4, p. 92, pl. 13, f. 6; WHITE, 1928, Journ. of Pal., vol. 2, p. 313, pl. 42, f. 7; REY, 1948, in Flandrin, Contribution à l'Etude stratigraphique du Nummulitique Algérien, p. 155.

Gaudryina pyramidata Cushman, CUSHMAN and RENZ, 1946, Cushman Lab. Foram. Res., Spec. Publ. 18, p. 21, pl. 2, f. 21; CUSHMAN and RENZ, 1948, Cushman Lab. Foram. Res., Spec. Publ. 24, p. 13, pl. 3, f. 4.

Occurrence--Common in Q 3.

Originally described from the Velasco shale of Mexico. Furthermore recorded from the Upper Cretaceous —lower zone of the Lizard Springs formation—and the Eocene of Trinidad and from the Danian of Algeria.

Family TROCHAMMINIDAE

Genus **Trochammina** Parker and Jones, 1859

Trochammina bradyi (Schwager)

Plate 15, figures 7a-c

Haplophragmium bradyi SCHWAGER, 1883, Palaeontogr., vol. 30, pt. 1, pal. pt., p. 117, pl. 29, f. 19.

Haplophragmoides diagonis CARSEY, 1926, Univ. Texas Bull. 2612, p. 22, pl. 3, f. 1.

Trochammina diagonis (Carsey) CUSHMAN, 1927, Contrib. Cushman Lab. Foram. Res., vol. 2, p. 84, pl. 10, f. 7; GALLOWAY and MORREY, 1931, Journ. of Pal., vol. 5, p. 332, pl. 37, f. 4.

Haplophragmoides sp.? WHITE, 1928, Journ. of Pal., vol. 2, p. 307, pl. 41, f. 4.

Description—Test slightly, often indistinctly, trochoid, strongly compressed. usually flattened by later distortion; periphery narrowly rounded, usually sharp, lobulate; chambers about six in the final whorl; sutures straight to moderately and often irregularly curved; wall finely arenaceous, generally smoothly finished; aperture indistinct. Maximum diameter 0.4 mm.

Remarks—It is highly probable that in all the above quoted references one and the same species is meant, the individuals of which are usually completely flattened by compression of the embedding sediment (see Pl. 15, fig. 7). As a result of this action the early characteristics of the test have mostly been obliterated, often giving a bilaterally symmetrical appearance to the test.

Occurrence—Common in Q 1, Q 3 and 699, few in Q 12.

The species was originally described from the Paleocene of El-Guss-Abu-Said, Egypt. It also occurs in beds of Taylor and Navarro age in Texas and in the Uppermost Cretaceous (about Danian) of Mexico.

Family LAGENIDAE

Genus **Lenticulina** Lamarck, 1804

Lenticulina sp. cf. **L. velascoensis** (White)

Astacolus velascoensis WHITE, 1928, Journ. of Pal., vol. 2, p. 202, pl. 28, f. 12.

Remarks—The few specimens, found in the Algerian material, are rather badly preserved. In most of them the sutures are moderately raised and for which reasons they are tentatively referred to White's species.

Occurrence—Rare in Q 3.

Reported from Upper San Felipe to Velasco of Mexico.

Genus **Dentalina** d'Orbigny, 1826

Dentalina sp. cf. **O. inornata** Orbigny

Dentalina inornata ORBIGNY, 1846, Foram. Foss. Bass. Tert. Vienne, p. 44, pl. 1, f. 50, 51.

Dentalina aff. *inornata* Orbigny, SCHWAGER, 1883, Palaeontogr., vol. 30, pt. 1, pal. pt., p. 107, pl. 26, f. 3.

Remarks—Few fragmentary specimens were found, which resemble the one pictured by Schwager from the Paleocene of Egypt.

Occurrence—Rare in C 265.

Genus **Nodosaria** Lamarck, 1812

Nodosaria bacillum Defrance

Plate 15, figure 8

Nodosaria bacillum DEFRANCE, 1826, Dict. des Sc. Nat., vol. 35, p. 127, pl. 13, f. 4; D'ORBIGNY, 1846, Foram. Foss. Bass. Tert. Vienne, p. 40, pl. 1, f. 40-47.

Remarks—Many fragments of a large costate *Nodosaria* were found, usually consisting of single chambers only, showing the following characteristics: chambers globular to somewhat longer than broad, variably ornamented with 8-25 heavy, longitudinal costae, which pass in diminishing strength, but uninterrupted, over the broad, deeply depressed sutures. Maximum observed breadth of a single chamber 0.8 mm.

In the literature numerous specific names were given to similar forms of *Nodosaria,* occurring in sediments from many parts of the world and from widely varying stratigraphic levels. Several of these forms have been referred to *N. affinis* Orbigny, which in our opinion is identical with Defrance's species. Thus the Algerian fragments are considered to belong to the earlier described *N. bacillum.*

Occurrence—Rare in Q 3, 699 and R 109.

In addition to the rare occurrences in some of the samples from the southern slopes of the Djebel Maadid, this species is abundant in several samples from the Cretaceous-Tertiary transitional strata of the neighbourhood of Aïn Fakroun and Oued Athmenia (Dept. of Constantine).

Genus **Vaginulina** Orbigny, 1826
Vaginulina legumen (Linné)
Plate 15, figures 9, 10

Nautilus legumen LINNÉ, 1758, Syst. Nat., ed. 10, vol. 1, p. 711, (Plancus, pl. 1, f. 7g-i).

Occurrence—Common in Q 3, few in G 64, rare in E 29D (collection Cruys). It is the only species present in E 29D from the Cretaceous-Tertiary transitional marls in the vicinity of Bordj Rh'dir.

Originally described as a recent species from the Adriatic sea, *V. legumen* has subsequently been widely reported from numerous different stratigraphical levels from Mesozoic to Recent. Many of these references, however, do not seem to belong to this species.

Family NONIONIDAE
Genus **Nonion** Montfort, 1808
Nonion acutidorsatum Dam
Plate 15, figures 11a, b

Nonion acutidorsatum DAM, 1944, Meded. Geol. Stichting, Ser. C, vol. 5, no. 3, p. 108, pl. 3, f. 19.

Remarks—Part of our specimens closely resemble the one, pictured by ten Dam, whereas others are somewhat more rounded in outline or with a slightly thicker test (see Pl. 15, fig. 11). The average number of chambers in the final whorl is eight, thus slightly less than in the typical form. Some specimens approach the type of the recent *N. labradoricum* (Dawson) (1860, Canad. Naturalist, vol. 5, p. 191, f. 4), whereas others again are slightly oblique and *Nonionella*-like. Notwithstanding these minor differences it is considered preferable to place the group of Algerian specimens as a whole in *N. acutidorsatum*.

Occurrence—Common in Q 12 and C 265, few in C 263, 699 and G 64.

Originally described from the Eocene (Lutetian) of the Netherlands.

Nonion sublaeve Dam
Plate 15, figure 12

Nonion sublaeve DAM, 1944, Meded. Geol. Stichting, ser. C, vol. 5, no. 3, p. 109, pl. 3, f. 8.

Occurrence—Few in C 265.

Originally described from the brackish-water Paleocene of the Netherlands.

Genus **Nonionella** Cushman, 1926
Nonionella insecta (Schwager)
Plate 15, figures 13a-c

Anomalina insecta SCHWAGER, 1883, Palaeontogr., vol. 30, pt. 1, pal. pt., p. 128, pl. 28, f. 2a-d.

Nonionella insecta (Schwager) CUSHMAN and PONTON, 1932, Contrib. Cushman Lab. Foram. Res., vol. 8, p. 65, pl. 8, f. 13, 14; GLAESSNER, 1937, Probl. Paleont., Moscow Univ., vols. 2-3, p. 368.

Remarks—The Algerian representatives of this species are small (larger diameter about 0.2 mm.) and closest to the young stage of the species, pictured by Cushman and Ponton. They show a faint resemblance with some of the individuals of *Nonion acutidorsatum* Dam, occurring in the same samples, but it was impossible to find convincing transient specimens between them and immature individuals of *Nonion acutidorsatum*. For this reason they are treated as belonging to a separate species.

Occurrence—Few in Q 12 and C 263.

Originally described from the Paleocene of El-Guss-Abu-Said, Egypt. Reported furthermore from the Wilcox Eocene of Alabama and the Paleocene of the Caucasus.

Nonionella ovata Brotzen

Nonionella ovata BROTZEN, 1948, Sver. Geol. Unders., Avh., ser. C, no. 493, årsb. 42, no. 2, p. 68, pl. 10, f. 13, 14.

Remarks—In sample Q 1, slightly above the *Cardita beaumonti*-level near the river Ksob, a single specimen of *Nonionella* was found, which is considered to belong to Brotzen's species. The only differing feature is in the very slight depression of the sutures in the Algerian specimen. Because of this characteristic there is some resemblance with the Upper Cretaceous *N. austinana* Cushman (1933, Contrib. Cushman Lab. Foram. Res., vol. 9, p. 57, pl. 7, f. 2), which is, however, considerably more compressed.

Occurrence—Rare in Q 1.

Described from the Paleocene of Sweden.

Family HETEROHELICIDAE
Genus **Gümbelina** Egger, 1899
Gümbelina morsei Kline
Plate 15, figure 14

Gümbelina morsei KLINE, 1943, Bull. Miss. Geol. Survey, no. 53, p. 44, pl. 7, f. 12.

Remarks—An insignificant number of small and strongly variable *Gümbelina* specimens from some of the samples seems to be closest to this species. Since variation among them is rather wide, several of the specimens approach the types of other species, but specific determination of these more or less aberrant forms would be impossible because of the lack of sufficient material. As a matter of fact, in the genus *Gümbelina* several of the described species are less different from one another than the specimens of a single fossil assemblage, which are reasonably considered to belong to one and the same species. When the variation of the individuals in a newly established species is insufficiently described as is often the case, later specific determination is severely hampered. Among the material of our samples some larger specimens are close to *G. striata* (Ehrenberg) and *G. ultimatumida* White, others again approach the type of *G. midwayensis* Cushman.

Occurrence—Few in C 263, 699 and G 64.

Originally described from the Paleocene Midway series of Mississippi.

Genus **Gümbelitria** Cushman, 1933

Gümbelitria triseriata (Terquem)

Plate 15, figures 15, 16

Textilaria triseriata TERQUEM, 1882, Mém. Soc. Géol. France, sér. 3, tome 2, p. 145, pl. 15, f. 10.

(?) *Gümbelitria stavensis* BANDY, 1949, Bull. Am. Paleont., vol. 32, no. 131, p. 124, pl. 24, f. 5.

Remarks—Many of the Algerian specimens are somewhat twisted or irregular in the later stages of individual development. The aperture is a semicircular opening at the base of the final chamber. Measured length up to 0.20 mm.

It should be remarked that in our material *G. triseriata* is found together with numerous representatives of *Bulimina trigonalis* Dam. In general appearance both species are very similar, the main distinguishing feature being the shape of the aperture. Unfortunately, in many specimens the aperture is rather ill-preserved, thus causing doubtful determinations in such cases. Intergradation of both species could not be observed, but it should be borne in mind that the indistinct apertural characteristics in many individuals hamper a clear decision on this subject. Such an intergradation is thought to be not entirely impossible, as many older species of *Bulimina* show a considerable amount of variation in the shape of their aperture.

Occurrence—Few in C 263.

Originally described from the Lower Eocene of France. Specimens resembling *G. stavensis* Bandy from the Claiborne Eocene of Alabama are equally represented in the Algerian material. They cannot be separated specifically here.

Family BULIMINIDAE

Genus **Buliminella** Cushman, 1911

Buliminella parvula Brotzen

Buliminella parvula BROTZEN, 1948, Sver. Geol. Unders., Avh., ser. C, no. 493, årsb. 42, no. 2, p. 57, pl. 10, f. 3, 4.

Remarks—In sample Q 3 one specimen was found, which closely resembles the one pictured by Brotzen as Fig. 3 from the Paleocene of Sweden.

Genus **Bulimina** d'Orbigny, 1826

Bulimina marksi Drooger, n. sp.

Plate 15, figures 17a-19

Description—Test small, 1½ times to twice as long as broad, bluntly triangular in transverse section, sides about parallel, initial end truncate and somewhat rounded; early chambers indistinct, later ones triserial, slightly inflated and overlapping, very slowly increasing in size as added; sutures somewhat depressed and sinuous; wall smooth, distinctly and rather coarsely perforate; aperture slightly elongate, at the inner margin of the last-formed chamber, extending upwards into the apertural face, lying in a wide depression of the latter. Length up to 0.20 mm.

Remarks—The most characteristic features of *B. marksi*, which also serve to distinguish it from the other representatives of the genus *Bulimina*, are the truncate initial end and the triangular, prismatic appearance of the test. Possibly *B. rugifera* Glaessner (1937, Probl. Paleont., Moscow Univ., vols. 2-3, p. 372, pl. 2, f. 19) from the Upper Senonian and the Paleocene of the Caucasus and the same species, reported from the Upper Velasco of Mexico [*B. velascoensis* White (non Cushman), 1929, Journ. of Pal., vol. 3, p. 50, pl. 5, f. 13] are related to the Algerian species, which is different by the more truncate lower part of the test and the lack of surface ornamentation. Another possibly allied species is *B. mendezensis* White (1929, Journ. of Pal., vol. 3, p. 49, pl. 5, f. 10) from the Upper Cretaceous Mendez shale of Mexico, which differs from *B. marksi* by the less truncate initial end and the more rounded cross section.

Occurrence—Common in C 263.

Bulimina ovata Orbigny

Bulimina ovata ORBIGNY, 1846, Foram. Foss. Bass. Tert. Vienne, p. 185, pl. 11, f. 13, 14; CUSHMAN and PARKER, 1937, Contrib. Cushman Lab. Foram. Res., vol. 13, p. 47, pl. 6, f. 4, 5; GLAESSNER, 1937, Probl. Paleont., Moscow Univ., vols. 2-3, p. 371; DAM, 1944, Meded. Geol. Stichting, ser. C, vol. 5, no. 3, p. 111, pl. 3, f. 10, 11; MARKS, 1951, Contrib. Cushman Found. Foram. Res., vol. 2, pt. 2, p. 57.

Occurrence—Rare in Q 3.

Originally described from the Miocene of the Vienna Basin. Probably ranging from Upper Cretaceous to Recent.

Bulimina trigonalis Dam

Plate 15, figures 20-22

Bulimina trigonalis DAM, 1944, Meded. Geol. Stichting, ser. C, vol. 5, no. 3, p. 112, pl. 3, f. 16, 17.

Remarks—Especially the smaller Algerian specimens closely resemble the individuals, pictured by ten Dam. In most of the larger ones the later chambers are somewhat more rapidly increasing in size than those of the early stages of individual development. Moreover the final chambers become more strongly twisted than those of the pictured Dutch forms, often tending towards biseriality. Length up to 0.4 mm.

Occurrence—Common to abundant in Q 3 and C 263.

Originally described from the littoral-marine Paleocene of the Netherlands.

Genus **Virgulina** Orbigny, 1826

Virgulina troosteri Drooger, n. sp.

Plate 15, figures 23a-24

Description—Test small, elongate, 2½-4 times as

long as broad, slightly to moderately compressed, sides about parallel to slowly tapering to the initial end; early triserial portion relatively very small, biserial part somewhat twisted, made up of 6-12 slightly inflated chambers; early biserial chambers broader than high, increasing upwards in relative height, resulting in final chambers with greater height than breadth; sutures distinct, slightly curved, making an angle of 50-80 degrees with the longer axis of the test, slightly depressed; wall smooth, finely perforate; aperture a large, wide opening at the inner margin of the final chamber. Length 0.24-0.36 mm., breadth about 0.9 mm.

Remarks—In general appearance *V. troosteri* resembles *V. tegulata* Reuss (1845, Verst. böhm. Kreide, pt. 1, p. 40, pl. 13, f. 81), reported from the Turonian of Central Europe and the same species pictured by Cushman (1937, Cushman Lab. Foram. Res., Spec. Publ. 9, p. 4, pl. 1, f. 9-12) from the Upper Cretaceous of North America, mainly differing in the shape of the aperture.

The species has been named in honor of the late S. G. Trooster, Professor of Geology of the State University of Utrecht.

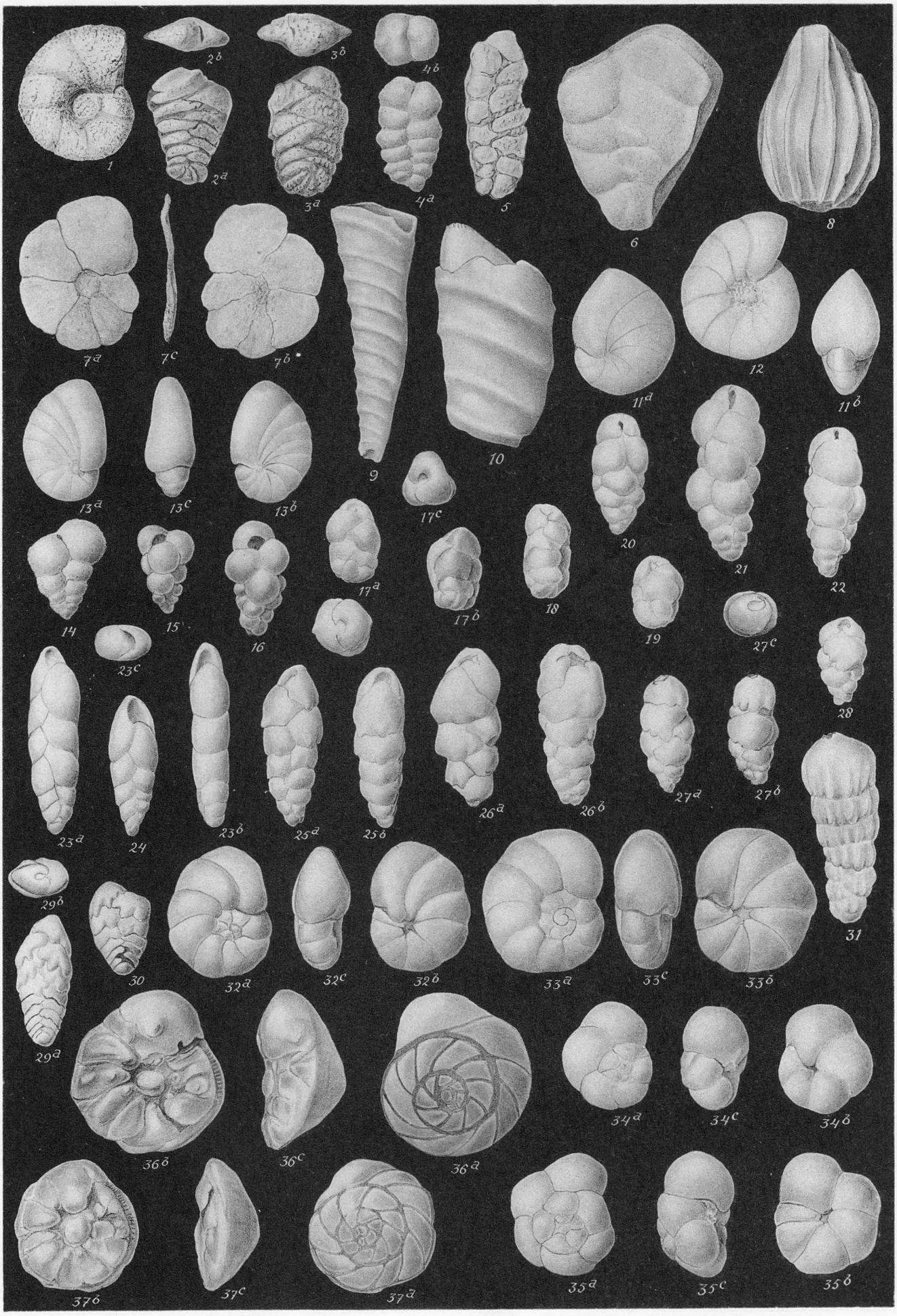
Occurrence—Common in C 263 and 699, few in Q 1 and Q 12. Holotype and paratypes from C 263.

Virgulina cruysi Drooger, n. sp.
Plate 15, figures 25a-26b

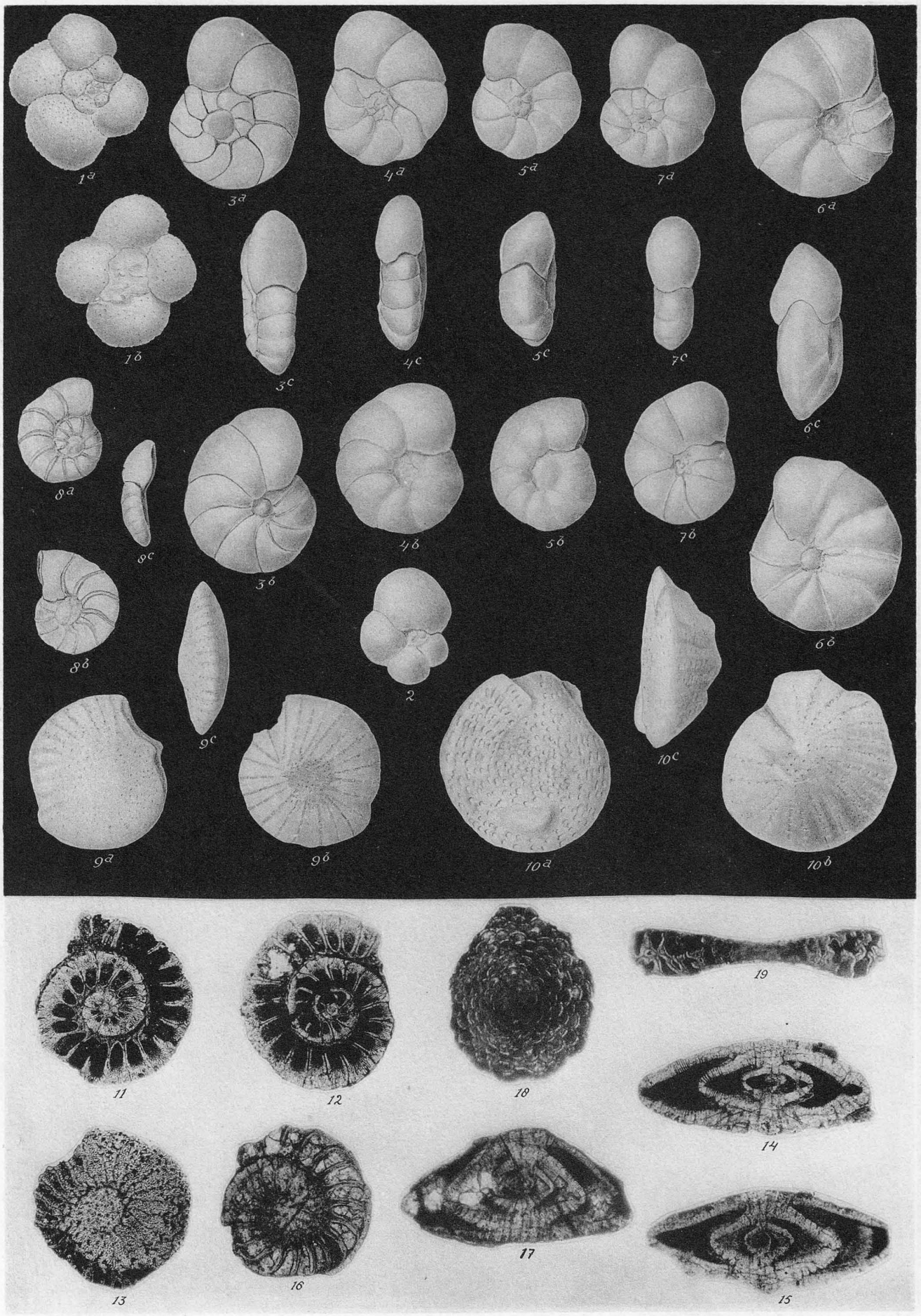
Description—Test elongate, 1½-3 times as long as broad, slightly compressed, occasionally from a somewhat oblique direction, more or less tapering, often with about parallel sides in the adult; triserial portion relatively small, biserial part slightly if at all twisted with 6-10 inflated chambers, which are in most larger specimens more or less protruding basally, forming processes, especially near the angles of the test; sutures depressed, at about right angles to the median line of the test; wall smooth, finely perforate; aperture large and wide, often with lateral extensions into the apertural face, at the inner margin of the last-formed chamber. Length up to 0.5 mm.

Remarks—The abundant specimens of *V. cruysi* show a wide variation as to the general appearance of the test, the degree of overhanging of the chambers and the shape of the aperture. Those with a distinctly tapering test throughout may be microspheric individuals, whereas others, which are more abundantly present, with about parallel sides and a very small triserial initial part may represent the megalospheric generation. On account of the peculiar apertural features several specimens were tested with hydrochloric acid, after which action only trifling amounts of fer-

EXPLANATION OF PLATE 15



Drooger, Algerian Cretaceous—Tertiary Foraminifera



Drooger, Algerian Cretaceous—Tertiary Foraminifera

ruginous material remained undissolved, these probably originating from secondary impregnation, as was observed in many more species of these samples. Because of this negative result the species is thought to belong to the genus *Virgulina*.

V. cruysi differs from *V. primitiva* Cushman (1936, Cushman Lab. Foram. Res., Spec. Publ. 6, p. 46, pl. 7, f. 1) and *V. subcretacea* Cushman (ibid., p. 46, pl. 7, f. 2) from the Lower Cretaceous of Texas and *V. miniacea* Cushman and Bermudez (1936, Contrib. Cushman Lab. Foram. Res., vol. 12, p. 30, pl. 5, f. 14) from the Upper Eocene of Cuba, by a relatively long, rather regularly biserial portion of the test and by the peculiar processes of the chambers. The latter characteristic together with the shape of the aperture distinguish *V. cruysi* from *V. sandegreni* Brotzen (1948, Sver. Geol. Unders., Avh., ser. C, no. 493, årsb. 42, no. 2, p. 65, pl. 9, f. 2) from the Lower Paleocene of Sweden.

Occurrence—Common in G 64.

Virgulina cruysi Drooger
var. **maadidensis** Drooger, n. var.
Plate 15, figures 27a-28

Description—Variety differing from the typical by its smaller size, the relatively unimportant biserial stage and the aperture, which in larger specimens is strongly contracted at its base, often being entirely separated from the inner margin of the final chamber. Length up to 0.35 mm.

Remarks—The individuals of sample 699 are smaller and usually less developed than those of sample G 64, showing a predominance of the triserial part, which often makes up the entire test. In the largest specimens, which possess a biserial part of 2-4 chambers, the aperture is separated or nearly so from the inner margin of the last-formed chamber. The latter feature allows to distinguish this variety from immature individuals of *V. cruysi*. Among the specimens of the latter in sample G 64 of El Melab no distinct representatives of *V. cruysi* var. *maadidensis* were encountered, whereas on the other hand in sample 699 mainly this variety is present. In another sample from the region of Bordj Rh'dir specimens were found which show a longer biserial portion of the test. Part of them somewhat resemble *Loxostomum cushmani* Wickenden (1932, Trans. Roy. Soc. Canada, ser. 3, vol. 26, sect. 6, p. 91, pl. 1, f. 6) from the American Upper Cretaceous.

Occurrence—Few in 699.

Genus **Bolivina** Orbigny, 1839
Bolivina betieri Drooger, n. sp.
Plate 15, figures 29a-30

Description—Test minute, 1½-2½ times as long as broad, gradually tapering to the rounded initial end, compressed, especially in the early portion of the test; periphery rounded; early chambers narrow, later ones more rapidly increasing in relative height and often also in thickness; sutures oblique, curved and slightly limbate in the early portion, in the upper part of the test crenulate with one or two deep reëntrants on each side of the chambers, the crenulate sutures appearing rather abruptly; wall smooth, finely perforate; aperture elongately oval at the inner margin of the final chamber, extending to the top of the test. Length up to 0.25 mm.

Remarks—*B. betieri* differs from most other *Bolivina* species with crenulate sutures by the absence of these crenulations on the early chambers. Some variation exists as to the relative length of the test. Extremely short variants (see Pl. 15, fig. 30) show some resemblance with *B. plicatella* Cushman var. *mera* Cushman and Ponton (1932, Florida Geol. Survey, Bull. 9, p. 82,

EXPLANATION OF PLATE 16

Figs.		Page
1a, b.	*Globigerina sp.* cf. *G. belli* White; Sample G 64; 1a dorsal view, 1b ventral view; 65 ×.	100
2.	*Globigerina voluta* White; Sample Q 12; 61 ×.	100
3a-c.	*Cibicides praecursorius* (Schwager); Sample Q 12; 3a dorsal view, 3b ventral view, 3c peripheral view; 95 ×.	101
4a-c.	*Cibicides praecursorius* (Schwager) var. *scrobiculata* (Schwager); Sample Q 12; 4a dorsal view, 4b ventral view, 4c peripheral view; 65 ×.	102
5a-c.	*Cibicides praecursorius* (Schwager) var. *umbonifera* (Schwager); Sample C 267; 5a dorsal view, 5b ventral view, 5c peripheral view; 65 ×.	102
6a-c.	*Anomalina midwayensis* (Plummer); Sample Q 3; 6a dorsal, 6b ventral, 6c peripheral view; 65 ×.	102
7a-c.	*Anomalina midwayensis* (Plummer) var. *trochoidea* (Plummer); Sample G 64; 7a dorsal view 7b ventral view, 7c peripheral view; 65 ×.	102
8a-c.	*Anomalina newmanae* (Plummer) var. *ksobensis* Drooger, n. var.; Sample 699; holotype; 8a dorsal view, 8b ventral view, 8c peripheral view; 65 ×.	102
9a-c, 11-15.	*Laffitteina bibensis* Marie; Sample C 265; 9a dorsal view, 9b ventral view, 9c peripheral view; 17 ×; 11, 12 median sections through dorsal sides of whorls showing canal systems and pores; 13 median section just below dorsal surface of test; 14, 15 transverse sections showing involute character of the walls and traces of the spiral canal system; 11 - 13 approx. 24 ×; 14 and 15 approx. 32 ×.	99
10a-c, 16, 17.	*Laffitteina conica* Drooger n. sp.; Sample C 267; holotype; 10a dorsal view, 10b ventral view, 10c peripheral view, 33 ×. 16 median section, 17 transverse section, both figs. approx. 39 ×.	100
18, 19.	*Omphalocyclus macropora* (Lamarck); Sample C 265; 18, median section; 19 transverse section, both figs. approx. 19 ×.	103

pl. 12, f. 4) from the Miocene of Florida and with *B. thomsoni* Howe (1939, Louis. Dept. Conserv., Geol. Survey, Bull. 14, p. 69, pl. 9, f. 17) from the Claiborne Eocene of Louisiana. *B. crenulata* Loetterle (non Cushman) (1937, Nebraska Geol. Survey, ser. 2, Bull. 12, p. 38, pl. 6, f. 1) from the Upper Cretaceous Niobrara formation has much higher early chambers than the Algerian species.

The species has been named in honour of G. Bétier, Inspecteur Général des Mines, Directeur du Service de la Carte Géologique de l'Algérie.

Occurrence—Common to abundant in C 263.

Genus **Loxostomum** Ehrenberg, 1854

Loxostomum plaitum (Carsey)

Bolivina plaita CARSEY, 1926, Univ. Texas Bull. 2612, p. 26, pl. 4, f. 2.

Loxostoma plaita (Carsey) CUSHMAN, 1937, Cushman Lab. Foram. Res., Spec. Publ. 9, p. 169, pl. 20, f. 1-4.

Occurrence—A single distinct specimen in C 263.

Originally described from the Lower Navarro of Texas. Widely distributed in the Upper Taylor and Navarro of the United States.

Genus **Siphogenerinoides** Cushman, 1927

Siphogenerinoides parvus Cushman

Plate 15, figure 31

Siphogenerinoides parva CUSHMAN, 1929, Contrib. Cushman Lab. Foram. Res., vol. 5, p. 58, pl. 9, f. 11-13; STONE, 1946, Journ. of Pal., vol. 20, p. 471, pl. 71, f. 11, 12.

Remarks—As far as could be ascertained the aperture in our specimens is arcuate, usually with a slight neck and a thickened rim. In the larger individuals the bi- (tri-) serial portion of the test is relatively small, even smaller than in the pictured American specimens. A drawing is given of one of the small specimens from our material (Pl. 15, fig. 31).

Occurrence—Few in Q 3.

Originally described from the Upper Cretaceous Colon shale of Venezuela.

Family ROTALIIDAE

Genus **Valvulineria** Cushman, 1926

Valvulineria koenigswaldi Drooger, n. sp.

Plate 15, figures 32a-33c

Description—Test small, trochoid, compressed, about equally biconvex; periphery rounded, slightly lobulate in the later portion; chambers distinct, somewhat inflated, especially in the adult, rapidly increasing in size as added, about two whorls visible dorsally, 7-9 chambers in the final convolution; sutures ventrally depressed and evenly curved, radiating from the small umbilical depression, dorsally depressed and curved, the spiral sutures being most strongly depressed; wall smooth and finely perforate; aperture somewhat variable and often indistinct, usually consisting of a narrow slit along the inner margin of the final chamber from the periphery to about half way towards the ventral umbilicus, with a curved narrow opening from about the middle of the basal slit, extending obliquely upwards into the apertural face and pointing to the ventral umbilicus. Larger diameter up to 0.85 mm., thickness up to 0.35 mm.

Remarks—In many specimens only the oblique opening of the aperture is distinct, whereas in others this part could not be traced. Sometimes it is less well-developed and evidently it is replaced then by a shallow closed furrow in the apertural face. Similar apertures occur in some described species of the genus *Valvulineria,* for which reason our species is placed here although distinct umbilical plates of the chambers are hardly developed, if not entirely lacking. The peculiar apertural characteristics of this species make its generic placement uncertain. In some respects the specimens resemble compressed *Gyroidina* species, whereas on the other hand the extension of the aperture towards the periphery seems to place this form in the vicinity of the *Anomalinidae.* A similar species in general appearance is *Gyroidina childsi* Martin (1943, Publ. Stanford Univ., Calif., Univ. Ser., Geol. Sci., vol. 3, no. 3, p. 112, pl. 6, f. 6) from the Eocene and Paleocene Lodo formation of California, which is different from *V. koenigswaldi* in its slightly higher number of less elongate chambers, whereas the aperture is evidently a simple basal slit in this American species.

The species has been named in honour of G. H. R. von Koenigswald, Professor of Paleontology of the State University of Utrecht.

Occurrence—Common in 699 and G 64, few in Q 1 and C 263, rare in R 109. Holotype and paratype from G 64.

Valvulineria palmi Drooger, n. sp.

Plate 15, figures 34a-35c

Description—Test small, trochoid, about equally biconvex; periphery broadly rounded and lobulate; chambers inflated, rather rapidly increasing in size as added, each with a slight extension over the small depressed ventral umbilicus, dorsally two whorls visible, about 5 chambers in the final coil; sutures depressed, curved; wall finely granular and coarsely perforate; aperture ventral, at the base of the last-formed chamber as a low arched slit from near the periphery to close to the umbilicus. Diameter up to 0.20 mm., thickness up to 0.13 mm.

Remarks—Except for its much smaller size *V. palmi* differs from *V. chirana* Cushman and Stone (1947, Cushman Lab. Foram. Res., Spec. Publ. 20, p. 22, pl. 3, f. 3) from the Upper Eocene of Peru, by its generally more curved sutures, whereas *Gyroidina byramensis* Cushman and Todd (1946, Contrib. Cushman Lab. Foram. Res., vol. 22, p. 98, pl. 16, f. 19-21) from the Oligocene Byram marl of Mississippi is somewhat more elongate and evidently possesses a flattened dorsal side.

Occurrence—Few in Q 12. In C 263 some rare specimens were encountered, which are close to *V. palmi,* only being relatively somewhat thicker with a wider aperture.

Genus **Rotalia** Lamarck, 1804

Rotalia sigali Drooger, n. sp.

Plate 15, figures 36a-37c

Description—Test small, trochoid, unequally biconvex to plano-convex, dorsal side most strongly elevated, forming a low, somewhat rounded cone, ventral side occasionally slightly convex, usually about flat; periphery subacute, formed by the thick peripheral part of the spiral wall, in some specimens with a beginning development of peripheral spines; ventral umbilicus filled with a large plug, somewhat variable in size, generally separated from the inner ends of the chambers, especially the later ones, by a deeply depressed furrow; chambers rather distinct, about three whorls visible dorsally, 8-11 chambers in the final convolution; dorsal sutures strongly oblique and somewhat curved, limbate, slightly raised in the early part of the test to slightly depressed in the adult; ventral sutures depressed, becoming deeper and wider towards the umbo, where they open into the umbilical furrow, radial to slightly tangential to the umbo, slightly curved, more strongly so near the periphery, where they often show a more or less developed bifurcation; wall smooth, perforate; aperture ventral at the base of the last-formed chamber, running from near the periphery to close to the umbo, in well-preserved specimens covered by a narrow, plate-like structure. Diameter up to 0.45 mm., thickness up to 0.18 mm.

Remarks—No clear thin sections of this small species could be made.

R. sigali shows morphologically some resemblance with *R. orientalis* Cushman and Bermudez (1947, Contrib. Cushman Lab. Foram. Res., vol. 23, p. 26, pl. 7, f. 2) from the Upper Eocene of Cuba and *R. cushmani* Applin and Jordan (1945, Journ. of Pal., vol. 19, p. 143) from the Upper Eocene of Florida. Since little is remarked about the variation of these species, it is impossible to obtain a clear comparison of the Algerian with the American forms. Some extreme variants of *R. sigali* approach the types of each of these species, but both from the figures and from the descriptions it is evident that many differences exist with the group of individuals from the Hodna Mountains. For this reason the latter is described as a new species. Bifurcating sutures and peripheral spines are shown in much higher development than in *R. sigali* in *R. lithothamnica* Uhlig (1886, Jahrb. Geol. Reichsanst., Wien, vol. 36, p. 195, pl. 5, f. 9-11) from the Lower Tertiary of the Carpathians.

Occurrence—Common in C 265, few in C 267. Holotype and paratype from C 265.

Genus **Laffitteina** Marie, 1945

Laffitteina bibensis Marie

Plate 16, figures 9a-c; 11-15

Laffitteina bibensis MARIE, 1945, Bull. Soc. Géol. France, ser. 5, vol. 15, p. 431, f. 1-3, 14-16, pl. 1, f. 1-6.

Remarks—The specimens of the Hodna material agree fairly well with those described by Marie. A few additional, partly differing, observations could be made on the inner structure.

In thin sections a canal system in the walls is apparent, which is best visible in the septae. This intraseptal system consists of fissure-like spaces in the septae, which send branches, either bifurcating or not, to the surface of the test, where they correspond with the openings along the sutures. In the central part of the test many of these canals, leading to the surface, are seen to pierce the involute later walls without interruption. A second, much less distinct canal system occurs on the dorsal side of the spiral walls of the earlier convolutions, where these are covered by the later whorls. This system, which is formed on the older spiral wall by an irregular covering with shell material from the chambers of the overlying whorls, consists of a number of thin, sometimes flattened, irregular and anastomosing, spirally arranged canals. In some of the sections the latter are distinctly seen to correspond with the intraseptal canals of the previous and overlying whorls. The spiral system is probably only developed on the dorsal part of the coils and it is absent in the final whorl.

When regarding the exterior, *Laffitteina* seems to be close to the genus *Faujasina* Orbigny, 1839, as was suggested by Marie. According to d'Orbigny (1846, Foram. Foss. Bass. Tert. Vienne, p. 194, pl. 21, f. 29-31) the type species of the latter genus, *Faujasina carinata,* had been derived from the Upper Cretaceous of Maastricht, Holland. Cushman remarked, however, (1939, U. S. Geol. Survey, Prof. Paper 191, p. 67) that this statement is probably erroneous, as *Faujasina carinata* occurs in the Pliocene of St. Erth in southern England, but has never again been found at Maastricht. An examination of material from St. Erth evidenced that the specimens from this English locality, which are completely identical with those pictured by d'Orbigny, belong to a thin-walled species, obviously closely related to recent species of *Elphidium.* When assuming very close relations between *Laffitteina bibensis* and *Faujasina carinata* we would have to conclude a wide, incomprehensible time-stratigraphic gap between the occurrences of both genera. Therefore it looks unlikely that *Faujasina* is connected directly with *Laffitteina,* their resemblance obviously being only superficial. It is worth mentioning moreover, that, according to Hofker (1928, Contrib. Cushman Lab. Foram. Res., vol. 4, p. 80), the species from St. Erth shows an

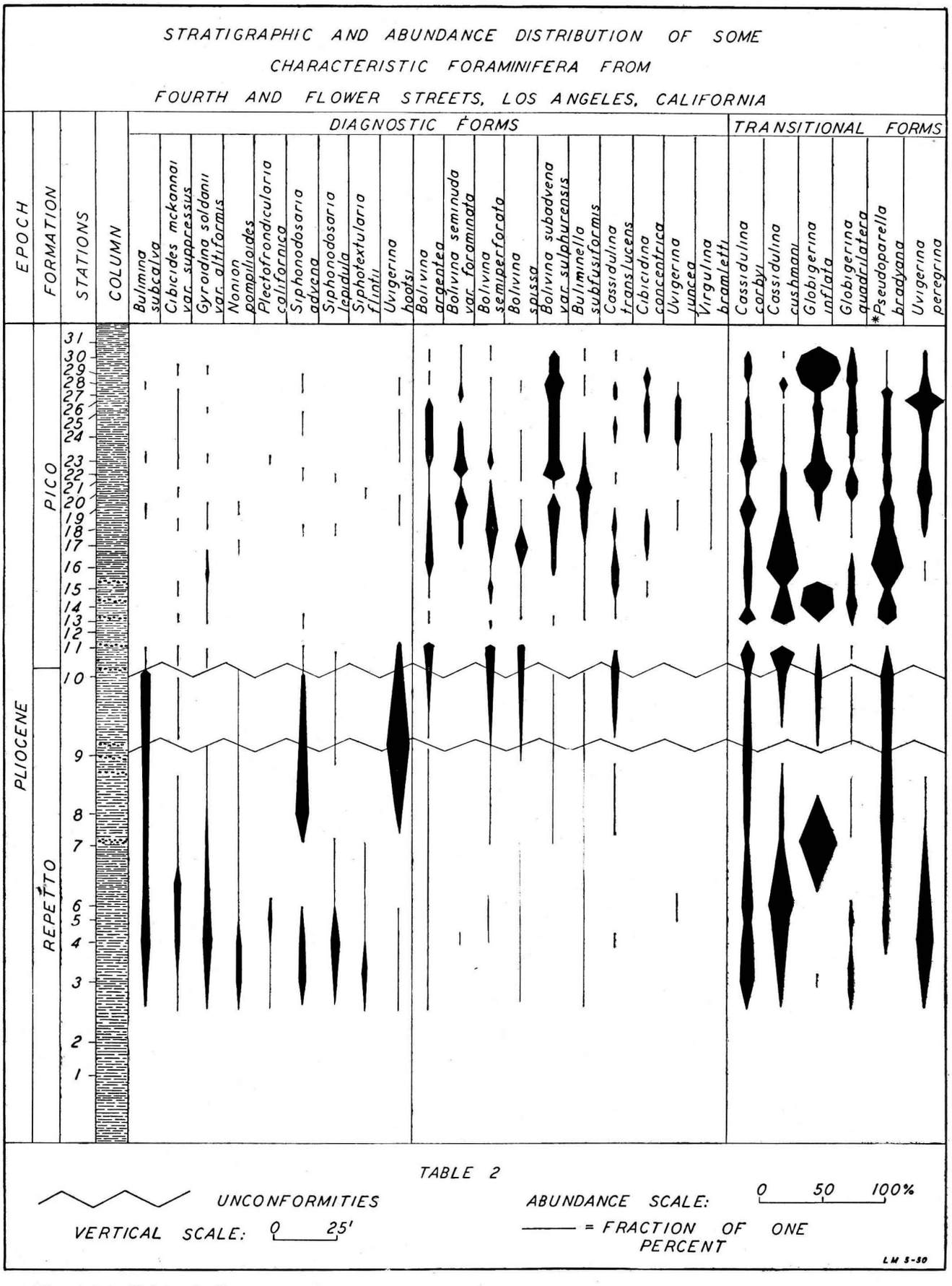


TABLE 2

* Allocated to **Epistominella**

posed. The stratigraphic thickness of the sampled section is approximately 325 feet (fig. 1). These beds are characterized by the massive nature of the silts and several interbedded conglomeratic lenses. The Repetto and Pico formations are similar lithologically so that age determinations must be made on the basis of microfaunal evidence. The Repetto dips about 60 degrees to the south whereas the Pico is less inclined and dips 40 degrees south. Both formations strike approximately in an east-west direction. In the area studied, the Puente, Repetto, and Pico formations appear to form a southward dipping monocline (fig. 2). Actually this is the southern limb of the Elysian Park anticline located about 2½ to 3 miles to the north (Arnold, 1907, p. 151).

Of significant interest is the angular unconformity of 5 to 10 degrees between the Repetto and Pico (fig. 1). This accounts for a change in dip of from 40 to 35 degrees. Directly below another angular unconformity is readily discernible by a change in dip of the conglomerate layers of 60 to 40 degrees south (fig. 1). This latter unconformity is considered to be within the Repetto formation. In general, at this outcrop the portion of the exposed Repetto is one of deposition of fine clastics interrupted at intervals by the introduction of conglomeratic material, whereas that of the Pico, with the exception of the basal conglomerate, represents a continuous deposition of fine clastics.

On the basis of microfaunal evidence to be presented in a later section, 2 major groups or zones are recognized in this paper. The lower portion of the outcrop below the 5 to 10 degree angular unconformity is assigned to the Repetto and the remaining overlying portion to the Pico (fig. 1; table 2) formations.

LITHOLOGY

As previously stated, the characteristic features of the Pliocene strata exposed in the northern part of the Los Angeles basin are the massiveness of the siltstone component and the presence of numerous thin conglomeratic lenses. Lithologically, the Repetto and Pico siltstones are similar and were it not for the conglomeratic layers any attempts to establish bedding planes would indeed be difficult.

The siltstone of both formations is olive-gray in color when dry, and a dark brownish yellow when wet. It disintegrates quite readily when placed in water and heated, and upon drying has a buff-yellow color. Near the base of the exposed Repetto several individual cobbles were found embedded in the silt (fig. 3). These do not constitute a conglomerate nor do they show any preferred orientation. Microscopic examination of the siltstone prior to preparation for analysis, reveals a random distribution of numerous foraminiferal tests. Similarly the large amounts of mica grains present display a lack of alignment of any kind. The degree of preservation of the tests varies throughout the outcrop, those of the Repetto silt are not well preserved, whereas those of the Pico yield excellent working material.

A wet sieve analysis was conducted to determine the percentages by weight of the clay and silt, very fine sand, and organic constituents of the siltstone. Two 50 gram composite samples were prepared from alternate stations of both formations and washed through a Tyler 250 mesh screen. In both instances, a very large amount of the clay and silt passed through the screen, leaving residues of very fine sand and foraminiferal tests. These residues were put through a carbon tetrachloride separation resulting in concentrates of Foraminifera and very fine sand. The latter concentrate revealed a distinct quartzose-mica element not seen in the unprocessed samples owing to blanketing by silt particles. As shown in Fig. 4, the amount of foraminiferal tests in the Repetto siltstone is somewhat less than that of the Pico. This discrepancy is thought to be partly correlative with the degree and nature of preservation, as many weathered broken tests were found in the very fine sand concentrate of the Repetto. The very fine sand constituents exhibit a 2:1 ratio in favor of the Pico suggesting that the Repetto received a greater amount of clay and silt. The clay and silt components differ conversely to a slight degree, but in both cases constitute an overwhelming percentage of the mass.

Direct measurements and counts were made of the very fine sand with the aid of an ocular micrometer. In both cases the bulk of the very fine sand residues falls within the assigned limits of Wentworth's classification of that category. Median size ranges, however, lie between 80 to 100 microns. An insignificant fraction of the grains were found to range up to 180 microns.

Analysis of the conglomerates discloses a range in thickness of from 8 to 26 inches and a spacing of from 4 to 12 feet (fig. 1). The thicker conglomerates are found in the Repetto with a gradual decrease occurring from the Repetto to the Pico suggesting a lessening in magnitude in the sedimentary interruptions of the overall depositional pattern. Nine conglomerates, from which the attitude of the siltstone is indicated, are exposed. The lowermost conglomerate is some 500 feet above the base of the Repetto (Soper and Grant, 1932, p. 1050). Making up the bulk of the lenses are granules, pebbles, and cobbles, some of which are sub-angular and others which are fairly well rounded. The conglomerates contain a large percentage of slabs, pebbles, cobbles, and blocks of a grey to buff whitish colored limestone. A varied assortment of igneous rocks account for the minor remaining elements. Edwards (1934, p. 797) presents a detailed petrologic analysis and discussion of these conglomerates and their source areas to which the reader is directed. He

favors a possible derivation of the conglomerates from the limestone lenses of the Modelo formation in the Santa Monica Mountains.

Much of the conglomeratic limestone material shows distinct pholadid borings. Several of the limestone cobbles were broken by the author and cross-sections of rotaloid Foraminifera that appear to be representative of the genera *Baggina* and *Valvulineria* were found. Also found associated with the conglomerates are occasional fragments of pectens, none of which, unfortunately, were specifically indentifiable. Significantly enough, the siltstone failed to yield any organic remains save that of the foraminiferal tests and occasionally of carbonized plant fragments.

FAUNAL CHARACTERISTICS

The microfauna described herein consists predominantly of smaller benthonic forms with a small pelagic representation. Both elements are present in large numbers, the pelagic forms making up in abundance what they lack in species. Following Galloway's classification, 10 families, 31 genera, and 92 species and varieties comprise the fauna. Among the more common and characteristic genera are: *Bolivina, Bulimina, Cassidulina, Globigerina, Lagena, Nodosaria, Epistominella,* and *Uvigerina.*

Full realization of the limitations imposed upon estimates of stratigraphic ranges of species in a section containing unconformities is taken into account, and for that reason no attempt has been made to define zonules or subzones. On the basis of characteristic species, percentage abundance counts, and association of species in the section however, two major groups or zones are recognized. Table 2 illustrates the stratigraphic ranges of the 25 most characteristic and abundant species. Forms listed are those considered to be diagnostic of the Repetto and Pico, as well as transitional forms. The latter group consists of species that occur quite commonly throughout the section, and which may have significant stratigraphic value if their vertical distribution and associations are understood. Table 3 tabulates the stratigraphic and relative abundance of the entire fauna. Both tables are based on a percentage abundance count of 7280 specimens, or 260 specimens per station.

In general, the fauna ranges indiscriminately throughout the section. Only two species were found to be restricted in the established zones, namely *Cibicidina concentrica* (Cushman) and *Virgulina bramlettei* Galloway and Morrey, both of which were found in the Pico. A few species nominally associated with the Repetto occurred in the Pico, among these are *Bulimina subcalva* Cushman and K. C. Stewart, *Nonion pompilioides* (Fichtel and Moll), and *Plectofrondicularia californica* Cushman and R. E. Stewart. The occurrence is intermittent, involving only 2 or 3 specimens of each species and does not nullify their value as stratigraphic markers.

Of general interest is the specific relationships of the fossil fauna and Recent homeomorphs from other provinces outside the California area. In the course of this study, it was found that 32% of the fauna has been reported from the Atlantic Ocean, 39% from the Gulf of Mexico and Caribbean areas, and 49% from the Pacific Ocean. A large number of these references are from more recent publications and no doubt subsequent work will continually alter the picture. (See synonymies).

The fauna as a whole shows striking resemblance and affinities to that reported by Natland (1933) from Hall Canyon in the Ventura basin and that of Cushman and R. E. and K. C. Stewart (1930) from the Wildcat series in Humboldt County, California.

ECOLOGY

Reconstruction of ecological conditions existing during Repetto and Pico times necessitates comparison

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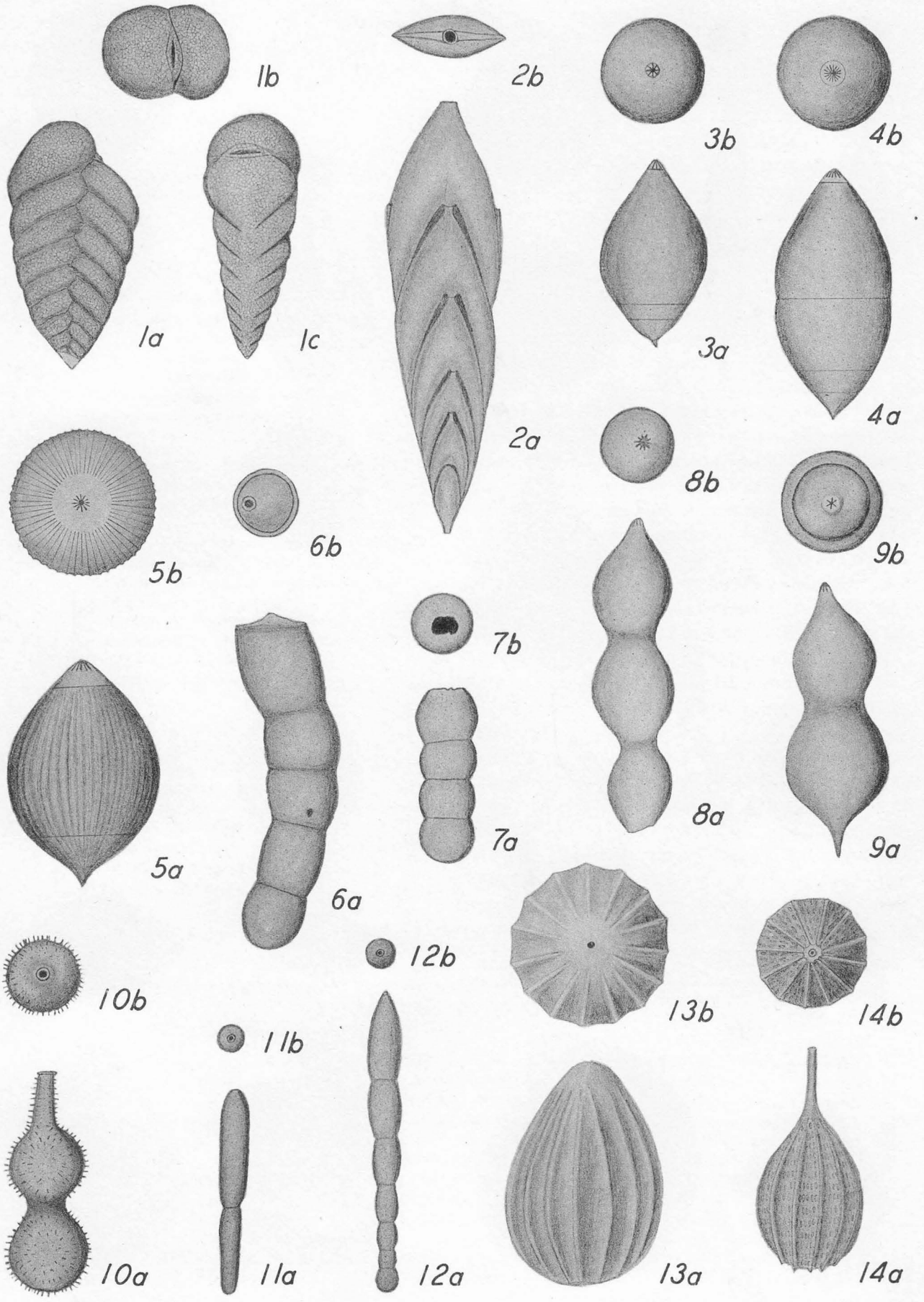
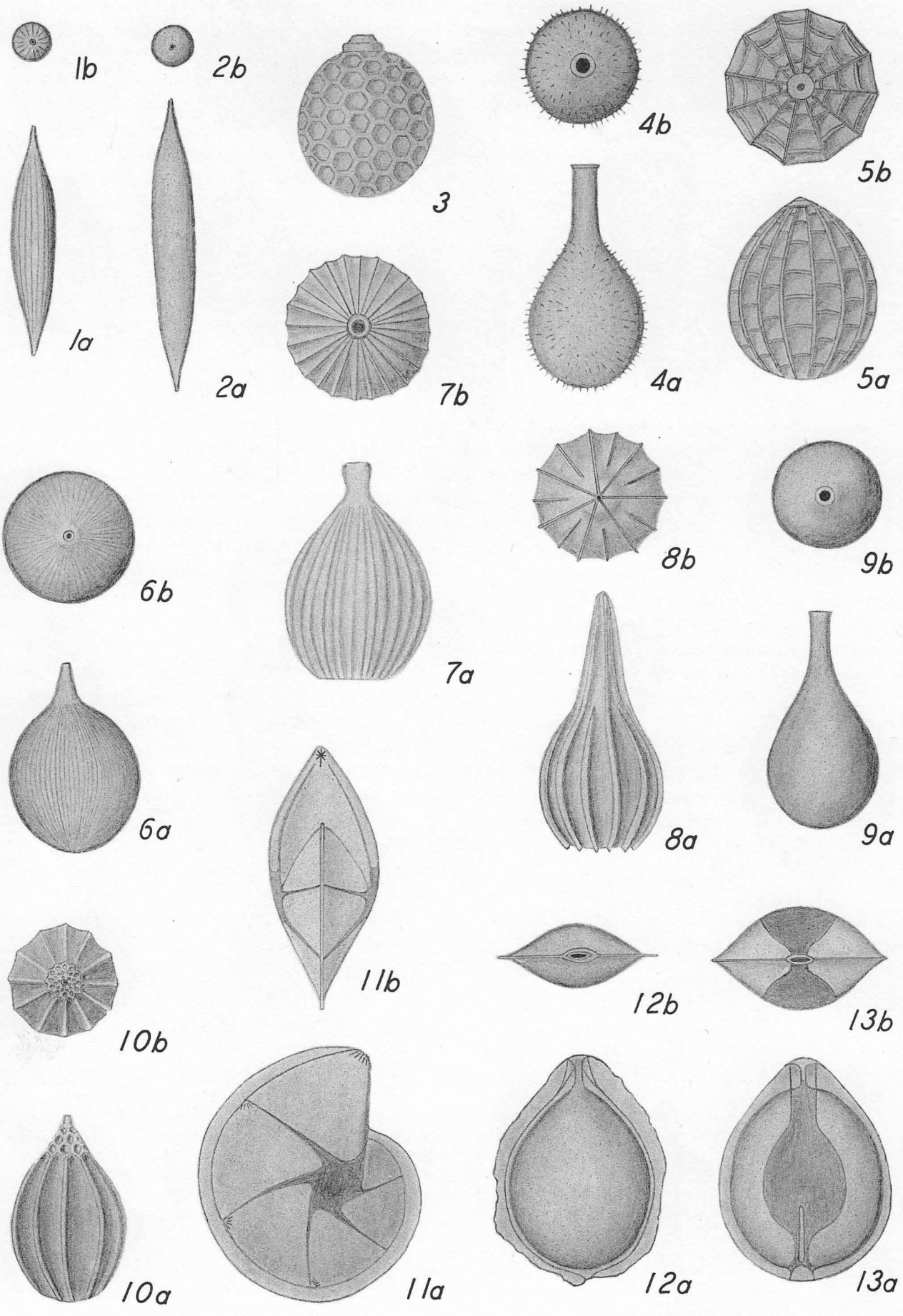
EXPLANATION OF PLATE 17



Martin: Pliocene Foraminifera, Los Angeles, California



Martin: Pliocene Foraminifera, Los Angeles, California

between Pliocene and Recent faunas, preferably, of the same province. Natland's (1933, pp. 227-228) contribution to the ecology of Foraminifera provides direct means for determining past conditions. His depth and ecological zones are as follows:

ZONE I.
Shallow, brackish-water lagoon
Depth at low tide, 1 foot, at high tide 4 to 7 feet
Abundant: **Rotalia beccarii** (Linnaeus)

ZONE II.
Bottom temperature range, 21.43 to 13.20 degrees C.
Depth range, 14 to 125 feet (open ocean)
Abundant: **Nonion scapha** (Fichtel and Moll)
Elphidium articulatum (Orbigny)
hannai Cushman and Grant
hughesi Cushman and Grant
spinatum Cushman and Valentine
Buliminella elegantissima (Orbigny)
Eponides ornatus (Orbigny)

ZONE III.
Bottom temperature range, 13.20 to 8.50 degrees C.
Depth range, 125 to 900 feet
Abundant: **Cassidulina californica** Cushman and Hughes
limbata Cushman and Hughes
tortuosa Cushman and Hughes
Eponides repandus (Fichtel and Moll)
Polymorphina charlottensis Cushman
Quinqueloculina akneriana Orbigny
Robertina charlottensis (Cushman)
Sigmomorphina frondicula riformis (Galloway and Wissler)
Triloculina trigonula (Lamarck)

ZONE IV.
Bottom temperature range, 8.50 to 4.00 degrees C.
Depth range, 900 to 6500 feet
Abundant: **Bolivina spissa** Cushman
argentea Cushman
Cassidulina cushmani Stewart and Stewart
Globobulimina pacifica Cushman
Epistominella pacifica (Cushman) (**Pulvinulinella pacifica** of author)
Uvigerina peregrina Cushman

ZONE V.
Bottom temperature range, 4.00 to 2.40 degrees C.
Depth range, 6500 to 8400 feet
Abundant: **Bulimina rostrata** Brady
Pullenia bulloides (Orbigny)
Nonion pacificus Cushman

It is at once apparent that the fauna reported in this study is wholly representative of zone IV. All of the zone indicators with the exception of *Globobulimina pacifica* Cushman occur abundantly within the section (Tables 1, 2). The limited occurrence of the *Plectofrondicularia californica* assemblage in association with large numbers of *Cassidulina cushmani* Stewart and Stewart and *Uvigerina peregrina* Cushman, both diagnostic of zone IV, indicates that differences in distribution of species between the Repetto and Pico formations at the locality are suggestive of shallowing within zone IV itself. This suggestion may be further amplified inasmuch as Repetto sediments are usually associated with the *Plectofrondicularia californica* assemblage and the depth indicators of zone V (Natland, 1933, p. 256). However such an affinity is not evident in this case and it appears that the marginal facies of the Repetto was deposited at a shallower depth somewhere within the prescribed limits of zone IV. This offers a unique example of time and ecologic indicators overlapping.

The periodic and recurrent fluctuations of the pelagic elements of the faunas as determined by the percentage abundance count has been plotted on Table 2. Whatever significance may be attributed to this oscillatory pattern must be highly conjectural and it may be that some unknown current action is intimately related with their deposition.

Adding to the general complexities of the ecological interpretation is the known occurrence of molluscan faunas from nearby areas in the Third Street tunnel between Hill and Hope Streets, Fourth and Hill Streets, and Fifth and Flower Streets (M; fig. 2). Soper and Grant (1932, p. 1065) assigned a general shallow-water facies to these faunas but state that more than one ecologic association is present. Woodring (1938, p. 16) has presented evidence in support of a fairly deep-

EXPLANATION OF PLATE 18

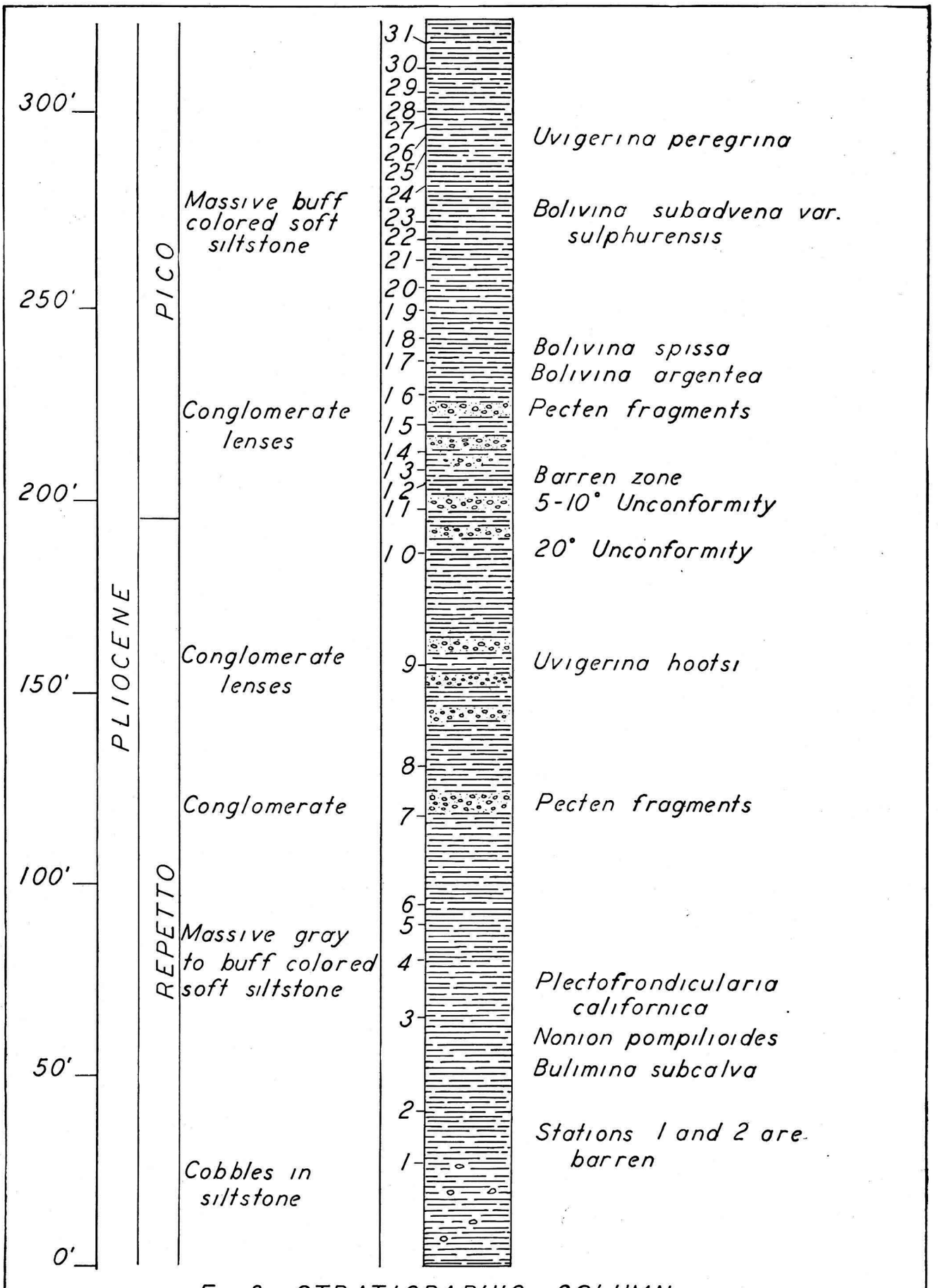


Fig. 3. STRATIGRAPHIC COLUMN
Fourth and Flower Streets, Los Angeles, California

LM 5-50

water environment. He reports a mixed assemblage of shallow, intermediate, and deep-water mollusks from the Third Street tunnel fauna. The shallow-water variety consists of broken and worn specimens which suggest transportation by some as yet unknown or not understood agency. In the same locality deep-water mollusks have been found together with foraminiferal silts (Woodring, 1938, p. 6). Modern counterparts of these Pliocene mollusks have been dredged from depths of 1800 to 2400 feet off the coast of California (Woodring, 1938, p. 15). The faunas from the Fourth and Hill and Fifth and Flower Streets localities are assigned a moderate or intermediate depth facies by Woodring (1938, p. 21).

The overwhelming numbers of specimens representative of *Bolivina, Bulimina, Cassidulina, Epistominella,* and *Uvigerina* invites comparison with recent work being done in the Gulf area. Lowman (1949, pp. 1954-1955) presents a generic depth distribution chart of Recent Gulf of Mexico Foraminifera in which he has erected a number of faunal associations. On the basis of generic affinities the Pliocene fauna analyzed herein is similar to faunal association number 10. The depth zone assigned to this faunal association ranges from 300 to over 2000 feet and within the designated limits the more typical generic representatives are *Bolivina* and *Uvigerina* (Lowman, 1949, p. 1956). While generic faunal comparisons appear to have grounds for validity, it is well to inject a note of caution in making regional comparative studies as in this case the depositional pattern of the basins off the southern California coast and that of the Gulf of Mexico differ greatly (Lowman, 1949, p. 1994).

DEPOSITIONAL ENVIRONMENT

As in the case of the Foraminifera where comparisons between Pliocene and Recent forms are made, so will the conglomerates be compared with their present-day counterparts. The constant and uniform occurrence of deep-water Foraminifera in an outcrop with angular unconformities and other interruptions in the sedimentary record leads to some rather interesting speculations regarding the origin of this phenomenon. At the onset of this work, it was thought that faunal evidence indicative of possible shallowing conditions about the unconformities encountered would be found. Such evidence is completely lacking and instead it is believed that a gradual shallowing occurred within the entire section. Inasmuch as the locality is held to be in Natland's zone IV, a relatively deep-water facies, the problem arises as to the mode of deposition of the conglomeratic lenses.

As depicted by Fig. 1, the conglomerates have a uniform thickness and size range of pebbles and cobbles. The only notable contrast in the size range of the conglomeratic material is noted at the 5 to 10 degree unconformity separating the Repetto and Pico formations. Several boulders ranging in size from 1½ to 2 feet are found associated with the more characteristic cobbles. This marked deviation in size points to an irregularity from the overall depositional pattern within the section.

An immediate lithologic change is exhibited at all contact planes of the siltstones and conglomerates. Samples of the siltstone collected directly above and below the lenses are found to contain the same deep-water Foraminifera that occur throughout the outcrop. The only exception is a 10 foot zone above station 12 suspected to be leached out (fig. 1). It would seem then that the conglomerates were deposited in deep-water and in themselves are not diagnostic of any environment but only indicate transportation from another area (Twenhofel, 1947, p. 121). Critical examination of the conglomerates has produced broken unidentifiable fragments of thick-shelled pectens and the cobbles themselves bear evidence of pholadid borings. While not entirely conclusive, these features subscribe to a possible derivation of conglomeratic material from a shallower site as in general thick-shelled invertebrates and particularly borers are restricted to rocky littoral bottoms (Hesse, 1937, p. 199). This suggested redeposition of pebbles and cobbles in deep waters has been observed in other areas where similar deposits are accumulating. As stated by Twenhofel (1936, p. 680) gravels may be deposited on the upper fourth or half of bathyal bottoms. Such occurrences are found close to land as in the case of many East and West Indian islands and off the coast of Japan. Similar rock fragments have been reported by Revelle and Shepard (1939, p. 254) along steep submarine slopes off the coast of southern California. Inasmuch as the problem of gravel and cobble deposition in deep waters is not fully understood at the present time, any possible conjectures or explanations, such as submarine slumping or action of submarine density currents should not be wholly overlooked in affecting a solution.

Intimately associated with the deposition of the conglomerates is the development of 2 unconformities, which, according to the evidence produced thus far, points to a submarine origin. Readily discernible by means of physical criteria, the circumstances peculiar to their origin appear to be quite complex. Essentially, the Pliocene strata at this locality represent a time of fine clastic deposition interrupted at intervals by the introduction of conglomeratic debris redeposited from another site. Accompanying intermittent periods of non-deposition, as indicated by the marginal hiatus found in the Los Angeles basin (Edwards, 1934, p. 808), and folding account for the unconformities and the present attitude of the strata. Accordingly, tilting or folding occured in (1) late Repetto, (2) between

TABLE 3

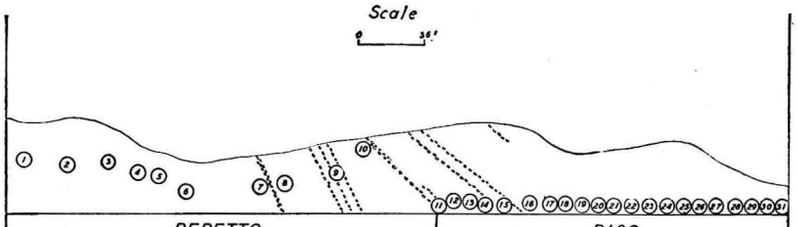
STRATIGRAPHIC DISTRIBUTION OF PLIOCENE FORAMINIFERA FOURTH AND FLOWER STREETS, LOS ANGELES, CALIFORNIA

LEGEND

Lithology: siltstone; conglomerate

Distribution: abundant 25-35 %; very common 15-25; common 5-15; present 2-5; rare 1-2; very rare 0.5-1

Scale 0 — 35'

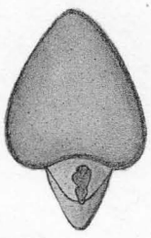


REPETTO | PICO

DIAGNOSTIC REPETTO FORAMINIFERA
Bulimina subcalva
Cibicides mckannai var. suppressus
Gyroidina soldanii var. altiformis
Nonion pompilioides
Plectofrondicularia californica
Siphonodosaria advena
Siphonodosaria lepidula
Siphotextularia flintii
Uvigerina hootsi
DIAGNOSTIC PICO FORAMINIFERA
Bolivina argentea
Bolivina seminuda var. foraminata
Bolivina semiperforata
Bolivina spissa
Bolivina subadvena var. sulphurensis
Buliminella subfusiformis
Cassidulina translucens
Cibicidina concentrica
Uvigerina juncea
Virgulina bramletti
TRANSITIONAL FORMS
Bolivina beyrichi
Bolivina seminuda
Bolivina sinuata
Bulimina marginata var. grandissima
Bulimina marginospinata
Bulimina ovula
Bulimina pagoda
Bulimina pseudoaffinis
Bulimina subacuminata
Buliminella brevior
Buliminella curta var. basispinata
Buliminella dubia
Cassidulina californica
Cassidulina corbyi
Cassidulina cushmani
Cassidulina limbata
Cassidulina lomitensis
Chilostomella czizeki
Chilostomella grandis
Cibicides fletcheri
Dentalina baggi
Dentalina soluta
Eponides subtenera
Eponides tenera
Fissurina marginata
Fissurina orbignyana var. elliptica
Frondicularia advena
Glandulina laevigata
Glandulina occidentalis
Glandulina tenuistriata
Globigerina inflata
Globigerina quadrilatera
Globobulimina glabra
Globobulimina pyrula
Globorotalia sacharina
Gyroidina soldanii var. multilocula
Lagena acuticosta
Lagena angelina
Lagena distoma
Lagena elongata
Lagena hexagona
Lagena hispida
Lagena scalariformis
Lagena striata
Lagena cf. L. sulcata
Lagena sulcata var. laevicostata
Lagena vulgaris
Lagena williamsoni
Loxostomum instabile
Nodosaria anomala
Nodosaria calomorpha
Nodosaria hispida
Nodosaria longiscata
Nodosaria parexilis
Nonion labradoricum
Orbulina universa
Planulina ornata
* Pseudoparella bradyana
* Pseudoparella pacifica
Pullenia cf. P. bulloides
Pullenia malkinae
Robulus cf. R. cultratus
Siphonodosaria antillea
Sphaeroidina chilostomata
Uvigerina hispida
Uvigerina hispida-costata
Uvigerina kernensis
Uvigerina modeloensis
Uvigerina peregrina
Uvigerina pigmea
Uvigerina proboscidea
Virgulina cornuta
Virgulina nodosa

LM 5-30

* Allocated to **Epistominella**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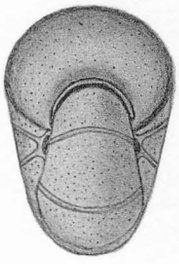
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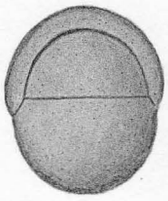
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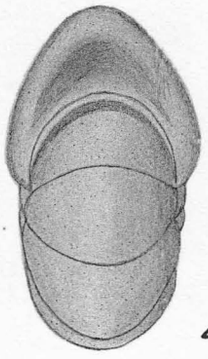
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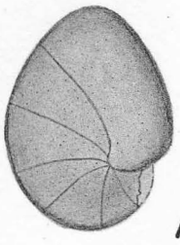
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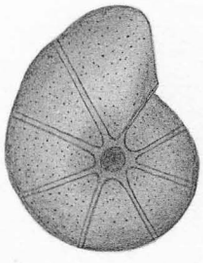
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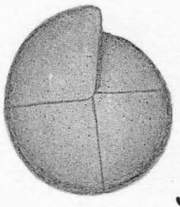
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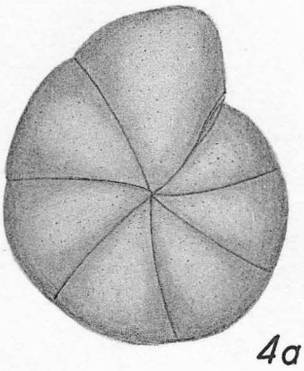
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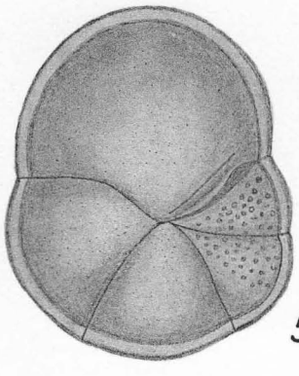
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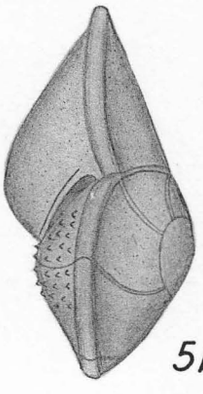
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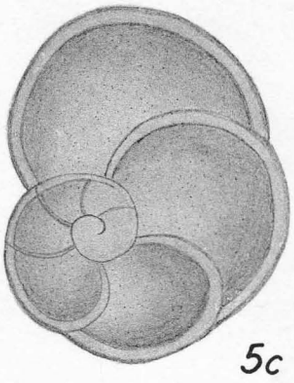
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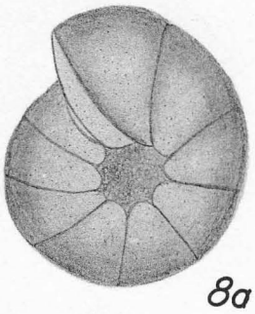
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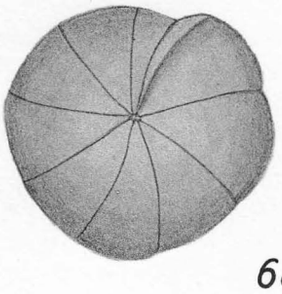
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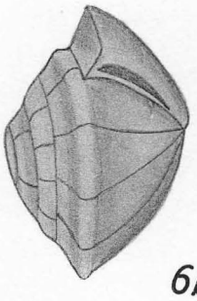
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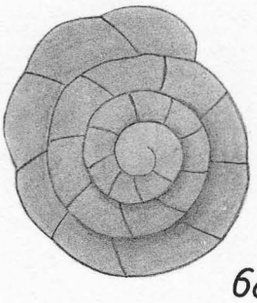
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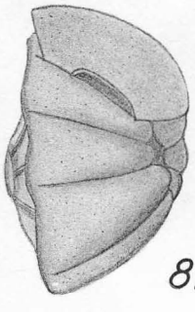
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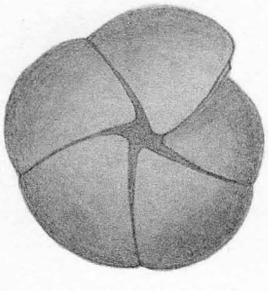
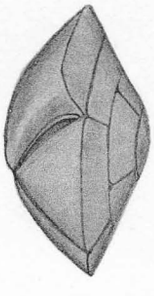
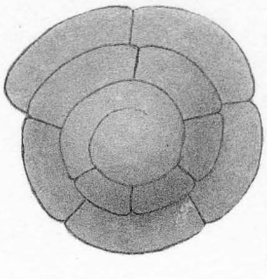
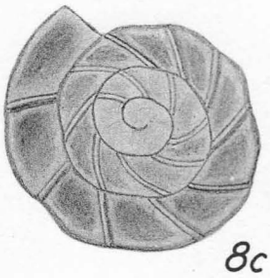

7a


7b


7c


8c

Martin: Pliocene Foraminifera, Los Angeles, California

Repetto and Pico, and in (3) presumably middle Pleistocene times.

SUMMARY

The more significant results of this study are:

1. The presentation as a faunal study of a portion of the Pliocene foraminiferal assemblage of the Los Angeles basin.

2. The describing and figuring of 92 species and varieties.

3. The discovery of 1 new species and 2 new varieties.

4. The determination of relative abundance and stratigraphic distribution of the faunas within the strata studied herein.

5. The determination of 2 major faunal facies assigned to the Repetto and Pico formations respectively. These groups are in accordance with previously established zones.

6. An attempt to present a well integrated overall picture of the ecological and depositional conditions obtaining during a portion of Pliocene time based on comparison with their Recent counterparts.

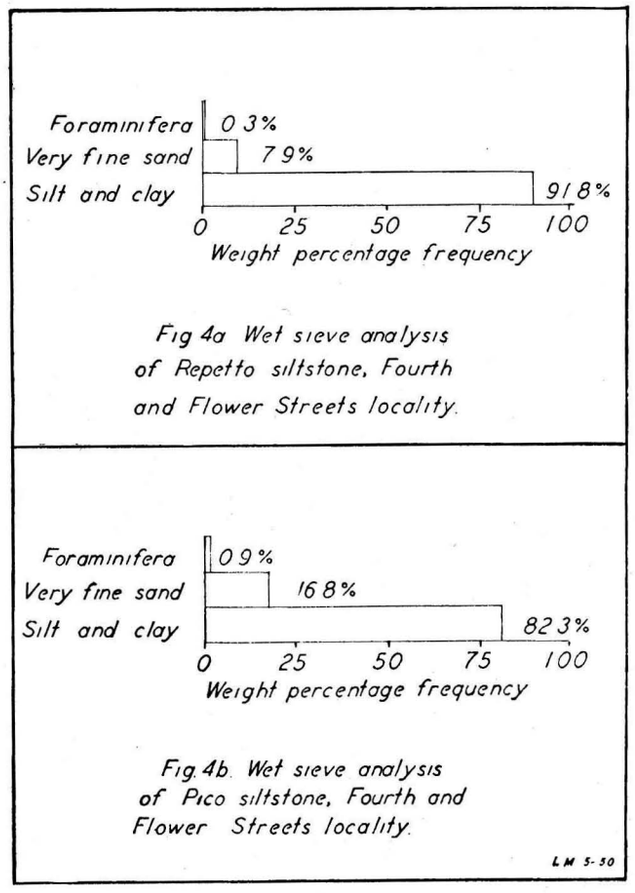


Fig 4a Wet sieve analysis of Repetto siltstone, Fourth and Flower Streets locality.

Fig 4b Wet sieve analysis of Pico siltstone, Fourth and Flower Streets locality.

SYSTEMATIC DESCRIPTIONS

All figured specimens are catalogued and deposited in the micropaleontological collection of the University of Southern California.

Phylum PROTOZOA
Class SARCODINA
Order FORAMINIFERA
Family TEXTULARIIDAE Orbigny, 1826
Genus **Siphotextularia** Finlay, 1939
Siphotextularia flintii (Cushman)

Plate 17, figures 1a-c

1911. **Textularia flintii** Cushman, U. S. Nat. Mus. Bull. 71, pt. 2, p. 21, figs. 36a, b; Recent, Guam.

1921. **Textularia flintii.** Cushman, U. S. Nat. Mus. Bull. 100, vol. 4, pp. 113-114, pl. 22, fig. 4; Recent, Atlantic.

1930. **Textularia flintii.** Cushman, Stewart and Stewart, Trans. San Diego Soc. Nat. Hist., vol. 6, no. 2, p. 50, pl. 1, figs. 1a, b; Pliocene, California.

1949. **Textularia flintii.** Bermudez, Special Publ. 25, Cushman Lab. Foram. Res., p. 61, pl. 2, figs. 11, 12; upper Oligocene, Dominican Republic.

Description.—Test roughly triangular in front view, short and broad, compressed and pointed at the initial end, apertural end broadly arched, widest portion formed by last pairs of chambers, broadly oval in end view, edge acute towards initial end, rounded towards apertural end; chambers numerous, about 10 pairs in adult form, broader than high, slightly inflated, increasing uniformly in size; sutures slightly curved, depressed, making an angle of about 35 degrees with the horizontal; wall finely arenaceous, smooth; aperture an elongate slit located at the base of last-formed chamber, with a distinct lip. Length, 0.80 mm.; width, 0.40 mm.; thickness, 0.20 mm. Rare.

Hypotype.—USC No. 865.

Family NODOSARIIDAE Schultze, 1854
Genus **Frondicularia** Defrance, 1826
Frondicularia advena Cushman

Plate 17, figures 2a, b

1884. **Frondicularia inaequalis** Brady (not Costa), Rep. Voy. Challenger, Zool., vol. 9, p. 521, pl. 66, figs. 8-12; Recent, Atlantic, Pacific.

1923. **Frondicularia advena** Cushman, U. S. Nat. Mus. Bull. 104, pt. 4, p. 141, pl. 20, figs. 1, 2; Recent Atlantic.

1927. **Frondicularia advena.** Galloway and Wissler, Journ Pal., vol. 1, no. 1, p. 41, pl. 8, figs. 7, 8; Pleistocene, California.

1930. **Frondicularia advena.** Cushman, Stewart and Stewart, Trans. San Diego Soc. Nat. Hist., vol. 6, no. 2, p. 57, pl. 3, fig. 5; Pliocene, California.

1946. **Frondicularia advena.** Cushman and Gray, Special Publ. 19, Cushman Lab. Foram. Res., p. 15, pl. 3, fig. 16; Pleistocene, California.

Description.—Test compressed, subelliptical in side view, initial end usually pointed with a subspherical proloculum, apertural end broadly rounded, thin marginal keel in adult forms; chambers inverted v-shaped, inflated, about 6 to 7 in number; sutures distinct, depressed; walls thin, transparent, smooth; aperture terminal, central, round. Length, 1.10 mm.; width, 0.35 mm.; thickness, 0.15 mm. Rare.

Hypotype.—USC No. 822.

Genus **Glandulina** Orbigny, 1839
Glandulina laevigata Orbigny

Plate 17, figures 3a, b

1826. **Nodosaria (Glandulina) laevigata** Orbigny, Ann. Sci. Nat., vol. 7, no. 1, p. 252, p. 10, figs. 1-3; Type level and locality not designated.

1846. **Glandulina laevigata.** Orbigny, Foraminifères fossiles du Bassin Tertiaire de Vienne, p. 29, pl. 1, figs. 4, 5; Miocene, Vienna Basin.

1884. **Glandulina laevigata.** Brady, Rep. Voy. **Challenger,** Zool., vol. 9, p. 490, pl. 61, figs. 20-22; Recent, All Oceans.

1930. **Glandulina laevigata.** Cushman, Stewart and Stewart, Trans. San Diego Soc. Nat. Hist., vol. 6, no. 2, p. 56, pl. 3, fig. 4; Pliocene, California.

1945. **Glandulina lavigata.** Cushman and Todd, Special Publ. 15, Cushman Lab. Foram. Res., p. 34, pl. 5, fig. 19; Miocene, Jamaica.

1949. **Glandulina laevigata.** Bandy, Amer. Pal. Bull. 131, p. 49, pl. 6, figs. 13a, b; Eocene, Alabama.

Description.—Test small, elliptical in outline, circular cross section, greatest width around the midlength, initial and apertural end pointed; chambers about 6 to 8 in adult form, greatly embracing preceding chamber; sutures flush with surface, transverse, sometimes at an angle; wall smooth, finely perforate; aperture terminal, central, radiate. Length, 0.55 mm.; diameter, 0.35 mm. Common.

Hypotype.—USC No. 823.

Glandulina occidentalis Cushman

Plate 17, figures 4a, b

1923. **Nodosaria (Glandulina) laevigata** var. **occidentalis** Cushman, U. S. Nat. Mus., Bull. 104, pt. 4, p. 64, pl. 12, fig. 8; Recent, Western Atlantic.

1949. **Glandulina occidentalis.** Bandy, Amer. Pal. Bull. 131, p. 49, pl. 6, figs. 14a, b; Eocene, Alabama.

Description.—Test subovate, circular in cross section, widest usually above the middle, initial end pointed, apertural end sharply rounded; chambers 5 to 6 in adult form, greatly embracing; sutures transverse, flush with the surface, sometimes at an angle; wall smooth, finely perforate; aperture terminal, central, radiate. Length, 0.60 mm.; diameter, 0.35 mm. Rare.

Hypotype.—USC No. 824.

Glandulina tenuistriata (Bermudez)

Plate 17, figures 5a, b

1949. **Pseudoglandulina tenuistriata** Bermudez, Special Publ. 25, Cushman Lab. Foram. Res., p. 163, pl. 10, fig. 45; Upper Miocene, Dominican Republic.

Description.—Test subovate, slightly longer than broad, initial end acute, apertural less so, widest about the middle, circular in cross section; chambers uniserial, greatly overlapping, indistinct, 3 to 4 in adult form, last-formed chamber comprising some ¾ of the test; sutures indistinct, normal to the longitudinal axis of the test; wall ornamented with very fine continuous longitudinal costae which end near the apertural area leaving a smooth area on the last chamber; aperture radiate, central, terminal. Length, 0.60 mm.; diameter, 0.40 mm. Rare.

Hypotype.—USC No. 825.

Remarks.—This species is quite similar to *Glandulina laevigata* var. *striatula* Cushman in which the fine costae continue on to the aperture and the initial end is not as acute.

Genus **Dentalina** Orbigny, 1839
Dentalina baggi Galloway and Wissler

Plate 17, figures 6a, b

1912. **Nodosaria pauperata.** Bagg (not Orbigny), U. S. Geol. Surv. Bull. 513, p. 57, pl. 16, figs. 2a-f; Pliocene, California.

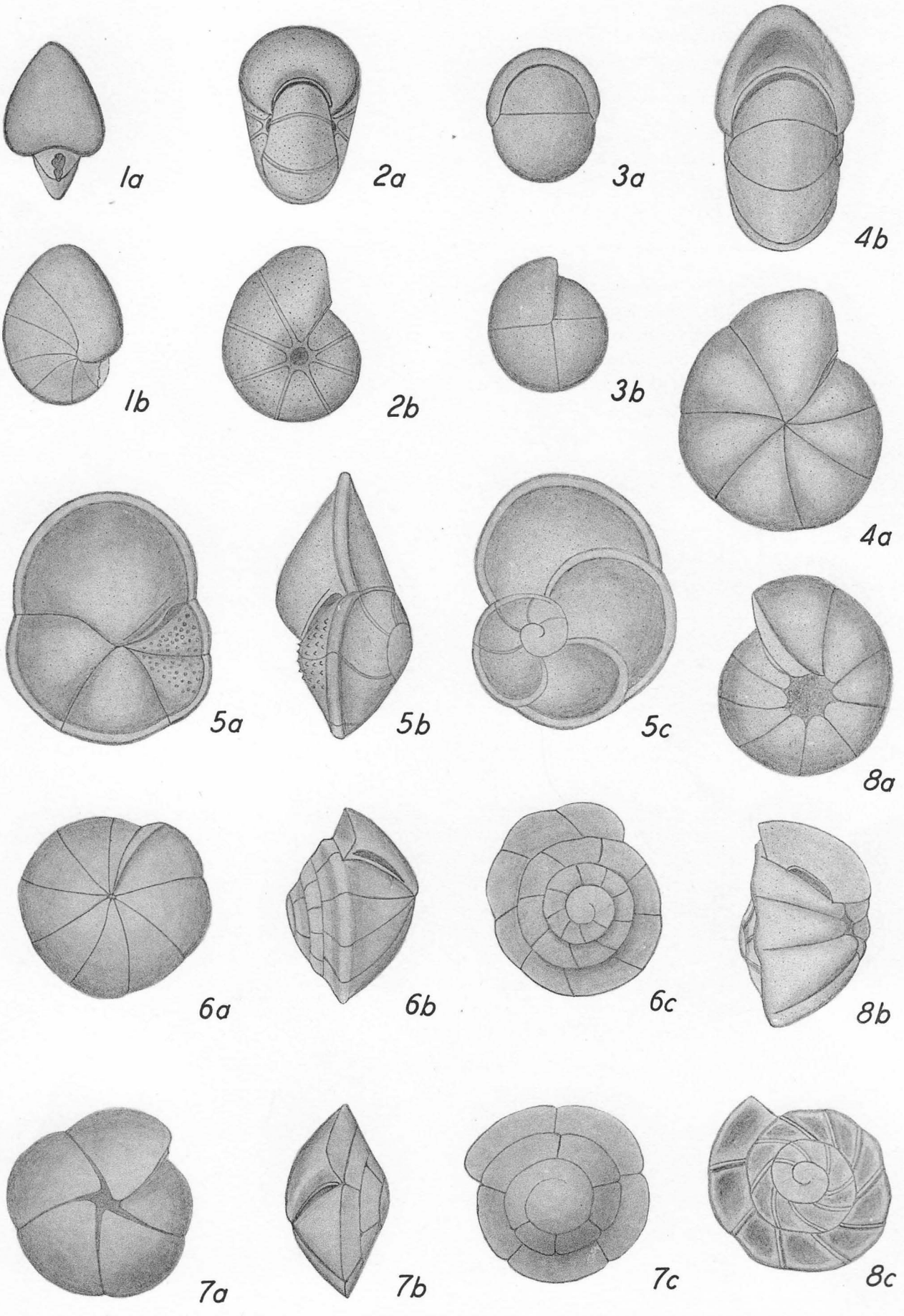
1927. **Dentalina baggi** Galloway and Wissler, Journ. Pal., vol. 1, no. 1, p. 49, pl. 8, figs. 14, 15; Pleistocene, California.

1946. **Dentalina baggi.** Cushman and Gray, Special Publ. 19, Cushman Lab. Foram. Res., p. 13, pl. 2, figs. 26, 27; Pleistocene, California.

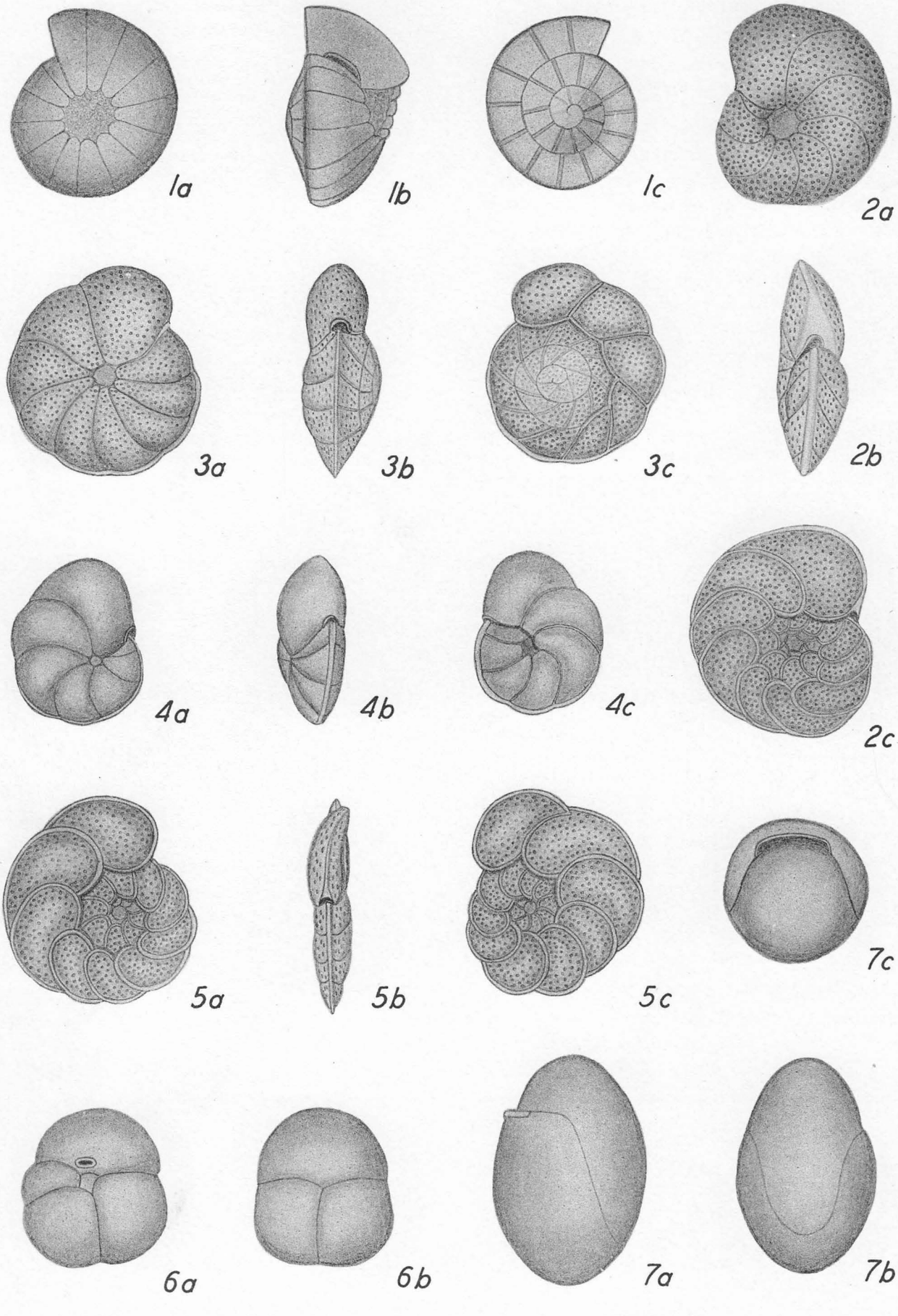
Description.—Test elongate, curved, chambers circular in cross section, initial end with the first-formed chamber often larger than the succeeding ones; chambers uniserial, inflated, increasing in size irregularly, sutures depressed, normal to longitudinal axis of test, may show some obliquity; wall smooth, finely perforate; aperture not observed but has been reported as terminal, radiate, produced, located towards the concave side of the test. Length of figured specimen, 2.0 mm.; diameter, 0.50 mm. Rare.

Hypotype.—USC No. 816.

EXPLANATION OF PLATE 19



Martin: Pliocene Foraminifera, Los Angeles, California



Martin: Pliocene Foraminifera, Los Angeles, California

Dentalina soluta Reuss

Plate 17, figures 8a, b

1851. **Dentalina soluta** Reuss, Zeitschr. Deutsch. Geol. Ges., vol. 3, p. 60, pl. 3, figs. 4a, b; Oligocene, Germany.

1912. **Nodosaria soluta.** Bagg, U. S. Geol. Surv. Bull. 513, p. 59, pl. 15, fig. 2; pl. 16, fig. 7; Pleistocene, California.

1926. **Nodosaria soluta.** Plummer, Univ. Texas, Bull. 2644, p. 78, pl. 14, fig. 10; Eocene, Texas.

1949. **Dentalina soluta.** Bandy, American Pal. Bull. 131, vol. 32, p. 53, pl. 7, figs. 5a, b; Eocene, Alabama.

Description.—Test elongate, slightly curved, chambers circular in cross section, initial end with a small basal spine; chambers uniserial, 5 to 6 in the adult form, inflated, increasing in size gradually; sutures straight, deeply constricted; wall smooth, finely perforate; aperture terminal, offset towards concave side of test, produced, radiate. Length, 0.70 mm.; diameter, 0.15 mm. Rare.

Hypotype.—USC No. 817.

Genus Nodosaria Lamarck, 1812

Nodosaria anomala Reuss

Plate 17, figures 7a, b

1866. **Nodosaria (Nodosaria) anomala** Reuss (not Stolley), K. Akad. Wiss. Wien, Math-Naturk. Cl., Denkschr. Bd. 25, Abt. 1, p. 129, pl. 1, figs. 20-22; Middle Oligocene, Germany.

1931. **Nodosaria anomala.** Cushman and Parker, Contr. Cushman Lab. Foram. Res., vol. 7, pt. 1, p. 4, pl. 1, figs. 12-14; Miocene, California.

1933. **Nodosaria anomala.** Barbat and Von Estorff, Journ. Pal., vol. 7, no. 2, p. 169; Lower Miocene, California.

1935. **Nodosaria anomala.** Cushman and Hobson, Contr. Cushman Lab. Foram. Res., vol. 11, pt. 3, p. 58, pl. 8, fig. 16; Oligocene, California.

Description.—Test elongate, straight, sides parallel, initial and apertural ends round; chambers up to 6, uniserial, circular in cross section, more or less equal in size, inflated; sutures depressed, normal to longitudinal axis of the test, distinct; wall smooth, finely perforate; aperture terminal, central, radiate. Length, 1.10 mm.; diameter, 0.35 mm. Rare.

Hypotype.—USC No. 846.

Remarks.—Several broken specimens were observed consisting of from 2 to 5 chambers. The figured specimen is typical of the material and agrees with other figures.

Nodosaria calomorpha Reuss

Plate 17, figures 9a, b

1866. **Nodosaria calomorpha** Reuss, Denkschr. K. Akad. Wiss. Wien, vol. 25, p. 129, pl. 1, figs. 15-19; Oligocene, Germany.

1923. **Nodosaria calomorpha.** Cushman, U. S. Nat. Mus. Bull. 104, pt. 4, p. 67, pl. 12, fig. 13; Recent, Atlantic. (Contains prior synonymy).

Description.—Test elongate, slender, straight, initial end with a basal spine, chambers uniserial, 2 to 3 in number, circular in cross section; sutures strongly constricted, limbate; wall smooth, finely perforate; aperture terminal, central, radiate, at the end of a short tapering neck. Length, 0.90 mm.; diameter, 0.30 mm. Rare.

Hypotype.—USC No. 847.

Nodosaria hispida Orbigny

Plate 17, figures 10a, b

1846. **Nodosaria hispida** Orbigny (not Schwager), Foram. Foss. Bass. Tert. Vienne, p. 35, pl. 1, figs. 24, 25; Tertiary, Austria.

1913. **Nodosaria hispida.** Cushman, U. S. Nat. Mus. Bull. 71, pt. 3, p. 60, p. 28, fig. 3; Recent, Pacific.

1923. **Nodosaria hispida.** Cushman, U. S. Nat. Mus. Bull. 104, pt. 4, p. 92, pl. 16, fig. 6; Recent, North Atlantic.

1949. **Nodosaria hispida.** Bermudez, Special Publ. 25, Cushman Lab. Foram. Res., p. 145, pl. 9, figs. 61-63; Upper Oligocene, Dominican Republic.

Description.—Test elongate, slender, straight, gradually tapering to the initial end; chambers uniserial, up to 5 or 6 in the adult form, globular, circular in cross section, very gradually increasing in size; sutures deeply constricted, sometimes extended forming a short neck between chambers; wall ornamented by numerous fine, delicate spines; aperture terminal, central, round, at the end of a short neck. Length, 0.60 mm.; diameter, 0.20 mm. Rare.

Hypotype.—USC No. 848.

EXPLANATION OF PLATE 20

Nodosaria longiscata Orbigny

Plate 17, figures 11a, b

1846. **Nodosaria longiscata** Orbigny, Foram. Foss. Bass. Tert. Vienne, p. 32, pl. 1, figs. 10-12; Miocene, Austria.

1933. **Nodosaria longiscata.** Barbat and Von Estorff, Journ. Pal., vol. 7, no. 2, p. 169; Lower Miocene, California.

1937. **Nodosaria longiscata.** Hedberg, Journ. Pal., vol. 11, no. 8, p. 671, pl. 91, figs. 3, 4; Oligocene, Venezuela.

1938. **Nodosaria longiscata.** Kleinpell, Miocene Stratigraphy of California, p. 218, pl. 9, fig. 16, Miocene, California.

1941. **Nodosaria longiscata.** Galloway and Heminway, New York Acad. Sci., vol. 3, pt. 4, p. 342, pl. 11, fig. 8; Oligocene, Puerto Rico.

1949. **Nodosaria longiscata.** Bermudez, Special Publ. 25, Cushman Lab. Foram. Res., p. 145, pl. 9, g. 57; Upper Oligocene, Dominican Republic.

Description.—Test elongate, slender, straight, initial and apertural end not preserved; chambers 2 or 3, uniserial, circular in cross section, cylindrical; sutures slightly depressed, normal to longitudinal axis of test; wall smooth, finely perforate; aperture not preserved, reported round or radiate. Length, 1.20 mm.; diameter, 0.15 mm. Present.

Hypotype.—USC No. 849.

Nodosaria parexilis Cushman and K. C. Stewart

Plate 17, figures 12a, b

1866. **Nodosaria exilis** Schwager (not Neugeboren), **Novara**-Exped., Geol. Theil., pt. 2, p. 223, pl. 5, fig 52; Pliocene, India.

1930. **Nodosaria parexilis** Cushman and K. C. Stewart, Trans. San Diego Soc. Nat. Hist., vol. 6, no. 2, p. 55, pl. 2, figs. 13-15; Pliocene, California.

1931. **Nodosaria parexilis.** Cushman and Parker, Contr. Cushman Lab. Foram. Res., vol. 7, pt. 1, p. 6, pl. 1, fig. 15; Miocene, California.

Description.—Test elongate, slender, straight, sides nearly parallel; chambers 6 or 7 in the adult form, circular in cross section, those of initial end as high as wide, later ones higher than broader, initial chamber globular and larger than second or third chamber, all slightly inflated; sutures depressed, normal to longitudinal axis of test; aperture terminal, central, round, slightly produced. Length, 2.75 mm.; diameter, 0.25 mm. Present.

Hypotype.—USC No. 850.

Genus Lagena Walker and Boys, 1784

Lagena acuticosta Reuss

Plate 17, figures 13a, b

1861. **Lagena acuticosta** Reuss, Sitz. Akad. Wiss. Wien, vol. 44, pt. 1, p. 305, pl. 1, fig. 4; Upper Cretaceous, Holland.

1884. **Lagena acuticosta.** Brady, Rep. Voy. **Challenger,** Zool., vol. 9, p. 464, pl. 57, figs. 31, 32; Recent, Pacific.

1923. **Lagena acuticosta.** Cushman, U. S. Nat. Mus. Bull. 104, pt. 4, p. 5, pl. 1, figs. 1-3; Recent, Atlantic. (Contains prior synonymy).

1930. **Lagena acuticosta.** Cushman, Stewart and Stewart, Trans. San Diego Soc. Nat. Hist., vol. 6, no. 2, p. 57, pl. 3, fig. 10; Pliocene, California.

1938. **Lagena acuticosta.** Kleinpell, Miocene Stratigraphy of California, p. 224, pl. 17, fig. 13; Miocene, California.

1946. **Lagena acuticosta** Cushman and Gray, Special Publ. 19, Cushman Lab. Foram. Res., p. 19, pl. 3, fig. 16; Pleistocene, California.

Description.—Test unilocular, subglobular to pyriform, broadest towards the basal end, sharply tapering towards the apertural end, circular in cross section; wall ornamented with 10-15 thin, highly elevated longitudinal costae which extend from the base to near the apertural end where they join to form a plate-like area around the aperture, finely perforate; aperture terminal, round. Length, 0.25 mm.; diameter, 0.20 mm. Rare.

Hypotype.—USC No. 833.

Lagena angelina Cushman

Plate 17, figures 14a, b

1929. **Lagena angelina** Cushman, Contr. Cushman Lab. Foram. Res., vol. 5, pt. 3, p. 71, pl. 11, fig. 10; Lower Pliocene, California.

Description.—Test unilocular, small, pyriform, circular cross section, basal end rounded, apertural end tapering with a long slender neck; wall ornamented with high plate-like costae which combine at the base of the neck, surface between the costae containing longitudinal rows of elliptical pits; aperture small, terminal, round, with a slight lip. Length, 0.30 mm.; diameter, 0.20 mm. Rare.

Hypotype.—USC No. 834.

Lagena distoma Parker and Jones

Plate 18, figures 1a, b

1857. **Lagena laevis** (Montagu) var. **striata** Parker and Jones (not **Lagena striata** (Walker and Boys)), Ann. Mag. Nat. Hist., ser. 2, vol. 19, p. 278, pl. 11, fig. 24; Recent, Norway.

1864. **Lagena distoma** Parker and Jones, in H. B. Brady, Trans. Linn. Soc. London, vol. 24, p. 467, pl. 48, fig. 6, Recent, England.

1884. **Lagena distoma.** Brady, Rep. Voy. **Challenger,** Zool., vol. 9, p. 461, pl. 58, figs. 11-15; Recent, Atlantic, Pacific.

1923. **Lagena distoma.** Cushman, U. S. Nat. Mus. Bull. 104, pt. 4, p. 14, pl. 3, figs. 2, 3; Recent, Western Atlantic. (Contains prior synonymy).

1946. **Lagena distoma.** Cushman and Gray, Special Publ. 19, Cushman Lab. Foram. Res., p. 24, pl. 4, figs. 8, 9; Pleistocene, California.

Description.—Test unilocular, elongate, slender, sides nearly parallel in the central portion, circular in cross section, apertural end tapering into a long slender neck with a lip, basal end tapering to a long narrow spine; wall smooth, thin, ornamented with 8 to 15 fine delicate longitudinal costae; aperture round with a slight lip. Length, 0.80 mm.; diameter, 0.20 mm. Rare.

Hypotype.—USC No. 835.

Lagena elongata (Ehrenberg)

Plate 18, figures 2a, b

1844. **Miliola elongata** Ehrenberg, Bericht Preuss, Akad. Wiss. Berlin, p. 274, type level not designated, Kurdistan.

1845. **Miliola elongata.** Ehrenberg, Bericht Preuss, Akad. Wiss. Berlin, p. 371; Recent, Straits Settlement.

1884. **Lagena elongata.** Brady, Rep. Voy. **Challenger,** Zool., vol. 9, p. 457, pl. 56, fig. 29; Recent, Atlantic.

1923. **Lagena elongata.** Cushman, U. S. Nat. Mus. Bull. 104, pt. 4, p. 15, pl. 3, fig. 4; Recent, Western Atlantic. (Contains prior synonymy).

1929. **Lagena elongata.** Cushman, Contr. Cushman Lab. Foram. Res., vol. 5, pt. 3, p. 67, pl. 11, fig. 1; Pliocene, California.

Description.—Test elongate, unilocular, slender, both ends tapering, the basal end to a long spine, the apertural end to a long neck with a lip, middle portion cylindrical, sometimes with the sides parallel, circular in cross section; wall smooth, finely perforate, translucent; aperture terminal, round, with a slight lip. Length, 0.95 mm.; diameter, 0.15 mm. Rare.

Hypotype.—USC No. 836.

Lagena hexagona (Williamson)

Plate 18, figure 3

1848. **Entosolenia squamosa** (Montagu) var. **hexagona** Williamson, Ann. Mag. Nat. Hist., ser. 2, vol. 1, p. 20, pl. 2, fig. 23; Recent, England.

1879. **Lagena hexagona.** Siddal. Cat. Brit. Rec. Foram., p. 6, Recent, England.

1923. **Lagena hexagona.** Cushman, U. S. Nat. Mus. Bull. 104, pt. 4, p. 24, pl. 4, fig. 6, Recent, Western Atlantic. (Contains prior synonymy).

1929. **Lagena hexagona.** Cushman, Contr. Cushman Lab. Foram. Res., vol. 5, pt. 3, p. 72, pl. 11, fig. 18, Pliocene, California.

1930. **Lagena hexagona.** Cushman, Stewart and Stewart, Trans. San Diego Soc. Nat. Hist., vol. 6, no. 2, p. 57, pl. 3, fig. 7; Pliocene, California.

1949. **Lagena hexagona.** Bermudez, Special Publ. 25, Cushman Lab. Foram. Res., p. 117; Miocene, Dominican Republic.

Description.—Test unilocular, globular, circular in cross section, basal end broadly rounded, apertural end slightly tapering; wall ornamented with hexagonal areas fairly regularly placed; aperture round, small, produced. Length, 0.25 mm.; diameter, 0.20 mm. Rare.

Hypotype.—USC No. 837.

Lagena hispida Reuss

Plate 18, figures 4a, b

1798. "Sphaerulae hispidae" Soldani, Testaceographica, vol. 2, p. 53, pl. 17, figs. 5, 10.

1858. **Lagena hispida** Reuss, Zeitschr. deutsch. geol. Ges., vol. 10, p. 43; Oligocene, Germany.

1884. **Lagena hispida.** Brady, Rep. Voy. **Challenger,** Zool. vol. 9, p. 459, pl. 57, figs. 1-4; Recent, Atlantic, Pacific.

1923. **Lagena hispida.** Cushman, U. S. Nat. Mus. Bull. 104, pt. 4, p. 26, pl. 4, figs. 7, 8; Recent, Atlantic. (Contains prior synonymy).

1929. **Lagena hispida.** Cushman, Contr. Cushman Lab. Foram. Res., vol. 5, pt. 3, p. 71, pl. 11, fig. 13; Pliocene, California.

1930. **Lagena hispida.** Cushman and Moyer, Contr. Cushman Lab. Foram. Res., vol. 6, pt. 3, p. 53, pl. 7, fig. 13; Recent, California.

Description.—Test unilocular, globular, with an elongate slender neck, circular in cross section; wall thin, ornamented with uniformly distributed small fine spines; aperture terminal, round. Length, 0.30 mm.; diameter, 0.15 mm. Rare.

Hypotype.—USC No. 838.

Lagena scalariformis (Williamson)

Plate 18, figures 5a, b

1858. **Entosolenia squamosa** (Montagu) var. **scalariformis** Williamson, Rec. Foram. Great Britain, p. 13, pl. 1, fig. 30; Recent, England.

1862. **Lagena scalariformis** Williamson. Reuss, Sitz. Akad. Wiss. Wien, vol. 46, pt. 1, p. 333, pl. 5, figs. 69-71; Oligocene, Germany.

1913. **Lagena hexagona** var. **scalariformis.** Cushman, U. S. Nat. Mus. Bull. 71, pt. 3, p. 17, pl. 6, fig. 4; Recent, Northern Pacific.

1929. **Lagena hexagona** var. **scalariformis,** Cushman, Contr. Cushman Lab. Foram. Res., vol. 5, pt. 3, p. 72, pl. 11, fig. 19; Pliocene, California.

1930. **Lagena hexagona** var. **scalariformis.** Cushman, Stewart and Stewart, Trans. San Diego Soc. Nat. Hist., vol. 6, no. 2, p. 58, pl. 3, fig. 8; Pliocene, Panama.

Description.—Test unilocular, globular to subglobular, circular in cross section, surface ornamented with a net-like design which is arranged in a series of longitudinal rows, the sides of which are often thickened forming costae; aperture round, slightly protruding. Length, 0.25 mm.; diameter, 0.20 mm. Rare.

Hypotype.—USC No. 839.

Lagena striata (Orbigny)

Plate 18, figures 6a, b

1839. **Oolina striata** Orbigny, Foram. Amer. Mérid., p. 21, pl. 5, fig. 12; Recent, Falkland Islands.

1862. **Lagena striata.** Reuss, Sitz. Akad. Wiss. Wien, vol. 46, pt. 1, p. 327, pl. 3, figs. 44, 45; pl. 4, figs. 46, 47; Oligocene, Germany.

1884. **Lagena striata.** Brady, Rep. Voy. **Challenger,** Zool., vol. 9, p. 460, pl. 57, figs. 22, 24; Recent, Atlantic.

1923. **Lagena striata.** Cushman, U. S. Nat. Mus. Bull. 104, pt. 4, p. 54, pl. 10, fig. 9; Recent, Atlantic. (Contains prior synonymy).

Description.—Test unilocular, globular to subglobular, circular in cross section, basal end broadly round, apertural end with a neck which may vary in length; wall ornamented with numerous fine longitudinal costae extending the entire length of the test; aperture terminal, round. Length, 0.20 mm.; diameter, 0.15 mm. Rare.

Hypotype.—USC No. 840.

Lagena sp. cf. **L. sulcata** (Walker and Jacob)

Plate 18, figures 7a, b

1784. **"Serpula (Lagena) striata sulcata rotunda"** Walker and Boys, Test. Min. p. 2, pl. 1, fig. 6, Recent, England.

1798. **Serpula (Lagena) sulcata** Walker and Jacob, Adams' Essays, Kanmacher's ed., p. 634, pl. 14, fig. 5; Recent, England.

1884. **Lagena sulcata.** Brady, Rep. Voy. **Challenger,** Zool., vol. 9, p. 462, pl. 57, figs. 23, 26, 33, 34; Recent, All Oceans.

1923. **Lagena sulcata.** Cushman, U. S. Nat. Mus. Bull.104, pt. 4, p. 58, pl. 11, fig. 2; Recent, Caribbean. (Contains prior synonymy).

1930. **Lagena sulcata.** Cushman, Stewart and Stewart, Trans. San Diego Soc. Nat. Hist., vol. 6, no. 2, p. 58, pl. 3, fig. 12; Pliocene, California.

1938. **Lagena sulcata.** Kleinpell, Miocene Stratigraphy of California, p. 227, Miocene, California.

1946. **Lagena sulcata.** Cushman and Gray, Special Publ. 19, Cushman Lab. Foram. Res., p. 13, pl. 2, fig. 26, 27; Pleistocene, California.

Description.—Test unilocular, subglobular, circular in cross section, basal end broadly round, apertural end with a fairly long neck; wall ornamented with 14 to 18 high costae extending from the basal end to the neck; aperture terminal, round. Length, 0.30 mm.; diameter, 0.20 mm. Rare.

Hypotype.—USC No. 841.

Lagena sulcata (Walker and Jacob) var. **laevicostata** Cushman and Gray

Plate 18, figures 8a, b

1946. **Lagena sulcata** var. **laevicostata** Cushman and Gray, Contr. Cushman Lab. Foram. Res., vol. 22, pt. 2, p. 68, figs. 13-14; Pleistocene, California.

1946. **Lagena sulcata** var. **laevicostata.** Cushman and Gray, Special Publ. 19, Cushman Lab. Foram. Res., p. 20, pl. 3, figs. 47, 48; Pleistocene, California.

Description.—Test unilocular, subglobular, circular in cross section, with a tapering neck; wall ornamented with 14 to 20 high plate-like costae, several continue on the neck towards the aperture; aperture terminal, round. Length, 0.55 mm.; diameter, 0.30 mm. Rare.

Hypotype.—USC No. 842.

Lagena vulgaris Williamson

Plate 18, figures 9a, b

1858. **Lagena vulgaris** Williamson, Rec. Foram. Gt. Brit., p. 3, pl. 1, figs. 5, 5a; Recent, England.

1946. **Lagena vulgaris.** Cushman and Gray, Special Publ. 19, Cushman Lab. Foram. Res., p. 18, pl. 3, figs. 28-30; Pleistocene, California.

Description.—Test unilocular, flask-shaped, circular cross section, long cylindrical neck at apertural end, basal end broadly rounded; wall smooth, finely perforate; aperture terminal, round, at end of long neck with a slight lip. Length, 0.40 mm.; diameter, 0.20 mm. Rare.

Hypotype.—USC No. 843.

Lagena williamsoni (Alcock)

Plate 18, figures 10a, b

1865. **Entosolenia williamsoni** Alcock, Lit. Philos. Soc. Proc., vol. 4, p. 193; Recent, England.

1923. **Lagena williamsoni.** Cushman, U. S. Nat. Mus. Bull. 104, pt. 4, p. 61, pl. 11, figs. 8, 9; Recent, Irish Coast. (Contains prior synonymy).

1929. **Lagena williamsoni.** Cushman, Contr. Cushman Lab. Foram. Res., vol. 5, pt. 3, p. 70, pl. 11, figs. 7, 8; Pliocene, California.

1930. **Lagena williamsoni.** Cushman, Stewart and Stewart, Trans. San Diego Soc. Nat. Hist., vol. 6, no. 2, p. 59, pl. 8, fig. 5; Pliocene, California.

1944. **Lagena williamsoni.** Bandy, Journ. Pal., vol. 18, no. 4, p. 369, pl. 60, fig. 13; Eocene, Oregon.

Description.—Test unilocular, subglobular to pyriform, widest below the middle, basal end round, apertural end tapering to a short slender neck, circular in cross section; wall ornamented with 12 to 15 high plate-like costae, joining below the apertural region forming a collar ornamented with 3 rings of hexagonal reticulations; aperture terminal, round. Length, 0.25 mm.; diameter, 0.15 mm. Rare.

Hypotype.—USC No. 844.

Genus **Robulus** Montfort, 1808

Robulus sp. cf. **R. cultratus** Montfort

Plate 18, figures 11a, b

1808. **Robulus cultratus** Montfort, Conch. Syst., vol. 1, p. 214, 54 genre; Type level not designated, Italy.

1884. **Cristellaria cultrata.** Brady, Rep. Voy. **Challenger,** Zool., vol. 9, p. 550, pl. 70, figs. 4, 5, 6; Recent, Atlantic.

1921. **Cristellaria cultrata.** Cushman, U. S. Nat. Mus. Bull. 100, vol. 4, p. 220; Recent, Western Pacific.

1927. **Robulus cultratus.** Cushman, Journ. Pal., vol. 1, no. 2, p. 151, pl. 23, figs. 7; Tertiary, Mexico.

1928. **Robulus cultratus.** Cushman, Special Publ. no. 1, Cushman Lab. Foram. Res., p. 185, pl. 24, figs. 1, 2; Original figure shown.

1933. **Robulus cultratus.** Galloway, A Manual of Foraminifera, p. 251, pl. 22, fig. 14; Original figure shown.

Description.—Test planispiral, bilaterally symmetrical, close coiled, compressed, lenticular in edge view, thin narrow peripheral keel; chambers 6 to 7 in last-formed coil, triangular in side view, slightly overlapping; sutures distinct, slightly curved, flush with surface, radiating from central boss; wall smooth, finely perforate; aperture radiate, with a median slit extending down on apertural face; apertural face triangular with a narrow rim on either side. Diameter, 0.60 mm.; thickness, 0.25 mm. Rare.

Hypotype.—USC No. 860.

Remarks.—Figured specimens by various authors show considerable variation from Montfort's original figure. Inasmuch as only a few specimens were found at USC locality 106 it seems best to refer them to Montfort's species with which they show the greatest affinities.

Genus **Fissurina** Reuss, 1850

Fissurina marginata (Walker and Boys)

Plate 18, figures 12a, b

1784. **"Serpula (Lagena) marginata"** Walker and Boys, Test. Min., p. 2, pl. 1, fig. 7; Recent, England.

1803. **Vermiculum marginatum.** Montagu, Test. Brit., p. 254; Recent, England.

1884. **Lagena marginata.** Brady, Rep. Voy. **Challenger,** Zool., vol. 9, p. 476, pl. 59, figs. 21-23; Recent, All Oceans.

1938. **Lagena marginata.** Kleinpell, Miocene Stratigraphy of California, p. 225, pl. 11, fig. 5; Miocene, California.

1949. **Lagena marginata.** Bermudez, Special Publ. 25, Cushman Lab. Foram. Res., p. 117, pl. 10, figs. 56-58; Upper Oligocene, Dominican Republic.

Description.—Test unilocular, more or less pyriform, tapering to the apertural end, basal end broadly rounded, elliptical in cross section, widest about the middle; wall smooth, finely perforate, pronounced lateral keel extending around the entire test coalescing at apertural region; aperture fissurine, parallel with keel, cylindrical tube leading into chamber. Length, 0.55 mm.; width, 0.40 mm.; thickness, 0.15 mm. Rare.

Hypotype.—USC No. 820.

Fissurina orbignyana (Seguenza)
var. **elliptica** (Cushman)

Plate 18, figures 13a, b

1923. **Lagena orbignyana** var. **elliptica** Cushman, U. S. Nat. Mus. Bull. 104, pt. 4, p. 42, pl. 6, figs. 10-12; Recent, Caribbean.

1927. **Lagena orbignyana** var. **elliptica.** Cushman, Scripps Inst. Oceanography Bull. Tech. Ser., vol. 1, p. 146, Recent, Eastern Pacific.

1929. **Lagena orbignyana** var. **elliptica.** Cushman, Contr. Cushman Lab. Foram. Res., vol. 5, pt. 3, p. 71, pl. 11, fig. 16; Pliocene, California.

Description.—Test unilocular, pyriform, elliptical cross section about the middle, length about 1½ times as long as wide, in side view tapering towards the apertural end, sharp thin edge with lateral keels; wall thin, finely perforate, translucent, area between keel and adjacent inner margin opaque; aperture elliptical. Length, 0.35 mm.; width, 0.30 mm.; thickness, 0.15 mm. Present.

Hypotype.—USC No. 821.

Family NONIONIDAE Reuss, 1860

Genus **Nonion** Montfort, 1808

Nonion labradoricus (Dawson)

Plate 19, figures 1a, b

1860. **Nonionina labradorica** Dawson, Canadian Naturalist, vol. 5, p. 191, fig. 4; Recent, Canada.

1866. **Nonionina labradorica.** Jones, Parker, and Brady, Crag Foraminifera, Pal. Soc. Publ., vol. 19, pl. 12, figs. 44, 45; Late Tertiary, Labrador.

1927. **Nonion labradorica.** Cushman, Bull. Scripps Inst. Oceanography, Tech. Ser., vol. 1, p. 148, pl. 2, figs. 7, 8; Recent, Eastern Pacific.

1930. **Nonion labradorica.** Cushman, U. S. Nat. Mus. Bull. 104, pt. 7, p. 11, pl. 4, figs. 6-12; Recent, Western Atlantic.

1939. **Nonion labradoricum.** Cushman, U. S. Geol. Surv. Prof. Paper 191, p. 23, pl. 6, figs. 13-16; Recent, New England Coast.

1949. **Nonion labradoricum.** Bermudez, Special Publ. 25, Cushman Lab. Foram. Res., p. 165, pl. 11, figs. 17, 18; Upper Oligocene, Dominican Republic.

Description.—Test small, planispiral, completely involute, bilaterally symmetrical, edge bluntly rounded, broad triangular apertural face, sides convex; chambers few, increasing in size rapidly and uniformly, last-formed chamber overlapping either side of earlier chambers; sutures distinct, slightly depressed, curved; wall thin, finely perforate, aperture a narrow slit at the base of the apertural face. Diameter, 0.50 mm.; thickness, 0.35 mm. Rare.

Hypotype.—USC No. 851.

Nonion pompilioides (Fichtel and Moll)

Plate 19, figures 2a, b

1798. **Nautilus pompilioides** Fichtel and Moll, Test. Micr., p. 31, pl. 2, figs. a-c; Recent, Mediterranean.

1884. **Nonionina pompilioides.** Brady, Rep. Voy. **Challenger,** Zool., vol. 9, p. 727, pl. 109, figs. 10-11; Recent, Atlantic, Pacific.

1929. **Nonion pompilioides.** Cushman, Contr. Cushman Lab. Foram. Res., vol. 5, pt. 4, p. 89, pl. 13, figs. 25a, b; Middle Tertiary, Ecuador, Venezuela, and Trinidad.

1941. **Nonion pompilioides.** Galloway and Hemingway, New York Acad. Sci., vol. 3, pt. 4, p. 357, pl. 14, figs. 1a, b; Oligocene, Puerto Rico.

Description.—Test planispiral, bilaterally symmetrical, subcircular in side view, nearly as long as broad, closely coiled, ovate in apertural view, umbilici moderately large and deep; chambers 6 to 8 in the last-formed whorl, increasing in size gradually and uniformly, closely apressed; sutures narrow, flush with surface, marked by clear test material; wall smooth, coarsely perforate; aperture an arched elongate slit at the base of the last septal face, apertural face convex, wider than high. Diameter, 0.35 mm.; thickness, 0.25 mm. Present.

Hypotype.—USC No. 852.

Genus **Pullenia** Parker and Jones, 1862

Pullenia sp. cf. **P. bulloides** (Orbigny)

Plate 19, figures 3a, b

1826. **Nonionina bulloides** Orbigny, Ann. Sci. Nat., vol. 7, p. 293; Pliocene, Italy.

1846. **Nonionina bulloides.** Orbigny, Foram. Foss. Bass. Tert. Vienne, p. 107, pl. 5, figs. 9, 10; Tertiary, Austria.

1884. **Pullenia sphaeroides.** Brady, Rep. Voy. **Challenger,** Zool., vol. 9, p. 615, pl. 84, figs. 12, 13; Recent, Cosmopolitan.

1924. **Pullenia bulloides.** Cushman, U. S. Nat. Mus. Bull. 104, pt. 5, p. 40, pl. 8, figs. 3, 4; Recent, Western Atlantic.

1938. **Pullenia bulloides.** Kleinpell, Miocene Stratigraphy of California, p. 338, pl. 5, figs. 10-13; Miocene, California.

1943. **Pullenia bulloides.** Cushman and Todd, Contr. Cushman Lab. Foram. Res., vol. 19, pt. 1, p. 13, pl. 2, figs. 15-18; Miocene, Vienna Basin. (Contains prior synonymy).

1949. **Pullenia bulloides.** Cushman and Todd, Contr. Cushman Lab. Foram. Res., vol. 25, pt. 4, p. 82, pl. 14, fig. 21; Eocene, Peru.

Description.—Test small, planispiral, close coiled, subglobular, periphery slightly if at all lobulate, very broadly rounded; chambers involute, 4 in the last-formed whorl, increasing very slightly in size as added; sutures radial, straight; wall smooth, finely perforate; aperture a low crescentic opening at base of last chamber, with a slight lip, apertural face low. Diameter, 0.25 mm.; width, 0.20 mm. Rare.

Hypotype.—USC No. 858.

Remarks.—This small characteristic foraminifer is referred to d'Orbigny's species. His original figure shows very strongly curved and depressed sutures. As witnessed by our figure the California Pliocene variety has straight sutures that are slightly depressed. The publications cited in the synonymy illustrate the variability of this species.

Pullenia malkinae Coryell and Mossman

Plate 19, figures 4a, b

1942. **Pullenia malkinae** Coryell and Mossman, Journ. Pal., vol. 16, no. 2, p. 234, pl. 36, figs. 3, 4; Pliocene, Panama.

1943. **Pullenia malkinae.** Cushman and Todd, Contr. Cushman Lab. Foram. Res., vol. 19, pt. 1, p. 21, pl. 3, fig. 12; Pliocene, Panama.

1945. **Pullenia malkinae.** Cushman and Todd, Special Publ. 15, Cushman Lab. Foram. Res., p. 65, pl. 11, figs. 8a, b; Miocene, Jamaica.

Description.—Test planispiral, bilaterally symmetrical, length about 2 times as long as wide, edge rounded, periphery slightly lobulate, close coiled; chambers involute, 7 to 8 in last-formed whorl, uniformly increasing in size; sutures curved, distinct, radial, slightly depressed; wall smooth, very finely perforate; aperture a low crescentic arched slit at inner base of the last septal face, extending from one umbilicus to the other, last septal face smoothly concave. Diameter, 0.60 mm.; thickness, 0.35 mm. Rare.

Hypotype.—USC No. 859.

Family ROTALIIDAE Reuss, 1860

Genus **Globorotalia** Cushman, 1927

Globorotalia sacharina (Schwager)

Plate 19, figures 5a-c

1866. **Discorbina sacharina** Schwager, **Novara**-Exped., Geol. Theil., vol. 2, p. 257, pl. 7, fig. 107; Pliocene, India.

1939. **"Discorbina sacharina."** Cushman, Journ. Geol. Soc. Japan, vol. 46, no. 546, p. 153, pl. 10 (6), figs. 17, 18; Pliocene, India.

Description.—Test medium sized for genus, unequally biconvex, dorsal side moderately convex, ventral side strongly so, slightly umbilicate, edge sharply rounded, periphery broadly lobulate, almost all chambers seen dorsally, only last-formed whorl seen ventrally, chambers distinct, 5 to 6 in the last whorl, last-formed chamber much more inflated ventrally than preceding ones; sutures strongly curved and slightly oblique on dorsal side, ventral sutures depressed, slightly curved; wall smooth, finely perforate, ventrally ornamented with small papillae about the apertural region, later ventral chambers smooth; aperture a large elongate slit extending from the periphery to the umbilical area. Diameter, 0.70 mm.; thickness, 0.30 mm. Rare.

Hypotype.—USC No. 830.

Remarks.—This variety is very similar to *Globorotalia menardii* (Orbigny) except for the small papillae found about the apertural region.

Genus **Eponides** Montfort, 1808

Eponides subtener (Galloway and Wissler)

Plate 19, figures 6a-c

1927. **Rotalia subtenera** Galloway and Wissler, Journ. Pal., vol. 1, no. 1, p. 60, pl. 10, fig. 4; Pleistocene, California.

Description.—Test trochoid, unequally biconvex, dorsal side nearly flat, ventral side convex, edge acute, periphery slightly lobulate, slight umbilicus on ventral side, about 2 to 2½ seen on dorsal side, only last-formed whorl seen on ventral side; chambers 8 in last-formed whorl, increasing gradually and uniformly in size; sutures slightly limbate on the dorsal side, straight, not radial, on ventral side slightly depressed, radial, straight; wall smooth, finely perforate; aperture a curved slit at the middle of the septal face of the last chamber, with a slight lip. Diameter, 0.40 mm.; thickness, 0.20 mm. Rare.

Hypotype.—USC No. 818.

Remarks.—This species does not appear to have been previously reported from the Pliocene of California. It differs from *Eponides tenera* (Brady) in its greater number of chambers in the last whorl and in its smaller size.

Eponides tener (Brady)

Plate 19, figures 7a-c

1884. **Truncatulina tenera.** Brady, Rep. Voy. **Challenger,** Zool., vol. 9, p. 655, pl. 95, figs. 11a-c; Recent, Atlantic, Pacific.

1921. **Truncatulina tenera.** Cushman, U. S. Nat. Mus. Bull. 100, vol. 4, p. 318, pl. 64, figs. 2a-c; Recent, Philippines.

1926. **Truncatulina tenera.** Plummer, Univ. Texas, Bull. 2466, p. 146, pl. 9, figs. 5a-c; Eocene, Texas.

1927. **Eponides tenera.** Cushman, Bull. Scripps Inst. Oceanography Tech. Ser., vol. 1, p. 163, pl. 5, figs. 6, 7; Recent, Eastern Pacific.

1930. **Eponides tenera.** Cushman, Stewart and Stewart, Trans. San Diego Soc. Nat. Hist., vol. 6, no. 2, p. 72, pl. 6, figs. 3a-c; Pliocene, California.

Description.—Test trochoid, unequally biconvex, ventral side much convex, dorsal side less so, edge acute, periphery lobulate, about 2 whorls seen dorsally, only last-formed whorl seen on ventral side; chambers 5 to 6 in the last whorl, increasing in size gradually; sutures distinct, dorsally straight, radial, ventrally slightly depressed and offset with regard to the umbilicus; wall smooth, finely perforate; aperture elongate, narrow slit on septal face of last-formed chamber, between periphery and umbilicus. Diameter, 0.50 mm.; thickness, 0.25 mm. Present.

Hypotype.—USC No. 819.

Genus **Gyroidina** Orbigny, 1826
Gyroidina altiformis R. E. and K. C. Stewart
Plate 19, figures 8a-c

1930. **Gyroidina soldanii** var. **altiformis** R. E. and K. C. Stewart, Journ. Pal., vol. 4, no. 1, p. 67, pl. 9, figs. 2a-c; Pliocene, California.

1931. **Gyroidina soldanii** var. **altiformis.** Cushman, U. S. Nat. Mus. Bull. 104, pt. 8, p. 41, pl. 8, figs. 10a-c; pl. 9, figs. 1a-c; Recent, Western Atlantic.

1940. **Gyroidina soldanii** var. **altiformis.** Coryell and Rivero, Journ. Pal., vol. 14, no. 4, p. 337, pl. 43, fig. 19; Middle Miocene, Haiti.

1949. **Gyroidina altiformis.** Bermudez, Special Publ. 25, Cushman Lab. Foram. Res., p. 251, pl. 17, figs. 64-66; Upper Oligocene, Dominican Republic. (Contains prior synonymy).

Description.—Test trochoid, plano-convex, circular when viewed dorsally, dorsal side with early portion of spiral slightly convex, last-formed whorl flattened, ventral side strongly convex, with deep umbilicus, edge very slightly rounded, periphery slightly lobulate; chambers numerous, 10 or 11 in the last-formed whorl, later chambers with the septal face tilted backwards, early ones covered up by umbonate growth; sutures distinct, on dorsal side in the last chambers raised and oblique, on ventral side depressed around the umbilicus, less so near the periphery; wall smooth, finely perforate; aperture a narrow slit at inner margin of ventral side. Diameter, 0.75 mm.; thickness, 0.45 mm. Present.

Hypotype.—USC No. 831.

Gyroidina soldanii Orbigny
var. **multilocula** Coryell and Mossman
Plate 20, figures 1a-c

1942. **Gyroidina soldanii** var. **multilocula** Coryell and Mossman, Journ. Pal., vol. 16, no. 2, p. 237, pl. 36, fig. 20; Pliocene, Panama.

Description.—Test trochoid, plano-convex, circular when viewed dorsally, dorsal side almost flat, earlier whorls slightly convex, last-formed whorl flat, ventral side strongly convex, high, with a large umbilicus, edge subacute, periphery non-lobulate; chambers about 12-14 in last-formed whorl, closely appressed, increasing in size uniformly and gradually; dorsal sutures radial, flush with surface, ventral sutures slightly curved, flush with surface; wall smooth, finely perforate; aperture a narrow slit at base of the last-formed septal face, midway between the periphery and umbilicus. Diameter, 0.60 mm.; thickness, 0.45 mm. Present.

Hypotype.—USC No. 832.

Remarks.—The additional numbers of chambers distinguishes this variety from Orbigny's species which only has 9 chambers in the last-formed whorl.

Genus **Cibicidina** Bandy, 1949
Cibicidina concentrica (Cushman)
Plate 20, figures 4a-c

1918. **Truncatulina concentrica** Cushman, U. S. Geol. Surv. Bull. 676, p. 64, pl. 21, fig. 3; Upper Miocene, Florida.

1930. **Cibicides concentricus.** Cushman, Florida Geol. Surv. Bull. 4, p. 61, pl. 12, figs. 4a-c; Miocene, Florida.

1931. **Cibicides concentricus.** Cushman, U. S. Nat. Mus. Bull. 104, pt. 8, p. 120, pl. 21, figs. 1, 2; Recent, Florida.

1948. **Cibicides concentricus.** Dorsey, Maryland Geol. Surv. Bull. 2, p. 315, pl. 34, figs. 1a-c, 2a-c; Miocene, Maryland.

1949. **Cibicides concentricus.** Bermudez, Special Publ. 25, Cushman Lab. Foram. Res., p. 296, pl. 26, figs. 7-12; Pliocene, Dominican Republic.

Description.—Test rotaloid, unequally biconvex, dorsal side slightly convex, ventral side very much so, edge acute, periphery slightly lobulate, umbilicate on ventral side, dorsal spire almost concealed by the involute last whorl, only last whorl visible on ventral side; chambers 7 to 9 in last-formed whorl, closely appressed, inflated; sutures distinct, depressed on ventral side, on dorsal side flush with surface in young stages, depressed as last chambers are added; wall smooth, very finely perforate; aperture a small arched opening at base of last septal face at the periphery. Diameter, 0.50 mm.; thickness, 0.25 mm. Present.

Hypotype.—USC No. 815.

Remarks.—This planoconvex species is placed in the genus *Cibicidina* Bandy, 1949, because of the involute and concealed character of the dorsal side and also because of its finer perforations.

Genus **Cibicides** Montfort, 1808
Cibicides fletcheri Galloway and Wissler
Plate 20, figures 2a-c

1927. **Cibicides fletcheri** Galloway and Wissler, Journ. Pal., vol. 1, no. 1, p. 64, pl. 10, figs. 8, 9; Pleistocene, California.

Description.—Test planoconvex, ventral side convex with umbo of clear shell material, dorsal side slightly concave, edge subacute, periphery lobulate, slightly oval in side view; chambers 10 to 12 in the last-formed whorl, increasing in size uniformly; sutures limbate on

dorsal side, curved on both sides; wall smooth, coarsely perforate; aperture an arched-like opening not extending very far on the ventral side but dorsally extending along the suture line for 3 or 4 chambers, with a lip. Diameter, 0.50 mm.; thickness, 0.10 mm. Rare.

Hypotype.—USC No. 813.

Remarks.—The figured specimen shows greater affinities with Galloway and Wissler's paratype than with their holotype. Their holotype has a strongly concave dorsal side, whereas the paratype exhibits a slight dorsal concavity. The few specimens found at the Fourth and Flower Streets locality tend to display the latter characteristic.

Cibicides mckannai Galloway and Wissler
var. **suppressus** Martin, n. var.

Plate 20, figures 3a-c

Description.—Test slightly unequally biconvex, the dorsal side less so, compressed, umbonate, edge acute but not keeled. periphery slightly lobulate particularly the last 4 or 5 chambers; chambers numerous, 9 to 10 in the last-formed whorl; sutures on dorsal side slightly curved, oblique, central portion umbonate obscuring early sutures, ventral sutures slightly depressed, curved at outer margin, straight at inner central portion continuing on to central ventral umbo; wall smooth, coarsely perforate; aperture peripheral with a distinctive lip, extending a short distance ventrally, dorsally extending along the spiral suture for 1 or 2 chambers. Diameter, 0.50 mm.; thickness, 0.15 mm. Common.

Holotype.—USC No. 814, Station No. 4.

Remarks.—The distinguishing features of this variety which separate it from *Cibicides mckannai* Galloway and Wissler are the compressed test and the oblique nearly straight dorsal sutures. *C. mckannai* is much thicker and has strongly curved dorsal sutures.

Genus **Planulina** Orbigny, 1826

Planulina sp. cf. **P. ornata** (Orbigny)

Plate 20, figures 5a-c

1839. **Truncatulina ornata** Orbigny, Voy. Amèr. Mérid., vol. 5, pt. 5, Foraminifères, p. 40, pl. 6, figs. 7, 9; Recent, Chile.

1927. **Planulina ornata.** Cushman, Bull. Scripps Inst. Oceanography, Tech. Ser., vol. 1, p. 176, pl. 6, fig. 12; Recent, Eastern Pacific.

1930. **Planulina ornata.** Cushman, Stewart and Stewart, Trans. San Diego Soc. Nat. Hist., vol. 6, no. 2, p. 78, pl. 7, figs. 7a-c; Pliocene, California.

1942. **Planulina ornata.** Coryell and Mossman, Journ. Pal., vol. 16, no. 2, p. 237, pl. 36, fig. 2, 3; Pliocene, Panama.

1946. **Planulina ornata.** Cushman and Gray, Special Publ. 19, Cushman Lab. Foram. Res., p. 44, pl. 8, figs. 9-12; Pleistocene, California.

Description.—Test nearly biconvex, compressed, slenderly lenticular in end view, edge subacute, with thickened keel, periphery lobulate; chambers about 9 in last-formed whorl, elongate, curved, distinct; sutures limbate, curved, raised in the early portion, depressed in later portion of test, joining with the peripheral keel; wall coarsely perforate, reticulated; aperture peripheral, extending on dorsal side, with a flat lip. Diameter, 1.0 mm.; thickness, 0.20 mm. Rare.

Hypotype.—USC No. 854.

Remarks.—Comparison with d'Orbigny's original figure revealed that the specimens obtained from Fourth and Flower Streets tend to be nearly biconvex, a characteristic not shared by d'Orbigny's holotype.

Family CHILOSTOMELLIIDAE Brady, 1884

Genus **Chilostomella** Reuss, 1850

Chilostomella czizeki Reuss

Plate 20, figures 7a-c

1850. **Chilostomella czizeki** Reuss, Denkschr. Akad. Wiss. Wien, vol. 1, p. 380, pl. 48, fig. 13; Miocene, Austria.

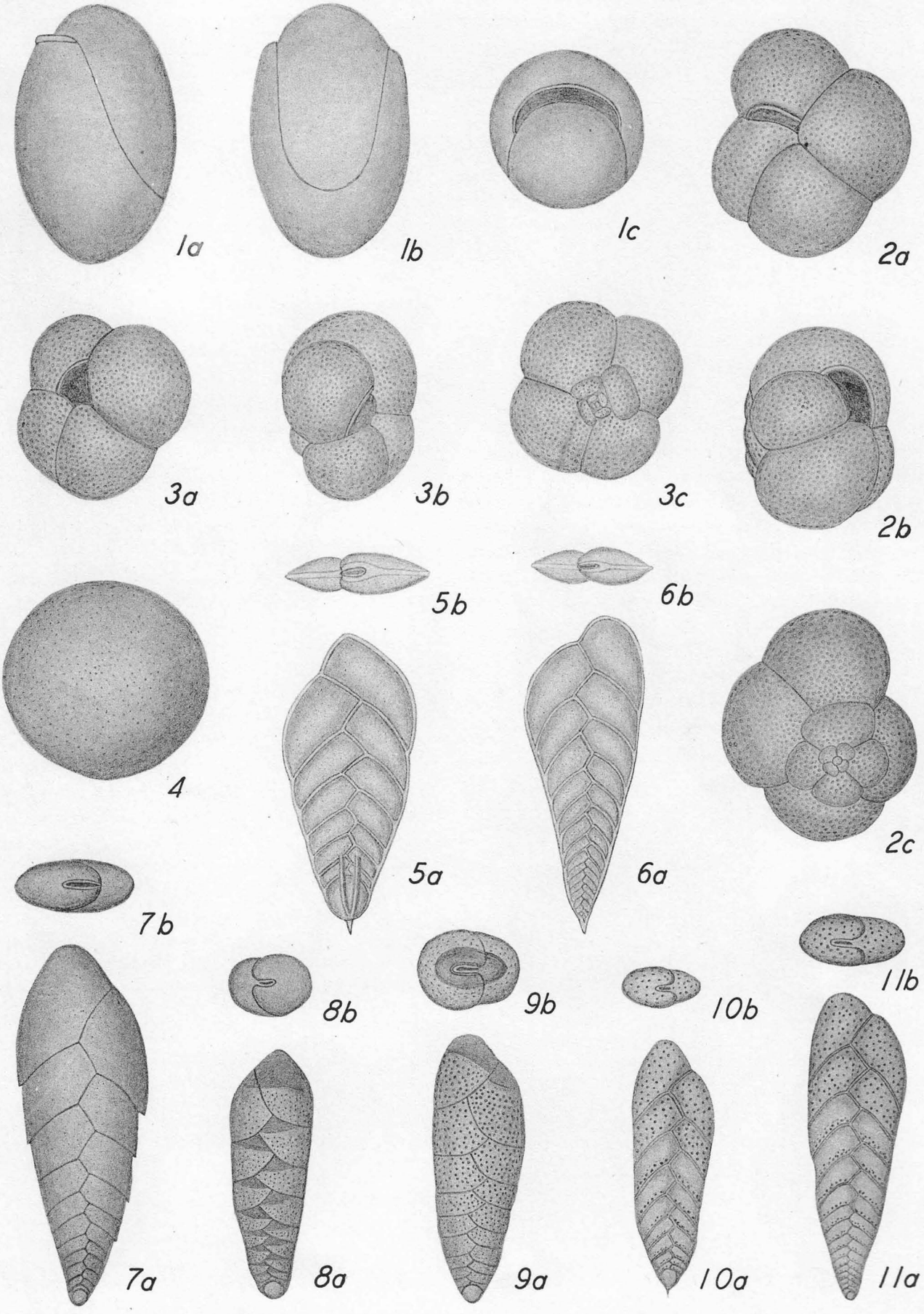
1926. **Chilostomella czizeki.** Cushman, Contr. Cushman Lab. Foram. Res., vol. 1, pt. 4, p. 74, pl. 11, fig. 2; Miocene, Austria.

1941. **Chilostomella czizeki.** Galloway and Heminway, New York Acad. Sci., vol. 3, pt. 4, p. 409, pl. 28, figs. 3a-c; Oligocene, Puerto Rico.

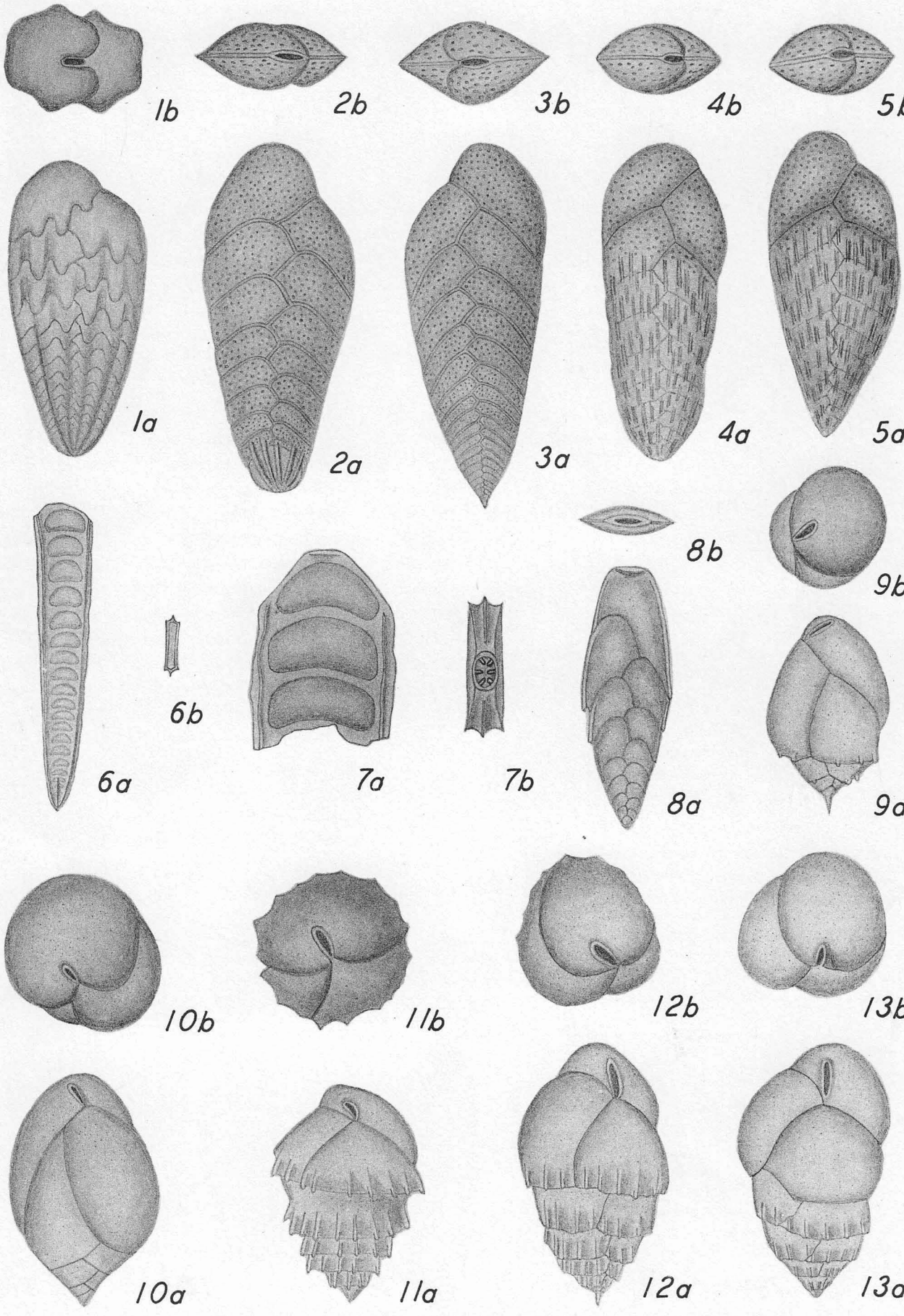
1942. **Chilostomella czizeki.** Coryell and Mossman, Journ. Pal., vol. 16, no. 2, p. 237, pl. 36, figs. 24, 25; Pliocene, Panama.

1949. **Chilostomella czizeki.** Cushman, Contr. Cushman Lab. Foram. Res., vol. 35, pt. 4, p. 90, pl. 15, figs. 20-23; Miocene, Austria; Pliocene, Panama.

EXPLANATION OF PLATE 21



Martin: Pliocene Foraminifera, Los Angeles, California



Martin: Pliocene Foraminifera, Los Angeles, California

Description.—Test small, elliptical in side view, circular cross section, widest about the middle, ends broadly rounded, about 1½ times as long as wide; chambers distinct, slightly inflated, the last-formed chamber covering up almost ⅔ of the ventral portion of the preceding chamber, proloculus and early chambers sometimes seen on back of the test; suture line distinct, extremely concave on the back of the test; wall smooth, finely perforate; aperture a narrow crescentic opening, with a lip on the inner margin. Length, 0.60 mm.; diameter, 0.30 mm. Common.

Hypotype.—USC No. 811.

Chilostomella grandis Cushman

Plate 21, figures 1a-c

1917. **Chilostomella grandis** Cushman, Rep. U. S. Nat. Mus., vol. 51, p. 662; Recent, Philippines.
1921. **Chilostomella grandis.** Cushman, U. S. Nat. Mus. Bull. 100, vol. 4, p. 283, pl. 57, fig. 5; Recent, Philippines.
1926. **Chilostomella grandis.** Cushman, Contr. Cushman Lab. Foram. Res., vol. 1, pt. 4, p. 75, pl. 11, fig. 12; Recent, Australia.
1930. **Chilostomella grandis.** Cushman and Moyer, Contr. Cushman Lab. Foram. Res., vol. 6, pt. 3, p. 61, pl. 18, figs. 14, 15; Recent, California.
1949. **Chilostomella grandis.** Cushman and Todd, Contr. Cushman Lab. Foram. Res., vol. 25, pt. 4, p. 92, pl. 16, figs. 1, 2, 6; Recent, Philippines.

Description.—Test large, broadly elliptical in side view, circular in end view, length about 1½ times as long as wide, widest about the middle; chambers distinct, slightly inflated, the last-formed one making up about ⅔ of the ventral portion of the test; sutures distinct, slightly if at all depressed, the suture line being deeply concave on the back of the test, sometimes earlier chambers partially seen; wall smooth, thick, finely perforate; aperture narrow, crescentic, extending about ½ of the circumference of the test, with a slight marginal lip. Length, 1.25 mm.; diameter, 0.60 mm. Common.

Hypotype.—USC No. 812.

Genus Sphaeroidina Orbigny, 1826
Sphaeroidina chilostomata Galloway and Morrey

Plate 20, figures 6a, b

1924. **Sphaeroidina bulloides** Orbigny var. **chilostomata** Galloway and Morrey, Bull. Amer. Pal., vol. 15, no. 55, p. 32, pl. 5, fig. 1; Upper Eocene, Ecuador.
1930. **Sphaeroidina bulloides.** Cushman and Stewart and Stewart, (not Orbigny), Trans. San Diego Soc. Nat. Hist., vol. 6, no. 2, p. 76, pl. 7, fig. 2; Pliocene, California.
1945. **Sphaeroidina bulloides.** Cushman and Todd, Special Publ. no. 15, Cushman Lab. Foram. Res., p. 65, pl. 11, fig. 9; Miocene, Jamaica.
1948. **Sphaeroidina bulloides.** Cushman and Stewart and Stewart, Bull. 36, Ore. Dept. Geol. and Min. Ind., pt. 1, p. 22, pl. 4, figs. 1, 2; Miocene, Oregon.
1949. **Sphaeroidina chilostomata.** Cushman and Todd, Contr. Cushman Lab. Foram. Res., vol. 25, pt. 1, p. 18, pl. 4, figs. 10-12; Miocene, West Indies, Pliocene, California.

Description.—Test subspherical in outline, cubic in shape; chambers inflated, rapidly increasing in size as added, 4 in the last-formed whorl, the last-chamber making up about 4/5 of the test; sutures straight, depressed; wall smooth, polished, finely perforate; aperture a curved slit surrounded by an arched lip, located at the base of the last septal face just above the suture. Diameter, 0.30 mm. Rare.

Hypotype.—USC No. 861.

Family ORBULINIDAE Schultze, 1854

Genus Globigerina Orbigny, 1826
Globigerina inflata Orbigny

Plate 21, figures 2a-c

1839. **Globigerina inflata** Orbigny, Barker, Webb, and Berthelot, Hist. Nat. Isle Canaries, vol. 2, pt. 2. Foraminiferes, p. 134, pl. 2, figs. 7-9; Recent, Canary Islands.
1884. **Globigerina inflata.** Brady, Rep. Voy. **Challenger,** Zool., vol. 9, p. 601, pl. 70, figs. 8, 10; Recent, All Oceans.
1924. **Globigerina inflata.** Cushman, U. S. Nat. Mus. Bull. 104, pt. 5, p. 12, pl. 3, figs. 1-3; Recent, New England Coast.

EXPLANATION OF PLATE 22

1927. **Globigerina inflata.** Galloway and Wissler, Journ. Pal., vol. 1, no. 1, p. 43, pl. 8, fig. 1; Pleistocene, California.

1930. **Globigerina inflata.** Cushman, Stewart and Stewart, Trans. San Diego Soc. Nat. Hist., vol. 6, no. 2, p. 76, Pliocene, California.

1941. **Globigerina inflata.** Galloway and Heminway, New York Acad. Sci., vol. 3, pt. 4, p. 412, pl. 29, figs. 3a-c; Upper Oligocene, Lower Miocene, Puerto Rico.

Description.—Test rotaloid, consisting of 2 or 3 whorls, dorsal side nearly flat, ventral side rather deep due to rapid increase in volume and height of chambers, periphery lobulate; chambers distinct, inflated, about 12-14 seen on dorsal side, last whorl consisting of 4; sutures depressed, slightly curved; wall finely perforate, surface smooth; aperture a high arch on the ventral side extending from the periphery to the umbilicus with a thin lip. Diameter, 0.50 mm.; thickness, 0.30 mm. Abundant.

Hypotype.—USC No. 826.

Globigerina quadrilatera Galloway and Wissler

Plate 21, figures 3a-c

1927. **Globigerina quadrilatera** Galloway and Wissler, Journ. Pal., vol. 1, no. 1, p. 44, pl. 7, fig. 11; Pleistocene, California.

1944. **Globigerina quadrilatera.** Cushman and Gray, Special Publ. 19, Cushman Lab. Foram. Res., p. 44, pl. 8, fig. 5, Pleistocene, California.

Description.—Test rotaloid, length about as long as broad, consisting of 2½ whorls arranged in a low spire, 4 chambers making up the last whorl, periphery lobulate; chambers inflated, distinct, numbering about 10, increasing in size regularly except the last-formed chamber which is smaller; sutures depressed, distinct; wall reticulate, finely perforate; aperture opening into the umbilicus, at inner margin of last-formed chamber, apertures of preceding chambers may be seen. Length, 0.30 mm.; width, 0.25 mm. Common.

Hypotype.—USC No. 827.

Genus **Orbulina** Orbigny, 1839

Orbulina universa Orbigny

Plate 21, figure 4

1839. **Orbulina universa** Orbigny, De La Sagra, Hist. Phys. Pol. Nat. Cuba. Foraminifères, p. 3, pl. 1, fig. 1; Recent, Type locality not given.

1884. **Orbulina universa.** Brady, Rep. Voy. **Challenger,** Zool., vol. 9, p. 608, pl. 78, fig. 1; Recent, Cosmopolitan.

1923. **Orbulina universa.** Cushman, U. S. Nat. Mus. Bull. 104, pt. 5, p. 28, pl. 5, figs. 2-9; Recent, Atlantic. (Contains prior synonymy).

1927. **Orbulina universa.** Galloway and Wissler, Journ. Pal., vol. 1, no. 1, p. 45, pl. 8, fig. 3; Pliocene, Panama.

1942. **Orbulina universa.** Coryell and Mossman, Journ. Pal., vol. 16, no. 2, p. 239, pl. 36, fig. 32; Pliocene, Panama.

1946. **Orbulina universa.** Cushman and Gray, Special Publ. 19, Cushman Lab. Foram. Res., p. 44, pl. 8, fig. 7; Pleistocene, California.

Description.—Test globular, consisting of only one exterior chamber, earlier chambers sometimes seen on surface; wall finely reticulate, smooth; aperture simple, round, not always present.

Hypotype.—USC No. 853.

Family HETEROHELICIDAE Cushman, 1927

Genus **Bolivina** Orbigny, 1839

Bolivina argentea Cushman

Plate 21, figures 5a, b; 6a, b

1926. **Bolivina argentea** Cushman, Contr. Cushman Lab. Foram. Res., vol. 2, pt. 2, p. 42, pl. 6, fig. 5; Pliocene, California.

1927. **Bolivina argentea.** Cushman, Bull. Scripps Inst. Oceanography, Tech. Ser., vol. 1, p. 155, pl. 3, fig. 5; Recent, Eastern Pacific.

1930. **Bolivina argentea.** Cushman and Moyer, Contr. Cushman Lab. Foram. Res., vol. 6, pt. 3, p. 57, pl. 8, fig. 3; Recent, California Coast.

1937. **Bolivina argentea.** Cushman, Special Publ. 9, Cushman Lab. Foram. Res., p. 140, pl. 19, figs. 7-11; Pliocene, California.

1942. **Bolivina argentea.** Cushman and McCulloch. Allan Hancock Pacific Exped., vol. 6, no. 4, p. 188, pl. 22, figs. 2-6, Recent, West Coast, Gulf of California to Oregon.

Description.—Test elongate, very much compressed, length 3 to 4 times longer than broad, edge acute, usually not keeled, initial end sharply pointed in microspheric specimens, rounded in megalospheric specimens, tapering with the greatest width formed by the last pair of chambers; chambers biserial, numerous, 12 to 14 pairs, increasing in size uniformly, narrow in young stage, less so towards the apertural end; sutures curved, oblique, early ones limbate, later ones slightly depressed; wall smooth, except at the initial end where longitudinal costae may be found, very finely perforate; aperture elongate, narrow, on face of last-formed chamber. Length, 0.85 mm.; width, 0.35 mm.; thickness, 0.10 mm. Abundant.

Hypotype.—USC No. 786.

Bolivina beyrichi Reuss

Plate 21, figures 7a, b

1851. **Bolivina beyrichi** Reuss, Zeitschr. deutsch. geol. Ges., vol. 3, p. 83, pl. 6, fig. 51; Eocene, Germany.

1884. **Bolivina beyrichi.** Brady, Rep. Voy. **Challenger,** Zool., vol. 9, p. 422, pl. 53, fig. 1; Recent, Western Pacific.

1912. **Bolivina beyrichi.** Bagg, U. S. Geol. Surv., Bull. 513, p. 40, pl. 10, fig. 10; Pliocene, California.

1921. **Bolivina beyrichi.** Cushman, U. S. Nat. Mus., Bull. 100, vol. 4, p. 128; Recent, Philippines Seas.

1922. **Bolivina beyrichi.** Cushman, U. S. Nat. Mus., Bull. 104, pt. 3, p. 30, pl. 9, fig. 6; Recent, Atlantic. (Contains prior synonymy).

1937. **Bolivina beyrichi.** Cushman, Special Publ. 9, Cushman Lab. Foram. Res., p. 74-75, pl. 9, figs. 3-6; Middle Oligocene, Germany.

Description.—Test elongate, length 3 to 4 times

longer than broad, much compressed, edge subacute, lower margin of the chambers forming a backward projecting point, initial end acute, apertural end rounded; chambers biserial, numerous, 8 to 10 pairs, increasing rapidly in height towards the aperture, being higher than broad; sutures distinct, early ones limbate, later ones very slightly depressed, obliquely curved; wall smooth, finely perforate; aperture elongate, elliptical, with a slight lip. Length, 0.80 mm.; breadth, 0.20 mm.; thickness, 0.10 mm. Rare.

Hypotype.—USC No. 787

Bolivina seminuda Cushman

Plate 21, figures 8a, b

1911. **Bolivina seminuda** Cushman, U. S. Nat. Mus., Bull. 71, pt. 2, p. 34, fig. 55; Recent, Bering Sea.

1926. **Bolivina seminuda.** Cushman, Contr. Cushman Lab. Foram. Res., vol. 2, pt. 2, p. 43; no fig. given; Pliocene, California.

1930. **Bolivina seminuda.** Cushman and Moyer, Contr. Cushman Lab. Foram. Res., p. 142, pl. 18, figs. 13-15; Pliocene, California.

Description.—Test elongate, length 3 to 4 times longer than broad, slightly compressed, initial end rounded, apertural end broadly rounded, periphery very slightly lobulate; chambers biserial, numerous, very slightly inflated, increasing in size uniformly, early ones broader than higher, later ones higher than broad; sutures slightly depressed and curved, increasing the angle with the horizontal towards the apertural end; wall smooth, finely perforate and clear in the upper portion of the chambers, coarsely perforate in the lower half, lower portion of chambers whitish contrasting with the upper portion; aperture elongate, narrow slit. Length, 0.70 mm.; thickness, 0.20 mm.

Hypotype.—USC No. 788.

Bolivina seminuda Cushman var. **foraminata** R. E. and K. C. Stewart

Plate 21, figures 9a, b

1930. **Bolivina seminuda** var. **foraminata** R. E. and K. C. Stewart, Journ. Pal., vol. 4, no. 1, p. 66, pl. 8, figs. 5a, b; Pliocene, California.

1937. **Bolivina seminuda** var. **foraminata.** Cushman, Special Publ. 9, Cushman Lab. Foram. Res., p. 119, pl. 14, fig. 11; Pliocene, California.

1942. **Bolivina foraminata.** Coryell and Mossman, Journ. Pal., vol. 16, no. 2, p. 239, pl. 36, fig. 34; Pliocene, Panama.

Description.—Test elongate, length 3 to 4 times longer than broad, slightly compressed, initial end rounded in megalospheric forms, bluntly pointed in microspheric forms, periphery slightly lobulate; chambers numerous, biserial, increasing in size uniformly, about 9 to 10 pairs, chambers towards the apertural end higher than broad, those towards the initial end conversely so, slightly inflated; sutures distinct, slightly depressed, increasing the angle with the horizontal towards the apertural end; wall smooth, upper portions of chambers finely perforate, clear and transparent, lower portions coarsely perforate and whitish in color, clear, and transparent, clear portions covered by succeeding chambers except in the last-formed pair; aperture elongate narrow slit. Length, 0.80 mm.; thickness, 0.30 mm. Abundant.

Hypotype.—USC No. 789.

Bolivina semiperforata Martin, n. sp.

Plate 21, figures 10a, b; 11a, b

Description.—Test elongate, slender, compressed in cross section; initial end acute in microspheric forms, sharply rounded in megalospheric forms; latter forms often with a small basal spine; sides gradually tapering towards initial end, edge rounded; chambers numerous, biserial, 8 to 9 pairs in megalospheric forms, 12 to 15 pairs in microspheric forms, increasing in size gradually and uniformly; sutures oblique, making angle of about 50 degrees with the horizontal, slightly curved and limbate; wall smooth, translucent, distinctly perforate only in the lower portion of chambers with the exception of the last 2 pairs which are entirely perforate; aperture a narrow elliptical slit, with a slight lip. Length, 0.80 mm.; width, 0.20 mm.; thickness, 0.10 mm. Common.

Holotype.—USC No. 790; Station No. 17.

Remarks.—This characteristic foraminifer is distinguished from *Bolivina doniezi* Cushman and Wickenden by its more slender test, greater number of chambers, the degree of tapering, which is greater in Cushman's species, and in the greater obliquity of the sutures.

Bolivina sinuata Galloway and Wissler

Plate 22, figures 1a, b

1927. **Bolivina sinuata** Galloway and Wissler, Journ. Pal., vol. 1, no. 1, p. 71, pl. 11, figs. 9a, b; Pleistocene, California.

1937. **Bolivina sinuata.** Cushman, Special Publ. 9, Cushman Lab. Foram. Res., p. 120, pl. 14, figs. 19, 20; Pliocene, California.

Description.—Test elongate, length 3 to 4 times longer than broad, compressed, initial end bluntly rounded, apertural end broadly rounded, slight tapering towards the initial end, oval in cross section, 4 high rounded, thick costae which are discontinuous at the sutures, develop into sinuate lobes on later parts of the test; chambers numerous, biserial, 12 to 13 pairs in the adult forms; sutures lobate, distinct towards the apertural end, less so towards the initial end; wall finely perforate; aperture narrow, elliptical, at base of the last-formed chamber. Length, 0.95 mm.; width, 0.30 mm. Abundant.

Hypotype.—USC No. 791.

Bolivina spissa Cushman

Plate 22, figures 2a, b; 3a, b

1926. **Bolivina subadvena** Cushman var. **spissa** Cushman, Contr. Cushman Lab. Foram. Res., vol. 2, pt. 2, p. 45, pl. 6, figs. 8a, b; Pliocene, California.

1927. **Bolivina spissa.** Galloway aud Wissler, Journ. Pal., vol. 1, no. 1, p. 72, pl. 11, figs. 14-16; Pleistocene, California.

1930. **Bolivina subadvena** var. **spissa.** Cushman, Stewart and Stewart, Trans. San Diego Soc. Nat. Hist., vol. 6, no. 2, p. 67, pl. 5, fig. 7; Pliocene, California.

1930. **Bolivina subadvena** var. **spissa.** Cushman and Moyer, Contr. Cushman Lab. Foram. Res., vol. 6, pt. 3, p. 58; Recent, California.

1942. **Bolivina spissa.** Cushman and McCulloch, Allan Hancock Pacific Exped., vol. 6, no. 4, p. 211, pl. 26, figs. 7-11; Recent, California.

Description.—Test much compressed, thickened along the median part line, tapering towards the initial end, length 2 to 3 times longer than broad, widest at the apertural end, edge acute, ranging from a smooth to a serrate edge, initial end of microspheric forms sharply acute, that of megalospheric forms rounded with a few costae extending over the first chambers of the test; chambers numerous, distinct, 8 to 15 pairs, very slightly inflated, increasing gradually in height, constantly broader than high; sutures curved, limbate, set at an angle of approximately 45 degrees with the horizontal; wall smooth, coarsely perforate; aperture elongate, narrow, at base of last formed chamber. Length, 0.75 mm.; width, 0.25 mm.; thickness, 0.10 mm. Common.

Hypotype.—USC No. 782.

Bolivina subadvena Cushman var. **sulphurensis** Cushman and Adams

Plate 22, figures 4a, b; 5a, b

1935. **Bolivina subadvena** Cushman var. **sulphurensis** Cushman and Adams, Contr. Cushman Lab. Foram. Res., vol. 11, pt. 1, p. 20, pl. 3, figs. 8, 9; Pliocene, California.

1937. **Bolivina subadvena** var. **sulphurensis.** Cushman, Special Publ. 9, Cushman Lab. Foram. Res., p. 117, pl. 12, figs. 19, 20; Late Tertiary, California.

Description.—Test elongate, length 2 to 3 times longer than broader, compressed, tapering towards the initial end, initial end in microspheric forms sharply acute, rounded in megalospheric forms, edge subacute; chambers numerous, biserial, 12 to 14 pairs, increasing in height uniformly, the later chambers as high as broad; sutures distinct in the adult stage, less so towards initial end; wall lower end of test ornamented with matte process obscuring chambers and sutures, towards the aperture wall tends to become smooth; aperture a small narrow slit at the base of the last-formed chamber. Length, 0.65 mm.; width, 0.20 mm.; thickness, 0.10 mm. Abundant.

Hypotype.—USC No. 793.

Genus **Plectofrondicularia** Liebus, 1903

Plectofrondicularia californica Cushman and R. E. Stewart

Plate 22, figures 6a, b; 7a, b

1926. **Plectofrondicularia californica** Cushman and R. E. Stewart, Contr. Cushman Lab. Foram. Res., vol. 2, pt. 2, p. 39, pl. 6, figs. 9-11; Pliocene, California.

1930. **Plectofrondicularia californica.** Cushman, Stewart and Stewart, Trans. San Diego Soc. Nat. Hist., vol. 6, no. 2, p. 63, pl. 4, figs. 3, 4; Pliocene, California.

1938. **Plectofrondicularia californica.** Kleinpell, Miocene Stratigraphy of California, p. 239, pl. 4, figs. 17, 19; Miocene, California.

1946. **Plectofrondicularia californica.** Cushman and Gray, Special Publ. 19, Cushman Lab. Foram. Res., p. 27, pl. 15, figs. 1, 2; Pleistocene, California.

1948. **Plectofrondicularia californica.** Cushman and Stevenson, Contr. Cushman Lab. Foram. Res., vol. 24, pt. 3, p. 55, pl. 9, figs. 16, 17; Miocene, Ecuador.

Description.—Test elongate, compressed, about 5 times as long as wide, usually bilaterally symmetrical, occassionally asymmetrical due to slight curvature of early portion, very gradual tapering towards the initial end, initial end sharply rounded, apertural end broadly rounded in side view, greatest width at last-formed chamber, edge ornamented with 3 plate-like keels, one central, 2 lateral, chambers numerous, biserial in early stage, uniserial in later portion, rectilinear, curved, convex towards the apertural end, low broader than high, increasing in height gradually and uniformly as added; sutures curved, limbate, later ones slightly curved, depressed; wall smooth, with a small costae at the initial end; aperture a broad oval opening in septal face of last-formed chamber, ornamented with 6 small teeth. Length, 2.10 mm.; width, 0.35 mm.; thickness, 0.10 mm. Present.

Hypotype.—USC No. 855.

Genus **Loxostomum** Ehrenberg, 1854

Loxostomum instabile Cushman and McCulloch

Plate 22, figures 8a, b

1942. **Loxostomum instabile** Cushman and McCulloch, Allan Hancock Pacific Exped., vol. 6, no. 4, p. 221, pl. 27, figs. 15-17; pl. 28; figs. 1-7; Recent, Eastern Pacific.

1946. **Loxostomum instabile.** Cushman and Gray, Special Publ. 19, Cushman Lab. Foram. Res., p. 36, pl. 6, fig. 7-9; Pleistocene, California.

Description.—Test elongate, slender, length 4 to 5 times as long as broad, compressed, tapering towards the initial end, edge at apertural end acute and keeled, initial and middle portions biserial, tending to become uniserial at the apertural end; chambers distinct, increasing in size gradually at the initial end, becoming rapidly larger, compressed, uniserial and keeled at the periphery at the apertural end, the basal margins of the chambers extending backwards into distinct spines; sutures distinct, depressed towards the apertural end, strongly curved; wall smooth, coarsely perforate; aper-

ture terminal, elliptical, with a marginal lip. Length, 0.60 mm.; width, 0.30 mm.; thickness, 0.15 mm. Rare.

Hypotype.—USC No. 845.

Family BULIMINIDAE Jones, 1876
Genus **Bulimina** Orbigny, 1826
Bulimina marginata Orbigny
var. **grandissima** Martin, n. var.
Plate 23, figures 1a, b

Description.—Test elongate, large, tapering towards initial end, apertural end broadly rounded, widest part at apertural end formed by last whorl, 5 to 6 whorls in adult form; chambers triserial, numerous, inflated, basal margin undercut at a sharp angle; sutures distinctly depressed; wall ornamented by plate-like costae extending beyond the basal margin of the chambers forming short sharp spines, chambers of the last-formed whorl are ornamented only with marginal spines, the test of the apertural area being smooth; aperture a comma-shaped slit, terminal. Length, 0.90 mm.; diameter, 0.40 mm. Present.

Holotype.—USC No. 794; Station No. 5.

Remarks.—The terminal position of the aperture and the presence of costae extending the full length of the chambers distinguish the variety from *Bulimina marginata* Orbigny.

Bulimina marginospinata Cushman and Parker
Plate 22, figures 9a, b

1936. **Bulimina marginospinata** Cushman and Parker, Contr. Lab. Foram. Res., vol. 14, pt. 3, p. 57, pl. 9, fig. 11; Pliocene, California.

1946. **Bulimina marginospinata.** Cushman and Parker, U. S. Geol. Surv. Prof. Paper 210-D, p. 117, pl. 27, fig. 12; Pliocene, California.

Description.—Test broadly fusiform, widest below the middle, length about 2 times as long as wide, initial end acute, apertural end bluntly subangular, 5 whorls in the adult form; chambers distinct, inflated, the last 3 making up over ⅔ of the test, increasing rapidly in size, overlapping; sutures slightly depressed, distinct; wall smooth except for several small short spines at the basal margin of the chambers, finely perforate; aperture narrow, elongate with a raised lip. Length, 0.40 mm.; diameter, 0.25 mm. Present.

Hypotype.—USC No. 795.

Bulimina ovula Orbigny
Plate 22, figures 10a, b

1839. **Bulimina ovula** Orbigny (not Terquem), Voy. Amer. Mérid. vol. 5, pt. 5, Foraminifères, p. 51, pl. 1, figs. 10, 11; Recent, Chile.

1927. **Bulimina ovula.** Cushman, Bull. Scripps Inst. Oceanography Tech. Ser., vol. 1, p. 150, pl. 2, fig. 10; Recent, California Coast.

1930. **Bulimina ovula.** Cushman and Moyer, Contr. Cushman Lab. Foram. Res., vol. 6, pt. 3, p. 56, pl. 7, fig. 21; Recent, California Coast.

1946. **Bulimina ovula.** Cushman and Parker, U. S. Geol. Surv. Prof. Paper 210-D, p. 122, pl. 28, figs. 20-22; Recent, Eastern Pacific. (Contains prior synonymy).

Description.—Test broadly oval, widest about the midlength, length about 1½ times as wide, consisting of 2 or 3 whorls, last-formed whorl comprising 4/5 of the test, microspheric forms with a pointed initial end, megalospheric forms with a bluntly rounded initial end; chambers distinct, last-formed much inflated, increasing in size rapidly; sutures slightly depressed; wall smooth, finely perforate; aperture comma-shaped with a long curved tooth. Length, 0.60 mm.; diameter, 0.40 mm. Rare.

Hypotype.—USC No. 796.

Bulimina pagoda Cushman
Plate 22, figures 11a, b

1927. **Bulimina pagoda** Cushman, Bull. Scripps Inst. Oceanography, Tech. Ser., vol. 1, p. 152, pl. 2, fig. 16; Recent, Eastern Pacific.

1930. **Bulimina pagoda.** Cushman, Stewart and Stewart, Trans. San Diego Soc. Nat. Hist., vol. 6, no. 2, p. 66, pl. 5, figs. 6a-c; Pliocene, California.

1940. **Bulimina pagoda.** Cushman and Parker, Contr. Cushman Lab. Foram. Res., vol. 16, pt. 1, p. 17, pl. 3, figs. 11, 12; Recent, Panama.

1942. **Bulimina pagoda.** Coryell and Mossman, Journ. Pal., vol. 16, no. 2, p. 242, pl. 36, fig. 44; Pliocene, Panama.

1946. **Bulimina pagoda.** Cushman and Parker, U. S. Geol. Surv. Prof. Paper 210-D, p. 126, pl. 29, figs. 10, 11; Recent, Panama.

Description.—Test medium size, rapidly tapering, widest at apertural end, initial end acute, apertural end broadly subangular, length 1½ times longer than broad, about 4 or 5 whorls in the adult; chambers undercut deeply at the basal margins, increasing in size rapidly, rather inflated, particularly those of the last whorl; early sutures defined by undercutting of the chambers, later sutures distinct, depressed; walls smooth, except at marginal base of each chamber where a number of broad spines project and curve downwards, coarsely perforate; aperture comma-shaped, at apex of test, above junction of the second and third chambers. Length, 0.50 mm.; diameter, 0.35 mm. Present.

Hypotype.—USC No. 797.

Bulimina pseudoaffinis Kleinpell
Plate 23, figures 4a, b

1938. **Bulimina pseudoaffinis** Kleinpell, Miocene Stratigraphy of California, p. 257, pl. 9, fig. 9; Middle Miocene, California.

1946. **Bulimina pseudoaffinis.** Cushman and Parker, U. S. Geol. Surv. Prof. Paper 210-D, p. 113, pl. 26, fig. 20; Miocene, California. (Contains prior synonymy).

Description.—Test medium size, widest portion just above the middle, initial end sharply rounded, apertural end broadly rounded, tapering towards initial end, 3 whorls in the adult form, last whorls forming ¾

of the test; chambers distinct, inflated, increasing in size rapidly; sutures distinct, depressed; wall smooth, finely perforate; aperture elongate, comma-shaped. Length, 0.70 mm.; diameter, 0.35 mm. Rare.

Hypotype.—USC No. 798.

Bulimina subacuminata Cushman and R. E. Stewart

Plate 22, figures 12a, b

1930. **Bulimina subacuminata** Cushman and R. E. Stewart, Trans. San Diego Soc. Nat. Hist., vol. 6, no. 2, p. 65, pl. 5, figs. 2, 3a, b; Pliocene, California.

1938. **Bulimina subacuminata**. Cushman, Contr. Cushman Lab. Foram. Res., vol. 14, pt. 3, p. 56, pl. 9, fig. 9; Pliocene, California.

1946. **Bulimina subacuminata.** Cushman and Parker, U. S. Geol. Surv. Prof. Paper 210-D, p. 116, pl. 27, fig. 8; Pliocene, California.

Description.—Test small, length 2 times longer than broad, somewhat fusiform, initial end acute, apertural end tapering bluntly angled, widest above the middle, tapering towards the initial end, with a basal spine, 6 whorls in the adult form; chambers distinct, inflated in last whorl, increasing in size rapidly; sutures fairly distinct, depressed; wall finely perforate, upper portion of last-formed whorl smooth, remainder of test ornamented by high, narrow, plate-like costae; aperture loop-shaped, above the junction of second and third chambers. Length, 0.55 mm.; diameter, 0.30 mm. Present.

Hypotype.—USC No. 799.

Bulimina subcalva Cushman and K. C. Stewart

Plate 22, figures 13a, b

1930. **Bulimina subcalva** Cushman and K. C. Stewart, Trans., San Diego Soc. Nat. Hist., vol. 6, no. 2, p. 65, pl. 4, figs. 8a-c; Pliocene, California.

1946. **Bulimina subcalva.** Cushman and Parker, U. S. Geol. Surv. Prof. Paper 210-D, p. 116, pl. 27, fig. 7; Pliocene, California. (Contains prior synonymy).

Description.—Test small, slightly longer than broad, widest towards the apertural end, initial end acute, apertural end rounded, tapering towards the initial end, sometimes with a short basal spine, about 5 whorls in the adult form; chambers distinct, numerous, inflated, increasing in size rapidly, last whorl making up about ⅔ of the test, suture distinct, depressed at the apertural end, less distinct towards the initial end; wall finely perforate, earlier chambers ornamented by plate-like costae, later chambers smooth; aperture elongate, oval, rather large. Length, 0.60 mm.; diameter, 0.35 mm. Common.

Hypotype.—USC No. 800.

Genus **Globobulimina** Cushman, 1927

Globobulimina glabra Cushman and Parker

Plate 23, figures 7a-c

1884. **?Bulimina pyrula** Brady (not Orbigny), Rep. Voy. **Challenger,** Zool., vol. 9, p. 399, pl. 50, figs. 7-10; Recent, New Zealand.

1946. **Globobulimina glabra** Cushman and Parker, U. S. Geol. Surv. Prof. Paper 210-D, p. 134, pl. 29, figs. 35, 36; Pliocene, Italy.

Description.—Test of medium size for the genus, ovate, length about 2 times as long as broad, circular in cross section, initial end sharply rounded, apertural end less so, last three chambers making up greater part of test; chambers triserial, distinct, the first-formed one of the last whorl not completely inclosed so that it is visible on both sides of the test, slightly inflated; sutures distinct, slightly depressed; wall thin smooth, finely perforate; aperture comma-shaped, with a lip and high curved tooth. Length, 0.45 mm.; diameter, 0.30 mm. Rare.

Hypotype.—USC No. 828.

Remarks.—This species is distinguished from *Globobulimina pacifica* Cushman by the fact that the first chamber of the last-formed whorl is visible on both sides of the test.

Globobulimina pyrula (Orbigny)

Plate 23, figures 8a, b

1846. **Bulimina pyrula** Orbigny, Foraminifères fossiles du Bassin Tertaire de Vienne, p. 104, pl. 11, figs. 9, 10; Miocene, Austria.

1884. **Bulimina pyrula.** Brady, Rep. Voy. **Challenger,** Zool., vol. 9, p. 399, pl. 50, figs. 7-10; Recent, All Oceans.

1937. **Bulimina pyrula.** Cushman and Parker, Contr. Cushman Lab. Foram. Res., vol. 13, pt. 2, p. 46, pl. 6, fig. 1; Eocene, Germany.

1944. **Bulimina pyrula.** LeRoy, Colorado School of Mines, Quart., vol. 39, no. 3, p. 26, pl. 5, figs. 14; Miocene, Sumatra.

1946. **Bulimina pyrula.** Cushman and Parker, U. S. Geol. Surv. Prof. Paper 210-D, p. 104, pl. 25, fig. 2; Pliocene, California. (Contains prior synonymy).

Description.—Test of medium size, length 1½ times longer than wide, initial end sharply rounded, 2 to 3 whorls in the adult form, last-formed whorl comprising about 5/6 of the test; chambers slightly inflated, those of the last whorl more so, increasing in size rapidly; sutures distinct, slightly depressed, wall smooth, often translucent, sometimes ornamented by a small basal spine, coarsely perforated; aperture loop-shaped, with a lip and tooth. Length, 0.40 mm.; diameter, 0.25 mm. Present.

Hypotype.—USC No. 829.

Remarks.—This species is placed in the genus *Globobulimina* Cushman, 1927 because of the envolving nature of the last-formed whorl Other atypical species of the genus *Bulimina* Orbigny 1826 such as *Bulimina ovula* Orbigny and *Bulimina marginospinata* Cushman and Parker may conceivably fall into this category. However these latter species show several of their earlier whorls whereas *Globobulimina pyrula* (Orbigny) does not.

Genus **Virgulina** Orbigny, 1826
Virgulina bramlettei Galloway and Morrey

Plate 23, figures 10a, b

1929. **Virgulina bramlettei** Galloway and Morrey, Bull. Amer. Pal., vol. 15, p. 37, fig. 14; Upper Eocene (?), Ecuador.
1929. **Virgulina bramlettei.** Cushman, Contr. Cushman Lab. Foram. Res., vol. 5, pt. 4, p. 94, pl. 13, fig. 30; Miocene, Venezuela.
1930. **Virgulina bramlettei.** Cushman and Moyer, Contr. Cushman Lab. Foram. Res., vol. 6, pt. 3, p. 57, pl. 8, fig. 2; Recent, California Coast.
1937. **Virgulina bramlettei.** Cushman, Special Publ. 9, Cushman Lab. Foram. Res., p. 20, pl. 3, figs. 6-9; Miocene, California.
1938. **Virgulina bramlettei.** Cushman and LeRoy, Journ. Pal., vol. 12, no. 2, p. 125, pl. 22, figs. 19a-c; Miocene, California.

Description.—Test elongate, slightly fusiform, widest towards the apertural end, length about 3 times as long as wide, slightly compressed in cross section, initial end sharply rounded, occasionally with a small basal spine, apertural end rounded, early portion of test triserial, later part irregularly biserial; chambers distinct, slightly inflated, higher than broad in the adult stage, 8 to 10 in number; sutures slightly depressed, varying in inclination with the horizontal in different parts of the test; wall smooth, finely perforate; aperture elongate, narrow, loop-shaped, above suture line of second chamber. Length, 0.60 mm.; width, 0.20 mm.; thickness, 0.15 mm. Present.

Hypotype.—USC No. 875.

Virgulina cornuta Cushman

Plate 23, figures 9a-c

1913. **Virgulina cornuta** Cushman, Proc. U. S. Nat. Mus., vol. 44, p. 637, pl. 80, fig. 1; Recent, Philippines.
1930. **Virgulina cornuta.** Cushman and Moyer, Contr. Cushman Lab. Foram. Res., vol. 6, pt. 3, p. 57, pl. 8, fig. 1; Recent, California Coast.
1937. **Virgulina cornuta.** Cushman, Special Publ. 9, Cushman Lab. Foram. Res., p. 28, pl. 4, figs. 20, 21; Recent, California.

Description.—Test short, broad, about ¾ times as long as wide, widest about the middle, slightly compressed in cross section, periphery broadly rounded, initial end subacute, spirally twisted, apertural end biserial with a slight twisted tendency; chambers distinct inflated towards the apertural end, particularly on the apertural side; sutures distinct, curved on apertural side, less so on opposite side, slightly depressed; wall smooth, finely perforate; aperture comma-shaped, in a slight depression. Length, 0.55 mm.; width, 0.35 mm.; thickness, 0.30 mm. Rare.

Hypotype.—USC No. 876.

Virgulina nodosa R. E. and K. C. Stewart

Plate 24, figures 1a-c

1930. **Virgulina nodosa** R. E. and K. C. Stewart, Journ. Pal., vol. 4, no. 1, p. 64, pl. 8, figs. 4a-c; Pliocene, California.
1932. **Virgulina nodosa.** Cushman, Contr. Cushman Lab. Foram. Res., vol. 8, pt. 1, p. 16, pl. 3, figs. 3a-c; Pliocene, California.
1937. **Virgulina nodosa.** Cushman, Special Publ. 9, Cushman Lab. Foram. Res., p. 22, pl. 3, fig. 24; Pliocene, California.

Description.—Test elongate, spirally twisted, slightly compressed in cross section, length about 3 times as long as wide, widest portion formed by last pair of chambers, apertural end rounded in apertural view, sharply rounded in side view, gradual tapering to a blunt initial end; chambers inflated, distinct, early chambers triserial, later ones biserial, the last 3 making up about ½ the test; sutures much depressed; wall smooth, finely perforate; aperture comma-shaped, in a depression on inner face of last-formed chamber. Length, 0.50 mm.; width, 0.20 mm.; thickness, 0.15 mm. Rare.

Hypotype.—USC No. 877.

Genus **Buliminella** Cushman, 1911
Buliminella brevior Cushman

Plate 23, figures 5a, b

1925. **Buliminella brevior** Cushman, Contr. Cushman Lab. Foram. Res., vol. 1, pt. 2, p. 33, pl. 5, fig. 14; Miocene, California.
1938. **Buliminella brevior.** Kleinpell, Miocene Stratigraphy of California, p. 247, pl. 12, fig. 10; Miocene, California.
1947. **Buliminella brevior.** Cushman and Parker, U. S. Geol. Surv. Prof. Paper 210-D, p. 65, pl. 16, fig. 24; Miocene, California.

Description.—Test short, broad, somewhat fusiform, widest above the middle, length 2 times as long as wide, initial end sharply pointed, apertural end bluntly rounded, about 4 whorls to the adult form; chambers distinct, inflated, 4 to 5 to a whorl, increasing in size regularly, last whorl making up ⅔ of the test; wall smooth, finely perforate; sutures depressed, distinct; aperture comma-shaped in a narrow depression at the base of the last-formed chamber. Length, 0.50 mm.; diameter, 0.30 mm. Rare.

Hypotype.—USC No. 801.

Buliminella curta Cushman
var. **basispinata** R. E. and K. C. Stewart

Plate 23, figures 2a, b

1930. **Buliminella curta** var. **basispinata** R. E. and K. C. Stewart, Journ. Pal., vol. 4, no. 1, p. 63, pl. 8, fig. 6; Pliocene, California.
1938. **Buliminella curta** var. **basispinata.** Cushman, Contr. Cushman Lab. Foram. Res., vol. 14, pt. 3, p. 59, pl. 10, fig. 10; Pliocene, California.
1942. **Buliminella inconstans** var. **basispinata.** Coryell and Mossman, Journ. Pal., vol. 16, no. 2, p. 243, pl. 36, fig. 46; Pliocene, Panama.
1946. **Buliminella curta** var. **basispinata.** Cushman and Parker, U. S. Geol. Surv. Prof. Paper 210-D, p. 65, pl. 16, fig. 23; Pliocene, California.

Description.—Test elongate, spiral, tapering towards

initial end, somewhat fusiform, widest above the middle, length 2 times as long as wide, initial end bluntly pointed, numerous short, blunt spines covering first few chambers, about 4 to 5 whorls in the adult form; chambers numerous, slightly inflated, 4 to a whorl, increasing in size regularly; sutures distinct, depressed; wall smooth in later portion of test, spinose at initial end, finely perforate; aperture comma-shaped, at base of last-formed chamber, in a depression, usually with a tooth. Length, 0.85 mm.; diameter, 0.35 mm. Rare.

Hypotype.—USC No. 802.

Buliminella dubia Barbat and Johnson

Plate 23, figures 3a, b

1934. **Buliminella dubia** Barbat and Johnson, Journ. Pal., vol. 8, no. 1, p. 13, pl. 1, figs. 14, 15; Upper Miocene, California.

1938. **Buliminella dubia.** Kleinpell, Miocene Stratigraphy of California, p. 249, pl. 16, fig. 7; Miocene, California.

1946. **Buliminella dubia.** Cushman and Parker, U. S. Geol. Surv. Prof. Paper 210-D, p. 66, pl. 17, fig. 3, 4; Miocene, Pliocene, California.

Description.—Test small, fusiform, spiral, widest towards the apertural end, 3 to 4 whorls in the adult form, initial end pointed, apertural end sharply rounded, periphery slightly lobulate, length 2 times as long as wide; chambers distinct, inflated, 4 to a whorl, about as high as wide; sutures distinct, slightly depressed; wall smooth, finely perforate; aperture comma-shaped, in a small depression in the last-formed chamber. Length, 0.35 mm.; diameter, 0.20 mm. Present.

Hypotype.—USC No. 803.

Buliminella subfusiformis Cushman

Plate 23, figures 6a, b

1925. **Buliminella subfusiformis** Cushman, Contr. Cushman Lab. Foram. Res., vol. 1, pt. 2, p. 33, pl. 5, fig. 12; Miocene, California.

1930. **Buliminella subfusiformis.** Cushman, Stewart and Stewart, Trans. San Diego Soc. Nat. Hist., vol. 6, no. 2, p. 64, pl. 4, fig. 8a, b; Pliocene, California.

1946. **Buliminella subfusiformis.** Cushman and Parker, U. S. Geol. Surv. Prof. Paper 210-D, p. 64, pl. 16, fig. 21; Miocene, California.

Description.—Test elongate, slender, fusiform, initial end subacute, apertural end rounded, 4 to 5 whorls in the adult form, widest towards the apertural end, length 4 times as long as wide; chambers distinct, inflated, 4 to a whorl, increasing in size uniformly and gradually, chambers of last whorl higher than broad; sutures depressed, slightly curved, wall smooth, finely perforate; aperture comma-shaped, in a depression on face of last-formed chamber. Length, 0.60 mm.; diameter, 0.15 mm. Common.

Hypotype.—USC No. 804.

Family CASSIDULINIDAE Orbigny, 1839

Genus **Cassidulina** Orbigny, 1826

Cassidulina californica Cushman and Hughes

Plate 24, figures 2a, b

1925. **Cassidulina californica** Cushman and Hughes, Contr. Cushman Lab. Foram. Res., vol. 1, pt. 1, p. 12, pl. 2, fig. 1; Pliocene, California.

1927. **Cassidulina californica.** Galloway and Wissler, Journ Pal., vol. 1, no. 1, p. 78, pl. 12, figs. 6, 7; Pleistocene, California.

1930. **Cassidulina californica.** Cushman, Stewart and Stewart, Trans. San Diego Soc. Nat. Hist., vol. 6, no. 2, p. 75, pl. 6, figs. 8a, b; Pliocene, California.

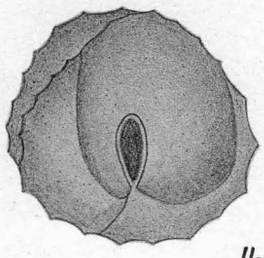
1942. **Cassidulina californica.** Coryell and Mossman, Journ. Pal., vol. 16, no. 2, p. 243, pl. 36, fig. 47; Pliocene, Panama.

1946. **Cassidulina californica.** Cushman and Gray, Special Publ. 9, Cushman Lab. Foram. Res., p. 39, pl. 7, figs. 10a-c; Pleistocene, California.

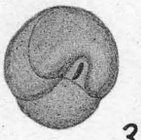
Description.—Test close coiled, circular in outline except for the last-formed chamber which projects slightly, periphery slightly lobulate, oval in edge view, sides parallel, ends broadly rounded; chambers few, alternating, about 5 pairs in last formed coil; sutures distinct, slightly depressed, radial; wall smooth, finely perforate; aperture elongate, with a plate-like tooth, in axis of coil. Diameter, 0.70 mm.; thickness, 0.40 mm. Present.

Hypotype.—USC No. 805.

EXPLANATION OF PLATE 23


1b


2b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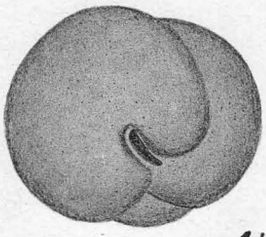
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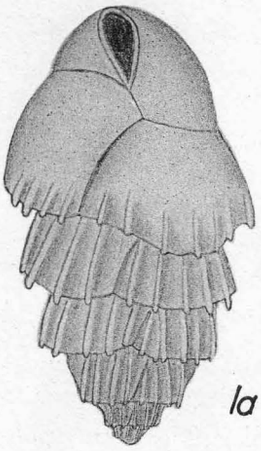
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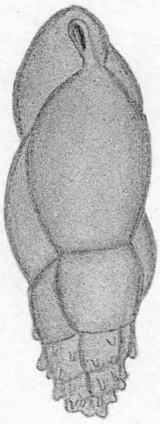
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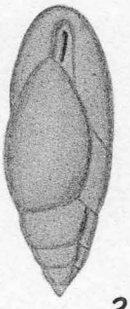
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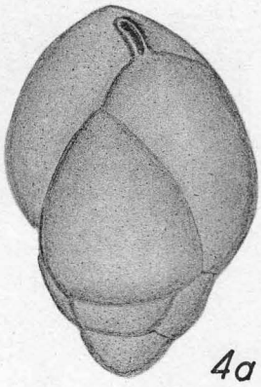
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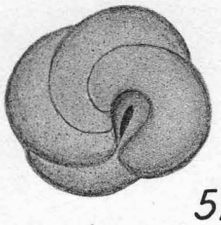
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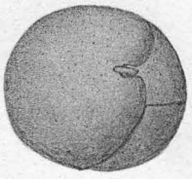
6b


7a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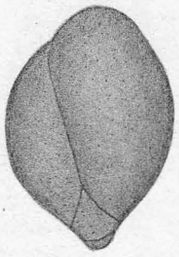
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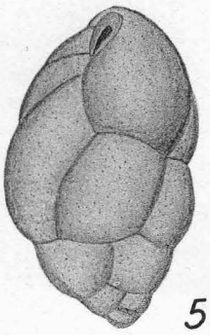
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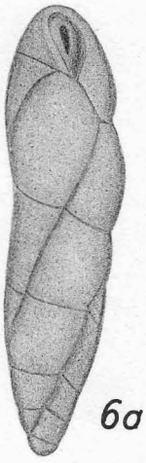
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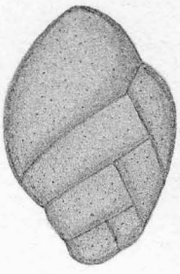
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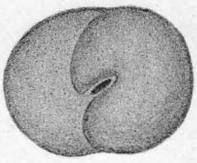
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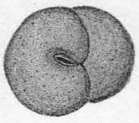
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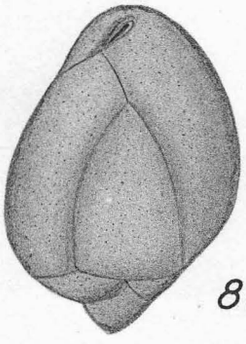
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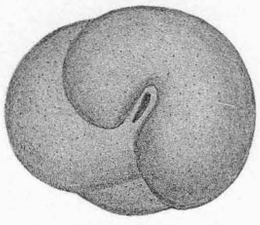
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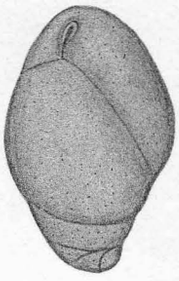
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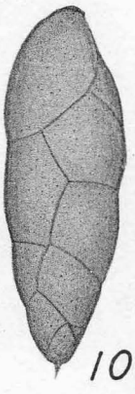
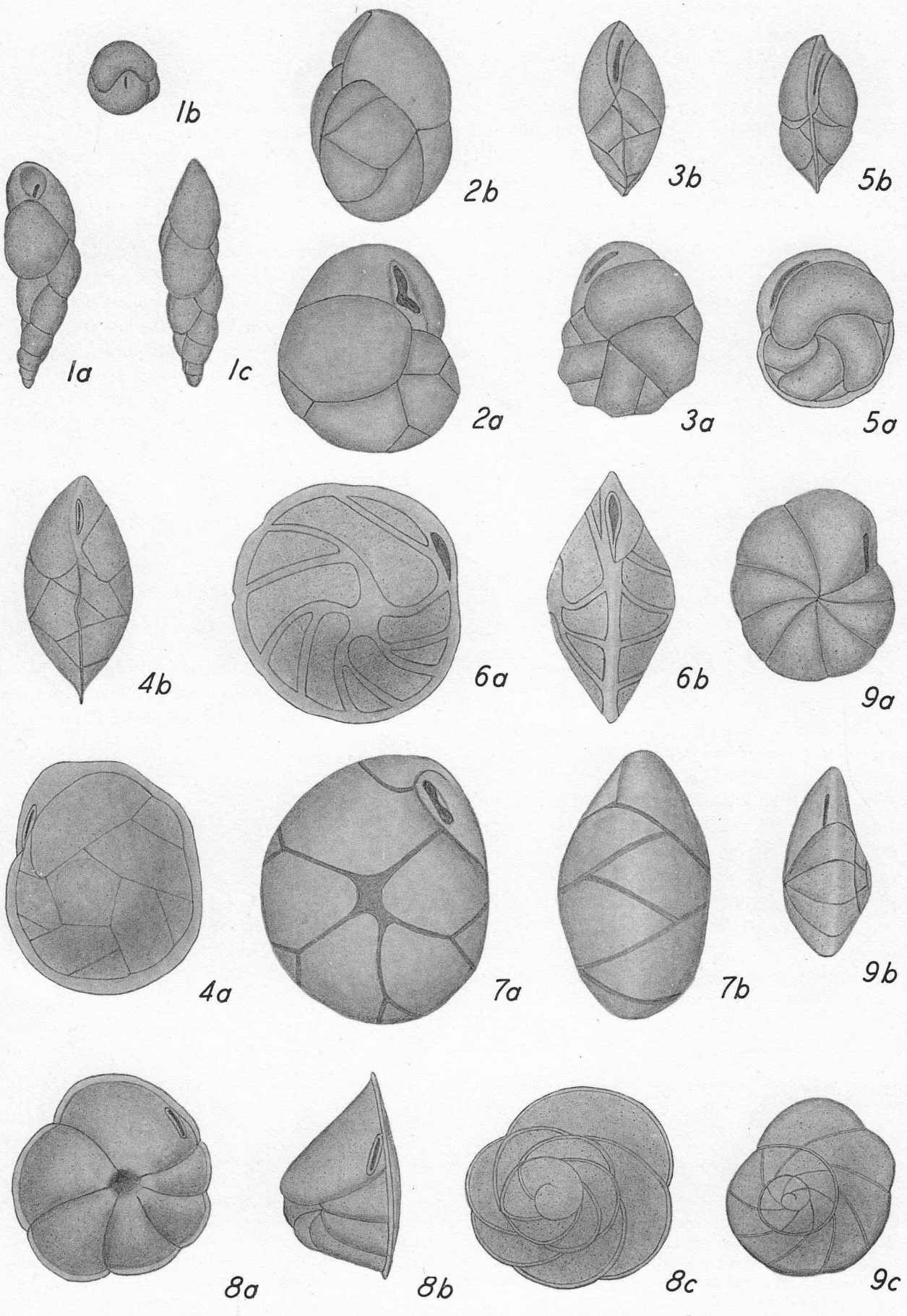

10a

Martin: Pliocene Foraminifera, Los Angeles, California



Martin: Pliocene Foraminifera, Los Angeles, California

Cassidulina corbyi Cushman and Hughes

Plate 24, figures 3a, b

1925. **Cassidulina corbyi** Cushman and Hughes, Contr. Cushman Lab. Foram. Res., vol. 1, no. 1, p. 14, pl. 2, figs. 3a, b; Pliocene, California.

Description.—Test oval, about 1½ times as long as broad, close coiled, edge strongly serrate, periphery acute, lenticular in edge view, central portion slightly umbilicate; chambers alternating, 5 to 6 pairs in last-formed coil, angled at the periphery; sutures straight, slightly depressed, not limbate; wall smooth, polished, finely perforate; aperture elongate slit in the axis of coiling, narrow. Diameter, 0.35 mm.; thickness, 0.15 mm. Common.

Hypotype.—USC No. 806.

Cassidulina cushmani R. E. and K. C. Stewart

Plate 24, figures 5a, b

1930. **Cassidulina cushmani** R. E. and K. C. Stewart, Journ. Pal., vol. 4, no. 1, p. 71, pl. 9, figs. 5a, b; Pliocene, California.

1942. **Cassidulina cushmani.** Coryell and Mossman, Journ. Pal., vol. 16, no. 2, p. 243, pl. 36, fig. 48; Pliocene, Panama.

Description.—Test close coiled, equally biconvex, compressed, circular side view, lenticular in edge view, last-formed chamber usually projecting, edge acute, periphery slightly lobulate, carinate in adult forms; chambers distinct, alternating, slightly inflated, curved, 4 pairs making up the last-formed coil; sutures distinct, depressed; wall thin, finely perforate, smooth and polished; aperture elongate, narrow, slit, following the curve of the preceding chamber, with a slight tooth. Diameter, 0.25 mm.; thickness, 0.10 mm. Abundant.

Hypotype.—USC No. 807.

Cassidulina limbata Cushman and Hughes

Plate 24, figures 6a, b

1925. **Cassidulina limbata** Cushman and Hughes, Contr. Cushman Lab. Foram. Res., vol. 1, pt. 1, p. 12, pl. 2, fig. 2; Pleistocene, California.

1927. **Cassidulina limbata.** Galloway and Wissler, Journ. Pal., vol. 1, no. 1, p. 78, pl. 12, fig. 12; Pliocene, Pleistocene, California.

1930. **Cassidulina limbata.** Cushman, Stewart and Stewart, Trans. San Diego Soc. Nat. Hist., vol. 6, no. 2, pp. 74-75, pl. 6, figs. 7a, b; Pliocene, California.

1930. **Cassidulina limbata.** Cushman and Moyer, Contr. Cushman Lab. Foram. Res., vol. 6, pt. 3, p. 61; Recent, California.

1946 **Cassidulina limbata.** Cushman and Gray, Special Publ. 19, Cushman Lab. Foram. Res., p. 42, pl. 7, figs. 14-16; Pleistocene, California.

Description.—Test close coiled, equally biconvex, nearly circular in side view; lenticular in edge view, the last-formed chamber slightly projecting, central umbo of clear shell material, periphery slightly lobulate, edge carinate; chambers numerous, alternating, curved, 5 or 6 pairs making up the last coil, characteristically constricted in the middle portion; sutures distinct, limbate, curved; wall smooth, very finely perforate; aperture elongate, narrow, parallel to the plane of coiling, with a slight plate-like tooth. Diameter, 0.65 mm.; thickness, 0.40 mm. Rare.

Hypotype.—USC No. 808.

Cassidulina lomitensis Galloway and Wissler

Plate 24, figures 7a, b

1927. **Cassidulina lomitensis** Galloway and Wissler, Journ. Pal., vol. 1, no. 1, p. 79, pl. 12, figs. 10a, b; Pleistocene, California.

1946. **Cassidulina lomitensis.** Cushman and Gray, Special Publ. 19, Cushman Lab. Foram. Res., p. 43, pl. 7, fig. 18; Pleistocene, California.

1948. **Cassidulina lomitensis.** Cushman and Stevenson, Contr. Cushman Lab. Foram. Res., vol. 24, pt. 3, p. 65, pl. 10, fig. 19; Miocene, Ecuador.

Description.—Test close coiled, broadly oval in edge view, round in side view, periphery non-lobulate; chambers not inflated, 5 pairs in last formed whorl, alternating; sutures limbate, flush with wall surface, at inner end of chambers in central part of the test form a stellate design of clear shell material; wall smooth, finely perforate; aperture elongate, elliptical, with a plate-like tooth, parallel to the plane of coiling. Diameter, 1.20 mm.; thickness, 0.60 mm. Rare.

Hypotype.—USC No. 809.

EXPLANATION OF PLATE 24

Cassidulina translucens Cushman and Hughes

Plate 24, figures 4a, b

1925. **Cassidulina translucens** Cushman and Hughes, Contr. Cushman Lab. Foram. Res., vol. 1, pt. 1, p. 15, pl. 2, fig. 5; Pleistocene, California.

1925. **Cassidulina translucens.** Cushman, Contr. Cushman Lab. Foram. Res., vol. 1, pt. 3, p. 54, pl. 9, figs. 3, 4; Pleistocene, California.

1927. **Cassidulina translucens.** Galloway and Wissler, Journ. Pal., vol. 1, no. 1, p. 80, pl. 12, figs. 11a, b; Pleistocene, California.

1930. **Cassidulina translucens.** Cushman and Moyer, Contr. Cushman Lab. Foram. Res., vol. 6, pt. 3, p. 60; Recent, California.

Description.—Test close coiled, equally biconvex, circular in side view, lenticular in edge view, with thin broad keel; chambers alternating, 5 or 6 pairs in the last-formed whorl, not inflated, slightly overlapping; sutures distinct, straight, flush with wall surface; wall smooth, finely perforate, transparent, earlier chambers and proloculum visible, aperture elongate, with a long thin tooth, in plane of coiling. Diameter, 0.50 mm.; thickness, 0.25 mm. Common.

Hypotype.—USC No. 810.

Genus **Epistominella** Husezima and Maruhasi, 1944

Epistominella bradyana (Cushman)

Plate 24, figures 9a-c

1884. **Truncatulina pygmaea** Brady (part), (not Hantken), Rep. Voy. **Challenger,** Zool., vol. 9, p. 666, pl. 95, fig. 10; Recent, Atlantic, Pacific.

1927. **Pulvinulinella bradyana** Cushman, Bull. Scripps Inst. Oceanography, Tech. Ser., vol. 1, p. 165, pl. 5, figs. 11-13; Recent, Eastern Pacific.

1938. **Pulvinulinella bradyana.** Kleinpell, Miocene Stratigraphy of California, p. 327; Miocene, California.

Description.—Test small, rotaloid, close-coiled, unequally biconvex, edge acute, periphery slightly lobulate, slightly umbilicate; chambers about 8 in the last-formed whorl seen ventrally; sutures distinct, slightly limbate, oblique dorsally, nearly radial ventrally; wall smooth, finely perforate; aperture elongate, loop-shaped, nearly parallel to the plane of coiling, with a slight tooth on the ventral lip. Diameter, 0.35 mm.; thickness, 0.25 mm. Abundant.

Hypotype.—USC No. 856.

Epistominella pacifica (Cushman)

Plate 24, figures 8a-c

1927. **Pulvinulinella pacifica** Cushman, Bull. Scripps Inst. Oceanography, Tech. Ser., vol. 1, p. 165, pl. 5, figs. 14, 15; Recent, Eastern Pacific.

1930. **Pulvinulinella pacifica.** Cushman, Stewart and Stewart, Trans. San Diego Soc. Nat. Hist., vol. 6, no. 2, p. 73, pl. 6, figs. 5a-c; Pliocene, California.

1938. **Pulvinulinella pacifica.** Kleinpell, Miocene Stratigraphy of California, p. 328; Miocene, California.

Description.—Test trochoid, plano-convex, dorsal side flattened, ventral side strongly convex, umbilicate edge acute or slightly keeled, periphery often lobulate; chambers distinct, not inflated, 6 in the last-formed whorl; sutures obliquely curved on dorsal side, slightly curved on ventral side, nearly radial, flush with surface; wall smooth, finely perforate; aperture elongate, narrow, nearly parallel to the periphery and to plane of coiling, ventral. Diameter, 0.40 mm.; thickness, 0.20 mm. Common.

Hypotype.—USC No. 857.

Remarks.—Some question exists as to the relationship between this species and *Epistominella smithi* (R. E. and K. C. Stewart). The author found that a series of specimens ranging from a very characteristic *Epistominella smithi* (R. E. and K. C. Stewart) to an equally characteristic *Epistominella pacifica* (Cushman) can be assembled. At one end of the scale a form similar to *Epistominella smithi,* without an umbilicus and almost biconvex, may be observed to gradually acquire the characteristics of *Epistominella pacifica* as succeeding chambers are added. The resulting form is trochoid with the ventral side strongly convex and a well developed umbilicus. The periphery is often very lobulate but specimens with only the slightest tendency have been noted.

Family UVIGERINIDAE
Galloway and Wissler, 1927

Genus **Uvigerina** Orbigny, 1826

Uvigerina hispida Schwager

Plate 25, figures 1a, b

1866. **Uvigerina hispida** Schwager, Novara Exped., Geol. Theil., Bd. 2, Abt. 2, p. 249, pl. 7, fig. 95; Pliocene, India.

1938. **Uvigerina hispida.** Kleinpell, Miocene Stratigraphy of California, p. 295, pl. 5, figs. 8, 16; Miocene, California.

1941. **Uvigerina hispida.** Cushman and Todd, Contr. Cushman Lab. Foram. Res., vol. 17, pt. 3, p. 73, pl. 17, fig. 8; Pliocene, India. (Contains prior synonymy).

Description.—Test elongate, fusiform, about 2 times as long as broad, widest about the middle, slightly compressed, aperture strongly so, initial end somewhat blunt; chambers triserial, initial end spirally arranged, slightly inflated, later ones tending to become biserial, last-formed chamber twisted, pointed, and strongly erect with the upper part rather narrow; sutures deeply incised, distinct; wall ornamented with coarse spines, perforate; aperture at end of neck, round, central. Length, 0.70 mm.; diameter, 0.40 mm. Present.

Hypotype.—USC No. 866.

Uvigerina hispido-costata Cushman and Todd

Plate 25, figures 2a, b

1945. **Uvigerina hispido-costata** Cushman and Todd, Special Publ. 15, Cushman Lab. Foram. Res., p. 51 pl. 7, figs. 27, 31; Miocene, Jamaica.

1949. **Uvigerina hispido-costata.** Bermudez, Special Publ. 25, Cushman Lab. Foram. Res., p. 206, pl. 13, figs. 37, 38; Upper Miocene, Dominican Republic. (Contains prior synonymy).

Description.—Test stout, compact, fusiform, about 1½ to 2½ times as long as broad, initial end blunt, apertural end rounded, widest about the middle; chambers numerous, triserial, early ones low, later ones higher and slightly inflated; sutures slightly depressed; wall ornamented by numerous plate-like costae not continuous across the sutures, costae breaking into serrations and spines at both ends, apertural end usually more spinose, proportion of costae to spines greatly varying among specimens; aperture terminal, at end of long, slender neck, with a slight lip. Length, 0.75 mm.; diameter, 0.45 mm. Common.

Hypotype.—USC No. 867.

Uvigerina hootsi Rankin

Plate 25, figures 3a, b

1934. **Uvigerina hootsi** Rankin, in Cushman and Kleinpell, Contr. Cushman Lab. Foram. Res., vol. 10, pt. 1, p. 22, pl. 3, figs. 8, 9; Miocene, California.
1938. **Uvigerina hootsi.** Kleinpell, Miocene Stratigraphy of California, p. 295, pl. 22, fig. 6; Miocene, California.
1941. **Uvigerina hootsi.** Cushman, Contr. Cushman Lab. Foram. Res., vol. 17, pt. 2, p. 46, pl. 13, figs. 16, 17; Miocene, California.
1946. **Uvigerina hootsi.** Cushman and Gray, Special Publ. 19, Cushman Lab. Foram. Res., p. 36, pl. 6, fig. 13; Pleistocene, California.
1948. **Uvigerina hootsi.** Cushman and McCulloch, Allan Hancock Pacific Exped., vol. 6, no. 5, p. 229, pl. 33, fig. 3; Recent (?), Miocene (?), Eastern Pacific (Redeposition suggested.)

Description.—Test medium sized for the genus, about 2 times as long as broad, greatest width above the middle, tapering towards the initial end, apertural end broadly rounded; chambers triserial, inflated, increasing in size rapidly and uniformly; sutures distinct, depressed; wall smooth, very slightly costate at initial end sometimes, finely perforate; aperture small, round, terminal, at end of a very short neck with a flaring lip. Length, 0.50 mm.; diameter, 0.35 mm. Common.

Hypotype.—USC No. 868.

Uvigerina juncea Cushman and Todd

Plate 25, figures 4a, b

1941. **Uvigerina juncea** Cushman and Todd, Contr. Cushman Lab. Foram. Res., vol. 17, pt. 3, p. 78, pl. 20, figs. 4-11; Pleistocene, California.
1946. **Uvigerina juncea.** Cushman and Gray, Special Publ. 19, Cushman Lab. Foram. Res., p. 36, pl. 6, figs. 10-12; Pleistocene, California.

Description.—Test elongate, slender, circular in cross section, tapering rapidly at initial end, side nearly parallel, outline lobulate; chambers triserial, later ones tending to become biserial towards apertural end, large, high, inflated, increasing in size rapidly at initial end, less so in later part of test; sutures distinct, deeply cut, slightly curved; wall ornamented by low, widespaced plate-like costae, 10 to a chamber and not crossing the suture lines, becoming finely spinose at apertural end; aperture terminal, round, at end of small neck with a flaring lip. Length, 0.80 mm.; diameter, 0.30 mm. Present.

Hypotype.—USC No. 869.

Uvigerina kernensis Barbat and von Estorff

Plate 25, figures 5a, b

1933. **Uvigerina kernensis** Barbat and von Estorff, Journ. Pal., vol. 7, no. 2, p. 172, pl. 23, fig. 13; Miocene, California.
1938. **Uvigerina kernensis.** Kleinpell, Miocene Stratigraphy of California, p. 296; Miocene, California.
1941. **Uvigerina kernensis.** Cushman and Todd, Contr. Cushman Lab. Foram. Res., vol. 17, pt. 2, p. 49, pl. 12, figs. 6, 7; Miocene, California.

Description.—Test short, stout, fusiform, length about 1½ times as long as broad, widest slightly above the middle, outline lobulate; chambers distinct, numerous, triserial, increasing in size rapidly; sutures distinct, depressed; wall ornamented with moderately raised costae, 7 to 9 per chamber, not continuing across suture lines, last 2 chambers may or may not have costae, usually ornamented with small spines; aperture terminal, round, at end of short neck with a very slight lip. Length, 0.60 mm.; diameter, 0.45 mm. Rare.

Hypotype.—USC No. 870.

Uvigerina modeloensis Cushman and Kleinpell

Plate 25, figures 6a, b

1934. **Uvigerina modeloensis** Cushman and Kleinpell, Contr. Cushman Lab. Foram. Res., vol. 10, pt. 1, p. 12, pl. 2, fig. 8; Miocene, California.
1938. **Uvigerina modeloensis.** Kleinpell, Miocene Stratigraphy of California, p. 297; Miocene, California.
1941. **Uvigerina modeloensis.** Cushman and Todd, Contr. Cushman Lab. Foram. Res., vol. 17, pt. 2, p. 50, pl. 14, fig. 13; Miocene, California.

Description.—Test elongate, slender, circular in cross section, sides nearly parallel, outline slightly lobulate, initial end sharply rounded; chambers numerous, triserial, inflated, high, slightly overlapping; sutures distinct, depressed; wall smooth, finely perforate; aperture terminal, round, at end of short neck which may be seen at the inner face of the last-formed chamber. Length, 0.60 mm.; diameter, 0.25 mm. Rare.

Hypotype.—USC No. 871.

Uvigerina peregrina Cushman

Plate 25, figures 7a, b

1899. **Uvigerina pigmea** Flint (not Orbigny), Rep. U. S. Nat. Mus., p. 320, pl. 68, fig. 2; Recent, Western Atlantic.
1923. **Uvigerina peregrina** Cushman, U. S. Nat. Mus. Bull. 104, pt. 4, p. 166, pl. 42, figs. 7-10; Recent, Western Atlantic.
1927. **Uvigerina peregrina.** Galloway and Wissler, Journ. Pal., vol. 1, no. 1, p. 76, pl. 12, figs. 1, 2; Pleistocene, California.

1930. **Uvigerina peregrina.** Cushman, Stewart and Stewart, Trans. San Diego Soc. Nat. Hist., vol. 6, no. 2, p. 69, pl. 5, fig. 11; Pliocene, California.

1941. **Uvigerina peregrina.** Cushman and Todd, Contr. Cushman Lab. Foram. Res., vol. 17, pt. 2, p. 51, pl. 14, figs. 14-17; Miocene, West Indies; Recent, Atlantic.

Description.—Test elongate, fusiform, length about 2 to 2½ times as long as broad, widest about the middle, circular in cross section, initial end acute to subacute; chambers numerous, inflated, triserial; sutures depressed, distinct; wall ornamented with very high, thin, and sharp longitudinal costae, usually 10 to a chamber, not continuous with across suture lines, becoming irregular and spinose towards apertural and initial ends; aperture terminal, round, at end of short neck with a flaring lip. Length, 0.80 mm.; diameter, 0.50 mm. Very abundant.

Hypotype.—USC No. 872.

Uvigerina pigmea Orbigny

Plate 25, figures 8a, b

1826. **Uvigerina pigmea** Orbigny, Ann. Sci. Nat., vol. 7, p. 269, pl. 12, figs. 8, 9; Pliocene, Italy.

1930. **Uvigerina pigmea.** Cushman, Contr. Cushman Lab. Foram. Res., vol. 6, pt. 3, p. 62, pl. 9, figs. 14-20; Miocene, Vienna Basin; Pliocene, Italy.

1941. **Uvigerina pigmea.** Cushman and Todd, Contr. Cushman Lab. Foram. Res., vol. 17, pt. 3, p. 70, pl. 17, figs. 1, 2; pl. 19, fig. 1; Pliocene, Italy.

1949. **Uvigerina pigmea.** Bermudez, Special Publ. 25, Cushman Lab. Foram. Res., p. 209, pl. 13, fig. 44; Upper Oligocene, Dominican Republic.

Description.—Test medium sized for genus, elongate, length about 2 to 3 times as long as broad, initial end acute to subacute, widest slightly above the middle; chambers triserial, inflated, increasing in size rapidly, last chamber somewhat extended, erect; sutures distinct, depressed; wall ornamented with longitudinal costae not continuous across the suture lines, last two chambers lacking costae and having a smooth surface; aperture terminal, round, at end of a long slender neck with a flaring lip. Length, 0.60 mm.; diameter, 0.20 mm. Present.

Hypotype.—USC No. 873.

Uvigerina proboscidea Schwager

Plate 25, figures 9a, b

1866. **Uvigerina proboscidea** Schwager, **Novara**-Exped., Geol. Theil., Bd. 2, p. 250, pl. 7, fig. 96; Pliocene, India.

1930. **Uvigerina proboscidea.** Cushman, Stewart and Stewart, Trans. San Diego Soc. Nat. Hist., vol. 6, no. 2, p. 69, pl. 5, fig. 10; Pliocene, California.

1941. **Uvigerina proboscidea.** Cushman and Todd, Contr. Cushman Lab. Foram. Res., vol. 17, pt. 3, p. 73, pl. 17, fig. 9; pl. 19, figs. 3-9; Pliocene, India.

1948. **Uvigerina proboscidea.** Cushman and McCulloch, Allan Hancock Pacific Exped., vol. 6, no. 5, p. 267, pl. 34, fig. 4; Recent, Eastern Pacific. (Contains prior synonymy).

1949. **Uvigerina proboscidea.** Bermudez, Special Publ. 25, Cushman Lab. Foram. Res., p. 209, pl. 13, fig. 45; Upper Miocene, Dominican Republic.

Description.—Test fusiform, stout, length about 2 times as long as broad, widest at the middle, apertural region elongated, initial area compact and broadly rounded, often with a small basal spine; chambers triserial, inflated, last-formed chamber elongated upward, erect; sutures distinct, deeply incised, not curved; wall ornamented with small spines; aperture terminal, round, at end of a long slender neck. Length, 0.70 mm.; diameter, 0.30 mm. Rare.

Hypotype.—USC No. 874.

Genus Siphonodosaria Silvestri, 1924

Siphonodosaria advena (Cushman and Laiming)

Plate 25, figures 10a, b

1931. **Nodogenerina advena** Cushman and Laiming, Journ. Pal., vol. 5, no. 2, p. 106, pl. 11, fig. 19; Miocene, California.

1932. **Nodogenerina advena.** Cushman and Ponton, Florida Geol. Surv., Bull. 9, p. 75, pl. 11, fig. 10; Upper Miocene, Florida.

1933. **Nodogenerina advena.** Barbat and Estorff, Journ. Pal., vol. 7, no. 2, p. 171, pl. 23, fig. 2; Lower Miocene, California.

1946. **Nodogenerina advena.** Cushman and Gray, Special Publ. 19, Cushman Lab. Foram. Res., p. 27, pl. 5, figs. 5, 6; Pleistocene, California. (Contains prior synonymy).

1948. **Nodogenerina advena.** Cushman and Stevenson, Contr. Cushman Lab. Foram. Res., vol. 24, pt. 3, p. 55, pl. 10, fig. 10; Miocene, Ecuador.

Description.—Test elongate, gradually tapering towards initial end, circular in cross section; chambers distinct, inflated, closely set, increasing gradually in size, later ones slightly higher than earlier chambers; sutures distinct, depressed, normal to longitudinal axis of test; wall with slight longitudinal spinose roughenings, otherwise smooth, finely perforate; aperture terminal, central, round, at the end of a short neck, with a slight lip. Length, 1.00 mm.; diameter, 0.25 mm. Present.

Hypotype.—USC No. 862.

Remarks.—Inasmuch as the original generic descriptions of *Nodogenerina* Cushman, 1927 and *Siphonodosaria* Silvestri, 1924 are identical, forms referred to *Nodogenerina* are placed in the latter genus which has priority. Some authors distinguish one from the other by the presence or absence of a tooth in the aperture. However, examination of most specific descriptions reveals that such a criterion, if it exists, has not been utilized.

Siphonodosaria antillea (Cushman)

Plate 25, figures 11a, b

1884. **Sagrina virgula** Brady (part), Rep. Voy. **Challenger,** Zool., vol. 9, p. 583, pl. 76, figs. 9, 10; Recent, Brazilian Coast, Pacific.

1923. **Nodosaria antillea** Cushman, U. S. Nat. Mus. Bull. 104, pt. 4, p. 91, pl. 14, fig. 9; Recent, Atlantic.

Description.—Test elongate, slender, tapering towards the initial end, straight, widest part formed by last-formed chambers; chambers uniserial, 6 to 7 in number, those of initial end appressed, later ones remote and high, circular in cross section, angled at the basal margin; sutures depressed, distinct, normal to longitudinal axis of test; wall smooth in the upper portion of chambers, spinose at the base; aperture terminal, central, round, with tooth, at end of a short neck with a phialine lip. Length, 1.00 mm.; diameter, 0.20 mm. Rare.

Hypotype.—USC No. 863.

Siphonodosaria lepidula (Schwager)

Plate 25, figures 12a, b

1866. **Nodosaria lepidula** Schwager, **Novara**-Exped., Geol. Theil., pt. 2, p. 210, pl. 5, figs. 27, 25; Pliocene, India.

1921. **Nodosaria lepidula.** Cushman, U. S. Nat. Mus. Bull. 100, vol. 4, p. 203, pl. 36, fig. 6; Recent, Philippines.

1930. **Nodogenerina lepidula.** Cushman, Stewart and Stewart, Trans. San Diego Soc. Nat. Hist., vol. 6, no. 2, p. 63, pl. 4, fig. 5; Pliocene, California.

1931. **Nodogenerina lepidula.** Galloway and Morrey, Journ. Pal., vol. 5, no. 4, p. 337, pl. 38, fig. 1; Upper Cretaceous, Mexico.

1934. **Nodogenerina lepidula.** Cushman, Bernice P. Bishop Mus. Bull. 119, p. 122, pl. 14, figs. 15, 16; Late Tertiary, Fiji Islands.

Description.—Test elongate, slender, straight, gradually tapering towards the initial end; initial end sometimes with a small spine; chambers uniserial, 8 or 9 in adult form, circular in cross section, somewhat pyriform in shape with a series of short blunt spines about the widest portion; sutures deeply constricted, limbate; wall finely perforate; aperture terminal, central, round, at the end of a slight neck. Length, 0.95 mm.; diameter, 0.15 mm. Present.

Hypotype.—USC No. 864.

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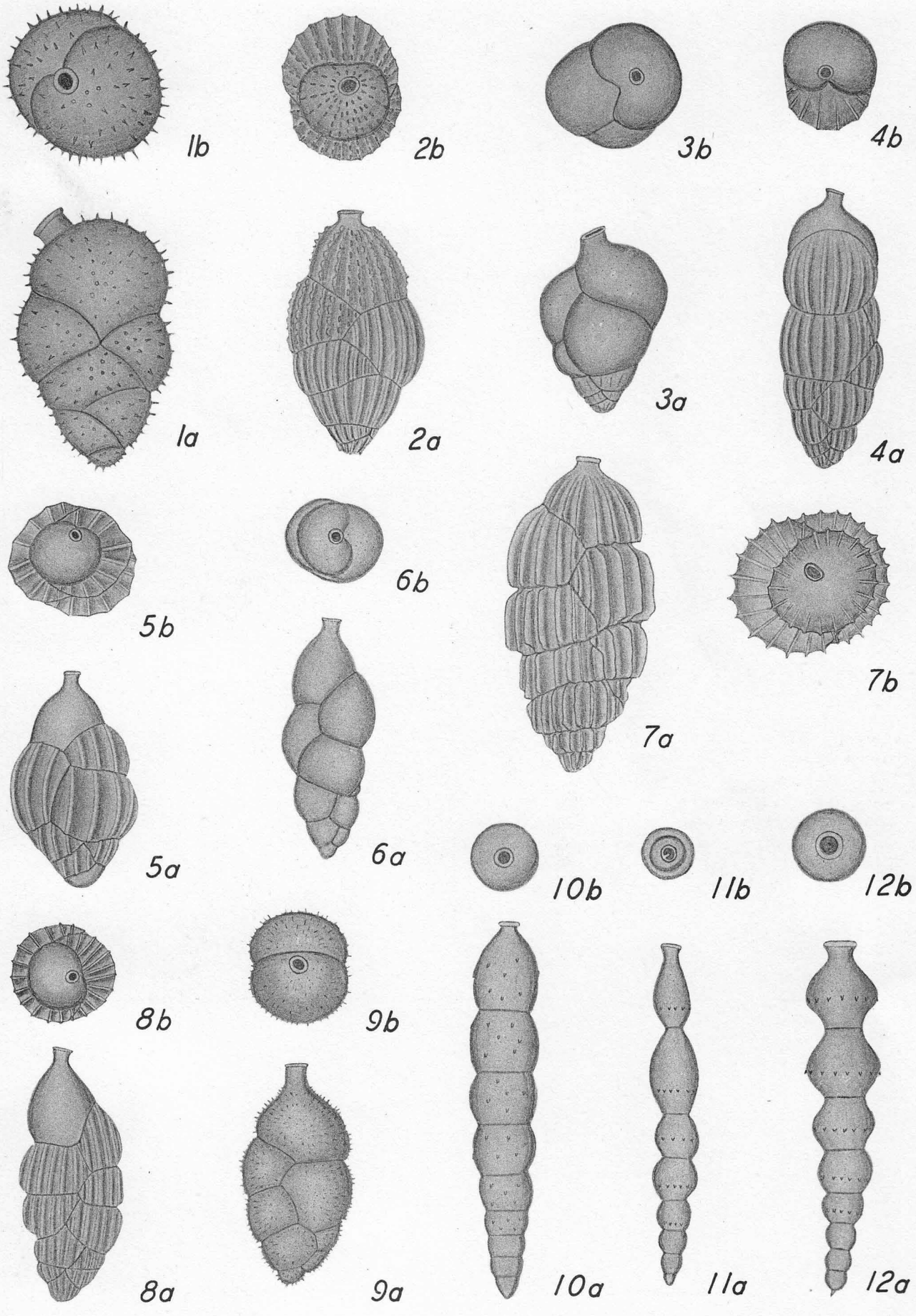
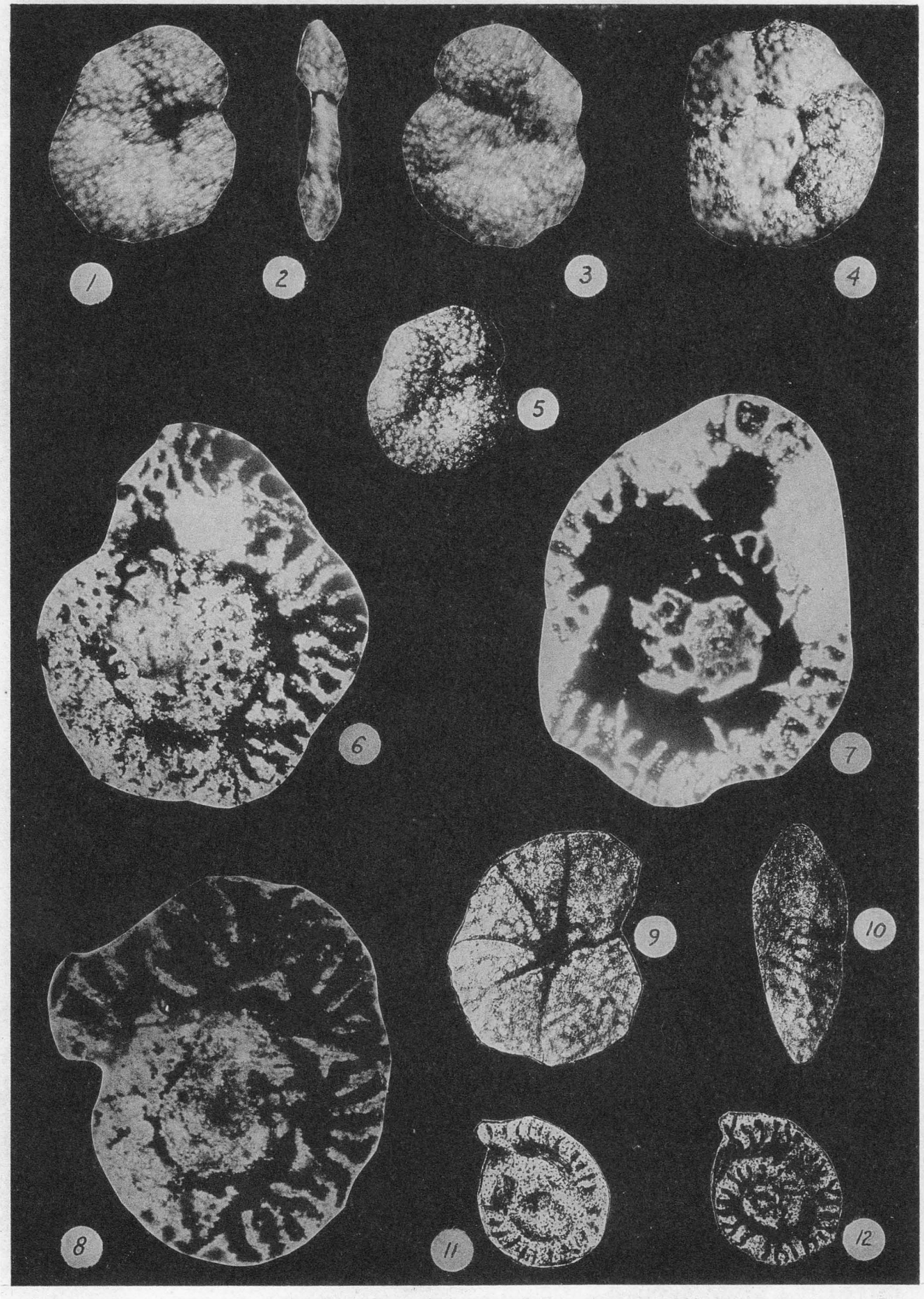
EXPLANATION OF PLATE 25



Martin: Pliocene Foraminifera, Los Angeles, California



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64. *ALVEOLOPHRAGMIUM VENEZUELANUM* N. SP. FROM THE OLIGO-MIOCENE OF VENEZUELA

(with a discussion of other species of the genus)

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ABSTRACT.—The foraminiferal genus **Alveolophragmium** Stschedrina, 1936, not previously known to occur outside of Asia, is here recorded from the Western Hemisphere.

A new species, **Alveolophragmium venezuelanum** n. sp., formerly referred to as **Haplophragmoides emaciatum** (Brady) Renz, 1948, is described from the Oligo-Miocene of Venezuela. This new species also occurs in the Lower Miocene of Trinidad, B.W.I.

Ammobaculites sp cf. **A. foliaceus** (Brady) Cushman and Stone, 1949, from the Eocene of Peru, is a true representative of the genus **Alveolophragmium** and here described as **Alveolophragmium peruvianum** n. sp.

Haplophragmoides reticulatus Boomgart, 1949, Miocene Rembang beds, East Java, is also referred to the genus **Alveolophragmium.**

It is suggested that **Alveolophragmium planum** Bykova, 1939, from the late Paleocene of the Ferghana Basin, Uzbek S.S.R., be placed in the genus **Ammobaculites** Cushman.

During his routine work in Venezuela the writer has encountered quite a number of specimens of a *Haplophragmoides*-like foraminifer which reveals an alveolar wall structure and, therefore, obviously belongs to the genus *Alveolophragmium* Stschedrina, 1936.

The genus *Alveolophragmium* was erected in 1936 by Stschedrina for an arenaceous form related to *Haplophragmoides* Cushman which — contrary to the latter genus — displays a cellular-alveolar wall structure (Stschedrina, 1936; see Ellis and Messina, 1940 etc.). Its genotype, *Alveolophragmium orbiculatum* Stschedrina, 1936, occurs in recent sediments dredged in the Bay of Peter The Great (Petra Velikogo Bay), off Vladivostok. The two varieties hitherto known, *A. orbiculatum* var. *caraensis* Stschedrina, and *A. orbicu-*

EXPLANATION OF PLATE 26

FIGS. — PAGE

1-8. *Alveolophragmium venezuelanum* Maync, n. sp. 142
- 1-3. Holotype. Exterior views. × 36.
- 5. Holotype. Same as Fig. 1. Note the reticulate near-surface layer. × 27.
- 4. Specimen showing pitted weathered surface (labyrinthic hypodermis). × 36.
- 6, 8. Median section disclosing labyrinthic wall structure. × 70.
- 7. Median section, interior filled with pyrite. × 83.

All the figured specimens are derived from cuttings 9210'-9270' in Venezuelan Atlantic Refining Company's well Jaito 1-A, State of Monagas, Eastern Venezuela (Lower-Middle Miocene La Pica formation)

9-10. *Alveolophragmium reticulatum* (Boomgart). 143
Type figures ex Boomgart, 1949, Pl. II, figs. 9 and 10. Note reticulate near-surface structure. × 38.

11-12. *Alveolophragmium peruvianum* Maync, n. sp. 142
Hypotype. Figures ex Cushman and Stone, 1949, *Ammobaculites* cf. *foliaceus,* Pl. 13, figs. 14a-b.
- 11. Exterior view. × 33.
- 12. Median section showing dendritic passages of labyrinthic wall structure. × 33.

latum var. *ochotonensis* Stschedrina, have been found in recent deposits in the Kara Sea and the Sea of Okhotsk, U.S.S.R.

SYSTEMATIC DESCRIPTIONS

Family LITUOLIDAE Brady
Subfamily SPIROCYCLININAE Maync, 1949
Genus **Alveolophragmium** Stschedrina, 1936
Alveolophragmium venezuelanum n. sp.

Synonymy. *Haplophragmoides emaciatum* Renz, 1948 (non Brady, 1884), Geol. Soc. America, Mem. 32, p. 142, Pl. I, figs. 6a-b.

Type figure. Holotype: Pl. 26, figs. 1-3, 5.

Type description. Test free, planispiral, laterally symmetrical; more or less evolute (inner whorl partly visible); depressed at the umbilicus; tending to be distorted, chambers sometimes collapsed, the last one often inflated; periphery rounded or subrounded, sometimes lobulate; chambers generally distinct, of uniform size, 5-7 in the last-formed coil; sutures fairly distinct, straight or slightly curved with marked constrictions; smoothly finished on the exterior (thin epidermal coating), translucent; walls labyrinthic (see Pl. 26, figs. 6-8); hypodermal layer with reticulate honeycomb pattern, showing at the surface as an areolate pitted meshwork (figs. 1-5); aperture indistinct, apparently a crescentiform slit at the base of the apertural face (interio-marginal).

Dimensions. Holotype (Pl. 26, figs. 1-3, 5):

Greatest diameter:	1.0 mm.
Least diameter:	0.85 mm.
Thickness:	0.24 mm.

Type level. Lower part of the La Pica formation (Lower-Middle Miocene).

Type locality. Venezuelan Atlantic Refining Company's well Jaito 1-A, about 15 Kms WSW of the town Maturin, State of Monagas, Eastern Venezuela; in cuttings from between 9210′ and 9270′ depth.

The holotype, as well as the figured specimens and thin-sections of *Alveolophragmium venezuelanum* n. sp. are deposited in the collection of the Cushman Foundation, U. S. National Museum, Washington, D.C.

Alveolophragmium venezuelanum n. sp. was observed by the writer in many well samples from Oligo-Miocene formations (Carapita and La Pica formations) of the Maturin Basin, Eastern Venezuela. Some rare specimens were also found in the Upper Oligocene Cerro Pelado formation of Western Venezuela (Churuguara area, State of Lara).

Haplophragomides emaciatum Renz, 1948 (non Brady), which is referred to *Alveolophragmium venezuelanum* n. sp., was found in Upper Oligocene to Lower Miocene surface formations of the Isidro region, State of Falcón, Western Venezuela (see Renz, 1948).

Haplophragmoides emaciatum Renz, 1948, is quite different from Brady's species; the latter shows no alveolar wall structure at all but is characterized by a roughly finished outer wall with incorporated angular sand grains and pieces of broken sponge spicules[1] (see type figures in Brady, 1884, Pl. 33, figs. 26-28). Typical specimens showing this agglomeration of sponge spicules have been figured by Flint in his catalogue of recent foraminifera (Flint, 1899, Pl. 19, fig. 5). The very same type of test is also displayed in *Trochammina spiculolega* Parr (Parr, 1950, Pl. 5, figs. 8-10). The pitted surface shown in H. H. Renz' specimens (Renz, 1948, Pl. I, figs. 6a-b) and in most of the specimens at hand is not due to a coarsely arenaceous texture of the test but is a phenomenon of weathering which has attacked the inner reticulate layer of the wall. Topotype specimens of the Falcón species were kindly put at the writer's disposal by H. H. Renz, Mene Grande Oil Co., Caracas; thin-sections made from several of these specimens clearly reveal this alveolar wall structure which differentiates *Alveolophragmium* from *Haplophragmoides*.

H. H. Renz-Renz also provided the author with typical specimens of *Alveolophragmium venezuelanum* n. sp. from the Lower Miocene Cruse formation of the Guayaguayare area, southeastern Trinidad, B.W.I., which is herewith gratefully acknowledged.

Alveolophragmium peruvianum n. sp.

Synonymy. *Ammobaculites* cf. *foliaceus* Cushman and Stone, 1949 (non Brady, 1881), Contr. Cushman Lab. Foram. Research, vol. 25, pt. 4, p. 76, Pl. 13, figs. 14a-b. Refigured in the present paper, Pl. 26, figs. 11 and 12.

The form described by Cushman and Stone from the Eocene Verdun formation of Peru has nothing to do with *Lituola (Haplophragmium) foliaceum* Brady, 1881[2]: While the latter shows a simple internal structure (see Brady, 1884, Pl. 33, fig. 24), the Peruvian form distinctly displays a labyrinthic interior pattern (see Cushman and Stone, 1949, Pl. 13, fig. 14b; Pl. 26, fig. 12 of the present paper). On account of this characteristic alveolar wall structure, *Ammobaculites* cf. *foliaceus* Cushman and Stone, 1949, is therefore referred to the genus *Alveolophragmium* Stschedrina, 1936. By its smaller size, its finely dendritic pattern of the wall, and by its stratigraphic occurrence (Eocene), the Peruvian species differs from *Alveolophragmium venezuelanum* n. sp., and the erection of a new species, *A. peruvianum* n. sp., seems to be justified.

1 The writer cannot support the statement that the wall in **Haplophragmoides emaciatum** (Brady) is labyrinthic and **Cyclammina**-like (Cushman, 1920, p. 40).

2 H. B. Brady's form **Lituola (Haplophragmium) foliaceum** possesses a simple terminal aperture and can, accordingly, not be referred to **Lituola** or **Haplophragmium, olim** (see Maync, 1952). On account of its strongly compressed test it can neither be placed in the genus **Ammobaculites** (see Cushman, 1910, p. 177) but is a representative of the genus **Ammomarginulina** Wiesner, 1931.

Alveolophragmium reticulatum (Boomgart)

Synonymy. *Haplophragmoides reticulatus* BOOMGART, 1949, Smaller Foraminifera from Bodjonegoro (Java), p. 47, Pl. II, figs. 4a-b. Refigured in the present paper, Pl. 26, figs. 9 and 10.

Boomgart's type figures positively show the reticulate hypodermal layer (near-surface honeycomb pattern) which is diagnostic of the genus *Alveolophragmium* Stschedrina, 1936.

Diagnosis. "Test close-coiled, moderately compressed; periphery subacute; seven to nine chambers, gradually increasing in size as added; sutures slightly depressed, practically straight, meeting in the umbilical point; wall smoothly finished, showing a reticulate texture; aperture at the base of the last-formed chamber. Dimensions: 1.00 x 0.70 x 0.48 mm." (Boomgart, 1949, p. 47).

The Javanese form differs from *Alveolophragmium venezuelanum* n. sp. in being nearly involute, in having a subacute, not lobulate, periphery, more chambers, and very distinct straight sutures.

Alveolophragmium planum Bykova, 1939

In 1939, Bykova described a new species of *Alveolophragmium* from the Paleocene of the Ferghana Basin, Uzbek S.S.R. (Russian Turkestan), viz. *A. planum* Bykova (Bykova, 1939, see Ellis and Messina, 1940 etc.).

The figured sections (Bykova, 1939, p. 20, textfigs. 1a and 1b) as well as the holotype specimen (ibid., Pl. 1, fig. 10), however, do by no means prove that the Russian species was correctly referred to the genus *Alveolophragmium*. The given illustrations show, on the contrary, that *A. planum* Bykova lacks a reticulate hypodermis and a truly labyrinthic interior structure, but merely displays irregularly contoured lumina, such as are present in certain species of the genus *Ammobaculites* (*A. expansus* Plummer, *A. midwayensis* Plummer, *A. calcareum* (Brady), etc.). Although nothing is known concerning the character of the aperture, the writer is inclined in the light of the foregoing remarks to refer *Alveolophragmium planum* Bykova to *Ammobaculites,* the more so as the Russian form clearly shows a tendency of uncoiling in the adult (see Bykova, 1939, textfig. 1b). Bykova's form from the Ferghana region should, therefore, be named: *Ammobaculites planus* (Bykova).

Cyclammina tasmanica Parr, 1950, has been compared by its author with *Alveolophragmium orbiculatum* var. *ochotonensis Stschedrina* (Parr, 1950, p. 274). In its outer appearance, the Australian species is a true *Cyclammina* (external shape and outline, sigmoidal sutures, etc.); its "thick internal layer which is closely perforated with tubular passages opening into the interior of the test" (Parr, 1950, p. 274) suggests a coarsely labyrinthic structure (*Cyclammina* type). *Cyclammina tasmanica* Parr, however, is stated to have a simple interio-marginal apertural slit, apparently without the supplementary pores which are typical of *Cyclammina*. The taxonomic position of this Tasmanian form is, therefore, still questionable.

TAXONOMY

According to Stschedrina, *Alveolophragmium* is not a member of the *Haplophragmiinae* (olim), which disclose a simple wall structure, but is referable to the *Lituolinae* (olim) with a labyrinthic interior. In accordance with the writer's revised classification of the *Lituolidae* (Maync, 1952), all the genera characterized by a reticulate hypodermis and/or a labyrinthic interior structure are placed in the subfamily *Spirocyclininae* Maync, 1949, and the term *Lituolinae* is restricted to include only internally simple genera uncoiling in the adult. The non-labyrinthic genera that remain coiled through all ontogenetic stages are included in the subfamily *Haplophragmoidinae* Maync, 1952. Conformably, the genus *Alveolophragmium* is regarded as being a member of the *Spirocyclininae* (see Maync, 1952).

On account of its labyrinthic interior structure, *Alveolophragmium* was compared by Stschedrina with *Pseudocyclammina* Yabe and Hanzawa. In view of the considerable difference of the apertures, however, *Pseudocyclammina* having a cribrate aperture while *Alveolophragmium* shows a curved interio-marginal slit, the new genus *Alveolophragmium* was established.

According to its author, *Alveolophragmium* is possibly a transitional form between Lituolids with simple wall structure and those with a labyrinthic interior. Yet as the given microphotographs reveal a truly labyrinthic wall structure (see Pl. 26, figs. 6-8), the genus *Alveolophragmium* Stschedrina positively belongs to the spirocyclinine group of lituolid foraminifera, and its resemblance with some representatives of the *Haplophragmoidinae* is purely superficial.

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65. OCCURRENCE OF HANTKENINA AT TORQUAY, AUSTRALIA AND THE AGE OF THE "JANJUKIAN" AND "ANGLESEAN" STAGES

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In a paper on "Some Tertiary Foraminifera from Victoria, Australia" published in these "Contributions" (Vol. I, 1950, pp. 70-75, pl. 10) it was stated that certain of the species were of Lower Miocene and others of Oligocene age. Since that time, new information has become available which makes it necessary to re-consider that statement.

The recent discovery of *Hantkenina alabamensis* Cushman in a thin bed in the basal part of the Bird Rock Cliff section, Torquay, which also contains *Quinqueloculina ornithopetra* Crespin, *Quinqueloculina singletoni* Crespin, *Massilina torquayensis* (Chapman), *Bulimina pupula* Stache, *Dimorphina janjukensis* Crespin, *Vaginulinopsis gippslandicus* (Chapman and Crespin), *Frondicularia victoriae* Crespin, *Sherbornina atkinsoni* Chapman, and *Victoriella plecte* (Chapman) indicates an Upper Eocene age for the well-known "Janjukian" beds, which in the above-cited paper were placed into the Lower Miocene.

The beds containing *Ammodiscus parri* Crespin, *Cyclammina incisa* Stache, *Cyclammina rotundata* Chapman and Crespin, *Cyclammina paupera* Chapman, and *Bathysiphon angleseaensis* Crespin occur stratigraphically below the *Hantkenina* horizon, and are usually referred to the "Anglesean" stage. They are most probably of Middle Eocene age, and not Oligocene, as previously stated.

Many species which are characteristic of the Miocene deposits of Australia make an early appearance in the "Janjukian" beds at Bird Rock and it is interesting to note that J. A. Cushman in discussing some of the species in his paper "New species of Foraminifera from the Lower Oligocene of Mississippi" (Contr. Cushman Labor. Foram. Research, vol. 11, 1935, pp. 25-39, pls. 4, 5) noted "a very close relationship [of the Lower Oligocene fauna of Mississippi] to the fauna of the Indo-Pacific, particularly to that of the Miocene of Australia."

66. THREE NEW NAMES FOR BASAL MIDWAY FORAMINIFERA FROM ARKANSAS

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Dr. Hans Thalmann of Stanford, California, has called attention to three homonyms occurring in the publication "Microfauna of basal Midway outcrops near Hope, Arkansas," by R. W. Harris and Billye Irene Jobe, Transcript Press of Norman, Oklahoma, October, 1951. We gratefully acknowledge the constructive criticism, and make herewith the following corrections:

Frondicularia frankei Cushman, 1936, var. *costata* Harris and Jobe, 1951, loc. cit., p. 29, pl. 6, fig. 2,

Paleocene Arkansas, is preoccupied by: *Frondicularia costata* Kübler and Zwingli, 1866, Neujahrsbl. Burgersbibl. Winterthur, p. 8, pl. 1, fig. 1, from the Jurassic of Switzerland; and by *Frondicularia inaequalis* Costa, 1857, var. *costata* Silvestri, 1896, Mem. Pont. Accad. N. Lincei, vol. 12, p. 187, pl. 6, figs. 28-31 from the Pliocene of Italy. (*Frondicularia costata* R. E. Koch, 1926, has been changed to *Frondicularia bulonganensis* R. E. Koch, 1935). For our homonym *Frondicularia surfibrata* Harris and Jobe, nom. nov. is herewith proposed.

Polymorphina palmaris Harris and Jobe, 1951, var. *parallela* Harris and Jobe, 1951, loc. cit., p. 34, pl. 7, fig. 1, Paleocene, Arkansas, preoccupied by *Polymorphina regularis* Münster, 1838, var. *parallela* Millett, 1895, Trans. Roy. Geol. Soc. Cornwall, p. 658, figs. 5 and 6, Pliocene, England, is herewith changed to *Polymorphina undacuneata* Harris and Jobe, nom. nov.

Reophax sabulosus Harris and Jobe, 1951, loc. cit., p. 5, pl. 1, fig. 3, Paleocene, Arkansas, preoccupied by *Reophax sabulosus* Brady, 1881, Quart. Journ. Micr. Soc., vol. 21, p. 49, figured in Brady, 1884, Voyage Challenger, Repts., Zool., vol. 9, p. 298, pl. 32, figs. 5, 6, Recent, Faröe Channel, is herewith renamed *Reophax hempsteadensis* Harris and Jobe, nom. nov.

Further corrections are made regarding *Bairdia magna* Alexander, 1927 (loc. cit., p. 69, pl. 12, fig. 2, Paleocene, Arkansas), and *Bairdia nasunca* Harris and Jobe 1951, (loc. cit., p. 69, pl. 12, fig. 1, Paleocene, Arkansas). Reexamination of these two ostracod species revealed that the accessory terminal hingement places them into the genus *Bairdoppilata* Coryell, Sample, and Jennings.

67. TWENTY YEARS OF "FORAMINIFERAL STATISTICS": 1931 TO 1950

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For more than twenty years the writer has recorded regularly in the "Journal of Paleontology" the literature and new taxonomic units of Foraminifera. Ten years ago a summary was given covering the period from 1931 to 1940 inclusive (Bull. Geol. Soc. America, vol. 53, Nr. 12, pt. 2, p. 1810, 1942).

Since then another decade has been added, largely characterized by a slackening of "production" due to the years of World War II — but notably and rapidly picking up again since then. The following tabulation demonstrates the amount of *new* taxonomic units amongst the Foraminifera for the two decades 1931-1940, and 1941-1950 respectively, and the total for the twenty years period: 1931 to 1950 inclusive:

	1931-1940	1941-1950	Total: 1931-1950
Superfamiliae	0	8	8
Familiae	28	15	43
Subfamiliae	44	17	61
Genera	270	262	532
Subgenera	38	21	59
Species	3833	3925	7758
Subspecies et Var.	674	605	1279
Nomina nova	65	120	185
Homonyma	250	99	349
Scripta	3443	3418	6861

In other words, during these twenty years every six months two new families, every four months one new subfamily and one new subgenus, every month 2 new genera and 5 subspecies or varieties, and every day one new species and one paper on Foraminifera were published.

Looking back over these twenty years the question arises: where does this sizeable production of new taxonomic units lead to? Are all these new forms necessary for the progress of foraminiferology? From a scientific point of view, we are still in the stage of recording and cataloguing the foraminiferal content of recent seas, bays, inlets, and of analysing the faunal assemblages of countless numbers of sedimentary layers from the Cambrian to the Pleistocene all the world over. In addition, modern phylo-morphogenetically and micro-anatomically oriented studies of whole faunas, genera and lineages of species, ecological, paleoecological investigations (facies studies) will add in future many new units in order to understand better than we do to-day the taxonomy and phylogeny of the Foraminifera and thus provide a firm base for their natural classification. For such a purpose and final goal each new taxonomic unit will necessarily become an asset provided that it is erected with sound judgment after an extensive search of all available literature, comparison with nearly-related forms, examination of enough specimens to make sure beyond doubt that it is *really new to science.* It will be the duty of each worker to observe strictly the International Rules of Zoological Nomenclature in their present or future emended form regardless of the personal attitude of the individual scientist towards these Rules. Everyone intending to erect new genera, species or subspecies should always be aware of the fact that, by doing so, he takes over an *obligation* and *responsibility* not only towards the contemporaneous but also towards future generations, and

that a new taxonomic unit, once published, can not even be undone by its author. If new genera, species, subspecies or other taxonomic units are correctly and, most of all, conscientiously erected they will be a credit to their authors and a welcome and valuable contribution to the progress of foraminiferology — if not done so, they will be a tremendous burden and dead weight to our science. In case of doubt whether a certain form might unquestionably be new to science, the worker always has recourse to the *nomenclatura aperta,* which has been developed to avoid a precocious taxonomic allocation and unnecessary encumbrance to nomenclature.

68. PLUMMERITA NEW NAME FOR PLUMMERELLA BRONNIMANN, 1952 (non Plummerella DeLong, 1942)

PAUL BRONNIMANN
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Hans E. Thalmann has called my attention to the fact that *Plummerella* Bronnimann, 1952, a new subgenus of *Rugoglobigerina* Bronnimann, 1952 (Bull. Amer. Paleont., vol. 34, Nr. 140, p. 37, with subgenerotype: *Rugoglobigerina (Plummerella) hantkeninoides* Bronnimann, 1952, from the Maestrichtian of Trinidad, B.W.I.) is a primary homonym of the hemidopteran genus *Plummerella* DeLong, 1942 (Ann. Entom. Soc. America, vol. 35, p. 200). The substitute name *Plummerita* nom. nov. is, therefore, proposed for *Plummerella* Bronnimann, 1952, non DeLong, 1942.

69. NODOSARIA NOMENCLATURE

R. M. STAINFORTH
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Mr. N. de B. Hornibrook has kindly drawn my attention to, and provided a copy of, a 1947 paper by the late H. J. Finlay[1] which should have been cited in my own recent paper in this journal[2] on the classification of uniserial calcareous foraminifera. Unfortunately I was not aware of Finlay's publication and must make up for the omission by the following notes.

Finlay strongly urges the suppression of *Ellipsonodosaria* as a synonym of *Nodosarella.* He cites Martinotti to the effect that the early chambers of *Nodosarella* may be biserial in the microspheric form. (Stainforth, 1952, preferred to regard *Nodosarella* as strictly uniserial and to use *Ellipsoidella* for the initially biserial forms, but recognized the difficulty of separating marginal species).

Finlay recognizes the synonymy of *Siphonodosaria* and *Nodogenerina* but draws attention to an awkward taxonomic point. *Siphonodosaria* Silvestri, 1924 was proposed as a genus with no designated species and ought to be considered a nude name until it was validated by Cushman, who referred *Nodosaria abyssorum* Brady to this genus in March 1927. Meanwhile *Nodogenerina* Cushman had been proposed, with *N. bradyi* as genotype, in January 1927. It can be argued from these facts that *Nodogenerina* has prior validity over *Siphonodosaria.* Finlay leaves this question open and goes on to claim that *Stilostomella* Guppy, 1894[3] is congeneric with *Siphonodosaria* and *Nodogenerina* and has priority over both of them. (Stainforth, 1952, considered that *Siphonodosaria* was the valid name by priority of publication. He overlooked *Stilostomella* but here states the opinion that Finlay appears to be correct. Guppy's description and figures of *Stilostomella rugosa* match only one well-known species-group in the Eo-Oligocene of Trinidad: unless his types can be located it appears impossible to identify the exact species, but *S. rugosa* falls in the plexus of *"Ellipsonodosaria" curvatura* Cushman, *"E." subspinosa* Cushman, *"E." recta* Palmer and Bermudez, etc.).

Finlay's views are expressed above in a highly compressed form. His paper should be read in full by anyone concerned with these taxonomic matters.

This opportunity is taken to mention that J. J. Galloway[4] should be cited among others who have noted synonymy of nodosarian genera.

1 H. J. Finlay, N. Z. Jour. Sci. Tech., vol. 28, no. 5 (sec. B), pp. 272-275, etc. Wellington, 1947.

2 R. M. Stainforth, Cushman Found. Foram. Res., Contr., vol. 3, pp. 6-14. 1952.

3 R. J. L. Guppy, Zool. Soc. London, Proc., p. 649. London, 1894.

4 J. J. Galloway, Manual of Foraminifera, pp. 247, 376, 383, 384, etc. Bloomington, Ind. 1933.