CUSHMAN FOUNDATION FOR FORAMINIFERAL RESEARCH

SPECIAL PUBLICATION NO. 1

AN EOCENE FORAMINIFERAL FAUNA FROM THE AGUA FRESCA SHALE OF MAGALLANES PROVINCE, SOUTHERNMOST CHILE

By

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WASHINGTON, D. C., U. S. A.

SEPTEMBER 2, 1952

Price $1.50 postpaid

AN EOCENE FORAMINIFERAL FAUNA FROM THE AGUA FRESCA SHALE OF MAGALLANES PROVINCE, SOUTHERNMOST CHILE[1, 2]

By RUTH TODD[3] and HEDWIG T. KNIKER[4]

ABSTRACT—Smaller Foraminifera are recorded and illustrated from the Agua Fresca shale of southernmost Chile as represented by 20 outcrop samples and 46 well cores. Of the 114 species and varieties included, 29 species are described as new, and one new name is proposed. The fauna is correlated with that of the Kreyenhagen shale of California. The composition of the fauna indicates deposition at considerable depth and under open-sea conditions.

INTRODUCTION

This paper is a report on one of the prolific foraminiferal faunas found in recent years in Magallanes Province, southern Chile. Magallanes Province (see fig. 1) is in the extreme southern part of South America. It consists of Brunswick Peninsula, the southern tip of continental South America; Estrecho de Magallanes (Straits of Magellan); and the islands of Tierra del Fuego to the south and east of the Straits; and extends northward in the Long Land, Chile, some 550 km. west of north from Punta Arenas.

History

The type locality of the Agua Fresca formation was selected by the Decat-Pomeyrol[5] commission along Río Agua Fresca, a river flowing eastward into the Straits of Magellan, its mouth being 25 km. south of Punta Arenas. In the early 1940's the North American geologists conducting explorations in this area named the Skyring formation from along the shore of Seno Skyring (Skyring Sound), these beds being of the same age as the Agua Fresca. In 1948 the geological staff of Corporación de Fomento at Punta Arenas abolished the name Skyring and reinstated the name Agua Fresca and its type locality as defined earlier by Decat and Pomeyrol. The change was made because the name Agua Fresca had formerly been used by Decat and Pomeyrol for the same deposits. Their type locality along Río Agua Fresca presents a much more complete section than that along Seno Skyring where there are exposures of several other formations, of Upper Cretaceous age, and only an incomplete portion of the Agua Fresca formation is exposed and thus a good section can not be measured.

For additional information regarding the geology of Magallanes Province, see C. R. Thomas[6], "Geology and Petroleum Exploration in Magallanes Province, Chile."

Stratigraphy

The Agua Fresca formation consists of gray, finely silty clay shale containing layers of large limestone concretions and small quantities of fine glauconite.

In his original unpublished report on the Río Grande and El Ganso areas, C. L. Mohr, geologist for United Engineering Corporation, states: "Along the southeast coast of Seno Otway and farther inland, the same horizons of the Skyring[7] are exposed repeatedly at many localities; and it has been possible to recognize several zones of shale, each of which has certain distinctive characteristics. From the top downward, the present report refers to these as: the zone of worm-hole concretions, the well bedded zone, the zone of heavy concretions, and the silty shale zone."

In a supplementary report, dated October 31, 1946, Mr. Mohr states:

"*Paleontological zones.* As a result of her studies of the Skyring foraminifera in this and adjacent areas, Miss Kniker has tentatively divided the Skyring shale into three principal members: upper, middle, and lower. The middle Skyring has been divided into an upper zone above the youngest abundant occurrence of *Spiroplectammina brunswickensis*, and the *S. brunswickensis* zone, which extends down to the top of the lower Skyring [which member also contains *S. brunswickensis* in abundance]. The 'Transition zone' [now called basal middle Agua Fresca] represents a gradational and evolutionary change between the middle and lower Skyring and is tentatively grouped with the middle Skyring. The lower Skyring has two faunal and lithologic members: the upper [now divided into an upper and lower member], containing a fauna of Eocene aspect related to that of the Chorrillo Alicia conglomerate of the Agua Fresca area reported by H. W. Thoms, and the lower hard concretionary zone extending down to the top of the Rocallosa sand at Cerro

1 Publication authorized by the Director, U. S. Geological Survey.

2 Published by permission of and with the encouragement of Corporación de Fomento de la Producción, Chile.

3 U. S. Geological Survey, Washington, D. C.

4 761 Baker Avenue, Seguin, Texas.

5 Jules Decat y R. Pomeyrol, "Informe Geológico sobre las possibilidades petrolíferas de la Región Magallanes," Boletín del Departamento de Minas y Petróleo Ministeria de Fomento (Chile, Septiembre 1931).

6 Bull. Amer. Assoc. Petrol. Geologists, vol. 33, No. 9, September 1949, pp. 1553-1578.

7 Now Agua Fresca.

Canelos and having faunal affinities to the Rocallosa and Fuentes of Cretaceous age.

"*Thicknesses.* In preceding reports, estimates of thicknesses in this area have been inaccurate in some instances, owing to lack of workable outcrops. These estimates were based in part on thicknesses in adjacent areas. By the aid of recent correlations based on paleontology by Miss Kniker, it is now possible to compute the thicknesses of various faunal subdivisions of the Skyring with much greater accuracy. In this area the following figures are now applicable: upper Skyring 250 meters, middle Skyring above *Spiroplectammina brunswickensis* 300 meters, *S. brunswickensis* zone 500 meters on the Río Grande anticline and 1000 meters in the Chorrillo Iznati syncline, transitional zone 150 meters, lower Skyring above concretionary zone 780 meters, concretionary zone 200 meters.

"*Relation between Paleontologic and Lithologic Zones.* Some of the paleontological subdivisions of the Skyring coincide approximately with earlier subdivisions based on lithology. The upper Skyring of Miss Kniker represents the upper 250 meters of the 'zone of wormhole concretions,' 310 meters thick described in the Río Grande report. The middle Skyring above the *Spiroplectammina brunswickensis* zone has few bedding planes and no large concretions. The *S. brunswickensis* zone is harder, has more definite bedding, and is characterized by thin, flat concretions. The upper part of the lower Skyring [now upper and lower parts of lower Agua Fresca] has few concretions but abundant distinct bedding planes. The concretionary zone of the lower Skyring is harder, more silty and calcareous than the overlying shales, is distinguished by the very abundant lime concretions of various sizes, and is conglomeratic in places." This zone is now not considered part of the Agua Fresca.

The Chilean Departamento de Minas y Petróleo drilled a number of wells in Magallanes Province between 1928 and the late thirties, coring them almost completely. The first of these wells was P-7, 18 km. southwest of Punta Arenas on Río Tres Brazos. With very few gaps, cores are available from this well from 101 meters to 1296 meters, in this section being contained the most complete sequence of upper Agua Fresca beds available so far. The well started drilling in the geologic column approximately 515 meters below the Tres Brazos sand. There is an unconformity between the Tres Brazos and the Agua Fresca formations, and it is not yet known how much of this interval is occupied by beds of Agua Fresca age and how much by Tres Brazos shale. Besides drilling through 480 meters of upper Agua Fresca, the P-7 well also penetrated 715 meters of middle Agua Fresca beds without reaching the base of this unit. The bottommost part of the well was not cored.

Much of Brunswick Peninsula is covered with a thick mantle of reworked glacial deposits. This is true of most of the areas where the Agua Fresca formation is present, including the type locality. Therefore, surface samples have to be collected along rivers and other bodies of water in the Province. The P-7 well is located near the type locality of the Agua Fresca formation, being 12½ km. north of Río Agua Fresca, and since a continuous section cannot be sampled at the surface, due to the mantle of fluvio-glacial deposits, Foraminifera from this well were used instead of specimens from outcrops at the type section.

This paper is based on the study of selected foraminiferal faunules from 46 cores from the P-7 well and 20 outcrop samples. The well samples were collected by the Departamento de Minas y Petróleo, and the surface samples by Corporación de Fomento de la Producción, Chile. We acknowledge our gratitude to Corporación de Fomento de la Producción, Chile, for making these cores and samples available for study. The species included here do not represent the complete foraminiferal fauna of the Agua Fresca. The accompanying map (fig. 1) shows location of the well and these outcrops:

1. Location of Agua Fresca type section.
2. Location of Clifford L. Mohr's samples from the El Ganso (Nos. 16, 21, 46, 72) and Canelos (No. 64) anticlines.
3. Location of C. R. Thomas' sample 148 from the type locality of the former "Skyring" formation on the south shore of Seno Skyring.
4. Location of E. S. Shaw's and Glen M. Ruby's samples from the Río Grande anticline and C. R. Thomas' sample 69 from the Cerro Laurita anticline.
5. Location of Mina Rica well. Beds of upper Agua Fresca age were penetrated in the lower part of this well.
6. Location of P-7 well.
7. Outcrop of Agua Fresca shale on south shore of Bahia Inutil, Tierra del Fuego.

Position of samples in the formation:

Upper Agua Fresca
- P-7 well cores from 101 meters to 575 meters.
- Shaw samples 31, 34, 35, 39, 43.

Middle Agua Fresca, main body.
- P-7 well samples from 581 meters to 1296 meters.
- Shaw sample 23.
- Ruby samples 7 and 5.
- Mohr sample 46.

Middle Agua Fresca, basal zone.
- Ruby samples 4 and 3.
- Thomas sample 69.

Lower Agua Fresca, upper part.
- Shaw sample 10.
- Ruby samples 2 and 1.
- Mohr samples 16 and 72.

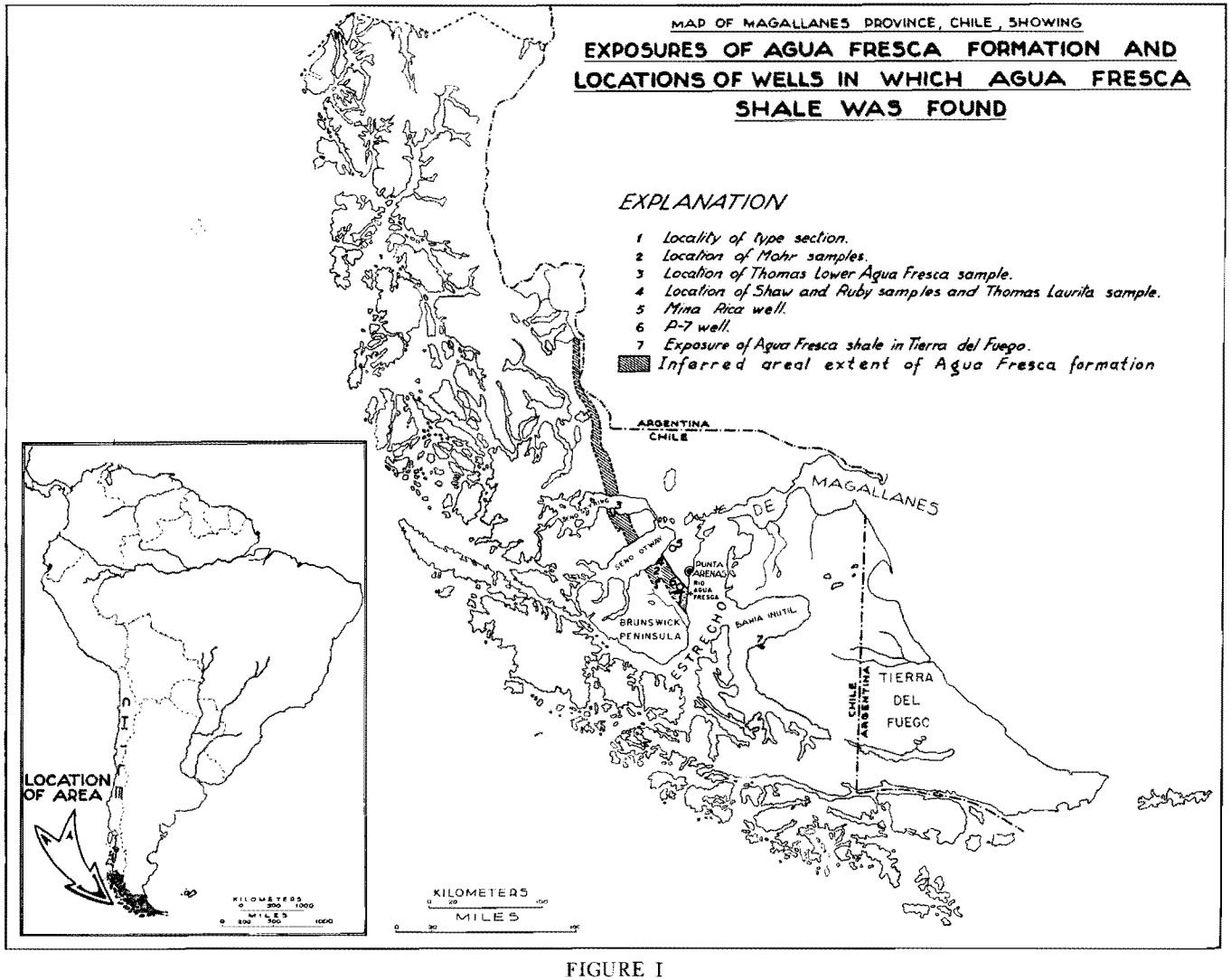

MAP OF MAGALLANES PROVINCE, CHILE, SHOWING
EXPOSURES OF AGUA FRESCA FORMATION AND LOCATIONS OF WELLS IN WHICH AGUA FRESCA SHALE WAS FOUND
EXPLANATION
1 Locality of type section.
2 Location of Mohr samples.
3 Location of Thomas Lower Agua Fresca sample.
4 Location of Shaw and Ruby samples and Thomas Laurita sample.
5 Mina Rica well.
6 P-7 well.
7 Exposure of Agua Fresca shale in Tierra del Fuego.
Inferred areal extent of Agua Fresca formation
ARGENTINA
CHILE
MAGALLANES
DE
SENO OTWAY
PUNTA ARENAS
RIO AGUA FRESCA
BRUNSWICK PENINSULA
ESTRECHO
BAHIA INUTIL
TIERRA DEL FUEGO
CHILE
ARGENTINA
LOCATION OF AREA
KILOMETERS
MILES
KILOMETERS
MILES

FIGURE I

Lower Agua Fresca, lower part.
Mohr samples 21 and 64.
Thomas sample 148.

Age and Correlation

The Agua Fresca fauna shows marked relationships to some upper Eocene faunas of California, Oregon, Washington, and Peru, as will be observed from the synonymies included in the systematic descriptions. It is particularly closely related to the fauna of the Kreyenhagen shale of California, of late Eocene age.

In a letter to the junior author, dated January 31, 1949, Joseph A. Cushman stated: "I think that a number of the more characteristic species [of the Agua Fresca] are most like those of the Kreyenhagen of California which is upper Eocene. * * * * Of course, it [the Agua Fresca] is a long way from most of the published material and a number of the things are apparently new, but these species which are abundant there in a great number of samples seem to place it definitely."

The striking resemblance between the Agua Fresca fauna and the Kreyenhagen shale fauna[8] is borne out by the following species common to both formations:

Bathysiphon eocenicus Cushman and G. D. Hanna
Clavulinoides sp. (= *Clavulinoides chileana* n. sp. in Chile)
Dorothia? sp. (=*Dorothia asiphonia* (Andreae) in Chile)
Dorothia principensis Cushman and Bermudez
Tritaxilina colei Cushman and Siegfus
Robulus alato-limbatus (Gümbel)
Marginulina asperuliformis (Nuttall)
Bulimina corrugata Cushman and Siegfus
Valvulineria advena Cushman and Siegfus (= *Quadrimorphina advena* (Cushman and Siegfus) in Chile)
Pullenia eocenica Cushman and Siegfus
Anomalina garzaensis Cushman and Siegfus
Gyroidina soldanii Orbigny var. *octocamerata* Cushman and G. D. Hanna (= *Gyroidina soldanii* Orbigny (in part) in Chile)

In addition to these species in common, others described as new are very close to their Kreyenhagen relatives. These are:

Agua Fresca
Dentalina patagonica, n. sp.
Spiroplectammina brunswickensis, n. sp.
Osangularia brunswickensis, n. sp.
Kreyenhagen
Dentalina hispido-costata Cushman and Siegfus
"*Bolivinopsis directa* (Cushman and Siegfus)" (= *Spiroplectammina*)
"*Pulvinulinella tenuicarinata* Cushman and Siegfus" (= *Osangularia*)

8 Cushman and Siegfus, Trans. San Diego Soc. Nat. Hist., vol. 9, No. 34, 1942.

Of the above species, the following are markers of the Canoas siltstone member, basal member of the Kreyenhagen shale:

Marginulina asperuliformis (Nuttall)
Quadrimorphina advena (Cushman and Siegfus)
Bulimina corrugata Cushman and Siegfus

This seems to indicate that the Agua Fresca fauna correlates with the Canoas siltstone member of the Kreyenhagen shale of California.

From the following factors in the composition of the Agua Fresca fauna it can be concluded that the sediments were deposited at considerable depth and under open-sea conditions:

abundance of well developed arenaceous forms
abundance and variety of lagenid species
abundance and variety of species in the family Chilostomellidae
abundance of *Globigerina*
scarcity of miliolid species
absence of peneroplid species

In the systematic part of this paper, some rare species and other forms which require more study are not included.

The types and figured specimens, as well as representative specimens from all the samples studied, are deposited in the Cushman Collection at the United States National Museum, Washington, D. C.

SYSTEMATIC DESCRIPTIONS

Family ASTRORHIZIDAE

Genus **Rhabdammina** M. Sars, 1869

Rhabdammina eocenica Cushman and G. D. Hanna

Plate 1, figures 1, 2

Rhabdammina eocenica Cushman and G. D. Hanna, Proc. Calif. Acad. Sci., ser. 4, vol. 16, 1927, p. 209, pl. 13, fig. 1.

Specimens have been compared with paratypes of this species described from the Eocene of California and seem to be the same. The paratypes are heavily stained orange while the Chilean specimens are white, but the grain size, including both amorphous material and angular quartz fragments, is similar in both. Both show a considerable amount of variation in diameter of the tests. Some are so slender that no internal opening is visible, and others have what appear to be supplementary flanges along the tubes. Tests probably were flexible as many show compression. In some there are faint traces of annular constrictions. A single specimen (see fig. 1) was found which appears to show the central chamber, represented by an enlargement of the tube and a deep depression of the wall on one side (possibly due to collapse or breaking away entirely of part of the wall), and two arms extending out from it.

Specimens referred to *R. discreta* Brady from the Oligocene Cipero marl of Trinidad (Cushman and

Stainforth, Special Publ. 14, Cushman Lab. Foram. Res., 1945, p. 13, pl. 1, fig. 3) and the Eocene Verdun formation of Peru (Cushman and Stone, Contr. Cushman Lab. Foram. Res., vol. 25, 1949, p. 74, pl. 13, fig. 2), particularly the latter, are very similar to these from Chile and may prove to be the same.

Specimens are distributed in scattered samples throughout the section.

Family RHIZAMMINIDAE

Genus **Bathysiphon** M. Sars, 1872

Bathysiphon cocenicus Cushman and G. D. Hanna

Plate 1, figures 3, 4

Bathysiphon eocenica Cushman and G. D. Hanna, Proc. Calif. Acad. Sci., ser. 4, vol. 16, 1927, p. 210, pl. 13, figs. 2, 3.—Cushman and Siegfus, Trans. San Diego Soc. Nat. Hist., vol. 9, 1942, p. 400, pl. 15, fig. 1.—Kelley, Bull. Amer. Assoc. Petr. Geol., vol. 27, 1943, p. 11 (list).—Curran, l. c., pp. 1378, 1381 (lists).—Martin, Stanford Univ. Publ., Univ. Ser., Geol. Sci., vol. 3, No. 3, 1943, p. 9 (list).—Cushman and Simonson, Journ. Pal., vol. 18, 1944, p. 193, pl. 30, fig. 1.—Cushman and R. E. and K. C. Stewart, Bull. 36, Oregon Dept. Geol. and Min. Ind., pt. 5, 1947 (1948), p. 97, pl. 12, figs. 1, 2.—Cushman and Stone, Special Publ. 20, Cushman Lab. Foram. Res., 1947, p. 2, pl. 1, fig. 1.—Bermudez, l. c., Special Publ. 25, 1949, p. 47, pl. 1, figs. 1, 2.—Cushman and Stone, l. c., Contr., vol. 25, 1949, p. 75, pl. 13, fig. 3.

Bathysiphon sp. cf. **B. eocenica** Cushman and McMasters, Journ. Pal., vol. 10, 1936, p. 508, pl. 74, fig. 1.

This species is one of the most conspicuous forms in these Agua Fresca samples, due to its abundance, large size, and light color. The uneroded surface of the tests is black but in most of the specimens this thin coating is worn off in varying degrees, resulting in various shades of dark to light gray. Preservation is very good and most of the specimens are undeformed. In a few cases the interior of the tube is not completely filled.

The wall is composed of fine siliceous sponge spicules and the relative thickness of the wall is a variable feature. Two specimens are illustrated to show the extremes in size of the internal tube. The diameter of the tests is about 1.1 mm. Specimens are larger but otherwise very close to those recorded from the Eocene of California, Oregon, Haiti, and Peru.

Family AMMODISCIDAE

Genus **Ammodiscus** Reuss, 1861

Ammodiscus sp. cf. **A. restinensis** Berry

Plate 1, figure 5

Ammodiscus restinensis Berry, Eclogae geol. Helvetiae, vol. 21, 1928, p. 131, pl., fig. 4; p. 390.—Cushman and Stone, Contr. Cushman Lab. Foram. Res., vol. 25, 1949, p. 50, pl. 9, fig. 3.

Test small for the genus, thin, usually showing evidence of deformation; composed of 7 or more whorls with the tube very gradually increasing in size; wall smooth, very finely granular, white except for the dark spiral suture, often appearing translucent.

This species seems to be close to *A. restinensis* described from the Restin shale of northwestern Peru and resembles somewhat a specimen from the Chacra formation of Peru. The Chilean specimens are larger, have more whorls and may be distinct.

Genus **Lituotuba** Rhumbler, 1895

Lituotuba chilcana Todd and Kniker, n. sp.

Plate 1, figures 6-8

Test with the early portion strongly compressed, in some specimens irregularly coiled in the initial stage, composed of as many as 4 or 5 whorls before the *Ammodiscus*-stage is completed; chamber slender, increasing very gradually in diameter as added throughout the coiled portion, then decreasing slightly in diameter in the uniserial portion, uniserial portion bending abruptly away from the coiled portion and projecting outward in a straight line which in some instances lies at a slight angle to the plane of coiling of the early stage; suture rather deeply incised; wall white, of rather coarse but well-sorted angular fragments and much cement, smoothly finished, flexible so that tests have withstood considerable deformation during fossilization and still remained recognizable; aperture the open end of the tube. Average diameter 1.00 mm.; but specimens up to 2 mm. in diameter have been observed; average thickness 0.20 mm. Maximum observed length of uniserial portion 0.60 mm.

Holotype (Cushman Coll. No. 64265) from Shaw 35.

This species differs from *L. chirana* Cushman and Stone from the Eocene, Chira shale, of Peru in its much larger *Ammodiscus*-stage with a more distinctly incised suture and its slenderer uniserial portion. The two resemble each other in their wall texture. The uniserial portion being at an angle to the plane of coiling may not be true in the original state of the species but may have resulted from deformation during fossilization.

The uniserial portion is very fragile and often broken off at or near the coiled stage, and some specimens would be indistinguishable from *Ammodiscus* without the more complete specimens showing the uniserial stage. The large specimen figured as *Ammodiscus* sp. cf. *A. incertus* Cushman and Stone (not Orbigny) (Special Publ. 20, Cushman Lab. Foram. Res., 1947, p. 2, pl. 1, fig. 2) from the Chira shale seems to be a *Lituotuba* possibly identical with the present species with the uniserial part broken off, as can be seen by the position of the opening in the end of the tube.

Some specimens are darker and have a somewhat glossy and translucent appearance, but this seems to be a result of the different conditions of preservation.

Family LITUOLIDAE

Genus **Haplophragmoides** Cushman, 1910

Haplophragmoides chilenum Todd and Kniker, n. sp.

Plate 1, figures 10, 11

Test robust, thick, close-coiled, umbilici open and depressed, periphery rounded, not lobulate; chambers 7 to 9 in the last whorl, not inflated; sutures distinct, limbate, dark, not depressed, radial; wall finely arenaceous, smoothly finished, often translucent, particularly when moistened; aperture not observed. Diameter 0.50-0.75 mm.; thickness impossible to estimate because of distortion.

Holotype (Cushman Coll. No. 64267) from well P-7, at 611-617 meters.

This species differs from *H. mauricensis* Howe and Ellis in its much larger size and smooth, not lobulate, periphery. Specimens are almost all so greatly distorted that the original shape of the test is questionable. The wall appears to have been easily flexible.

Genus **Ammobaculites** Cushman, 1910

Ammobaculites cubensis Cushman and Bermudez

Plate 1, figures 12-14

Ammobaculites cubensis Cushman and Bermudez, Contr. Cushman Lab. Foram. Res., vol. 13, 1937, p. 106, pl. 16, figs. 4, 16-18.—Bermudez, Mem. Soc. Cubana Hist. Nat., vol. 11, 1937, p. 338.—Curran, Bull. Amer. Assoc. Petr. Geol., vol. 27, 1943, p. 1378 (list).—Bermudez, Special Publ. 25, Cushman Lab. Foram. Res., 1949, p. 50, pl. 1, figs. 18-21.

Ammobaculites cf. **A. cubensis** Cushman and Renz, Special Publ. 24, Cushman Lab. Foram. Res., 1948, p. 10, pl. 2, fig. 7.

This species is fairly common and is scattered throughout the section. Specimens are almost all much flattened and the tests must have originally been flexible to withstand so much distortion without breaking. The sutures are strongly constricted, and the wall is composed of very coarse and not well-sorted grains but they are cemented together very neatly. The aperture has a distinct and protruding neck, but this is not always present, probably due to breaking or distortion. The initial coiled portion is more often than not broken off. There seems to be a great range in variation from a very small coiled stage with numerous inflated uniserial chambers increasing in size as added, to a more prominent initial stage and the uniserial chambers fewer, not inflated, and not increasing in size as added; the former variation representing microspheric individuals and the latter megalospheric individuals. A specimen of each is illustrated. Maximum length observed 4.00 mm.

Genus **Cyclammina** H. B. Brady, 1876

Cyclammina simiensis Cushman and McMasters

Plate 1, figure 9

Cyclammina simiensis Cushman and McMasters, Journ. Pal., vol. 10, 1936, p. 509, pl. 74, fig. 3.—Martin, Stanford Univ. Publ., Univ. Ser., Geol. Sci., vol. 3, no. 3, 1943, p. 10 (list).—Cushman and Stone, Special Publ. 20, Cushman Lab. Foram. Res., 1947, pl. 1, p. 3, fig. 3.

Except for their larger size and a few more chambers in the last whorl, the very abundant specimens throughout the section seem to belong to *C. simiensis* Cushman and McMasters described from the middle Eocene Llajas formation of Ventura Co., Calif., and recorded from the Eocene Lodo formation of California and the Eocene Chira shale of Peru.

The largest observed specimens were 3.00 mm. in diameter. Tests exhibit extreme degrees of distortion, both longitudinal and transverse, without becoming unrecognizable. In some specimens the smooth outer layer seems to have been worn off, and the coarsely arenaceous and labyrinthic interior is visible. In some specimens the test is dark in color with a peculiar mottled appearance, characteristic of labyrinthic structure, showing through the smooth outer wall.

Specimens referred to *C. pacifica* Beck, also from the Eocene, may prove to be indistinguishable from *C. simiensis*.

Family TEXTULARIIDAE

Genus **Spiroplectammina** Cushman, 1927

Spiroplectammina adamsi Lalicker

Plate 1, figures 18, 19

Spiroplectammina adamsi Lalicker, Contr. Cushman Lab. Foram. Res., vol. 11, 1935, p. 39, pl. 6, figs. 1, 2.—Bandy, Journ. Pal., vol. 18, 1944, p. 367, pl. 60, fig. 3.

Very abundant specimens seem to be referable to this species described from the Eocene Martinez formation of California and recorded from the middle Eocene of Cape Blanco, Oregon. They are, however, much larger and better developed, and, by comparison, the paratypes of *S. adamsi* appear immature. They are characterized by a test rather thick in the middle and with the chamber walls, particularly toward the periphery, being usually collapsed, leaving the sutures raised. The periphery is acute and tends to be irregularly spinose. The chambers are numerous, low, and narrow and rapidly increasing in breadth, resulting in a rather broadly tapering test.

There is a considerable amount of variation in the species, and specimens with collapsed and non-collapsed walls appear quite different, but that feature seems to be a secondary one and not a specific character.

The species differs from *S. mississippiensis* (Cushman) and its varieties in its broader shape and longer and narrower chambers. It resembles *Textularia hockleyensis* Cushman and Applin but its sutures lack the upward curve characteristic of *T. hockleyensis*.

Spiroplectammina brunswickensis Todd and Kniker, n. sp.

Plate 1, figure 16

Test elongate, 4 to 5 times as long as wide, strongly

compressed throughout, white, periphery acute but not keeled, sides approximately parallel throughout the test in the megalospheric form, microspheric form with the sides tapering from the blunt apex to the middle of the test and then tapering again toward the apertural end, initial end rounded, apertural end bluntly pointed; chambers planispiral in the initial portion, then biserial, distinct, of equal size throughout; sutures distinct, limbate, straight, oblique; wall arenaceous, thin, smooth, composed of angular quartz fragments very smoothly cemented with siliceous cement; aperture a short and narrow textularian opening at the suture between the last-formed and the previous chamber. Length up to 1.10 mm.; breadth 0.20-0.25 mm.; thickness 0.10-0.12 mm.

Holotype (Cushman Coll. No. 64279) from Mohr 46. It occurs throughout the section, very sparsely in the upper part and in the upper 300 meters of the middle part, and is abundant in the lower part and in the lower part of the middle.

This species differs from "*Bolivinopsis directa* (Cushman and Siegfus)" from the Kreyenhagen shale of California, which also should be placed in *Spiroplectammina*, in its more elongate and more compressed test and lack of any keel. The two seem to be very closely related and may prove to be indistinguishable. Although in the original description of *B. directa* the wall is said to be calcareous, reëxamination of paratypes and testing with HCl indicates it is arenaceous with siliceous cement, and the texture of the wall is very similar to that in the Chilean species. Petrographic examination by Sr. Mario Marino-Proby, petrographer for Corporación de Fomento de la Producción at Punta Arenas, Chile, clearly showed that the wall of the Chilean species is agglutinated. Sr. Marino-Proby reported "the test is entirely siliceous and is composed of arenaceous material, its walls being built of very fine, poorly sorted grains of clear quartz, average diameter of the medium sized grains ranging from 0.002 to 0.006 mm. approximately, bound by siliceous cement. It seems also to have had some degree of recrystallization, mainly in the inner walls between the chambers. No perforations can be observed in the outside walls."

The genus *Bolivinopsis* as distinguished from *Spiroplectammina* needs clarification. In the original description of *Bolivinopsis* it was not made precisely clear what the nature of the wall of the test was, but Macfadyen (Journ. Roy. Micr. Soc., vol. 53, 1933, p. 139) assumed that it was calcareous. Examination of topotype material of *B. capitata* Yakovlev from the Cretaceous of Russia is needed to determine whether the wall is calcareous or agglutinated. Regardless of that point, it is true that there are two types of wall in forms which are at present included in *Bolivinopsis* (formerly *Spiroplectoides*): one calcareous, represented by *B. rosula* (Ehrenberg) from the Upper Cretaceous of the Gulf Coastal region which is completely soluble in HCl; the other arenaceous with siliceous cement, represented by *B. directa* (Cushman and Siegfus) from the Eocene of California. These arenaceous species with siliceous cement should probably be placed in a separate genus from the more typical Spiroplectamminas, represented by *S. mississippiensis* (Cushman), which have calcareous cement. It is impossible at present to determine whether this genus should be called *Bolivinopsis*, leaving the calcareous and perforate forms in *Spiroplectoides* (the genotype of which is *Spiroplecta rosula* Ehrenberg), or whether a new genus should be erected for the forms with siliceous cement.

The distinction between these two forms now included in *Bolivinopsis* was recognized by J. A. Cushman in his study of *Spiroplectammina grzybowskii* Frizzell (a form belonging to the group having siliceous cement) from the Lizard Springs formation of Trinidad (Special Publ. 18, Cushman Lab. Foram. Res., 1946, p. 20).

Spiroplectammina elgansoensis Todd and Kniker, n. sp.
Plate 1, figure 17

Test very elongate, strongly compressed throughout, slightly tapering from the acutely pointed initial end in microspheric forms, in megalospheric forms the initial end bulbous and the test slightly decreasing in breadth before increasing again, grayish in color, periphery acute but not keeled, very slightly lobulate; chambers numerous, distinct, the initial ones in a planispiral coil, then biserial, slowly increasing in size as added; sutures fairly distinct, slightly depressed, straight, oblique; wall finely arenaceous with calcareous cement, smooth; aperture a narrow textularian opening in a reëntrant of the suture between the last two chambers. Length up to 1.10 mm.; breadth 0.15-0.20 mm.; thickness 0.10 mm.

Holotype (Cushman Coll. No. 64281) from Mohr 72. It is common at its type locality but was not found elsewhere in the samples examined.

This species differs from *S. mexiaensis* Lalicker in its much more elongate and narrower test and smoother surface of the wall.

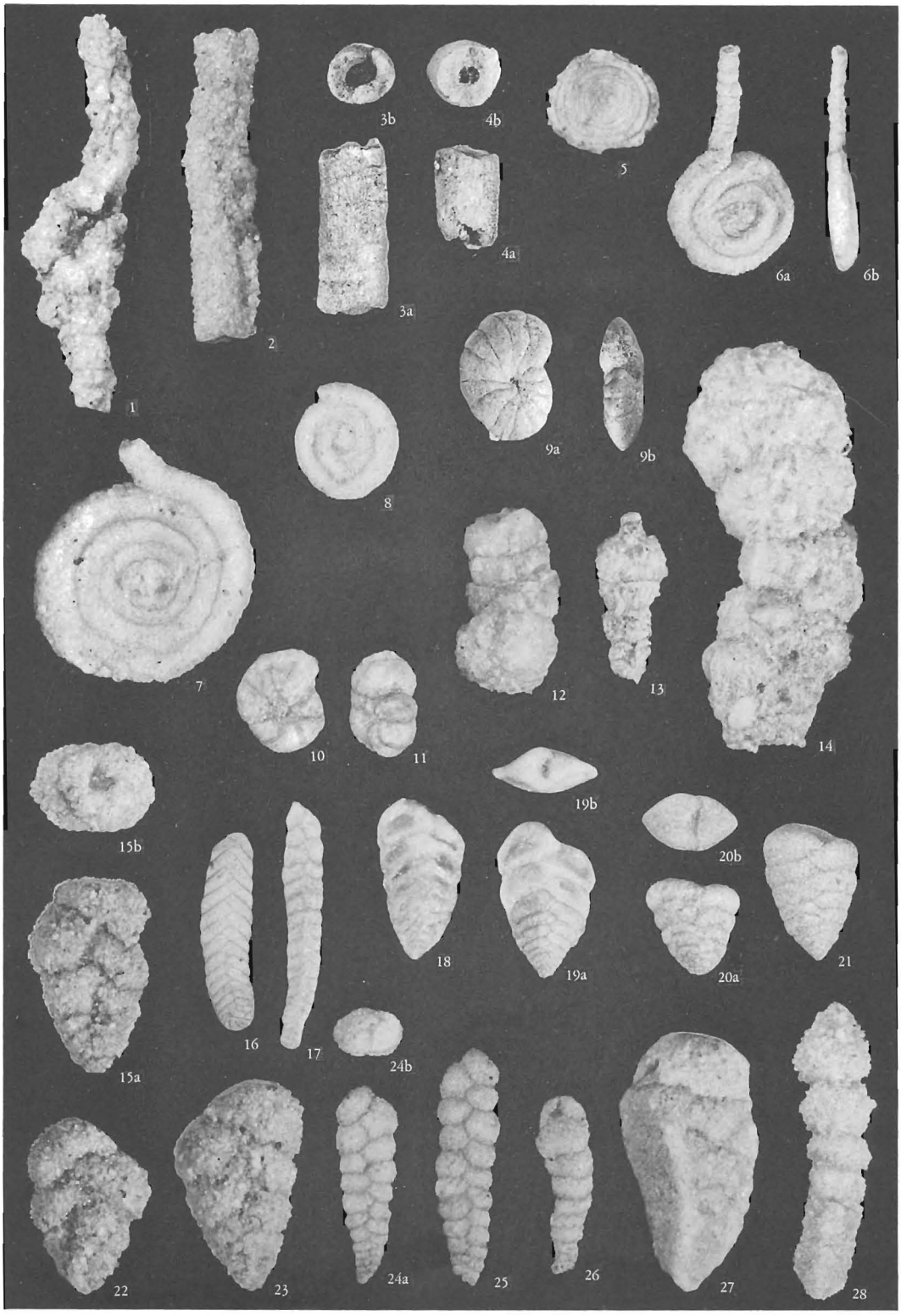
Genus **Textularia** Defrance, 1824

Textularia magallanica Todd and Kniker, n. sp.
Plate 1, figures 20, 21

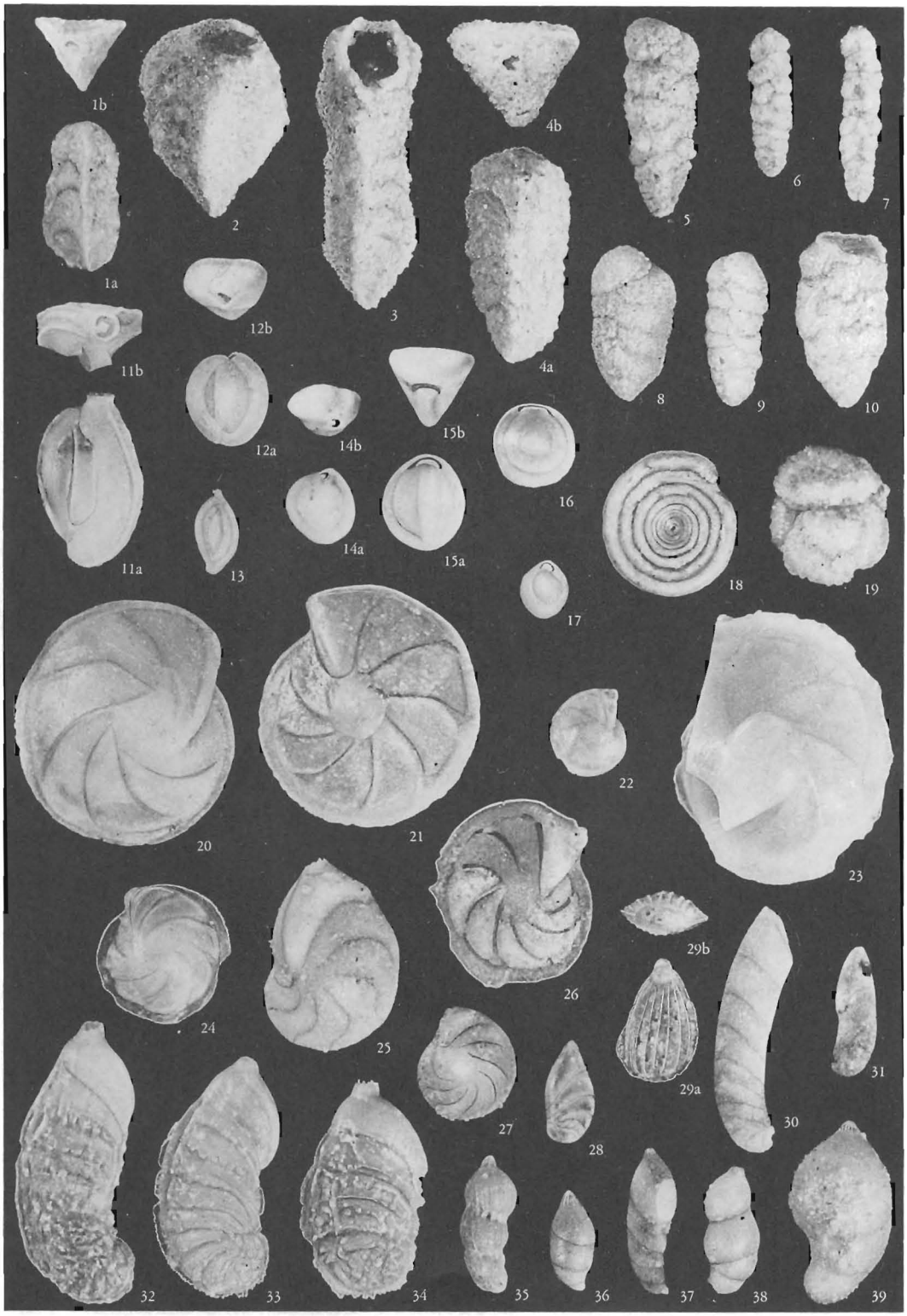
Test broadly tapering, compressed, periphery subacute, slightly lobulate; chambers indistinct, low and narrow, rapidly increasing in height as added, not inflated; sutures indistinct in the early portion, later slightly depressed, nearly horizontal, slightly curved; wall finely arenaceous, smoothly finished; aperture a low, elongate opening under the edge of the last-

EXPLANATION OF PLATE 1

FIGURE		PAGE
1, 2.	*Rhabdammina eocenica* Cushman and G. D. Hanna. × 25. Mohr 21.	4
3, 4.	*Bathysiphon eocenicus* Cushman and G. D. Hanna. × 8. 3*a*, 4*a*, side views; 3*b*, 4*b*, end views. 3, Ruby 4; 4, Well P-7, 420-426 meters.	5
5.	*Ammodiscus* sp. cf. *A. restinensis* Berry. × 32. Well P-7, 510-516 meters.	5
6-8.	*Lituotuba chileana* Todd and Kniker, n. sp. × 25. 6, Megalospheric form, *a*, side view, *b*, edge view. Well P-7, 324-330 meters. 7, Holotype. 8, Paratype, young specimen. Shaw 35.	5
9.	*Cyclammina simiensis* Cushman and McMasters. × 8. *a*, side view; *b*, edge view. Ruby 7.	6
10, 11.	*Haplophragmoides chilenum* Todd and Kniker, n. sp. × 25. 10, Holotype, side view; 11, Paratype, oblique edge view. Well P-7, 611-617 meters	6
12-14.	*Ammobaculites cubensis* Cushman and Bermudez. × 25. 12, Well P-7, 581-587 meters; 13, Well P-7, 740-746 meters; 14, Ruby 7.	6
15, 22, 23.	*Gaudryina chileana* Todd and Kniker, n. sp. × 25. 15, 22, Paratypes, 15*a*, side view; 15*b*, top view showing terminal aperture; 23, Holotype. Well P-7, 136-139 meters.	10
16.	*Spiroplectammina brunswickensis* Todd and Kniker, n. sp. × 32. Holotype. Megalospheric form. Mohr 46.	6
17.	*Spiroplectammina elgansoensis* Todd and Kniker, n. sp. × 32. Holotype. Megalospheric form. Mohr 72.	7
18, 19.	*Spiroplectammina adamsi* Lalicker. × 25. 18, 19*a*, side views; 19*b*, apertural view. Shaw 35.	6
20, 21.	*Textularia magallanica* Todd and Kniker, n. sp. × 25. 20, Paratype; 21, Holotype. 20*a*, 21, side views; 20*b*, apertural view. Well P-7, 712-717 meters.	7
24-26.	*Gaudryina brunswickensis* Todd and Kniker, n. sp. × 25. 24, Holotype; 25, 26, Paratypes. 24*a*, 25, side views; 26, edge view; 24*b*, end view. Well P-7, 605-611 meters.	10
27.	*Gaudryina (Pseudogaudryina) jacksonensis* Cushman. × 25. Mohr 21.	10
28.	*Pseudoclavulina anglica* Cushman. × 25. Ruby 5.	11



Todd and Kniker: Eocene Foraminifera, Magallanes Province, Chile



Todd and Kniker: Eocene Foraminifera, Magallanes Province, Chile

EXPLANATION OF PLATE 2

formed chamber, in length about half the thickness of the test. Length 0.55-0.80 mm.; breadth 0.40-0.55 mm.; thickness 0.25-0.35 mm.

Holotype (Cushman Coll. No. 64283) from well P-7, at 712-717 meters.

This species differs from *T. smithvillensis* Cushman and Ellisor from the Eocene of Texas in its smaller size, smoother wall, and aperture not in a deep re-ëntrant of the suture-line. It resembles *T. isidroensis* Cushman and Renz from the Miocene of Venezuela but that species has rather strongly curved sutures. It also resembles *T. lateralis* Lalicker from Recent material of the Caribbean Sea but that species is more broadly tapering and has a more acute and sometimes spinose periphery and the texture of the wall is much finer.

T. magallanica n. sp. occurs quite commonly throughout the section and some specimens show considerable distortion without breaking, during fossilization.

Family VERNEUILINIDAE

Genus **Gaudryina** Orbigny, 1839

Gaudryina chileana Todd and Kniker, n. sp.

Plate 1, figures 15, 22, 23

Test of medium size for the genus, broadly tapering, compressed, subquadrate in section, periphery rounded, initial part not triangular, triserial stage very brief and almost unnoticeable; chambers few, 3 to 5 biserial pairs comprising the bulk of the test, very rapidly increasing in size as added, inflated; sutures obscure in the early portion, later deeply excavated, resulting in a depressed area down the middle of each side and the periphery lobulate toward the apertural end; wall thick, coarsely arenaceous, very roughly finished on the surface, except surrounding the aperture, where the wall is relatively smooth; aperture circular, in a deep reëntrant of the suture of the last chamber, approaching a terminal position, and in rare cases actually terminal. Length 1.00-1.30 mm.; breadth 0.60-0.75 mm.; thickness 0.40-0.50 mm.

Holotype (Cushman Coll. No. 64286) from well P-7, at 136-139 meters.

It is very abundant at its type locality and also occurs commonly or abundantly throughout the section.

This species resembles *Gaudryina pseudocollinsi* Cushman and Stainforth and var. *primitiva* Cushman and Renz from the Oligocene and Eocene of Trinidad in its rough surface but differs in its less elongate and more broadly tapering test, and fewer and less inflated chambers, and in the very deep indentation of the suture line resulting in an almost terminal aperture.

This species at first glance appears more like *Textularia* than *Gaudryina* as the initial part is not triangular, but upon breaking open the test the triserial chamber arrangement can be seen. In the aperture approaching a terminal position the form resembles the genus *Migros* Finlay (Trans. Roy. Soc. New Zealand, vol. 69, 1939, p. 312). Out of several hundred specimens examined, only one was observed with a completely terminal aperture. Thus it seemed best to regard that specimen (Pl. 1, fig. 15) as abnormal, and retain the species in *Gaudryina*. However, this species may be regarded as a transitional form between the genera *Gaudryina* and *Migros*.

Gaudryina brunswickensis Todd and Kniker, n. sp.

Plate 1, figures 24-26

Test elongate, slender, slightly compressed, periphery rounded, indented, initial triserial part very minute, frequently appearing planispiral from one side and triangular from the opposite side; chambers numerous, distinct, inflated, as many as 10 pairs of biserial chambers, not much increasing in size as added; sutures distinct, straight, horizontal, distinctly incised; wall coarsely arenaceous, roughly finished; aperture small, circular, in an indentation of the suture line at the base of the last chamber. Length 1.00-1.40 mm.; breadth about 0.35 mm.; thickness about 0.22 mm.

Holotype (Cushman Coll. No. 64292) from well P-7, at 605-611 meters.

This species differs from *G. tenuis* Cushman from off the Philippines in its smaller and more tapering test and more lobulated periphery.

Specimens show considerable distortion, some being compressed laterally and others transversely, so that it is difficult to be sure of how much compression was original and how much secondary.

Gaudryina (Pseudogaudryina) jacksonensis Cushman

Plate 1, figure 27

Gaudryina jacksonensis Cushman, Contr. Cushman Lab. Foram. Res., vol. 2, pt. 2, 1926, p. 33, pl. 5, fig. 1.—Nuttall, Journ. Pal., vol. 6, 1932, p. 7, pl. 2, fig. 5.—Cushman, U. S. Geol. Survey Prof. Paper 181, 1935, p. 9, pl. 2, figs. 4-6.—Bermudez, Mem. Soc. Cubana Hist. Nat., vol. 12, 1938, p. 9.—van Bellen, de Witt Puyt, Rutgers, and van Soest, Proc. Ned. Akad. Wetenschappen, vol. 44, 1941, p. 1141.—Bergquist, Bull. 49, Mississippi State Geol. Survey, 1942, p. 18, pl. 1, fig. 16.—Martin, Stanford Univ. Publ., Univ. Ser., Geol. Sci., vol. 3, No. 3, 1943, p. 10 (list).—Bermudez, Special Publ. 25, Cushman Lab. Foram. Res., 1949, p. 75, pl. 3, figs. 67, 68.

Gaudryina (Pseudogaudryina) jacksonensis Palmer and Bermudez, Mem. Soc. Cubana Hist. Nat., vol. 10, 1936, p. 243.—Cushman, Special Publ. 7, Cushman Lab. Foram. Res., 1937, p. 89, pl. 13, figs. 2-4.—Hedberg, Journ. Pal., vol. 11, 1937, p. 667, pl. 90, fig. 7.—Renz, Proc. 8th Amer. Sci. Congress, 1942, p. 541 (list).—Franklin, Journ. Pal., vol. 18, 1944, p. 307, pl. 44, fig. 26.—Cushman, Special Publ. 7A, Cushman Lab. Foram. Res., 1946, p. 22; Special Publ. 16, 1946, p. 4, pl. 1, fig. 5.—Cushman and Todd, l. c., Contr., vol. 24, 1948, p. 10 (list).—Bandy, Bull. Amer. Pal., vol. 32, No. 131, 1949, p. 29, pl. 3, fig. 10.

Very typical specimens occur at Mohr 21 in the lowermost part of the section, but were not observed elsewhere in the samples examined. The species is known from the upper Eocene and Oligocene and is widely recorded in North America, Cuba, Dominican Republic, Venezuela, and Trinidad.

Genus **Pseudoclavulina** Cushman, 1936
Pseudoclavulina anglica Cushman
Plate 1, figure 28

Pseudoclavulina anglica Cushman, Special Publ. 6, Cushman Lab. Foram. Res., 1936, p. 18, pl. 3, fig. 5; Special Publ. 7, 1937, p. 111, pl. 15, figs. 26, 27.—ten Dam, Med. Geol. Stichting, ser. C-V, No. 3, 1944, p. 84.—Brotzen, Sver. Geol. Under., ser. C, No. 493, 1948, p. 37, pl. 5, figs. 1, 2.

Fairly common specimens seem to belong to this species described from the Eocene, London clay of England. The Chilean specimens have a somewhat more sharply keeled triangular initial part and slightly more constricted sutures. Both have a slightly protruding apertural end and roughly finished wall. These specimens, as well as almost all the arenaceous species, show a good deal of distortion.

Genus **Clavulinoides** Cushman, 1936
Clavulinoides brunswickensis Todd and Kniker, n. sp.
Plate 2, figure 1

Test acutely triangular throughout, with slightly concave sides, peripheral keels sharp, slightly undulating, breadth of test nearly uniform throughout or slightly decreasing toward the apertural end; chambers indistinct, not inflated; sutures indistinct in the early part, later curved and slightly depressed; wall of very fine arenaceous material, smoothly finished; aperture terminal, small, apertural end not projecting. Length 0.75-0.95 mm. (rarely up to 1.25 mm.), breadth 0.37-0.45 mm.

Holotype (Cushman Coll. No. 64299) from well P-7, at 1105-1115 meters. The species occurs commonly near the bottom of well P-7 in the lower part of the middle Agua Fresca (at 1021-1027, 1095-1099, 1105-1115, and 1145-1147 meters). It should form a useful marker for that portion of the section.

This species differs from *C. eucarinatus* Cushman and Bermudez from the Eocene of Cuba in its sharp keels and slightly concave sides throughout, whereas *C. eucarinatus* has rather limbate keels and the initial part of the test more or less bulging and rounded.

Clavulinoides chileana Todd and Kniker, n. sp.
Plate 2, figures 2-4

Clavulinoides sp. Cushman and Siegfus, Trans. San Diego Soc. Nat. Hist., vol. 9, 1942, p. 402, pl. 19, figs. 1-3.

Test elongate, 2 to 3 times as long as broad, of about equal breadth throughout, except for the bluntly tapering ends, sharply triangular in section, sides slightly concave with well-developed peripheral keels persisting onto the last formed chamber; chambers indistinct, not inflated; sutures obscured by the rough surface of the wall, curved and slightly depressed toward the apertural end; wall coarsely arenaceous but of well-sorted angular fragments, very roughly finished on the exterior; aperture terminal, small, irregular in shape, apertural face of last chamber slightly protruding. Length up to 1.75 mm.; breadth 0.50-0.65 mm.

Holotype (Cushman Coll. No. 64301) from well P-7, at 223-228 meters, where it occurs abundantly.

This species differs from *C. subulatus* Cushman and Bermudez in its stouter test, more bluntly tapering ends, and less distinct sutures and chambers. Specimens from the Eocene, Kreyenhagen shale, of California, noted in the synonymy, appear close to if not identical with this species.

Family VALVULINIDAE
Genus **Dorothia** Plummer, 1931
Dorothia asiphonia (Andreae)
Plate 2, figures 6, 7

Gaudryina siphonella Reuss, var. **asiphonia** Andreae, Abhandl. Geol. Special-Karte Elsass-Lothringen, vol. 2, 1884, pp. 108, 139, pl. 7, fig. 7.—Liebus, Neues Jahrb. für Min., 1901, p. 118.—Thürach and Herrmann, Mitteil. Badischen Geol. Landes., vol. 4, 1903, p. 545 (list).—Liebus, Sitz. Akad. Wiss. Wien, vol. 120, 1911, p. 74.—Klähn, Mitth. naturhist. Ges. Colmar, vol. 14, 1916-17 (1920), p. 10, pl. 7, figs. 1, 3, 5, 7, 8, 11; pl. 8, fig. 1.—Cushman, Special Publ. 7, Cushman Lab. Foram. Res., 1937, p. 100.

Gaudryina asiphonia Nuttall, Journ. Pal., vol. 6, 1932, p. 7, pl. 2, fig. 3.—Hadley, Bull. Amer. Pal., vol. 20, No. 70A, 1934, p. 8, pl. 1, fig. 6.—Galloway and Heminway, New York Acad. Sci., Sci. Survey Porto Rico and Virgin Islands, vol. 3, pt. 4, 1941, p. 323, pl. 7, fig. 1.

Dorothia asiphonia Cushman, Special Publ. 8, Cushman Lab. Foram. Res., 1937, p. 90, pl. 9, figs. 22, 23.—Hedberg, Journ. Pal., vol. 11, 1937, p. 668, pl. 90, fig. 10.—Franklin, l. c., vol. 18, 1944, p. 307, pl. 44, fig. 19.

Dorothia? sp. Cushman and Siegfus, Trans. San Diego Soc. Nat. Hist., vol. 9, 1942, p. 402, pl. 19, figs. 4-6.

Abundant specimens from the entire section are referred to this species described from the Oligocene of Alsace and also known from the Eocene of Europe and the Oligocene of Venezuela, Cuba, Porto Rico, and Mexico. Specimens from the Eocene Kreyenhagen shale of California, questionably referred to *Dorothia* (see synonymy above) seem to be identical with the specimens from Chile.

They are all quite strongly distorted. In cases where the distortion is transverse to the normal plane of compression of biserial forms, the resulting test appears uniserial; but upon examining the edges of such compressed tests, it can be seen that they are biserial.

Dorothia eocenica Cushman
Plate 2, figure 5

Dorothia eocenica Cushman, Special Publ. 6, Cushman Lab. Foram. Res., 1936, p. 28, pl. 4, fig. 14; Special

Publ. 8, 1937, p. 86, pl. 9, fig. 16.—Renz, Proc. 8th Amer. Sci. Congress, 1942, p. 541 (list).—Kelley, Bull. Amer. Assoc. Petr. Geol., vol. 27, 1943, p. 8 (list).—Martin, Stanford Univ. Publ., Univ. Ser., Geol. Sci., vol. 3, No. 3, 1943, p. 10 (list).—Cushman, Special Publ. 8A, Cushman Lab. Foram. Res., 1947, p. 29.—Cushman and Renz, l. c., Special Publ. 24, 1948, p. 15.—Cuvillier and Szakall, Foram. Aquitaine, Prem. Part., 1949, p. 30, pl. 14, fig. 9.

A few rather typical specimens were found in the Chilean material. The species is known from the Eocene of France, Austria, Trinidad, and California.

Dorothia principensis Cushman and Bermudez
Plate 2, figures 8, 9

Dorothia principensis Cushman and Bermudez, Contr. Cushman Lab. Foram. Res., vol. 12, 1936, p. 57, pl. 10, figs. 3, 4.—Cushman, l. c., Special Publ. 8, 1937, p. 87, pl. 9, figs. 20, 21.—Bermudez, Mem. Soc. Cubana Hist. Nat., vol. 12, 1938, p. 4.—Cushman and Siegfus, Contr. Cushman Lab. Foram. Res., vol. 15, 1939, p. 24, pl. 6, fig. 23; Trans. San Diego Soc. Nat. Hist., vol. 9, 1942, p. 402, pl. 15, fig. 9.—Bergquist, Bull. 49, Mississippi State Geol. Survey, 1942, p. 18, pl. 1, fig. 12.—Curran, Bull. Amer. Assoc. Petr. Geol., vol. 27, 1943, pp. 1378, 1381 (lists).—Cushman, Special Publ. 8A, Cushman Lab. Foram. Res., 1947, p. 29.—Bermudez, l. c., Special Publ. 25, 1949, p. 85, pl. 4, figs. 41, 42.

Numerous specimens, many showing great distortion, appear to belong to this species described from the Eocene of Cuba and recorded also in the Eocene, Kreyenhagen shale of California, Yazoo clay of Mississippi, and Abuillot formation of Haiti.

Genus Tritaxilina Cushman, 1911
Tritaxilina colei Cushman and Siegfus
Plate 2, figure 10

Tritaxilina colei Cushman and Siegfus, Contr. Cushman Lab. Foram. Res., vol. 11, 1935, p. 92, pl. 14, figs. 5, 6.—Cushman, l. c., Special Publ. 8, 1937, p. 155, pl. 18, figs. 1-3.—Bermudez, Mem. Soc. Cubana Hist. Nat., vol. 12, 1938, p. 24.—Cushman and Siegfus, Trans. San Diego Soc. Nat. Hist., vol. 9, 1942, p. 403, pl. 15, figs. 12, 13.—Kelley, Bull. Amer. Assoc. Petr. Geol., vol. 27, 1943, p. 8 (list).—Curran, l. c., pp. 1378, 1381 (lists).—Martin, Stanford Univ. Publ., Univ. Ser., Geol. Sci., vol. 3, No. 3, 1943, p. 12 (list).—Cushman, Special Publ. 8A, Cushman Lab. Foram. Res., 1947, p. 54.—Bermudez, l. c., Special Publ. 25, 1949, p. 94, pl. 5, figs. 59, 60.

This species, described from the Eocene of Mexico and known from the Eocene of California, Cuba, and Haiti, occurs very rarely. Specimens are robust and typical. The 4-chambered stage of development is prominent and the test is subquadrate in section.

Family MILIOLIDAE
Genus Quinqueloculina Orbigny, 1826
Quinqueloculina badenensis Orbigny
Plate 2, figure 11

Quinqueloculina badenensis Orbigny, Foram. Foss. Bass. Tert. Vienne, 1846, p. 299, pl. 20, figs. 10-12.—Karrer, Sitz. Akad. Wiss. Wien, vol. 58, pt. 1, 1868, p. 143.—Franzenau, Földt. Közlöny, vol. 11, 1881, p. 42.—Cloetus, Archiv. Ver. Freunde Nat. Mecklenburg, 75 Jahr., 1922, p. 95

Common and abundant specimens in the uppermost part of well P-7 (down to 307-319 meters) seem to be identical with a topotype of this species from the Miocene of Baden, Austria. The species is distinctive in its sharply angled truncate periphery and should prove a useful marker for the upper part of the Agua Fresca section.

Quinqueloculina sp. cf. Q. imperialis G. D. and M. A. Hanna
Plate 2, figure 12

Quinqueloculina imperialis G. D. and M. A. Hanna, Univ. Washington Publ. Geol., vol. 1, No. 4, 1924, p. 58, pl. 13, figs. 7, 8, 10.—Beck, Journ. Pal., vol. 17, 1943, p. 592, pl. 98, figs. 9, 10.—Cushman and Frizzell, Contr. Cushman Lab. Foram. Res., vol. 19, 1943, p. 82, pl. 14, fig. 1.—Cushman and R. E. and K. C. Stewart, Bull. 36, Oregon Dept. Geol. and Min. Ind., pt. 4, 1947 (1948), p. 74, pl. 9, fig. 3.—Rau, Journ. Pal., vol. 22, 1948, p. 159, pl. 27, figs. 12-14.

Scattered specimens from throughout the section are referred to this species described from the Eocene of Washington. They are smaller than normal and many of them are immature.

Genus Massilina Schlumberger, 1893
Massilina decorata Cushman
Plate 2, figure 13

Massilina decorata Cushman, U. S. Geol. Survey Prof. Paper 129-F, 1922, p. 143, pl. 34, fig. 7; Prof. Paper 133, 1923, p. 55.—Cushman and G. D. Hanna, Proc. Calif. Acad. Sci., ser. 4, vol. 16, 1927, p. 224.—Howe, Journ. Pal., vol. 2, 1928, p. 175 (list).—Cushman, Contr. Cushman Lab. Foram. Res., vol. 5, 1929, p. 40, pl. 7, fig. 1.—Cole and Ponton, Bull. 5, Florida State Geol. Survey, 1930, p. 29, pl. 10, fig. 5.—Howe and Wallace, Louisiana Geol. Bull. 2, 1932, p. 20, pl. 2, fig. 6.—Cushman and McMasters, Journ. Pal., vol. 10, 1936, p. 510, pl. 74, fig. 8.—Cushman, U. S. Geol. Survey Prof. Paper 181, 1935, p. 13, pl. 3, figs. 14-16; Contr. Cushman Lab. Foram. Res., vol. 15, 1939, p. 52, pl. 9, fig. 13.—Galloway and Heminway, New York Acad. Sci., Sci. Survey Porto Rico and Virgin Islands, vol. 3, pt. 4, 1941, p. 314, pl. 5, fig. 1.—Bergquist, Bull. 49, Mississippi State Geol. Survey, 1942, p. 22, pl. 1, fig. 26.—Cushman and McGlamery, U. S. Geol. Survey Prof. Paper 197-B, 1942, p. 66, pl. 4, fig. 3.—Franklin, Journ. Pal., vol. 18, 1944, p. 308, pl. 45, fig. 7.—Cushman, Special Publ. 16, Cushman Lab. Foram. Res., 1946, p. 5, pl. 1, fig. 11.—Cushman and Todd, l. c., Contr., vol. 24, 1948, p. 8 (list).—Cushman, Bull. 2, Maryland Dept. Geol., Mines and Water Resources, 1948, p. 227, pl. 16, fig. 7.—Cushman and Cederstrom, Bull. 67, Virginia Geol. Survey, 1945 (1949), p. 6.—Bandy, Bull. Amer. Pal., vol. 32, No. 131, 1949, p. 24, pl. 2, fig. 7.—Cushman and Stone, Contr. Cushman Lab. Foram. Res., vol. 25, 1949, p. 78, pl. 13, fig. 29.

A few small, but well-preserved specimens, showing the ornamentation characteristic of this species, occur in scattered samples in the middle and upper part of the section.

Genus **Triloculina** Orbigny, 1826

Triloculina globosa (G. D. and M. A. Hanna)

Plate 2, figure 14

Quinqueloculina globosa G. D. and M. A. Hanna, Univ. Washington Publ. Geol., vol. 1, No. 4, 1924, p. 58, pl. 13, figs. 1, 2.

Triloculina globosa Beck, Journ. Pal., vol. 17, 1943, p. 594, pl. 100, figs. 3, 4.

A few specimens were found in the Chilean material. Except for their somewhat smaller size they are quite typical. The species was described and recorded from the Eocene of Washington.

Genus **Miliolinella** Wiesner, 1931

Miliolinella sp.

Plate 2, figure 15

Specimens similar to that figured occur in scattered samples from the middle and lower parts of the section. The chamber arrangement is quinqueloculine and the aperture is unique in being a large arched opening filled by a broad, flat tooth, similar in this respect to *Miliolinella*.

Genus **Pyrgo** Defrance, 1824

Pyrgo sp.

Plate 2, figure 16

Rare specimens of a rather distinctive, flattened *Pyrgo* are here recorded and a typical one illustrated. In the compressed test and long, narrow apertural slit, the species resembles *P. depressa* (Orbigny), a Recent European form.

Genus **Biloculinella** Wiesner, 1931

Biloculinella cowlitzensis Beck, juv.

Plate 2, figure 17

Biloculinella cowlitzensis Beck, Journ. Pal., vol. 17, 1943, p. 594, pl. 101, figs. 6, 7.—Rau, l. c., vol. 22, 1948, p. 160, pl. 28, figs. 6, 7.

In the uppermost part of the section (well P-7 at 101-108 and 188-191 meters) two single immature specimens were found which are very close to this species described from the Eocene, Cowlitz formation, of Washington.

Family OPHTHALMIDIIDAE

Genus **Cornuspira** Schultze, 1854

Cornuspira cushmani Todd and Kniker, n. sp.

Plate 2, figure 18

Test large for the genus, composed of numerous coils (10 or more), narrow and thin in the early part, increasing little in width but rapidly in thickness as added, periphery truncate, with the two edges angular in young specimens, the angles becoming rounded in adult specimens; suture very distinct, dark in the early portion, progressively more deeply incised as growth proceeds; wall smooth, glossy; aperture rounded quadrangular, broader than high, at the slightly constricted open end of the tube. Diameter up to 1.20 mm.; thickness 0.20-0.30 mm.

Holotype (Cushman Coll. No. 64325) from Shaw 23.

This species differs from *C. lewisensis* Beck from the Eocene Cowlitz formation of Washington in its more numerous and narrower whorls and its truncate rather than smoothly rounded periphery.

Specimens are quite uniform in character, but a few strongly megalospheric ones differ in being less thick at the periphery which itself may be somewhat rounded instead of truncate.

Family TROCHAMMINIDAE

Genus **Trochammina** Parker and Jones, 1859

Trochammina? sp.

Plate 2, figure 19

Fairly abundant specimens are referred to this genus with some question. They are all extremely distorted, but so far as can be determined, the chambers were few, large, distinct, and inflated, the sutures incised, and the wall coarsely arenaceous but neatly cemented and flexible. They resemble somewhat one of the forms referred to *T. teasi* Cushman and Ellisor from the Eocene Verdun formation of Peru (Cushman and Stone, Contr. Cushman Lab. Foram. Res., vol. 25, 1949, p. 78, pl. 13, fig. 27).

Family LAGENIDAE

Genus **Robulus** Montfort, 1808

Robulus alato-limbatus (Gümbel)

Plate 2, figures 22, 23

Robulina alato-limbata Gümbel, Abhandl. kön. bay. Akad. Wiss. München, Cl. II, vol. 10, 1870, p. 641, pl. 1, fig. 70.

Cristellaria alato-limbata Cushman and Applin, Bull. Amer. Assoc. Petr. Geol., vol. 10, 1926, p. 171, pl. 8, fig. 8.

Robulus alato-limbatus Cole, Bull. Amer. Pal., vol. 14, No. 51, 1927, p. 18, pl. 4, fig. 1.—Howe and Wallace, Louisiana Geol. Bull. 2, 1932, p. 37, pl. 3, fig. 2.—Cushman, U. S. Geol. Survey Prof. Paper 181, 1935, p. 15, pl. 6, fig. 2.—Coryell and Embich, Journ. Pal., vol. 11, 1937, p. 299, pl. 41, fig. 16.—Howe, Geol. Bull. 14, Louisiana Geol. Survey, 1939, p. 40, pl. 4, fig. 18.—Bergquist, Bull. 49, Mississippi State Geol. Survey, 1942, p. 26, pl. 3, fig. 7.—Cushman and Siegfus, Trans. San Diego Soc. Nat. Hist., vol. 9, 1942, p. 404, pl. 15, figs. 19-21.—Cushman and Applin, Contr. Cushman Lab. Foram. Res., vol. 19, 1943, p. 33, pl. 7, fig. 11.—Cushman and Simonson, Journ. Pal., vol. 18, 1944, p. 194, pl. 30, fig. 8.—Cushman and Todd, Contr. Cushman Lab. Foram. Res., vol. 21, 1945, p. 13, pl. 3, fig. 11.—Cushman, Bull. 2, Maryland Dept. Geol., Mines and Water Resources, 1948, p. 227, pl. 16, fig. 8.

Numerous specimens have been compared with topotypes from the Eocene of Bavaria and are quite typical. The species is widely known, particularly in the Eocene.

Robulus arcuato-striatus (Hantken), var. **carolinianus** Cushman

Plate 2, figure 24

Robulus arcuato-striatus (Hantken), var. **carolinianus** Cushman, Contr. Cushman Lab. Foram. Res., vol. 9, 1933, p. 4, pl. 1, fig. 9; U. S. Geol. Survey Prof. Paper 181, 1935, p. 17, pl. 6, fig. 6.—Coryell and Embich, Journ. Pal., vol. 11, 1937, p. 299, pl. 41, fig. 18.—Bergquist, Bull. 49, Mississippi State Geol. Survey, 1942, p. 27, pl. 2, fig. 23.—Cushman, Special Publ. 16, Cushman Lab. Foram. Res., 1946, p. 10, pl. 1, fig. 14.

Robulus cf. **R. arcuato-striatus**, var. **carolinianus** Cushman and Simonson, Journ. Pal., vol. 18, 1944, p. 194, pl. 30, fig. 10.

Specimens which seem to be quite close to this variety, known from the Jackson formation of Eocene age of North America, occur in a few samples.

Robulus sp. cf. **R. inornatus** (Orbigny)

Plate 2, figures 20, 21

Robulina inornata Orbigny, Foram. Foss. Bass. Tert. Vienne, 1846, p. 102, pl. 4, figs. 25, 26.

Specimens resembling this widely recorded species occur in some numbers throughout the Chilean section. They are rather close to *R. alato-limbatus* (Gümbel) in appearance but the tangential sutures are slightly curved, and the chambers more numerous than in *R. alato-limbatus*. The character of the periphery is variable, some being keeled and others merely acute. A few specimens have the chamber walls collapsed around the prominent umbo.

Robulus limbosus (Reuss)

Plate 2, figure 26

Robulina limbosa Reuss, Sitz. Akad. Wiss. Wien, vol. 48, pt. 1, 1863, p. 55, pl. 6, fig. 69.—Hantken, Mitth. Jahrb. K. Ungar. geol. Anstalt, vol. 4, 1875 (1881), p. 57, pl. 6, fig. 11.

This species, described from the Oligocene, Septaria clay, of Offenbach, and also known in the Eocene of Europe, occurs commonly in the Chilean material. The species is characterized by its rather prominent, limbate, and curved sutures, small umbo, flat test, and rather broad, sharp keel.

Genus **Lenticulina** Lamarck, 1804

Lenticulina convergens (Bornemann)

Plate 2, figures 25, 27

Cristellaria convergens Bornemann, Zeitschr. deutsch. geol. Ges., vol. 7, 1855, p. 327, pl. 13, figs. 16, 17.

Specimens of this widely recorded species are fairly common. It was originally described from the Oligocene of Hermsdorf, near Berlin, Germany.

Genus **Astacolus** Montfort, 1808

Astacolus sp. cf. **A. crepidula** (Fichtel and Moll)

Plate 2, figure 28

Nautilus crepidula Fichtel and Moll, Test. Micr., 1803, p. 107, pl. 19, figs. g, h, i.

Forms similar to that figured are rare but quite constant in character.

Astacclus skyringensis Todd and Kniker, n. sp.

Plate 2, figure 29

Test small for the genus, inflated in the center but compressed toward the periphery and toward the aperture which is strongly protruding, close-coiled in the young, adult with the last several chambers greatly increasing in length and tending to uncoil, with a narrow sharp keel; periphery acute and chambers indistinct, about 6 in the close-coiled whorl; sutures indistinct except the last one or two, not depressed; wall ornamented by numerous, straight, sharp costae nearly parallel, but tending to converge toward the aperture; aperture a protruding, radiate cap set at the outer edge of the last-formed chamber. Length 0.50-0.60 mm.; thickness 0.20-0.25 mm.

Holotype (Cushman Coll. No. 64343) from Ruby 4.

This species is characterized by its distinctive ornamentation which obscures almost completely the sutures and chambers. It is restricted to the lower part of the middle and the upper part of the lower Agua Fresca.

Genus **Marginulina** Orbigny, 1826

Marginulina abbreviata Neugeboren

Plate 2, figures 36-39

Marginulina abbreviata Neugeboren, Verh. Mitth. Siebenburg. Ver. Nat., Jahrg. 2, 1851, p. 129, pl. 5, fig. 4; Denkschr. Akad. Wiss. Wien, vol. 12, 1856, p. 102.—Cushman and Ellisor, Journ. Pal., vol. 19, 1945, p. 554, pl. 73, fig. 16.

Marginulina cf. **M. abbreviata** Cushman and Stainforth, Special Publ. 14, Cushman Lab. Foram. Res., 1945, p. 23, pl. 3, fig. 9.—Cushman, l. c., Special Publ. 16, 1946, p. 12, pl. 3, fig. 7.—Cushman and Renz, l. c., Special Publ. 22, 1947, p. 13, pl. 4, fig. 2.

This widely recorded species occurs fairly commonly throughout the section. The four figured specimens (two microspheric and two megalospheric) illustrate the range in variation. The more inflated specimens tend to resemble *M. subbullata* Hantken but do not seem to be the same.

Marginulina nuttalli Todd and Kniker, new name

Plate 2, figures 30, 31

Cristellaria sublituus Nuttall (not **Marginulina sublituus** Orbigny), Journ. Pal., vol. 6, 1932, p. 11, pl. 1, figs. 13, 14.—Palmer and Bermudez, Mem. Soc. Cubana Hist. Nat., vol. 10, 1936, p. 256. Bermudez, l. c., vol. 12, 1938, p. 2.

Marginulina sublituus Hedberg, Journ. Pal., vol. 11, 1937, p. 170.—Bergquist, Bull. 49, Mississippi State Geol. Survey, 1942, p. 38, pl. 4, figs. 1, 3.—Cushman and Stainforth, Special Publ. 14, Cushman Lab. Foram. Res., 1945, p. 23, pl. 16, fig. 14.—Cushman and Ellisor, Journ. Pal., vol. 19, 1945, p. 554, pl. 73, figs. 9-15.—Cushman and Renz, Special Publ. 22, Cushman Lab. Foram. Res., 1947, p. 14.—Bermudez, l. c., Special Publ. 25, 1949, p. 141, pl. 9, figs. 27, 28.

Astacolus sublituus Galloway and Heminway, New York Acad. Sci., Sci. Survey Porto Rico and Virgin Islands, vol. 3, pt. 4, 1941, p. 335, pl. 8, fig. 11.—Renz, Mem. 32, Geol. Soc. Amer., 1948, p. 115.—Bandy, Bull. Amer. Pal., vol. 32, No. 131, 1949, p. 42, pl. 5, fig. 13.

This species described from the Oligocene of Mexico occurs rarely, but specimens are quite typical. The form requires a new name as the specific name was first used in *Marginulina* in 1826 for a Recent form from the Adriatic.

Marginulina asperuliformis (Nuttall)

Plate 2, figures 32-34

Cristellaria asperuliformis Nuttall, Journ. Pal., vol. 4, 1930, p. 282, pl. 23, figs. 9, 10.

Marginulina asperuliformis Bermudez, Mem. Soc. Cubana Hist. Nat., vol. 12, 1938, p. 15.—Cushman and Siegfus, Contr. Cushman Lab. Foram. Res., vol. 15, 1939, p. 24, pl. 6, figs. 1-3; Trans. San Diego Soc. Nat. Hist., vol. 9, 1942, p. 408, pl. 16, figs. 18-20.—Kelley, Bull. Amer. Assoc. Petr. Geol., vol. 27, 1943, p. 8 (list).—Curran, l. c., pp. 1379, 1381 (lists).—Martin, Stanford Univ. Publ., Univ. Ser., Geol. Sci., vol. 3, No. 3, 1943, p. 11 (list).

This species described from the Eocene, Aragon formation, of Mexico and also known in the Eocene of Cuba and California, occurs commonly or abundantly throughout the section. Specimens have been compared with the types and appear identical, but, like the types, show considerable variation in degree of ornamentation. Also, micro-, and megalospheric forms differ somewhat in appearance as shown by the figured specimens.

A somewhat similar form was described from the lowest middle Eocene of New Zealand, *Marginulinopsis waiparaensis* Finlay (Trans. Roy. Soc. New Zealand, vol. 69, 1939, p. 317, pl. 26, figs. 45, 46).

Marginulina sp.

Plate 2, figure 35

A few specimens of a finely costate species seem to represent an undescribed species. They seem to be closest to *Marginulina distincta* Cushman and Bermudez of the Paleocene, Madruga formation, of Cuba.

Genus Dentalina Orbigny, 1826

Dentalina consobrina Orbigny

Plate 3, figures 1, 2

Dentalina consobrina Orbigny, Foram. Foss. Bass. Tert. Vienne, 1846, p. 46, pl. 2, figs. 1-3.

Typical specimens occur throughout the section. The species was described from the Miocene of the Vienna Basin and is widely known from Eocene to Recent.

All, except immature specimens, are fragmentary. They vary from straight to arcuate but all have an initial spine.

Dentalina cooperensis Cushman

Plate 3, figure 3

Dentalina cooperensis Cushman, Contr. Cushman Lab. Foram. Res., vol. 9, 1933, p. 8, pl. 1, fig. 17; U. S. Geol. Survey Prof. Paper 181, 1935, p. 20, pl. 8, figs. 3, 4.—Palmer and Bermudez, Mem. Soc. Cubana Hist. Nat., vol. 10, 1936, p. 263, pl. 15, fig. 17.—Coryell and Embich, Journ. Pal., vol. 11, 1937, p. 298, pl. 42, fig. 7.—Bergquist, Bull. 49, Mississippi State Geol. Survey, 1942, p. 42, pl. 5, fig. 3.—Cushman and Simonson, Journ. Pal., vol. 18, 1944, p. 196, pl. 31, figs. 5-7.—Cushman, Special Publ. 16, Cushman Lab. Foram. Res., 1946, p. 12, pl. 3, figs. 13, 14; Bull. 2, Maryland Dept. Geol., Mines and Water Resources, 1948, p. 229, pl. 17, fig. 2.—Cushman and Cederstrom, Bull. 67, Virginia Geol. Survey, 1945 (1949), p. 12.—Cuvillier and Szakall, Foram. Aquitaine, Prem. Part., 1949, p. 78, pl. 28, fig. 22.—Bermudez, Special Publ. 25, Cushman Lab. Foram. Res., 1949, p. 143, pl. 9, fig. 46.

A few specimens seem to belong to this species although they show considerable variation in stoutness of the test and inflation of the chambers. The species was described from the upper Eocene of South Carolina, and is widely known in the Eocene and Oligocene.

Dentalina cooperensis Cushman, var. gracilescata Cushman

Plate 3, figure 4

Dentalina cooperensis Cushman, var. **gracilescata** Cushman, Special Publ. 16, Cushman Lab. Foram. Res., 1946, p. 13, pl. 3, fig. 15.

A few slender specimens, all from the outcrop samples and more abundant in the lower part of the section, appear to belong to this variety described from the Cocoa sand member of the Jackson formation.

Dentalina mucronata Neugeboren

Plate 3, figure 5

Dentalina mucronata Neugeboren, Denkschr. Akad. Wiss. Wien, vol. 12, 1856, p. 83, pl. 3, figs. 8-11.

Typical specimens of this widely distributed species occur throughout the section but never abundantly.

Dentalina soluta Reuss

Plate 3, figure 6

Dentalina soluta Reuss, Zeitschr. deutsch. geol. Ges., vol. 3, 1851, p. 60, pl. 3, fig. 4.

Rare specimens were found in 3 samples.

Dentalina elgansoensis Todd and Kniker, n. sp.

Plate 3, figures 7, 14

Test elongate, cylindrical, slightly arcuate, very

slightly tapering, initial end usually somewhat enlarged; chambers distinct, few, later ones slightly inflated, not much increasing in size as added; sutures distinct, straight, horizontal, limbate, strongly depressed in the later portion; wall thick, ornamented by 10 to 12 high, sharp, serrate, longitudinal costae, continuous across the sutures, with additional ones being intercalated as the test grows; aperture radiate, excentric, protruding. Length up to 2.50 mm.; diameter 0.35-0.45 mm.

Holotype (Cushman Coll. No. 64367) from Mohr 21. It is common at the type locality and also occurs at Thomas sample No. 148. It should prove to be a good marker for the lowermost part of the section.

It differs from *D. bevani* Cushman and Cederstrom in its stouter test without an initial spine and in its high serrate costae.

Dentalina patagonica Todd and Kniker, n. sp.

Plate 3, figure 15

Test elongate, cylindrical, not much tapering, initial end bulbous except in strongly microspheric specimens; chambers distinct, inflated, later ones more inflated than earlier ones, not much increasing in size as added; sutures distinct, incised, limbate, horizontal; wall thickly covered with rather coarse, blunt spines, without any regularity of arrangement, spines less well developed on the last-formed chamber; aperture radiate, protruding, excentric. Length up to 2 mm.; diameter 0.25-0.35 mm.

Holotype (Cushman Coll. No. 64370) from Shaw 39.

Specimens are found throughout the section but are nowhere very abundant. In some respects they resemble *D. hispido-costata* Cushman and Siegfus from the Kreyenhagen shale of California, but they lack any sign of costae, and the chambers are more compactly set together. Except for its aperture which is excentric, it is quite close to *Dentalina halkyardi* Cushman from strata of Jackson age in South Carolina.

Genus **Nodosaria** Lamarck, 1812

Nodosaria hispida Orbigny

Plate 3, figure 20

Nodosaria hispida Orbigny, Foram. Foss. Bass. Tert. Vienne, 1846, p. 35, pl. 1, figs. 24, 25.

Rare specimens occur in scattered samples throughout the section.

Nodosaria latejugata Gümbel

Plate 3, figures 8, 17

Nodosaria latejugata Gümbel, Abhandl. kön. bay. Akad. Wiss. München, Cl. II, vol. 10, 1870, p. 619, pl. 1, fig. 32.

This large species described from the Eocene of Bavaria and widely known in Europe and America occurs throughout the section. Specimens are uncommon and all except young forms all broken. Two forms occur: the megalospheric with few inflated chambers and the microspheric with more numerous, not inflated chambers and the whole test smoothly tapering.

Nodosaria longiscata Orbigny

Plate 3, figures 9, 10

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

Typical fragmentary specimens of this widely known species occur fairly commonly throughout the section.

Genus **Chrysalogonium** Schubert, 1907

Chrysalogonium magallanicum Todd and Kniker, n. sp.

Plate 3, figures 11-13

Test elongate, cylindrical or very slightly tapering, initial and apertural ends both bluntly rounded; chambers few, usually broader than long, not much increasing in size as added, last-formed chambers slightly inflated; sutures indistinct in the early portion, later becoming progressively more deeply incised, horizontal; wall ornamented by numerous longitudinal costae, about 12 to 20 on the complete circumference of the test, high, sharp but not serrate, continuous across the sutures; aperture a finely cribrate cap as a low cone on the last chamber, with earlier apertures as revealed by the breaking away of subsequent chambers having the pores fewer and larger and geometrically arranged on the apertural plate, apparently a result of resorbtion of the shell material. Length (incomplete) of largest specimen observed 1.80 mm.; diameter 0.22-0.32 mm.

Holotype (Cushman Coll. No. 64378) from well P-7, at 118-121 meters.

The species occurs in abundance in the type sample and at 121-127 meters and in Shaw 39, and very rarely in the upper Agua Fresca of the Mina Rica No. 1 well. Single specimens were found at 558-560 meters and at 967-972 meters in well P-7, but their origin may have been contamination.

This species differs from *C. breviloculum* Cushman and Jarvis from the Miocene of Trinidad in its much smaller size, more numerous and delicate costae, and less deeply incised sutures.

Genus **Pseudoglandulina** Cushman, 1929

Pseudoglandulina conica (Neugeboren)

Plate 3, figure 16

Glandulina conica Neugeboren, Verh. Mitth. Siebenburg. Ver. Nat., Jahrg. 2, 1851, p. 51, pl. 1, fig. 5.—Bandy, Bull. Amer. Pal., vol. 32, No. 131, 1949, p. 48, pl. 6, figs. 10, 11.

Pseudoglandulina conica Cushman and Parksdale, Contr. Dept. Geol., Stanford Univ., vol. 1, No. 1, 1930, p. 65, pl. 12, figs. 1-3.—Cushman, Bull. 2, Maryland Dept. Geol., Mines, and Water Resources, 1948, p. 220, pl. 17,

fig. 7.—Cushman and Cederstrom, Bull. 67, Virginia Geol. Survey, 1945 (1949), p. 16, pl. 3, fig. 2.—Bermudez, Special Publ. 25, Cushman Lab. Foram Res., 1949, p. 161, pl. 10, fig. 38.

This species occurs rarely but is quite constant in its characters; having inflated chambers separated by incised sutures, and a protruding radiate aperture. It was described from Hungary and is widely recorded from Miocene and Eocene.

Genus **Frondicularia** Defrance, 1824

Frondicularia capitaua Cushman and Stone

Plate 3, figure 21

Frondicularia capitana Cushman and Stone, Contr. Cushman Lab. Foram. Res., vol. 25, 1949, p. 51, pl. 9, figs. 9-11.

A single fragmentary specimen from well P-7 at 786-790 meters seems to be identical with this species described from the Eocene, Chacra formation, of Peru.

Another fragmentary specimen was found in H. W. Thoms' sample 327, Peninsula Brunswick, from the middle Agua Fresca.

Genus **Palmula** Lea, 1833

Palmula magallanica Todd and Kniker, n. sp.

Plate 3, figure 22

Test large for the genus, initial *Robulus*-stage raised and limbate, later part compressed, periphery truncate except around the *Robulus*-stage where it is acute and keeled; chambers distinct, uniserial ones increasing in width as added and not much embracing coiled ones; sutures raised and limbate; wall thick, ornamented by the limbate sutures and a few short, costae longitudinally placed over the bulbous initial stage; aperture radiate, slightly projecting. Length (maximum observed) 2.25 mm.; thickness of initial part 0.75 mm.; thickness of later part 0.25 mm.

Holotype (Cushman Coll. No. 64384) from Ruby 2.

This species differs from *P. meglameryae* Toulmin in its ornamentation of raised sutures and longitudinal ribs and its thicker and more conspicuous initial part.

This species is very rare but should be easily recognized even in fragmentary form. It has been found with a limited range both above and below the contact of the middle and lower parts of the Agua Fresca.

Genus **Lagena** Walker and Jacob, 1798

Lagena hispidula Cushman

Plate 3, figure 18

Lagena hispidula Cushman, Bull. 71, U. S. Nat. Mus., pt. 3, 1913, p. 14, pl. 5, figs. 2, 3.—Heron-Allen and Earland, Discovery Reports, vol. 4, 1932, p. 364, pl. 10, fig. 6.—Earland, l. c., vol. 7, 1933, p. 113; vol. 10, 1934, p. 152, pl. 6, figs. 58-60; vol. 13, 1936, p. 47.—Cushman and Gray, Special Publ. 19, Cushman Lab. Foram. Res., 1946, p. 21, pl. 4, fig. 6.

Typical specimens occur rarely. The species was described from Recent Pacific and Antarctic material and also recorded from the Pleistocene of Timms Point, California.

Lagena striatopunctata Parker and Jones

Lagena sulcata Walker and Jacob, var. **striatopunctata** Parker and Jones, Philos. Trans., 1865, p. 350, pl. 13, figs. 25-27.

Single specimens found in three samples: well P-7 at 121-127 and 374-380 meters, and Ruby 5, appear to belong to this distinctively ornamented species.

Lagena substriata Williamson

Plate 3, figure 19

Lagena substriata Williamson, Ann. Mag. Nat. Hist., ser. 2, vol. 1, 1848, p. 15, pl. 2, fig. 12.

This species of *Lagena*, finely striate with an elongate, slender neck, occurs rarely.

Family POLYMORPHINIDAE

Genus **Guttulina** Orbigny, 1839

Guttulina irregularis (Orbigny)

Plate 3, figure 28

Globulina irregularis Orbigny, Foram. Foss. Bass. Tert. Vienne, 1846, p. 226, pl. 13, figs. 9, 10.

Guttulina irregularis Cushman and Ozawa, Proc. U. S. Nat. Mus., vol. 77, Art. 6, 1930, p. 25, pl. 3, figs. 4, 5; pl. 7, figs. 1, 2.

This widely recorded species occurs in the Chilean material. Specimens are all smaller than typical.

Genus **Globulina** Orbigny, 1839

Globulina rotundata (Bornemann)

Plate 3, figure 26

Guttulina rotundata Bornemann, Zeitschr. deutsch. geol. Ges., vol. 7, 1855, p. 346, pl. 18, fig. 3.

Globulina rotundata Cushman and Ozawa, Proc. U. S. Nat. Mus., vol. 77, Art. 6, 1930, p. 86, pl. 21, figs. 3, 4.

This species occurs rarely throughout the section.

Genus **Pyrulina** Orbigny, 1839

Pyrulina sp.

Plate 3, figure 27

Small and possibly immature specimens seem to belong in this genus but are inadequate for identification.

Genus **Sigmomorphina** Cushman and Ozawa, 1928

Sigmomorphina sp. cf. **S. trinitatensis** Cushman and Ozawa

Plate 3, figures 23, 24

Sigmomorphina trinitatensis Cushman and Ozawa, Proc. U. S. Nat. Mus., vol. 77, Art. 6, 1930, p. 134, pl. 36, figs. 1, 2.

Specimens somewhat like this species known from the Eocene and Oligocene of Trinidad and the Domini-

can Republic occur in scattered samples throughout the section. Most of the specimens seem to be immature.

Sigmomorphina chileana Todd and Kniker, n. sp.

Plate 3, figure 25

Test elongate, almost rhombic, greatest breadth about the middle, compressed and strongly twisted, periphery rounded, slightly if at all indented, apical end rarely with a spine, usually sharply rounded but less so than apertural end; chambers few, elongated, not inflated, arranged in a sigmoid series; sutures gently curved, not depressed; wall smooth; aperture protruding, radiate. Length 0.60-1.00 mm.; breadth 0.35-0.50 mm.; thickness 0.25-0.30 mm.

Holotype (Cushman Coll. No. 64399) from Shaw 39.

This species occurs abundantly in scattered samples in the upper part of the section only. It differs from *S. vaughani* Cushman and Ozawa in its more elongate and narrower test, its greater compression and its more sharply pointed apical and apertural ends.

Genus **Glandulina** Orbigny, 1826

Glandulina laevigata Orbigny

Plate 3, figures 29, 30

Glandulina laevigata Orbigny. Foram. Foss. Bass. Tert. Vienne. 1846, p. 29, pl. 1, figs. 4, 5.

Rather large and thick specimens occur in few numbers throughout the section. Sutures and chambers are indistinct. The radiate aperture is large but does not project beyond the oval outline of the test.

Family NONIONIDAE

Genus **Nonion** Montfort, 1808

Nonion wilcoxensis Cushman and Ponton

Plate 3, figure 34

Nonion wilcoxensis Cushman and Ponton. Contr. Cushman Lab. Foram. Res., vol. 8, 1932, p. 64, pl. 8, fig. 11.—Cushman and Garrett, l. c., vol. 15, 1939, p. 81, pl. 14, fig. 14.—Cushman, U. S. Geol. Survey Prof. Paper 191, 1939, p. 5, pl. 1, fig. 16.—Kelley, Bull. Amer. Assoc. Petr. Geol., vol. 27, 1943, p. 8 (list).—Martin, Stanford Univ. Publ., Univ. Ser., Geol. Sci., vol. 3, No. 3, 1943, p. 11 (list).

Rare specimens were found in the upper part of the section in well P-7, between 121 and 191 meters. The species was described from the Wilcox group Eocene of Alabama and has been recorded from the Eocene, Anita shale and Lodo formation, of California.

Genus **Nonionella** Cushman, 1926

Nonionella sp.

Plate 3, figure 33

Three single specimens of a small *Nonionella* are recorded, although they are insufficient for identification. They are from Shaw 10 and 34 and Mohr 21. Chambers are few and the ventral umbilicus is relatively large and open.

Genus **Elphidium** Montfort, 1808

Elphidium skyringense Todd and Kniker, n. sp.

Plate 3, figure 39

Test close coiled, compressed, depressed at the umbilici, periphery acute but not keeled; chambers about 12 in the adult whorl, narrow, very strongly curved, not much increasing in size as added, chamber divisions obscured by the ornamentation; sutures deeply depressed, retral processes strongly developed in that each suture is bridged by about 9 prominent but narrow rods connecting the raised inter-sutural ridges which actually do not represent the suture lines but the chambers instead; wall completely covered by a reticulate network formed by the very strongly curved, raised, and limbate inter-sutural ridges and the prominent retral processes, apertural face ornamented by very fine and irregular striations; aperture a series of pores along the base of the apertural face. Diameter 0.60-0.80 mm.; thickness 0.30-0.40 mm.

Holotype (Cushman Coll. No. 64407) from Ruby 5.

This species is an index fossil for the middle part of the Agua Fresca formation down to the basal beds, and it occurs abundantly. It differs from *E. hampdenense* Finlay from the lower Bortonian of New Zealand in having more numerous chambers and retral processes and consequently a more crowded reticulate ornamentation, and in being somewhat more closely coiled and in having the apertural face ornamented by a fine pattern of wavy lines.

This species was named for the "Skyring formation," by which name the Agua Fresca formation was formerly known.

Elphidium patagonicum Todd and Kniker, n. sp.

Plate 3, figure 35

Test slightly compressed, close-coiled, apertural face bulging, periphery subacute, not lobulate; chambers distinct, about 10 in the adult whorl, curved, not much increasing in size as added; sutures distinct, curved, deeply depressed, each suture bridged by 4 or 5 broad and prominent retral processes; wall perforate, ornamented by inter-sutural ridges and a reticulated pattern of raised ridges which may be eroded, the retral processes resulting in a rather coarsely pitted appearance on eroded specimens, apertural face ornamented by very fine striations; aperture a series of low, arched openings along the base of the apertural face. Diameter 0.42-0.55 mm.; thickness 0.27-0.35 mm.

Holotype (Cushman Coll. No. 64411) from well P-7 at 118-121 meters.

This species is an index fossil for the upper part of the Agua Fresca. It differs from *E. skyringense* n. sp.

in its smaller, thicker test with a subacute periphery, in its fewer retral processes resulting in the appearance of a coarsely pitted surface instead of a reticulate one, and in its sutures being much less strongly curved.

Elphidium aguafrescaense Todd and Kniker, n. sp.

Plate 3, figure 36

Test compressed, periphery subacute, not lobulate; chambers distinct, 10 to 12 in the last whorl; sutures distinct, very strongly curved, depressed, retral processes large and prominent, 6 or 7 along each suture; wall perforate, covered by a reticulated network which in some instances is worn off leaving a smooth surface except for the retral processes and a ring of raised knobs of clear shell material around the umbilici; aperture a series of low, arched openings, about 6, along the base of the apertural face. Diameter 0.40-0.50 mm.; thickness 0.20-0.25 mm.

Holotype (Cushman Coll. No. 64409) from Thomas 69.

This species is an index fossil for the basal part of the middle Agua Fresca. It differs from *E. skyringense* n. sp. in the ornamentation being less elaborate, in the chambers being fewer and more distinct, and in the inter-sutural ridges being broader.

Elphidium chilenum Todd and Kniker, n. sp.

Plate 3, figure 37

Test compact, thick, umbilici depressed, periphery broadly rounded, slightly lobulate; chambers distinct, narrow, curved, 8 or 9 in the adult whorl, not much increasing in size as added, later ones slightly inflated; sutures distinct, slightly curved, later ones slightly depressed, retral processes short and inconspicuous; wall perforate, smooth; aperture a series of very small arched openings along the base of the apertural face. Diameter 0.35-0.40 mm.; thickness 0.25 mm.

Holotype (Cushman Coll. No. 64414) from Shaw 10.

This species is an index fossil for the upper part of the lower Agua Fresca formation. It differs from *E. articulatum* (Orbigny) from Recent material from the Falkland Islands in its thicker and closer coiled test and somewhat more prominent retral processes.

Elphidium lauritaense Todd and Kniker, n. sp.

Plate 3, figure 38

Test compact, thick, close coiled, depressed at the umbilici, periphery broadly rounded, slightly lobulate; chambers fairly distinct, about 10 in the last whorl, not much increasing in size as added; sutures depressed, slightly curved, retral processes short but numerous; wall perforate, smooth, retral processes resulting in a reticulate surface; aperture a series of very small, low, arched openings along the base of the apertural face. Diameter 0.45-0.60 mm.; thickness 0.30-0.35 mm.

Holotype (Cushman Coll. No. 64416) from Thomas 148.

This species is an index fossil for the lowermost part of the Agua Fresca section. It differs from *E. chilenum*, n. sp. in its larger size, and in its more numerous chambers and more prominent retral processes which result in a reticulate surface pattern which is lacking in *E. chilenum*. It also resembles *E. saginatum* Finlay from the middle Eocene of New Zealand, but differs in having more chambers and in lacking the umbilical ornamentation of *E. saginatum*.

This species was named for the Cerro Laurita anticline, where it was found well developed in outcrop samples. The types were chosen from an outcrop sample from the shore of Seno Skyring as specimens there were unusually well preserved.

Family BULIMINIDAE

Genus **Turrilina** Andreae, 1884

Turrilina robertsi (Howe and Ellis)

Plate 4, figure 8

Bulimina robertsi Howe and Ellis, in Howe, Geol. Bull. 14, Louisiana Geol. Survey, 1939, p. 63, pl. 8, figs. 32, 33. —Hussey, Journ. Pal., vol. 23, 1949, p. 131.

Buliminella robertsi Martin, Stanford Univ. Publ., Univ. Ser., Geol. Sci., vol. 3, No. 3, 1943, p. 9 (list).—Cushman and Herrick, Contr. Cushman Lab. Foram. Res., vol. 21, 1945, p. 64, pl. 10, fig. 15.—Cushman and Todd, l. c., p. 94, pl. 15, fig. 12.—Cushman and Parker, U. S. Geol. Survey Prof. Paper 210-D, 1947, p. 62, pl. 16, fig. 8.

Test small, short, bluntly pointed at apical end, rounded at apertural end, consisting of 3 or 4 whorls of chambers, greatest diameter through the last whorl; chambers indistinct, much embracing, later ones slightly inflated; sutures indistinct, limbate, slightly incised; wall smooth, finely perforate; aperture a low and elongate arched opening under the inbent edge of the wall of the last-formed chamber. Length 0.30-0.35 mm.; diameter 0.17-0.20 mm.

Specimens about twice as large as the types of this species are rather common in scattered samples throughout the section. This distinctive small species is known from the Eocene of Louisiana, Mississippi, Georgia, Texas, and California, and Eocene submarine cores on the Atlantic coast. It is placed in *Turrilina* on the basis of its broad, arched aperture instead of a comma-shaped one.

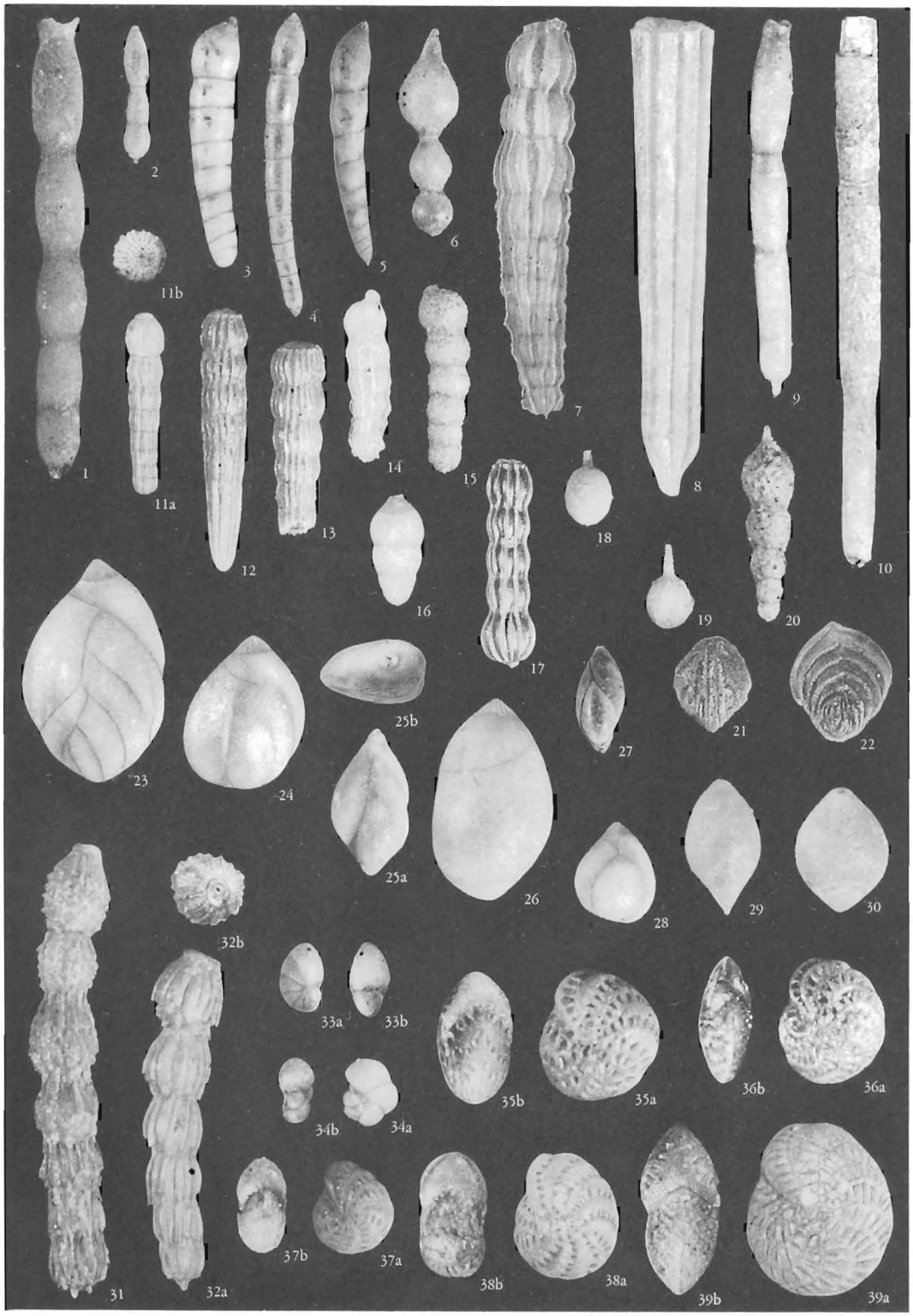
Genus **Bulimina** Orbigny, 1826

Bulimina pupoides Orbigny

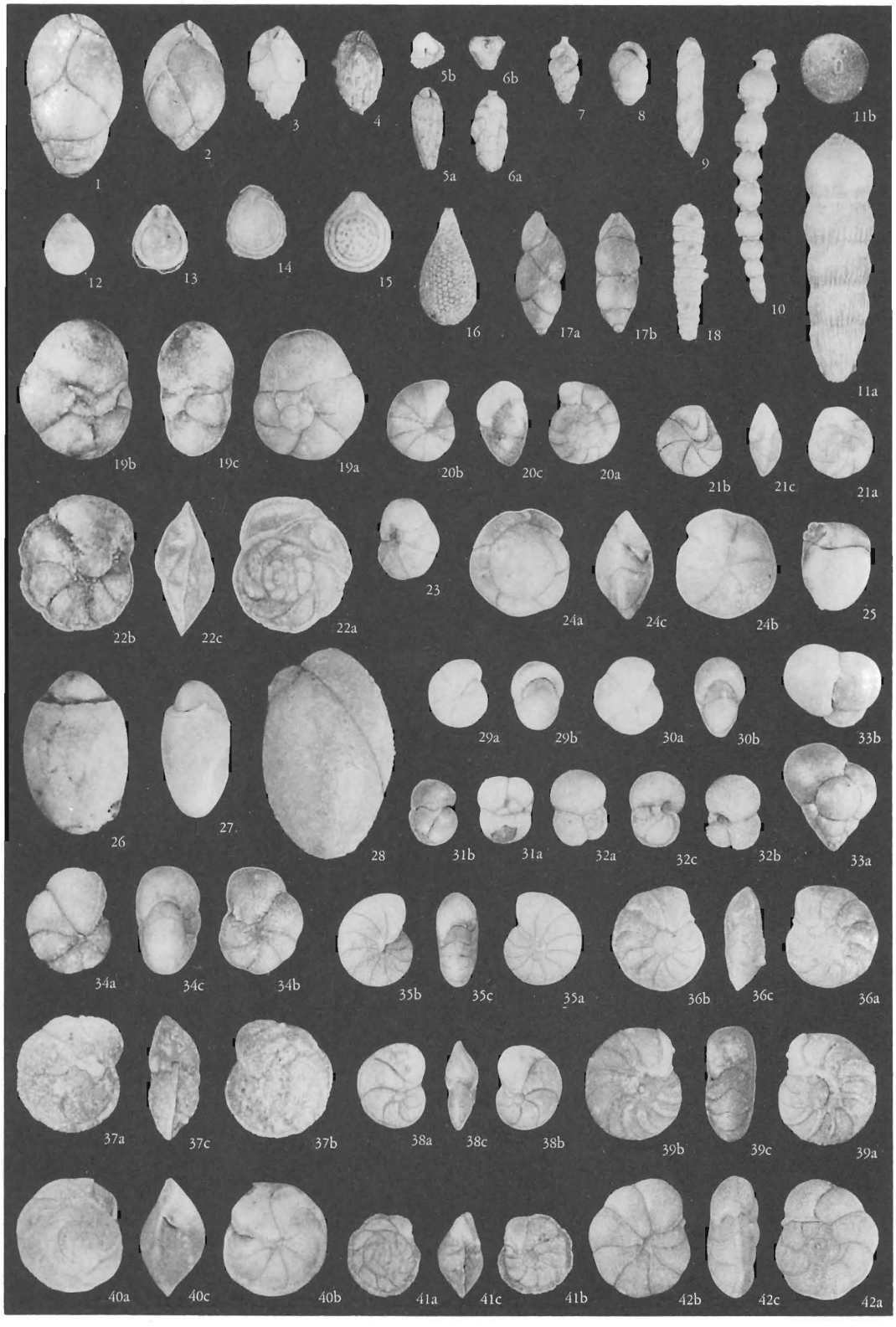
Plate 4, figures 1, 2

Bulimina pupoides Orbigny, Foram. Foss. Bass. Tert. Vienne, 1846, p. 185, pl. 11, figs. 11, 12.—Cushman and Parker, U. S. Geol. Survey Prof. Paper 210-D, 1947, p. 105, pl. 25, figs. 3-7.—Cushman and Renz, Special Publ. 24, Cushman Lab. Foram. Res., 1948, p. 25, pl. 5, fig.

EXPLANATION OF PLATE 3



Todd and Kniker: Eocene Foraminifera, Magallanes Province, Chile



Todd and Kniker: Eocene Foraminifera, Magallanes Province, Chile

EXPLANATION OF PLATE 4

16.—Renz, Mem. 32, Geol. Soc. Amer., 1948, p. 122, pl. 6, figs. 11, 12.—Bermudez, Special Publ. 25, Cushman Lab. Foram. Res., 1949, p. 183, pl. 11, fig. 67.—Cushman and Stone, l. c., Contr. vol. 25, 1949, p. 79, pl. 14, figs. 6, 7.

This species occurs abundantly throughout the section. A number of specimens have been crushed and apparently recemented during fossilization.

Bulimina alsatica Cushman and Parker

Plate 4, figure 3

Bulimina alsatica Cushman and Parker, Contr. Cushman Lab. Foram. Res., vol. 13, 1937, p. 39, pl. 4, figs. 6, 7; U. S. Geol. Survey Prof. Paper 210-D, 1947, p. 102, pl. 24, figs. 10, 11.

Specimens apparently identical with this species described from the Oligocene of Alsace, occur in scattered samples throughout the Agua Fresca formation.

Bulimina corrugata Cushman and Siegfus

Plate 4, figure 4

Bulimina corrugata Cushman and Siegfus, Contr. Cushman Lab. Foram. Res., vol. 11, 1935, p. 92, pl. 14, fig. 7; Trans. San Diego Soc. Nat. Hist., vol. 9, 1942, p. 411, pl. 16, fig. 38.—Cushman, Contr. Cushman Lab. Foram. Res., vol. 15, 1939, p. 64.—Curran, Bull. Amer. Assoc. Petr. Geol., vol. 27, 1943, pp. 1378, 1381 (lists).—Cushman and Parker, U. S. Geol. Survey Prof. Paper 210-D, 1947, p. 93, pl. 22, fig. 2.

This Eocene species occurs in Mohr 64 and has been found occasionally in other lower Agua Fresca samples.

Bulimina aguafrescaensis Todd and Kniker, n. sp.

Plate 4, figure 5

Test small, elongate, tapering from the acute initial end to the greatest breadth across the last whorl of chambers, triangular in section; chambers indistinct, numerous, low, not inflated; sutures indistinct, horizontal, slightly depressed; wall ornamented by numerous, prominent, irregular, longitudinal costae which cover all but the last whorl of chambers; aperture a large and high, loop-shaped opening extending upward from the base of the last chamber. Length 0.30-0.37 mm.; diameter 0.15 mm.

Holotype (Cushman Coll. No. 64427) from Shaw 34.

The species occurs fairly commonly at its type locality and rare specimens were found in the upper part of well P-7, at 449-456, 510-516, and 668-674 meters. The species should form a useful marker for this part of the Agua Fresca formation.

This species differs from *B. cacumenata* Cushman and Parker in its larger size and the coarser texture of the ornamentation. It also somewhat resembles *B. truncanella* Finlay, but that species is smaller and less elongate and the ornamentation is more regular than on the Chilean species.

Genus **Oolina** Orbigny, 1839

Oolina squamosa (Montagu), var. **catenulata** (Williamson)

Plate 4, figure 16

Entosolenia squamosa, var. **catenulata** Williamson, Ann. Mag. Nat. Hist., ser. 2, vol. 1, 1848, p. 19, pl. 2, fig. 20.

A few specimens, all from the upper part of the section, are quite uniform in character and resemble the type figure of this variety, which was described from Recent material of Great Britain. This form was defined as having very small and numerous aureolae arranged in perpendicular rows instead of being irregularly distributed over the surface as in *O. squamosa*.

Genus **Fissurina** Reuss, 1850

Fissurina laevigata Reuss

Plate 4, figure 12

Fissurina laevigata Reuss, Denkschr. Akad. Wiss. Wien, vol. 1, 1850, p. 366, pl. 46, fig. 1.

Entosolenia laevigata Cushman and McGlamery, U. S. Geol. Survey Prof. Paper 197-B, 1942, p. 70, pl. 5, figs. 19-21.

Typical specimens are found rarely in the upper and middle parts of the section.

Fissurina sp. cf. **F. marginata** (Walker and Boys)

Plate 4, figure 13

Very rare specimens, with a slight peripheral keel, are close to this species.

Fissurina sp. cf. **F. orbignyana** Seguenza

Plate 4, figure 14

Rare specimens from two samples in the middle Agua Fresca, Ruby 7, and well P-7 at 865-871 meters, are similar to this species.

Fissurina orbignyana Seguenza, var. **flintii** (Cushman)

Plate 4, figure 15

Lagena orbignyana (Seguenza), var. **flintii** Cushman, U. S. Geol. Survey Prof. Paper 129-F, 1922, p. 129, pl. 29, fig. 11; Prof. Paper 133, 1923, p. 26.

Entosolenia orbignyana, var. **flintii** Howe, Journ. Pal., vol. 2, 1928, p. 174 (list).—Cushman and Todd, Contr. Cushman Lab. Foram. Res., vol. 24, 1948, p. 9 (list), pl. 1, fig. 8.

Three specimens of this distinctively ornamented species were found at 757-763 meters in well P-7. It was described and only known from the Oligocene of Mississippi and Alabama, but these Chilean specimens seem typical.

Genus **Virgulina** Orbigny, 1826

Virgulina sp.

Plate 4, figure 9

Fairly common specimens of an elongate and nearly

cylindrical *Virgulina* seem to be new but are inadequate for full description.

Genus Uvigerina Orbigny, 1826
Uvigerina minuta Cushman and Stone
Plate 4, figure 7

Uvigerina minuta Cushman and Stone, Contr. Cushman Lab. Foram. Res., vol. 25, 1949, p. 54, pl. 10, figs. 5, 6.

Specimens identical with this minute spinose species described from the Eocene, Chacra formation, of Peru, occur sparsely in the upper part of the middle and in the upper Agua Fresca.

Genus Siphonodosaria A. Silvestri, 1924
Siphonodosaria gracilis (Palmer and Bermudez)
Plate 4, figure 10

Ellipsonodosaria gracilis Palmer and Bermudez, Mem. Soc. Cubana Hist. Nat., vol. 10, 1936, p. 296, pl. 18, figs. 8, 9.—Bermudez, l. c., vol. 12, 1938, p. 5.

Siphonodosaria gracilis Bermudez, Special Publ. 25, Cushman Lab. Foram. Res., 1949, p. 225, pl. 14, fig. 27.

Ellipsonodosaria sp. Cushman and R. E. and K. C. Stewart, Bull. 36, Oregon Dept. Geol. and Min. Ind., pt. 5, 1947 (1948), p. 102, pl. 12, figs. 8, 9.

This species, described from the Oligocene of Cuba occurs throughout the section, sometimes abundantly. Specimens vary somewhat in ornamentation; some of the tests have a finely hispid wall throughout in addition to the row of spines around the basal part of each chamber. Some specimens are much larger than typical and are straight instead of arcuate, and these may be distinct.

Siphonodosaria chileana Todd and Kniker, n. sp.
Plate 3, figures 31, 32

Test elongate, stout, slightly arcuate, little if at all tapering; chambers few, distinct, not much increasing in size as added, later ones slightly inflated; sutures distinct, horizontal, later ones progressively more deeply depressed; wall cemented by numerous high, plate-like longitudinal costae, interrupted at the sutures and ending in backwardly-projecting spines, last-formed few chambers with the costae progressively more broken up into backwardly-projecting spines; aperture large, circular, surrounded by a thickened rim, not projecting. Maximum length observed 2.6 mm.; diameter 0.30-0.40 mm.

Holotype (Cushman Coll. No. 64444) from Shaw 23.

This species occurs fairly commonly throughout the entire section. It differs from "*Ellipsonodosaria midwayensis* Cushman and Todd" (= *Siphonodosaria*) in its stouter and less tapering test with fewer chambers.

Genus Angulogerina Cushman, 1927
Angulogerina cushmani Todd and Kniker, n. sp.
Plate 4, figure 6

Test small, slightly tapering, greatest breadth near the apertural end, triangular throughout, with concave sides, peripheral angles truncate and slightly keeled, in side view periphery slightly lobulate; chambers distinct, not inflated, rapidly increasing in size; sutures distinct, strongly curved, limbate, slightly depressed; wall thin, perforate, ornamented by a few short costae over the earlier part; aperture at the end of a short neck, surrounded by a very narrow lip. Length 0.33-0.38 mm.; breadth 0.15-0.18 mm.

Holotype (Cushman Coll. No. 64448) from well P-7 at 223-228 meters. It is fairly common at its type locality and was found rarely at 188-191 meters in well P-7. It should be a good marker for the upper part of the Agua Fresca formation.

It differs from *A. cooperensis* Cushman in the truncate peripheral angles, in the more regular test and more distinct chambers, and the more prominent apertural neck.

Family ELLIPSOIDINIDAE
Genus Pleurostomella Reuss, 1860
Pleurostomella aguafrescaensis Todd and Kniker, n. sp.
Plate 4, figure 17

Test small, fusiform, stout, initial and apertural ends about equally pointed; chambers few, rapidly increasing in size as added, later ones somewhat inflated; last chamber in adult specimens much smaller than preceding ones; sutures distinct, depressed, wall smooth; aperture a large and broad T-shaped subterminal opening protected by a hood. Length 0.45-0.58 mm.; diameter 0.15-0.22 mm.

Holotype (Cushman Coll. No. 64450) from Mohr 16.

This species occurs abundantly only at its type locality but was found rarely in scattered samples throughout the section. It differs from *P. naranjoensis* Cushman and Bermudez in its slenderer test, more deeply depressed sutures, and in having the last chamber much reduced in size.

Genus Nodosarella Rzehak, 1895
Nodosarella? sp.
Plate 4, figure 18

A few very small specimens from Ruby sample No. 2 may belong in this genus but they are insufficient for full description. The chambers are low, the sutures incised, and the wall very finely striate.

Genus Ellipsoglandulina A. Silvestri, 1900
Ellipsoglandulina multicostata (Galloway and Morrey)
Plate 4, figure 11

Daucina multicostata Galloway and Morrey, Bull. Amer. Pal., vol. 15, No. 55, 1929, p. 42, pl. 6, fig. 13.

Ellipsoglandulina multicostata Nuttall, Journ. Pal., vol. 6, 1932, p. 24, pl. 4, fig. 4.—Bermudez, Mem. Soc. Cubana

Hist. Nat., vol. 12, 1938, p. 5.—Cushman and Stainforth, Special Publ. 14, Cushman Lab. Foram. Res., 1945, p. 58, pl. 10, figs. 6, 7.—Cushman and Renz, l. c., Special Publ. 22, 1947, p. 34.—Bermudez, l. c., Special Publ. 25, 1949, p. 228, pl. 14, figs. 46, 47.

This species described from near Manta, Ecuador, and recorded in the Oligocene and Eocene of Mexico, Cuba, Dominican Republic, and Trinidad, occurs in the middle part of the section. Specimens are large and well developed in Shaw 23. The costae are not as prominent or as regular as on topotypes with which they have been compared, and the last one or two chambers are usually almost smooth.

Family ROTALIIDAE

Genus Gyroidina Orbigny, 1826

Gyroidina soldanii Orbigny

Plate 4, figure 20

Gyroidina soldanii Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 278; Modèles, No. 36, ii livraison.—Parker, Jones, and H. B. Brady, Ann. Mag. Nat. Hist., 3d ser., vol. 16, 1865, p. 25, pl. 3, fig. 86; l. c., 4th ser., vol. 8, 1871, p. 176, pl. 12, fig. 151.—Galloway and Morrey, Bull. Amer. Pal., vol. 15, 1929, p. 27, pl. 4, fig. 4.—Cushman, Contr. Cushman Lab. Foram. Res., vol. 5, 1929, p. 98, pl. 14, figs. 6, 7.—Church, Rep't State Min. Calif., 1931, pl. C, figs. 1-3.—Franklin, Journ. Pal., vol. 18, No. 4, 1944, p. 315, pl. 47, fig. 1.

This species is common to abundant throughout the section and specimens show great variation. Although there are included some which might be referred to the variety *octocamerata* Cushman and Hanna, it is believed that the series cannot be separated other than arbitrarily. The average size, 0.45 mm. in diameter, is less than usual for this species. The number of chambers in the last whorl may be 8, 9, or 10. The sutures are distinct but not limbate. The periphery varies from acute to rounded and the dorsal surface may be flat or very slightly convex. Deformation of the specimens makes it difficult to be certain as to whether these features of the shape of the test are original or acquired in fossilization.

Genus Eponides Montfort, 1808

Eponides duprêi Cushman and Schenck

Plate 4, figure 24

Eponides duprêi Cushman and Schenck, Univ. Calif. Publ., Bull. Dept. Geol. Sci., vol. 17, 1928, p. 313, pl. 44, fig. 8.

Specimens occur fairly commonly throughout the section and are identical with types of this species described from the Eocene Keasy shale of Oregon.

Eponides lodoensis Martin

Eponides lodoensis Martin, Stanford Univ. Publ., Univ. Ser., Geol. Sci., vol. 3, No. 3, 1943, p. 23, pl. 6, fig. 8.

Rare specimens from Mohr 21 and 64 from the lower part of the lower Agua Fresca seem identical with types of this species described from the Lodo formation of California. This is a minute form with an acute, keeled, and slightly undulating periphery and a rather highly conical ventral side.

Genus Osangularia Brotzen, 1940

Osangularia brunswickensis Todd and Kniker, n. sp.

Plate 4, figure 22

Test trochoid, biconvex, compressed, periphery acute, slightly lobulate around the later chambers, surrounded by a sharp, narrow keel; chambers few for the genus, 6 or 7 (rarely as many as 9) comprising the adult whorl, not inflated; sutures distinct, straight, tangential, limbate and slightly raised on the dorsal side, radial, slightly curved, and somewhat depressed at their outer ends on the ventral side; wall perforate, smooth; aperture ventral, consisting of a low arched opening in a deep reëntrant of the ventral face of the last chamber, and a narrow elongate slit perpendicular to it extending into the ventral face from the peripheral end of it. Diameter 0.50-0.75 mm.; thickness 0.20-0.25 mm.

Holotype (Cushman Coll. No. 64461) from Mohr 21.

This species differs from *O. tenuicarinata* (Cushman and Siegfus) in its larger and more compressed test, fewer chambers, and more distinct chambers and sutures. It occurs fairly commonly in scattered samples throughout the section.

This generic name replaces *Parrella* Finlay, 1939, which was preoccupied by *Parrella* Ginsberg, 1938 (a fish).

Family CASSIDULINIDAE

Genus Ceratobulimina Toula, 1915

Ceratobulimina sp.

Plate 4, figure 23

Four specimens of a species which appears to be new in this genus were found in Shaw 43 from the upper part of the section. It is a globular form, more compact and thicker than *C. eximia* (Rzehak).

Genus Alabamina Toulmin, 1941

Alabamina atlantisae (Cushman)

Plate 4, figure 21

Pulvinulinella atlantisae Cushman, Contr. Cushman Lab. Foram. Res., vol. 15, 1939, p. 72, pl. 12, fig. 16.

Test close-coiled, compressed, ventral side more convex than the dorsal, periphery acute but not keeled, entire; chambers distinct, except the earlier ones, not inflated, six comprising the adult whorl, gradually increasing in size as added; sutures distinct, limbate but not raised, tangential on the dorsal side, radial on the ventral side, meeting in a slightly depressed area at the umbilicus; wall smooth, very finely perforate; aperture ventral, a low, elongate slit along the base of the

ventral face of the last chamber, with an elongate supplementary infolding of the wall extending parallel to the plane of the test just ventral to the periphery. Diameter 0.30-0.40 mm.; thickness 0.17-0.23 mm.

This species described from Eocene material from a submarine core off the east coast of the United States occurs fairly commonly in scattered samples throughout the section.

Family CHILOSTOMELLIDAE

Genus **Allomorphina** Reuss, 1850

Allomorphina macrostoma Karrer

Plate 4, figure 25

Allomorphina macrostoma Karrer, Sitz. Akad. Wiss. Wien, vol. 44, 1861 (1862), p. 448, pl. 2, fig. 4.—Nuttall, Journ. Pal., vol. 9, 1935, p. 129, pl. 15, fig. 28.—Cushman and Todd, Special Publ. 15, Cushman Lab. Foram. Res., 1945, p. 64, pl. 11, fig. 3; Contr. Cushman Lab. Foram. Res., vol. 25, 1949, p. 68, pl. 12, figs. 4, 5.

Allomorphina cf. **A. macrostoma** Cushman and McMasters, Journ. Pal., vol. 10, 1936, p. 516, pl. 76, fig. 7.—Ratu, l. c., vol. 22, 1948, p. 173, pl. 31, figs. 4, 5.

Rare specimens occur in all parts of the section.

Allomorphina conica Cushman and Todd

Plate 4, figure 33

Allomorphina conica Cushman and Todd, Contr. Cushman Lab. Foram. Res., vol. 25, 1949, p. 62, pl. 11, fig. 8.

Bulimina (?) **trochoides** Cushman (not "**Globigerina trochoides** Reuss"), Tenn. Div. Geol., Bull. 41, 1931, p. 48, pl. 7, fig. 20.

Allomorphina trochoides Cushman and Jarvis (not "**Globigerina trochoides** Reuss"), Proc. U. S. Nat. Mus., vol. 80, Art. 14, 1932, p. 49, pl. 15, fig. 3.—Cushman (part), U. S. Geol. Survey Prof. Paper 206, 1946, p. 145, pl. 60, fig. 7.—Cushman and Renz, Special Publ. 18, Cushman Lab. Foram. Res., 1946, p. 46, pl. 8, fig. 6; l. c., Contr., vol. 23, 1947, p. 49.

Eggerella (?) **trochoides** Cushman (part) (not "**Globigerina trochoides** Reuss"), Special Publ. 8, Cushman Lab. Foram. Res., 1937, p. 46, pl. 5, fig. 1 (not fig. 2); U. S. Geol. Survey Prof. Paper 206, 1946, p. 43, pl. 12, fig. 2.—Cushman and Renz, Special Publ. 18, Cushman Lab. Foram. Res., 1946, p. 22, pl. 2, fig. 29; l. c., Contr., vol. 23, 1947, p. 39.—Cushman, Bull. 2, Maryland Dept. Geol., Mines and Water Resources, 1948, p. 247, pl. 21, fig. 10.

Specimens are rare in the middle part of the section. They are typical of this species described from the Upper Cretaceous, Lizard Springs formation, of Trinidad, and also known in Upper Cretaceous beds of the Gulf Coastal region.

Allomorphina aguafrescaensis Todd and Kniker, n. sp.

Plate 4, figure 31

Test bluntly triangular, thick, periphery rounded, umbilicus large and deep; chambers few, inflated, last three comprising most of the test; sutures distinct, depressed, more deeply so on the ventral side; wall smooth, finely perforate; aperture a large, arched opening under the ventral edge of the last-formed chamber, protected by an overhanging lip. Length 0.25-0.35 mm.; breadth 0.20-0.28 mm.; thickness 0.20-0.23 mm.

Holotype (Cushman Coll. No. 64471) from well P-7, 255-261 meters.

This species differs from *A. halli* Jennings from the Eocene, Hornerstown marl, of New Jersey in its deeper and more open umbilical area with a larger overhanging lip.

Specimens are rare but occur throughout the section.

Genus **Quadrimorphina** Finlay, 1939

Quadrimorphina advena (Cushman and Siegfus)

Plate 4, figure 19

Valvulineria advena Cushman and Siegfus, Contr. Cushman Lab. Foram. Res., vol. 15, 1939, p. 31, pl. 6, fig. 22; Trans. San Diego Soc. Nat. Hist., vol. 9, 1942, p. 418, pl. 17, fig. 30.

Quadrimorphina advena Cushman and Todd, Contr. Cushman Lab. Foram. Res., vol. 25, 1949, p. 71, pl. 12, fig. 13.

This species, previously known only from the Eocene Kreyenhagen shale of California, occurs fairly commonly in certain samples throughout the section. Specimens are slightly larger than the holotype and some have 5 instead of 4 chambers comprising the last whorl. These variations are believed to be within the limits of this species, which is distinguished by its smoothly rounded dorsal surface, inflated ventral side, and its *Quadrimorphina*-type of aperture with a distinct lip.

Genus **Chilostomella** Reuss, 1850

Chilostomella cylindroides Reuss

Plate 4, figures 26, 27

Chilostomella cylindroides Reuss, Zeitschr. deutsch. geol. Ges., vol. 3, 1851, p. 80, pl. 6, fig. 43.—Bornemann, l. c., vol. 7, 1855, p. 343, pl. 17, fig. 1.—Reuss, Denkschr. Akad. Wiss. Wien, vol. 25, 1865, p. 156; Sitz. Akad. Wiss. Wien, vol. 62, pt. 1, 1870, p. 488, in von Schlicht, Foram. Sept. Pietzpuhl, 1870, pl. 25, figs. 37-48.—Hantken, Mitth. Jahrb. K. Ungar. geol. Anstalt, vol. 4, 1875 (1881), p. 63, pl. 7, fig. 7; Math. Nat. Ber. Ungarn, vol. 2, 1884, p. 130.—Andreae, Abhandl. Geol. Special-Karte Elsass-Lothringen, vol. 2, 1884, p. 127.—Cushman, Contr. Cushman Lab. Foram. Res., vol. 1, pt. 4, 1926, p. 76, pl. 11, figs. 14, 15.—Hucke, Ber. Nat. Ver. Dessau, Heft 2, 1930, p. 17 (list).—Colom, Num. 2, Estudios Geologicos, Instit. Invest. Geol., 1945, p. 74, pl. 5, figs. 124-129.—Cushman and Todd, Contr. Cushman Lab. Foram. Res., vol. 25, 1949, p. 87, pl. 15, figs. 8-10.

Chilostomella oolina Cushman (not Schwager), Bull. Scripps Instit. Oceanography, Tech. Ser., vol. 1, No. 10, 1927, p. 169.—Cushman and Moyer, Contr. Cushman Lab. Foram. Res., vol. 6, 1930, p. 61, pl. 8, fig. 15.

Chilostomella grandis Cushman and Moyer (not Cushman), l. c., vol. 6, 1930, p. 61, pl. 8, fig. 14.

Typical specimens are common to abundant throughout the section.

Genus Chilostomelloides Cushman, 1926

Chilostomelloides oviformis (Sherborn and Chapman)

Plate 4, figure 28

Lagena (Obliquina) oviformis Sherborn and Chapman, Journ. Roy. Micr. Soc., 1886, p. 745, pl. 14, fig. 19.

Chilostomella oviformis Sherborn and Chapman, l. c., 1889, p. 485, pl. 11, fig. 13.—Selli, Ann. Mus. Geol. Bologna, ser. 2, vol. 17, 1943-44 (1944), p. 71.

Chilostomelloides oviformis Cushman, Contr. Cushman Lab. Foram. Res., vol. 1, pt. 4, 1926, p. 77, pl. 11, figs. 17, 21; Journ. Pal., vol. 1, 1927, p. 168, pl. 26, fig. 10.—Cole, Bull. Amer. Pal., vol. 14, No. 53, 1928, p. 216 (16).—Nuttall, Journ. Pal., vol. 4, 1930, p. 289; vol. 6, 1932, p. 28.—Howe and Wallace, Louisiana Geol. Bull. No. 2, 1932, p. 73, pl. 15, fig. 5.—Cushman, Special Publ. 4, Cushman Lab. Foram. Res., 1933, pl. 26, fig. 9; Special Publ. 5, 1933, pl. 33, figs. 12, 13.—Bergquist, Bull. 49, Mississippi State Geol. Survey, 1942, p. 94, pl. 9, fig. 31.—Colom, Num. 2 Estudios Geologicos, Instit. Invest. Geol., 1945, p. 74, pl. 5, figs. 135-139.—Cushman and Todd, Contr. Cushman Lab. Foram. Res., vol. 25, 1949, p. 94, pl. 16, figs. 7-9.

Chilostomella ovoidea Sherborn and Chapman (not Reuss), Journ. Roy. Micr. Soc., 1889, p. 3, pl. 11, fig. 12.

Chilostomella eximia Franzenau, Termesz. Füzetek, vol. 11, 1889, pp. 147, 206, woodcut; Math. termesz. ertesito, vol. 7, 1889, p. 248, pl. 4, fig. 3; Math. Nat. Ber. Ungarn, vol. 7, 1889, p. 67, pl. 3, fig. 3.

Chilostomelloides eximia Cushman, Contr. Cushman Lab. Foram. Res., vol. 1, pt. 4, 1926, p. 77, pl. 11, fig. 18.

This species described from the Eocene, London clay, of England is present in typical form in the Agua Fresca formation. It is easily distinguished from *Chilostomella* by its circular and protruding aperture. It occurs rarely in the lower and middle parts of the section only.

Genus Pullenia Parker and Jones, 1862

Pullenia alazanensis Cushman

Plate 4, figure 30

Pullenia alazanensis Cushman, Journ. Pal., vol. 1, 1927, p. 168, pl. 26, figs. 14, 15.—Cushman and Todd, Contr. Cushman Lab. Foram. Res., vol. 19, 1943, p. 13, pl. 2, fig. 14.

Pullenia cf. **P. alazanensis** Cushman and Stone, Special Publ. 20, Cushman Lab. Foram. Res., 1947, p. 24, pl. 3, fig. 16.

This species described from the Oligocene, Alazan clay, of Mexico, is present and fairly common throughout the section. It is similar to a form in the Eocene, Chira shale of Peru, that was referred questionably to this species.

Pullenia eocenica Cushman and Siegfus

Plate 4, figure 29

Pullenia eocenica Cushman and Siegfus, Contr. Cushman Lab. Foram. Res., vol. 15, 1939, p. 31, pl. 7, fig. 1; Trans. San Diego Soc. Nat. Hist., vol. 9, 1942, p. 420, pl. 18, fig. 2.—Curran, Bull. Amer. Assoc. Petr. Geol., vol. 27, No. 10, 1943, pp. 1379, 1381 (lists).—Cushman and Todd, Contr. Cushman Lab. Foram. Res., vol. 19, 1943, p. 10, pl. 2, fig. 2.—Kelley, Bull. Amer. Assoc. Petr. Geol., vol. 27, No. 1, 1943, p. 8 (list).—Martin, Stanford Univ. Publ., Univ. Ser., Geol. Sci., vol. 3, No. 3, 1943, p. 12 (list).—Cushman, Bull. 2, Maryland Dept. Geol., Mines and Water Resources, 1948, p. 242, pl. 20, fig. 5.

Specimens which seem to be identical with, though slightly smaller than, this species described from the Eocene, Kreyenhagen shale, of California, are present in considerable numbers in the upper part of the section, with rare occurrences in the middle and lower parts of the section.

Family GLOBIGERINIDAE

Genus Globigerina Orbigny, 1826

Globigerina patagonica Todd and Kniker, n. sp.

Plate 4, figure 32

Test small for the genus, composed for the most part of the three last-formed chambers, the last one comprising about half the test, earlier chambers visible in a small, low spire; chambers globular, increasing very rapidly in size as added; sutures deeply depressed; wall thin, finely cancellated; aperture single, ventral, a very high, arched, slightly rimmed opening projecting into the last chamber along the suture between it and the third from the last chamber. Length 0.35-0.42 mm.; thickness 0.25-0.30 mm.

Holotype (Cushman Coll.No. 64483) from Shaw 34.

This species differs from *G. bulloides* Orbigny in having 3 chambers comprising the last whorl, in its cancellated instead of spinose wall, and in its high arched aperture which may be even elongated in some specimens.

This species is common to abundant throughout the Agua Fresca formation, more abundant in the upper than in the lower part of well P-7.

Globigerina sp. cf. G. compressa Plummer

Very rare specimens from three samples: Ruby 4, Shaw 10, and Mohr 72, seem very similar to this species described from the Midway group of Texas (Plummer, Bull. 2644, Univ. Texas, 1927, p. 135, pl. 8, fig. 11) and known from the Paleocene and Eocene.

Family ANOMALINIDAE

Genus Anomalina Orbigny, 1826

Anomalina garzaensis Cushman and Siegfus

Plate 4, figure 35

Anomalina garzaensis Cushman and Siegfus, Contr. Cushman Lab. Foram. Res., vol. 15, 1939, p. 32, pl. 7, fig. 3; Trans. San Diego Soc. Nat. Hist., vol. 9, 1942, p. 422, pl. 18, fig. 6.—Curran, Bull. Amer. Assoc. Petr. Geol., vol. 27, 1943, p. 1379 (list).

This species described from the Eocene, Kreyenhagen shale, of California occurs commonly to abundantly throughout the section.

Anomalina chileana Todd and Kniker, n. sp.

Plate 4, figure 34

Test compact, involute, almost equally biconvex, periphery rounded; chambers distinct, inflated, rapidly increasing in size as added, 6 or 7 comprising the adult whorl; sutures distinct, depressed, especially between the later chambers, not limbate; wall smooth, very coarsely perforate and appearing mottled; aperture a very low, elongate, arched opening between the base of the last chamber and the previous whorl, extending from the dorsal umbilicus to about the middle of the periphery, with a very slight rim on the last chamber. Diameter 0.45-0.58 mm.; thickness across last chamber 0.25-0.35 mm.

Holotype (Cushman Coll. No. 64487) from well P-7, 223-228 meters.

This species resembles *Cibicides vulgaris* (Plummer) in its coarsely perforate wall, but differs in being completely involute, in the test being thicker and more compact, and in the sutures not being limbate. It is a common form throughout the Agua Fresca formation.

Genus **Cibicides** Montfort, 1808

Cibicides perlucidus Nuttall

Plate 4, figure 40

Cibicides perlucida Nuttall, Journ. Pal., vol. 6, 1932, p. 33, pl. 8, figs. 10-12.—Galloway and Heminway, New York Acad. Sci., Sci. Survey Porto Rico and Virgin Ids., vol. 3, pt. 4, 1941, p. 394, pl. 23, fig. 4.—Bandy, Journ. Pal., vol. 18, 1944, p. 375, pl. 62, fig. 3.—Stainforth, l. c., vol. 22, 1948, p. 129, pl. 25, figs. 8-10.—Renz, Mem. 32, Geol. Soc. Amer., 1948, p. 129, pl. 11, fig. 9.—Bermudez, Special Publ. 25, Cushman Lab. Foram. Res., 1949, p. 304, pl. 25, figs. 16-18.

This species is restricted to the middle and lower parts of the section. Some of the specimens are smaller than the types and many appear to be deformed, but well preserved specimens are quite typical of this species described from the Alazan formation of Mexico and recorded from beds of Eocene and Oligocene age in America. The species is characterized by its thick, close-coiled test and slightly convex dorsal side.

Cibicides americanus (Cushman)

Plate 4, figure 38

Truncatulina americana Cushman, Bull. 103, U. S. Nat. Mus., 1918 (Jan. 7, 1919), p. 68, pl. 23, fig. 2.

Truncatulina americana Cushman, Bull. 676, U. S. Geol. Survey, 1918 (Jan. 14, 1919), p. 63, pl. 20, figs. 2, 3; pl. 21, fig. 1.

Cibicides americanus Cushman and Laiming, Journ. Pal., vol. 5, 1931, p. 119, pl. 14, fig. 6.—Nuttall, l. c., vol. 6, 1932, p. 32, pl. 7, figs. 10, 11.—Cushman and Ellisor, l. c., vol. 19, 1945, p. 571, pl. 78, fig. 7.—Renz, Mem. 32, Geol. Soc. Amer., 1948, p. 126, pl. 11, fig. 10.

This well known species was twice described as new; first from the Culebra formation of Panama and next from the Miocene, Duplin marl of South Carolina. In neither of the two descriptions, which appeared only a week apart, was any reference made to the other. Thus it may be concluded that Dr. Cushman regarded them as different and the use of the same specific name for both was accidental. Comparison of typical specimens from each locality leads us to agree with other authors who have placed the two forms in synonymy.

A few typical specimens are found in the upper part of the section only.

Cibicides sp. cf. **C. hodgei** Cushman and Schenck

Plate 4, figure 39

Cibicides hodgei Cushman and Schenck, Univ. Calif. Publ., Bull. Dept. Geol. Sci., vol. 17, 1928, p. 315, pl. 45, figs. 3-5.

Specimens from well P-7 between 449 and 909 meters are referred questionably to this species described from the Bassendorf shale of Oregon and recorded from the Tumey formation of California, both of Oligocene age. The present specimens are smaller and less distinctly plano-convex and may prove to be new.

Cibicides haydoni (Cushman and Schenck)

Plate 4, figure 37

Planulina haydoni Cushman and Schenck, Univ. Calif. Publ., Bull. Dept. Geol. Sci., vol. 17, 1928, p. 316, pl. 45, fig. 7.—Cushman and Simonson, Journ. Pal., vol. 18, 1944, p. 202, pl. 34, figs. 11, 12.—Detling, l. c., vol. 20, 1946, p. 359, pl. 51, fig. 1.

A few typical specimens occur in Ruby 4 and 5 from the middle part of the section, and in Shaw 10 from the lower part.

Cibicides parki Finlay

Plate 4, figure 41

Cibicides parki Finlay, Trans. Roy. Soc. New Zealand, vol. 68, 1939, p. 528, pl. 69, fig. 1.

Numerous specimens from the upper and middle parts of the section are referred to this species described from the Eocene of New Zealand. They are considerably smaller than the types, but otherwise similar.

Cibicides praecursorius (Schwager)

Plate 4, figure 42

Discorbina praecursoria Schwager, Palaeontographica, vol. 30, 1883, Pal. Theil, p. 125, pl. 27 (4), figs. 12, 13; pl. 29 (6), fig. 16.

Cibicides praecursorius Cushman and Todd, Contr. Cushman Lab. Foram. Res., vol. 18, 1942, p. 45, pl. 8, figs. 17-20.

This species, described from the middle Eocene of Egypt, and widely known in the Eocene and Paleocene of North America, occurs in typical form in the uppermost part of the Agua Fresca, best developed between 101 and 191 meters in well P-7, with rare occurrences lower in the section.

Cibicides sp. cf. **C. pseudoungerianus** (Cushman)

Plate 4, figure 36

Specimens are characterized by a coarsely perforate dorsal side ornamented by a supplementary deposit of rugose shell material over the central portion, and a more finely perforate ventral surface with a mass of clear shell material giving the appearance of a dark knob in the middle. The periphery is acute and bluntly keeled, but is entire, not lobulated, as in the type of this species. About 10 chambers comprise the adult whorl.

This species is common throughout the upper and middle parts of the section but does not occur in the lower part.