

CONTRIBUTIONS FROM THE CUSHMAN
LABORATORY FOR FORAMINIFERAL RESEARCH

189. SOME NOTES ON CRETACEOUS SPECIES OF
MARGINULINA

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The genus *Marginulina* is represented in the Cretaceous of Europe and America by many species. The names given to European species by earlier authors have been used almost entirely for American Cretaceous forms. A study of actual type specimens in European collections as well as numerous topotype specimens of the earlier described species has shown that nearly all of our American species are not identical with European ones, and are undescribed. A number of these are described here, and there are still others represented by too meagre material or which are similar to European species of which topotype material is not available at present.

Like most of the Lagenidae, the species belonging to *Marginulina* are very variable and particularly different in the microspheric and megalospheric forms. Large series of specimens are necessary to obtain an adequate idea of the limits of variation in a given species. Some of these species form rather good stratigraphic markers in the Cretaceous.

The generic name *Marginulina* has had somewhat different uses in regard to the species which it should include. The genotype as designated in 1913 is *Marginulina glabra* d'Orbigny, a species with generally rounded section, somewhat coiled in the early portion, especially of the microspheric form, and the adult uncoiled. The genus *Hemicristellaria* Stache, 1864, has been used by some authors in recent years for somewhat compressed species. The genotype of *Hemicristellaria* was designated in

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1927 by Galloway and Wissler as *H. procera* Stache, and the genus is described as "angled or carinate on both edges." I examined the type specimens of *H. procera* in Stache's collection in the Museum at Vienna, and have before me a drawing in two views made in Vienna of the holotype. It has a rounded test, and the transverse section nearly if not quite circular. *Hemicristellaria* therefore becomes an exact synonym of *Marginulina*.

The more compressed species have occasionally been placed under the generic name *Astacolus*. The relative amount of compression of the test is a variable character, and in different varieties of the same species may show wide changes. I have therefore preferred to treat those Lagenidae with coiled early stages and uncoiled adults, without a triangular section, as *Marginulina*, and those which have a triangular section in the adult, as *Saracenaria*. These two genera merge however, and it is sometimes difficult to decide in which of these a species should be placed. Likewise the distinctions between *Marginulina* and *Lenticulina* on the one hand, and *Marginulina* and *Dentalina* on the other, are frequently difficult to determine with any clear cut lines. The figures given on our two plates are mostly from photographs of the specimens.

MARGINULINA AUSTINANA Cushman, n. sp. (Pl. 13, figs. 1-4)

Test elongate, compressed, early portion close coiled and umbonate, later portion uncoiled, dorsal side gently curved, ventral side slightly lobulate; chambers of the early coiled portion indistinct, later uncoiled ones more distinct, but not inflated; sutures indistinct except in the later portion where they are slightly curved, somewhat limbate with a decided boss-like thickening toward the dorsal side of the middle; wall smooth except for the sutural enlargements; aperture radiate, at the outer peripheral angle. Length up to 2.50 mm.; breadth 0.70-0.80 mm.; thickness 0.30-0.40 mm.

Holotype (Cushman Coll. No. 24024) from the middle part of the Gober tongue of Austin chalk, Randolph rd., 4 miles N. of Leonard, Fannin Co., Texas. It occurs in typical form at numerous localities in the upper part of the Austin.

M. austinana differs from *M. modesta* Reuss in the more compressed test, larger number of coiled chambers, and the raised portion of the sutures. It is represented by variations in two directions, in one with greater compression and a shorter test, the other with less compression and a more elongate test.

MARGINULINA AUSTINANA Cushman, n. sp., var. DIRECTA Cushman, n. var.
(Pl. 13, figs. 5-8)

Variety differing from the typical in the less compressed test, fewer chambers in the coiled portion, dorsal side straight or slightly concave, and the later chambers more inflated.

Holotype of variety (Cushman Coll. No. 24029) from about the middle part of the Austin, ditch S. of highway leading W. from McKinney, 3.1 miles W. of McKinney, Texas.

This variety occurs in the upper part of the Austin, and continues on into the lower and middle parts of the Taylor in the Texas region.

MARGINULINA AUSTINANA Cushman, n. sp., var. ACESCENS Cushman, n. var.
(Pl. 13, fig. 9)

Variety differing from the typical in the more compressed test, with fewer uncoiled chambers, and the dorsal periphery strongly curved and often somewhat keeled.

Holotype of variety (Cushman Coll. No. 24027) from the lower part of the Gober tongue of Austin chalk, cut on T. P. R. R., 2.2 miles W. of High, Lamar Co., Texas.

Both varieties keep to some extent the thickenings of the sutures, and together form a related series.

MARGINULINA STEPHENSONI Cushman, n. sp. (Pl. 13, figs. 10, 11)

Test of two distinct portions, the earlier portion close coiled, umbonate, with subacute periphery, later consisting of 2—4 chambers uncoiled, inflated, nearly circular in transverse section; chambers distinct, later uncoiled ones inflated, earlier ones of uniform shape, increasing very gradually in size as added; sutures distinct, slightly limbate, oblique and nearly straight in the coiled portion, in later portion strongly depressed; wall smooth; aperture radiate, at the outer peripheral angle. Length up to 1.25 mm.; breadth of coiled portion 0.45-0.50 mm.

Holotype (Cushman Coll. No. 24021) from lower part of the Taylor marl, Chilton rd., 10 miles SSE. of Waco, Texas. It occurs at a number of localities in our material from the lower part of the Taylor of Texas.

This species differs from "*Astacolus taylorensis* Plummer" which it resembles in its earlier stages in the smaller number of chambers in a coil, broader periphery, and more definite and larger uniserial chambers.

MARGINULINA CRETACEA Cushman, n. sp. (Pl. 13, figs. 12-15)

Test much compressed, early portion coiled, especially in the microspheric form, later portion uncoiled, dorsal periphery strongly convex, not lobulate, ventral periphery concave, dorsal margin acute, ventral margin slightly rounded; chambers distinct, increasing gradually in size and breadth as added, not inflated; sutures distinct, slightly curved, not depressed; wall smooth; aperture radiate at the outer peripheral angle. Length 1.20-1.60 mm.; breadth 0.50-0.80 mm.

Holotype (Cushman Coll. No. 24018) from the upper part of the Taylor marl, gully S. of New Braunfels—Clear Springs rd., 4 miles SE. of New Braunfels, Guadalupe Co., Texas. This species is fairly common at numerous localities in Texas in rocks of Taylor age, including the Pecan Gap chalk member and the Annona chalk, and extending into the Neylandville marl of Navarro age.

M. cretacea differs from *M. hamulus* Chapman in the greater compression of the test, acute periphery, and concave ventral margin.

MARGINULINA PSEUDOMARCKI Cushman, n. sp. (Pl. 13, figs. 19, 20)

Test large, compressed, umbonate, close coiled in the early portion, in the adult becoming uncoiled, periphery entire, not lobulate; chambers distinct, increasing very regularly in size, those of the uncoiled portion somewhat reduced in size; sutures distinct, strongly oblique, only slightly curved, somewhat limbate, very slightly depressed in the adult uncoiled portion; wall smooth throughout; aperture radiate at the outer, peripheral angle. Length up to 5.00 mm.; breadth of coiled portion 2.00-2.50 mm.

Holotype (Cushman Coll. No. 24014) from Taylor marl (upper), from 13½-15 feet above water level, left bank of Onion Creek, ¾ SSE. of Delvalle, just above road crossing, Travis Co., Texas.

This species closely resembles *M. marcki* (Reuss) from the Upper Senonian of Westphalia, Germany. A study of topotype material shows that our species is much larger, less strongly umbonate, and the sutures less curved.

MARGINULINA DORSATA Cushman, n. sp. (Pl. 13, figs. 16-18)

Test elongate, 2½ to 3½ times as long as broad, gradually tapering in the early portion to about the middle, thence with the

sides nearly parallel, the earliest chambers in the microspheric form coiled, uncoiled portion making up a very large part of the test, dorsal side in the earlier part pinched in at either side leaving a dorsal ridge, becoming obsolete in the later portion; chambers distinct, comparatively few, earlier ones increasing rapidly in size as added, becoming distinctly inflated in the adult; sutures of the early portion not depressed, later distinctly depressed; wall smooth; aperture radiate, at the outer peripheral angle. Length 1.00-1.60 mm.; breadth 0.20-0.25 mm.

Holotype (Cushman Coll. No. 24036) from Annona chalk, 4 miles E. of Clarksville, Red River Co., Texas.

M. dorsata differs from *M. bullata* Reuss in the peculiar dorsal ridge, larger number of chambers, and less prominent apertural neck.

MARGINULINA TEXANA Cushman, n. sp. (Pl. 14, figs. 1-4)

Test elongate, slender, early portion coiled, rapidly becoming uncoiled with rather uniform diameter throughout, ventral margin in the adult convex, lobulated, dorsal margin concave, nearly circular in diameter; chambers distinct, strongly inflated in the later portion, increasing gradually in height toward the apertural end; sutures distinct, depressed in the later portion; wall smooth; aperture radiate, protuberant, at the dorsal peripheral angle. Length 1.50-2.25 mm.; diameter 0.25 mm.

Holotype (Cushman Coll. No. 24032) from Pecan Gap chalk member of Taylor marl, 3.2 miles SW. of Mart, McLennan Co., Texas, on secondary road to Otto at crossing of "Big Creek." In Texas this species occurs at numerous localities in the upper part of the Taylor marl, in the Pecan Gap chalk member of the Taylor, in the Annona chalk; it ranges upward into the Neylandville marl (lower Navarro). In Tennessee the species is present in beds of the Selma chalk that are of Neylandville (lower Navarro) age.

The species has been recorded as "*Marginulina elongata* d'Orbigny." It differs from that species in the more tumid and higher chambers, concave dorsal margin, and smaller coiled portion.

As d'Orbigny's species name has been widely used, a specimen from the White chalk of Bougival, France, which is practically a topotype is here figured (Pl. 14, fig. 8).

MARGINULINA cf. TRIPLEURA (Reuss) (Pl. 14, figs. 5, 6)

Under the name "*Cristellaria tripleura*," Reuss described and figured a species from the Upper Cretaceous of Germany that our

figured specimens strongly resemble. We have too few specimens to definitely determine these, but two of them are figured on our plate, both from the Taylor, one (Pl. 14, fig. 5) from the lower part of the Taylor, clay pit at Palmer, Texas, the other (Pl. 14, fig. 6) from the upper part of the Taylor, ditch of Seguin rd., E. facing slope of Martinez Creek, Bexar Co., Texas.

MARGINULINA BULLATA Reuss (Pl. 14, figs. 9-15)

Marginulina bullata REUSS, Verstein. Böhm. Kreide, 1845-46, pt. I, 1845, p. 29, pl. 13, figs. 34-38.

This is typically a few chambered species with very strongly inflated chambers, rapidly increasing in size as added, smooth surface, and the aperture radiate with a distinctly protuberant, cylindrical neck. Three of our figures (Pl. 14, figs. 9-11) are drawn from specimens identified by Reuss, and in the Reuss collections at Dresden and Cambridge, both marked "b. Bilin." I have topotype specimens also from Luschitz. Similar specimens occur in beds of late Taylor and early Navarro age in Texas, including the Pecan Gap member and the Annona chalk, and extending upward to the Neylandville marl.

The aperture is distinctive in having a definitely tubular neck at the side of the chamber, and the chambers are subglobular, and increase very rapidly in size.

MARGINULINA TAYLORANA Cushman, n. sp. (Pl. 14, fig. 7)

Test about 3 times as long as broad, early portion close coiled, later 3 or 4 chambers uncoiling, subcylindrical; chambers distinct, increasing gradually in size as added, later ones somewhat inflated; sutures distinct, slightly curved, in the later portion slightly depressed; wall smooth, polished; aperture radiate, at the outer peripheral angle. Length 1.00-1.25 mm.; diameter 0.40 mm.

Holotype (Cushman Coll. No. 24039) from upper part of the Taylor marl, Dallas rd., 4.3 miles SW. of Greenville, Hunt Co., Texas. It occurs in typical form at a number of upper Taylor localities in Texas.

M. taylorana differs from *M. bullata* Reuss in the larger coiled early portion, which is slightly compressed, and the less inflated chambers and lack of an apertural neck.

MARGINULINA PLUMMERAE Cushman, n. sp. (Pl. 13, figs. 21-23)

Hemicristellaria ensis PLUMMER (not REUSS), Univ. Texas Bull. 3101, 1931, p. 146, pl. X, figs. 1-4.

Cristellaria lineara CARSEY (not *C. linearis* D'ORBIGNY), Univ. Texas Bull. 2612, 1926, p. 86, pl. 2, fig. 3.

Test elongate, 4—5 times as long as broad, compressed, especially in the early portion which is coiled, very early becoming uncoiled and gradually less compressed until in some adult specimens the section becomes nearly circular, ventral side nearly straight, dorsal side slightly convex, in adults becoming straight or even slightly concave; chambers distinct, the few coiled ones increasing very rapidly in size, later uncoiled ones increasing very gradually, becoming distinctly inflated; sutures distinct, limbate, slightly raised, especially in the middle portion where they are somewhat more thickened than at the sides, slightly curved; wall smooth except for the raised sutures; aperture radiate, at the outer peripheral angle. Length 1.00-2.00 mm.; breadth 0.30-0.40 mm.

Holotype (Cushman Coll. No. 24030) from the Navarro group, Corsicana marl, road ditch, W.-facing slope of Big Creek valley, 3 miles SW. of Stranger, 1.3 miles SE. of Parsons Bridge, Falls Co., Texas. It occurs in the upper part of the Navarro group in material of both the Corsicana marl and the Kemp clay.

This species was referred to Reuss' *Marginulina ensis* from the Cretaceous of Bohemia. That species however is a larger, coarser species of much less compression, thicker wall and different sutures. Its position in the geologic section is much lower than that of our species. The figures of *M. ensis* are from specimens now in the Reuss collections of Dresden and Cambridge, named by him. It is very questionable if any of our American forms are identical with Reuss' species.

MARGINULINA SILICULA (Plummer) (Pl. 14, figs. 19-22)

Hemicristellaria silicula PLUMMER, Univ. Texas Bull. 3101, 1931, p. 148, pl. X, figs. 8, 9.

Vaginulina (?) *trilobata* (?) CUSHMAN, Contr. Cushman Lab. Foramin. Res., vol. 6, 1930, p. 30, pl. 4, fig. 11.

This species is a very distinctive one in the Corsicana marl of the Navarro group of Texas. It is interesting to find this large and striking species in identical form in the uppermost Cretaceous of Europe. Plate 14, figures 19 and 20 are of specimens from the

Corsicana marl of Texas, and figures 21 and 22 are from material which I collected at the famous locality of Gotzreuther Graben, near Siegsdorf, Bavaria, Germany. This Upper Cretaceous of Bavaria is very close in many of its species to that of the Navarro, and the two should be studied together to make certain of the species described by Egger from Bavaria. Egger's figures are usually wanting in detail, and type material is necessary for comparisons.

MARGINULINA NAVARROANA Cushman, n. sp. (Pl. 14, figs. 17, 18)

Test elongate, 4—5 times as long as broad, earliest portion coiled, rapidly becoming uncoiled, the last five uncoiled chambers in the adult making up almost the entire test, earliest portion slightly compressed, later circular in transverse section, periphery lobulate; chambers distinct, becoming strongly inflated in the adult, increasing gradually in height, but only very slightly in diameter; sutures fairly distinct, in the later portion where they are somewhat depressed; wall ornamented by longitudinal costae, somewhat variable in coarseness, slightly twisted, especially over the earlier portion, and independent of the sutures; aperture radiate, projecting, at the outer peripheral angle. Length 1.40-1.85 mm.; breadth 0.35-0.40 mm.

Holotype (Cushman Coll. No. 24034) from the Prairie Bluff chalk, U. S. Highway 80, 0.35 miles E. of So. Rwy. underpass at Livingston, Sumter Co., Alabama. The species also occurs in the Navarro group, Corsicana marl of Texas.

EXPLANATION OF PLATE 13

FIGS.

- 1-4. *Marginalina austinana* Cushman, n. sp. × 25. Fig. 1, Holotype. 2-4, Paratypes.
 5-8. *M. austinana* Cushman, n. sp., var. *directa* Cushman, n. var. × 25. 5, Holotype.
 9. *M. austinana* Cushman, n. sp., var. *acescens* Cushman, n. var. × 25. Holotype.
 10, 11. *M. stephensoni* Cushman, n. sp. × 50. 10 a, b, Holotype. a, front view; b, apertural view. 11, Paratype.
 12-15. *M. cretacea* Cushman, n. sp. × 25. 12, Holotype.
 16-18. *M. dorsata* Cushman, n. sp. × 25. 16, Holotype. 17, 18, Paratypes.
 19, 20. *M. pseudomarccki* Cushman, n. sp. × 25. 20, Holotype. 19, Paratype.
 21-23. *M. plummerae* Cushman, n. sp. × 25. 23, Holotype. 22, Paratype.





M. navarroana differs from *M. bullata* Reuss in the larger number of chambers, which are less globular, lack of cylindrical neck, and having the surface ornamented with longitudinal, somewhat twisted costae.

MARGINULINA TRINITATENSIS Cushman, n. sp. (Pl. 14, fig. 16)

Marginulina jonesi CUSHMAN and JARVIS (not REUSS), Proc. U. S. Nat. Mus., vol. 80, Art. 14, 1932, p. 27, pl. 9, figs. 1 a, b.

Test slightly longer than broad, early portion close coiled, last portion uncoiled, periphery acute and slightly keeled; chambers fairly distinct, earlier ones much compressed in the coiled portion, much inflated in the uniserial portion, increasing rapidly in size in the adult; sutures of the early portion indistinct, later distinct and strongly depressed; wall ornamented with numerous acute costae, usually somewhat broken at the sutures, last-formed chamber tending to become smooth; aperture radiate, terminal, with a slight neck. Length 0.90-1.00 mm.; breadth 0.35-0.60 mm.; thickness 0.25-0.50 mm.

Holotype (Cushman Coll. No. 15359) from the Upper Cretaceous, Pit at Lizard Springs, near Guayaguayare, SE. Trinidad, B. W. I.

This species differs from *M. jonesi* Reuss in the compressed and keeled coiled portion, fewer uncoiled and more coiled chambers, and much more distinctly inflated later chambers.

EXPLANATION OF PLATE 14

- 1-4. *Marginulina texana* Cushman, n. sp. × 25. 1, Holotype. 2, 3, Paratypes.
- 5-6. *M. cf. tripleura* (Reuss). × 25.
7. *M. taylorana* Cushman. × 50. Holotype.
8. *M. elongata* d'Orbigny. × 33. From White chalk, Bougival, France.
- 9-15. *M. bullata* Reuss. 9, × 50. Topotype from Reuss collection in Cambridge. 10, 11, × 33. Topotypes from Reuss collection in Dresden. 12-15, Texas specimens. × 25.
16. *M. trinitatensis* Cushman, n. sp. × 33. Holotype.
- 17, 18. *M. navarroana* Cushman, n. sp. × 25. 17, Holotype. 18, Paratype.
- 19-22. *M. silicula* (Plummer). × 25.
- 23-25. *M. ensis* Reuss. × 33. 23, Specimen in Reuss collection in Dresden. 24, 25, Specimens in Reuss collection in Cambridge.

190. A FEW NEW SPECIES OF AMERICAN CRETACEOUS
FORAMINIFERA

By JOSEPH A. CUSHMAN*

The few new descriptions of Cretaceous foraminifera are given here so that they may be available to the many workers on this group.

QUINQUELOCULINA MOREMANI Cushman, n. sp. (Pl. 15, fig. 1)

Quinqueloculina stelligera MOREMAN (not SCHLUMBERGER), Journ. Pal.,
vol. 1, 1927, p. 100, pl. 16, figs. 11, 12.

Test somewhat longer than broad, elongate, oval, with the apertural end distinctly projecting into a rounded tubular neck, angles of the chambers strongly developed, projecting, sides flattened or slightly concave; chambers distinct, quinqueloculine throughout, the last-formed chamber overlapping strongly at the base and very slightly expanded; sutures distinct, very slightly if at all depressed; wall fairly smooth, matte; aperture generally rounded, the inner side somewhat flattened, occasionally with traces of a small tooth. Length 0.50 mm.; diameter 0.25-0.28 mm.

Holotype (Cushman Coll. No. 24000) from the Eagle Ford shale about 175 feet below *Metoceras whitei* zone, 3 miles W. of Midlothian, Ellis Co., Texas.

In the reference above cited, Moreman records this species from the Eagle Ford 6 miles NW. of Irving, at an exposure near the Irving-Coppel road, Texas, representing a zone below the middle of the Eagle Ford, making it range downward to some distance below that of the type locality in the Eagle Ford.

The specimens from the Eagle Ford are much better preserved than those recorded from higher up in the section of the Upper Cretaceous. In some respects, this species resembles the Recent *Q. stelligera* Schlumberger, but is never so sharply carinate as that species. So far as we have seen, it is a very good marker for the Eagle Ford.

MASSILINA TEXASENSIS Cushman, n. sp. (Pl. 15, figs. 2, 3)

Test in the adult slightly longer than broad, very much compressed, oval or broadly elliptical, the earliest portion quin-

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quoloculine, periphery squarely truncate; chambers distinct, quadrangular in section, increasing slightly in width as added, the periphery slightly raised; sutures distinct, depressed; wall smooth, matte; aperture terminal, without a distinct neck, rounded, without a distinct tooth. Length 0.40-0.50 mm.; breadth 0.30-0.35 mm.; thickness 0.08 mm.

Holotype (Cushman Coll. No. 24001) from the Navarro group, Kemp clay, $\frac{3}{4}$ mile west of Old Garfield, Travis Co., Texas, in a well at a depth of 65-73 feet.

It occurs also in the Kemp clay, Bluff on Colorado River at Webberville, Travis Co., Texas. The specimens of this species are usually rather well preserved, but it has been found as yet only at these two localities, and then in but few numbers, and seems to be a good index fossil for this part of the Navarro. It differs from *M. ginginensis* Chapman, the only other described Cretaceous species in the much flatter test, and with a larger number of narrower chambers.

TRICHAMMINA TAYLORANA Cushman, n. sp. (Pl. 15, fig. 4)

Test small, compressed, periphery acute, lobulate, the last whorl somewhat open on both dorsal and ventral sides; chambers distinct, slightly inflated, 5 or 6 in the last-formed whorl, increasing rapidly in size as added; sutures distinct, slightly depressed, very slightly curved, nearly radial; wall distinctly arenaceous, of rather uniform sand grains with a few larger ones, firmly cemented; aperture ventral, at the inner margin of the last-formed chamber. Length 0.30 mm.; breadth 0.25 mm.; thickness 0.075 mm.

Holotype (Cushman Coll. No. 24003) from the Taylor marl (lower), 2.3 miles by road N. of Palmer, Ellis Co., Texas.

This is a distinct, very compressed, scale-like species, occurring in considerable numbers at this locality, but has not been found as yet elsewhere. This species differs from *T. diagonis* (Carsey) in the smaller size, flatter test, and more evolute ventral side.

VAGINULINA SELMAENSIS Cushman, n. sp. (Pl. 15, figs. 8, 9)

Vaginulina sp. (?) CUSHMAN, Tenn. Geol. Surv., Bull. 41, 1931, p. 34, pl. 4, figs. 9, 10.

Test elongate, only slightly compressed, sides nearly parallel, dorsal side straight, ventral side slightly convex, periphery rounded, initial end with a slight spine; chambers distinct, slight-

ly inflated, slightly higher than broad in the adult; sutures distinct, slightly depressed, somewhat oblique; wall ornamented with longitudinal costae, 8—10, visible on each side, often slightly oblique and independent of the chambers; aperture large, slightly protuberant, radiate, at the dorsal angle. Length nearly 1.00 mm.; breadth 0.18-0.20 mm.; thickness 0.15-0.18 mm.

Holotype (Cushman Coll. No. 22071) from Selma chalk, new Corinth highway, 12 $\frac{1}{2}$ miles S. of Selmer, McNairy Co., Tenn.

All of the available specimens of this species are megalospheric ones, but hold the characters very closely. It seems to belong to *Vaginulina*, as there is a tendency toward a compressed test, with oblique sutures, and the aperture is at the dorsal angle. It is known only from the type locality. The species differs from *Vaginulina texana* Cushman in the less compressed test with more numerous and slightly oblique costae.

VAGINULINA SUTURALIS Cushman, n. sp. (Pl. 15, figs. 5-7)

Vaginulina strigillata CUSHMAN (not REUSS), Contr. Cushman Lab. Foram. Res., vol. 6, 1930, p. 26, pl. 4, figs. 1, 9, 10.

Test slender, elongate, tapering, much compressed, greatest breadth made by the last-formed chamber, periphery rounded or slightly truncate, initial end acute; chambers distinct, very slightly if at all inflated, increasing very gradually but regularly in breadth and height; sutures distinct, straight or slightly curved, very strongly oblique, slightly raised, broken by numerous short costae parallel to the straight edge of the test; wall smooth except for the raised and costate sutures; aperture radiate, slightly produced, at the dorsal angle. Length up to 3.00 mm.; breadth 0.35-0.40 mm.; thickness 0.10-0.15 mm.

Holotype (Cushman Coll. No. 22069) from probably the Nacatoch sand, Arkadelphia, Clark Co., Arkansas, collected by L. W. Stephenson.

This species was originally identified as *V. strigillata* Reuss, but specimens from his type locality of Luschitz in Bohemia show the two to be distinct. Our species is characterized by the lack of costae on the chambers themselves, but they are developed on the sutures. Typical specimens are very long and slender. The species seems to be most characteristic of the upper part of the Taylor, but may extend somewhat higher in the section.

VAGINULINA SUBGRACILIS Cushman, n. sp. (Pl. 15, fig. 19)

Vaginulina gracilis CUSHMAN (not PLUMMER), Tenn. Geol. Survey, Bull. 41, 1931, p. 34, pl. 4, fig. 11.

Test elongate, very slightly compressed, the earliest portion partially coiled especially in the microspheric form, remainder of test uniserial with the greatest breadth attained before the test is half completed and containing the same breadth thereafter, periphery rounded; chambers distinct, but slightly inflated except at the apertural end, increasing gradually in height as added, earliest ones about three times as broad as high, in the adult slightly higher than broad; sutures limbate, those of the earliest portion somewhat raised and strongly thickened in the middle, in the last-formed portion becoming somewhat depressed; wall smooth, except for the raised sutures, finely perforate; aperture terminal, radiate. Length up to 1.60 mm.; breadth 0.18 mm.

Holotype (Cushman Coll. No. 22073) from upper part of the Navarro, Corsicana marl, pit of Corsicana Brick Co., 2 miles S. of Court House at Corsicana, Navarro Co., Texas.

Our species differs from *V. gracilis* Plummer in the somewhat smaller size, and the more cylindrical and less tapering test which is also less compressed.

NODOSARIA NAVARROANA Cushman, n. sp. (Pl. 15, fig. 11)

Test small, elongate, of about equal diameter throughout, except at the rapidly tapering initial end; chambers distinct, rapidly increasing in size and height in the early stages, especially in the microspheric form, very slightly inflated in the adult, not inflated in the earlier stages; sutures distinct, slightly limbate; wall ornamented by four longitudinal costae, running uninterruptedly from the initial end to the aperture which is terminal and radiate. Length 0.50-0.60 mm.; diameter 0.08-0.10 mm.

Holotype (Cushman Coll. No. 24005) from the Navarro group, Corsicana marl, pit of Corsicana Brick Co., 2 miles south of the Court House at Corsicana, Texas.

This species differs from *Dentalina affinis* (Reuss) in the very much smaller size and the number of costae, typically four instead of many. The species seems to be characteristic of this horizon.

ELLIPSONODOSARIA PSEUDOSCRIPTA Cushman, n. sp. (Pl. 15, fig. 14)

Test small, slender, gently tapering from the greatest breadth

formed by the last chamber toward the initial end, very slightly curved; chambers distinct, pyriform, slightly greater in diameter toward the base, increasing gradually in size and relative length as added, uniserial except in the microspheric form where the earliest ones tend to be biserial; sutures distinct, slightly depressed, more strongly so in the adult, slightly limbate; wall ornamented with very fine spines, short, and in the adult sometimes appearing as short, broken, longitudinal costae; aperture terminal, rounded, but with one side flattened with a lip, and narrow tooth projecting into the opening. Length 0.60-0.75 mm.; diameter 0.08 mm.

Holotype (Cushman Coll. No. 22730) from Taylor marl (upper), 1.9 miles WSW. of Prairie Hill, Limestone Co., Texas.

The species is a small but distinctive one, and keeps its characters very constantly. The spines are small and backwardly pointing, in the adult chamber assuming a peculiar arrangement in longitudinal lines and becoming hardly more than raised ridges.

This species differs from *E. horridens* Cushman in the much smaller, more tapering test, and the finer ornamentation.

BOLIVINOIDES AUSTINANA Cushman, n. sp. (Pl. 15, fig. 10)

Test tapering from the subacute or rounded initial end to the greatest width formed by the last-formed pair of chambers, somewhat compressed, periphery rounded, slightly if at all lobulate; chambers fairly distinct, somewhat inflated in the adult, increasing gradually in size as added; sutures distinct in the later portion; wall smooth except for a series of deep rounded pits marking the suture lines; aperture elongate, narrow, at the base of the inner margin of the thickened terminal face. Length 0.40 mm.; breadth 0.15 mm.; thickness 0.10 mm.

Holotype (Cushman Coll. No. 24010) from upper part of the Austin chalk, Pecan Creek, 3.4 miles S. by E. of Troy, Bell Co., Texas.

This species differs from *B. decorata* (Jones) in the more slender form, and the absence of definite, lobed projections of the chambers. Our species is apparently the oldest and most primitive of this genus so far as known.

BOLIVINOIDES TEXANA Cushman, n. sp. (Pl. 15, fig. 12)

Test very gradually tapering from the subacute initial end to the greatest breadth somewhat above the middle, thence often tapering somewhat toward the apertural end, strongly com-

pressed, periphery acute, somewhat lobulate; chambers very distinct, numerous, slightly inflated, increasing rather uniformly to the greatest size above the middle; sutures distinct throughout, somewhat depressed; wall smooth except for the slightly lobulate base of the chambers in the adult; aperture elongate, narrow, at the base of the inner margin of the thickened terminal face. Length 0.40-0.45 mm.; breadth 0.16-0.18 mm.; thickness 0.07-0.08 mm.

Holotype (Cushman Coll. No. 24010) from lower part of the Taylor marl, from ditch S. of McKinney-Farmersville road, 7.2 miles E. of Houston and Texas Central R. R. tracks in McKinney, Texas.

This species differs from *B. decorata* (Jones), var. *delicatula* Cushman in the very slight development of the lobes, giving a somewhat crenulate appearance to the base of the adult chambers. *B. texana* is probably the ancestor of that form which appears higher in the section.

BOLIVINITA COSTIFERA Cushman, n. sp. (Pl. 15, fig. 15)

Test small, about twice as long as broad, gradually tapering from the subacute initial end to the greatest breadth slightly above the middle, thence tapering slightly to the apertural end, periphery broadly rounded, strongly serrate in front view, in transverse section somewhat rhomboid, broader faces flattened or concave; chambers very distinct, increasing gradually in size as added, earlier ones flattened and compressed, later ones concave on the broader faces, and convex on the periphery, greatly increasing in thickness; sutures distinct, slightly curved in the early stages, more strongly so in the adult, slightly limbate; wall smooth and polished, except for the basal angle of the chamber in the adult which has a sharp angle which may develop into a raised costa-like ridge; aperture narrow, elongate, at the base of the inner margin of the apertural face. Length 0.25-0.30 mm.; breadth 0.12-0.15 mm.; thickness 0.08-0.10 mm.

Holotype (Cushman Coll. No. 24012) from Arkadelphia (?) marl, 5½ miles NE. of Hope, Hempstead Co., Arkansas.

This species most closely resembles *B. selmensis* Cushman, from which it is probably derived in the sharply concave basal angle of the adult chambers, and the development of a distinct costal ridge. The early stage of our species is very similar in its characters to the adult of *B. selmensis* Cushman.

191. ADDITIONAL NEW SPECIES OF EOCENE
FORAMINIFERA FROM CUBA

By JOSEPH A. CUSHMAN and PEDRO J. BERMUDEZ

Description and figures of a few additional species of Eocene foraminifera from Cuba are given below:

AMMOBACULITES CUBENSIS Cushman and Bermudez, n. sp. (Pl. 16, figs. 4, 16-18)

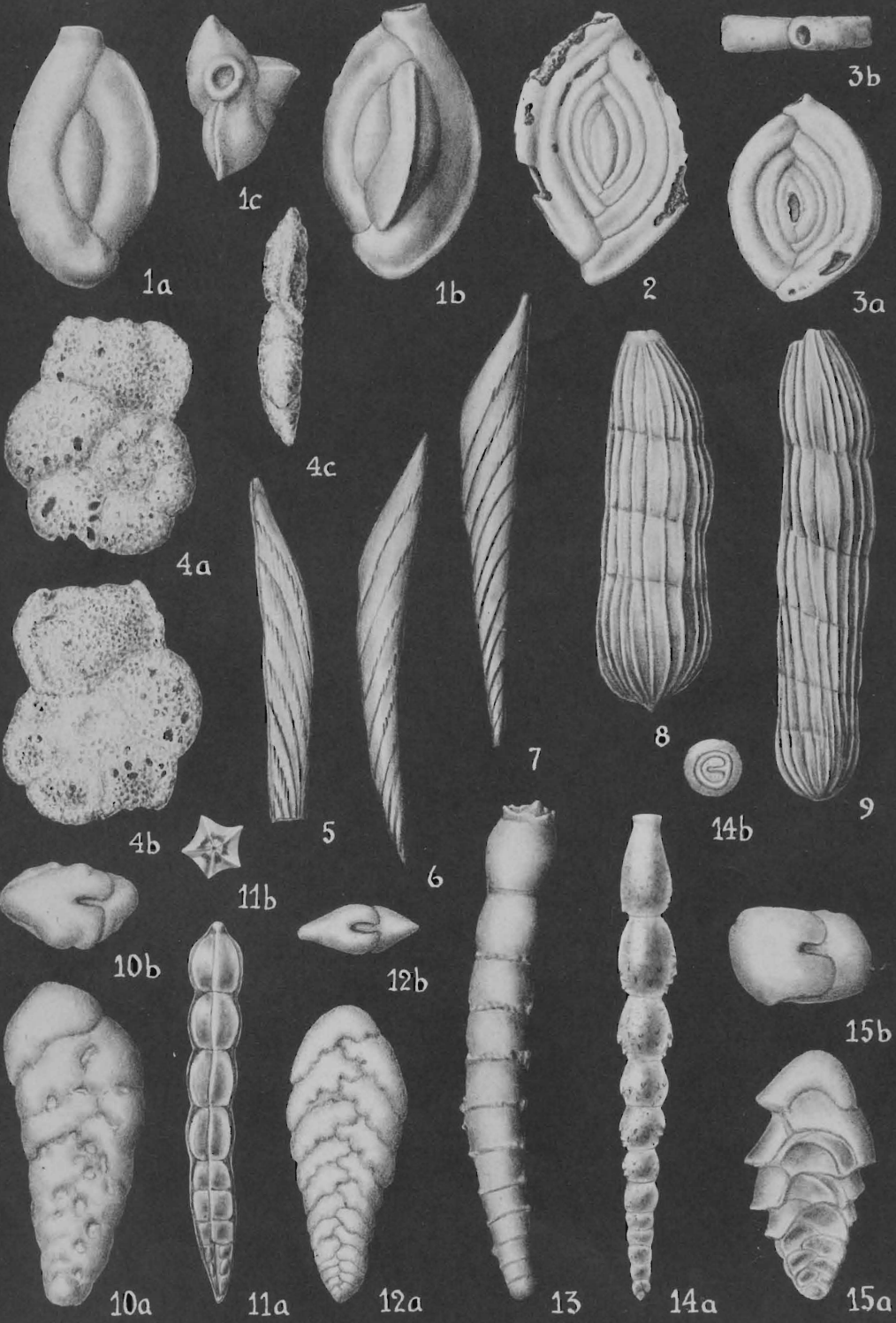
Test comparatively large, 2—2½ times as long as broad; somewhat compressed, periphery rounded; chambers of the early portion close coiled, rather indistinct, those of the later portion uncoiled, more distinct, 2—4 in number; sutures mostly indistinct, except in the later uncoiled portion; wall very coarsely arenaceous, but the fragments rather neatly cemented; aperture in the adult terminal, narrow, elongate. Length 2.00-3.00 mm.; breadth 1.00-1.50 mm.

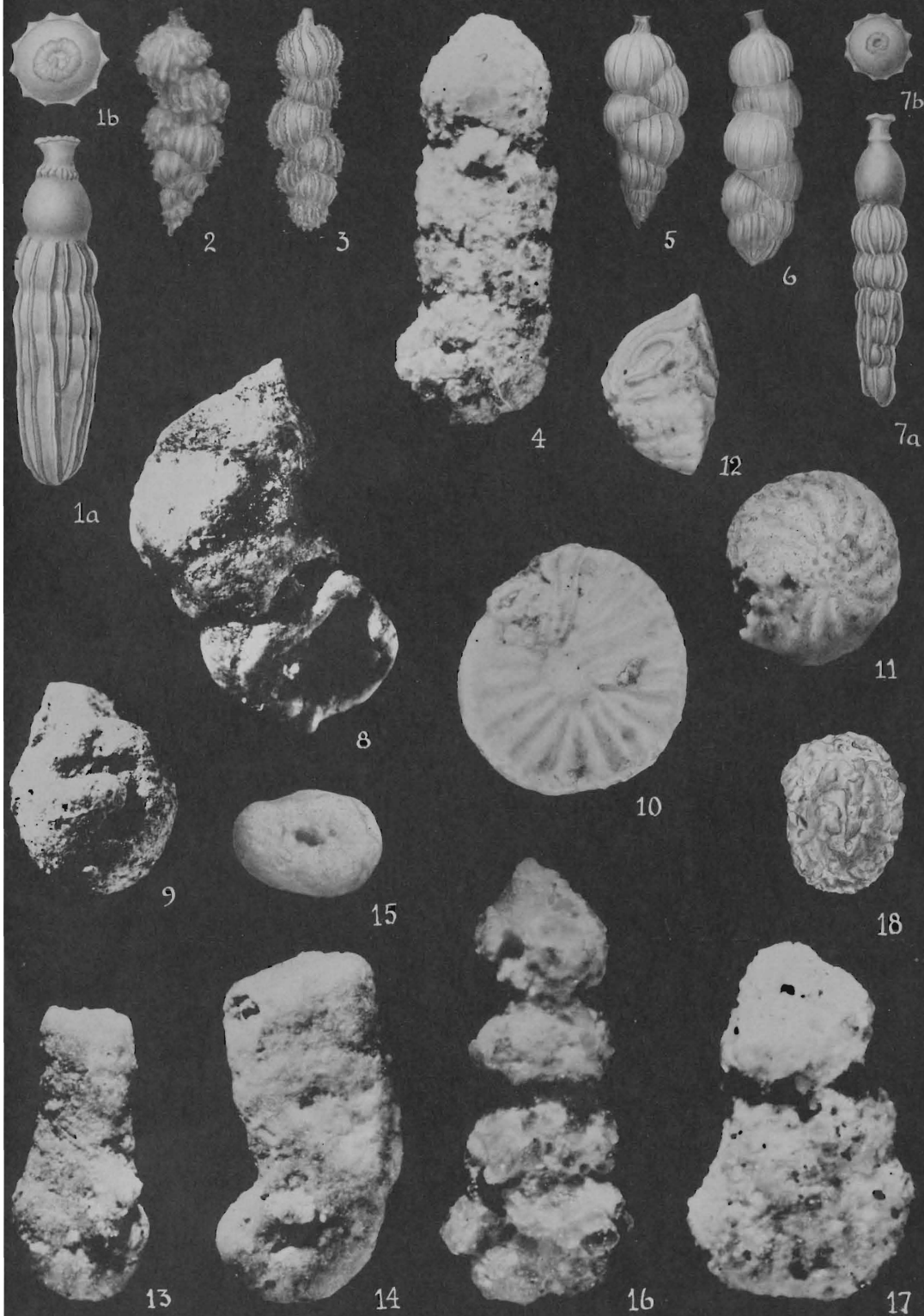
Holotype (Cushman Coll. No. 24052) from the Eocene of Norona, 3 kms. N. of Guanajay, Pinar del Rio Province, Cuba (Bermudez Sta. 275).

EXPLANATION OF PLATE 15

FIGS.

1. *Quinqueloculina moremani* Cushman, n. sp. × 90. Holotype. a, b, opposite sides; c, apertural view.
- 2, 3. *Massilina texasensis* Cushman, n. sp. × 90. 3, Holotype. 2, Paratype. a, front view; b, apertural view.
4. *Trochammina taylorana* Cushman, n. sp. × 120. a, dorsal view; b, ventral view; c, peripheral view. Holotype.
- 5-7. *Vaginulina suturalis* Cushman, n. sp. × 30. 6, Holotype. 7, Paratype.
- 8, 9. *V. selmaensis* Cushman, n. sp. × 85. 8, Holotype. 9, Paratype.
10. *Bolivinooides austinana* Cushman, n. sp. × 145. a, front view; b, apertural view. Holotype.
11. *Nodosaria navarroana* Cushman, n. sp. × 120. a, front view; b, apertural view. Holotype.
12. *Bolivinooides texana* Cushman, n. sp. × 120. a, front view; b, apertural view. Holotype.
13. *Vaginulina subgracilis* Cushman, n. sp. × 55. Holotype.
14. *Ellipsonodosaria pseudoscripta* Cushman, n. sp. × 120. a, front view; b, apertural view. Holotype.
15. *Bolivinita costifera* Cushman, n. sp. × 160. a, front view; b, apertural view. Holotype.





This species differs from *A. calcareum* (H. B. Brady) in the more rounded periphery, and the more distinct and rounded chambers in the uniserial portion.

AMMOBACULITES PENONENSIS Cushman and Bermudez, n. sp. (Pl. 16, figs. 13-15)

Test fairly large, about twice as long as broad, very slightly if at all compressed, periphery broadly rounded, the early coiled portion somewhat umbilicate; chambers mostly indistinct, those of the early portion close coiled, but sometimes slightly evolute leaving the center of the coiled portion depressed, the later chambers uncoiled, increasing only slightly if at all in size toward the apertural end; sutures indistinct; wall finely arenaceous, usually rather smoothly finished; aperture terminal, rounded, in a slight depression of the terminal face. Length 1.75-2.00 mm.; breadth 0.75-1.00 mm.

Holotype (Cushman Coll. No. 24055) from the Eocene of Penon Hole, 850 meters NW. of Penon Rancho, 7 kms. S. of Marti, Matangas Province, Cuba (Bermudez Sta. 110).

This species differs from *A. calcareum* H. B. Brady in the very slight compression and finely arenaceous wall.

HADDONIA CUBENSIS Cushman and Bermudez, n. sp. (Pl. 16, figs. 8, 9)

Test attached, 2—3 times as long as broad, earliest chambers somewhat coiled, later portion subcylindrical; chambers of the early portion indistinct, later ones inflated, low; sutures distinct

EXPLANATION OF PLATE 16

FIGS.

- 1, 7. *Ellipsonodosaria modesta* Bermudez, var. *prolata* Cushman and Bermudez, n. var. $\times 90$. 1, Holotype. 7, Paratype.
- 2, 3. *Uvigerina longa* Cushman and Bermudez, n. sp., var. *denticosta* Cushman and Bermudez, n. var. $\times 55$. 2, Holotype. 3, Paratype.
- 4, 16-18. *Ammobaculites cubensis* Cushman and Bermudez, n. sp. $\times 20$. 16, Holotype. 4, 17, 18, Paratypes.
- 5, 6. *Uvigerina longa* Cushman and Bermudez, n. sp. $\times 55$. 5, Holotype. 6, Paratype.
- 8, 9. *Haddonia cubensis* Cushman and Bermudez, n. sp. $\times 12$. 8, Holotype. 9, Paratype.
- 10-12. *Amphistegina pinarensis* Cushman and Bermudez, n. sp. $\times 20$. 10, Holotype. 11, 12, Paratypes.
- 13-15. *Ammobaculites penonensis* Cushman and Bermudez, n. sp. $\times 20$. 13, Holotype. 14, 15, Paratypes.

only in the later portion; wall finely arenaceous, smoothly finished; aperture a crescent-shaped, somewhat broad slit on the upper face of the last-formed chamber. Length up to 3.50 mm.; breadth 1.50 mm.

Holotype (Cushman Coll. No. 24064) from the Eocene of Penon Hole, 850 meters NW. of Penon Rancho, 7 kms. S. of Marti, Matangas Province, Cuba (Bermudez Sta. 110).

This species differs from *H. minor* Chapman in the aperture which in our species is a long, narrow, semicircular opening instead of a semi-elliptical one as shown in Chapman's figure, and the surface is smoother in our species.

It is interesting to find this genus occurring as far back as the Eocene. The type species, *H. torresiensis* Chapman, was described from recent specimens attached to coral-rock from Torres Strait (Journ. Linn. Soc., Zool., vol. 26, 1898, p. 454, pl. 28). This species clings rather closely to the surface on which it is attached, and does not become as erect as the other two species, but has typically many more chambers. It is also recorded by Chapman from Funafuti (l. c., vol. 28, 1899-1902, pp. 6, 183, 207, 416, pl. 35, fig. 1), by Heron-Allen and Earland from the Kerimba Archipelago off South-East Africa (Trans. Zool. Soc. London, vol. 20, 1915, p. 616, pl. 46, fig. 22), and from Lord Howe Island (Journ. Linn. Soc. Zool., vol. 35, 1924, p. 615, pl. 35, figs. 17-22). Hofker records it from the Dutch East Indies (Res. Sci. Voy. Indes Orient. Neerl., vol. II, fasc. I, 1930, p. 4, pl. 1, figs. 1-3). Bermudez records it for the first time in the Atlantic from the north coast of Cuba (Mem. Soc. Cubana Hist. Nat., vol. 9, 1935, p. 178, text fig. 1).

The other known species, *H. minor* Chapman, was described from Funafuti Atoll (Journ. Linn. Soc. Zool., vol. 28, 1902, p. 384, pl. 36, figs. 1, 2).

The only previous fossil record is for *H. minor*, recorded by Cushman from the Miocene, Bowden marl of Jamaica (Publ. 291, Carnegie Instit. Washington, 1919, p. 31).

As numerous elements of the Recent Indo-Pacific fauna had their early development in the West Indian region in the Eocene and Oligocene, it is of especial interest to record this Eocene Cuban species, as it is the earliest fossil record for the genus.

ELLIPSONODOSARIA MODESTA Bermudez, var. PROLATA Cushman and Bermudez,
n. var. (Pl. 16, figs. 1, 7)

Variety differing from the typical in the more elongate chambers which are also more distinctly inflated.

Holotype of variety (Cushman Coll. No. 24062) from the Eocene, 4.5 kms. W. of Guanajay on road to Mariel, Pinar del Rio Province, Cuba (Bermudez Sta. 337A).

UVIGERINA LONGA Cushman and Bermudez, n. sp. (Pl. 16, figs. 5, 6)

Test elongate, $2\frac{1}{2}$ —3 times as long as broad, the microspheric form gradually tapering with the greatest breadth toward the apertural end, the megalospheric form rapidly reaching its greatest diameter, and thence becoming slightly narrower toward the apertural end; chambers distinct, strongly inflated, particularly in the later stages where in the megalospheric form they become somewhat loosely arranged; sutures distinct, becoming progressively more deeply incised toward the apertural end; wall ornamented with numerous longitudinal costae, distinctly raised, only slightly interrupted at the sutures, 15—18 in the complete circumference in the adult; aperture terminal, rounded, with a slender cylindrical neck and slight lip. Length 0.75-0.90 mm.; breadth 0.25-0.30 mm.

Holotype (Cushman Coll. No. 24057) from the Eocene, Cliff under Hotel "Puerto Tarafa," Nuevitas, Camaguey Province, Cuba (Bermudez Sta. 157).

U. longa differs from *U. havanensis* Cushman and Bermudez in the more loosely arranged adult chambers and lack of spines at the base.

UVIGERINA LONGA Cushman and Bermudez, n. sp., var. DENTICOSTA Cushman and Bermudez, n. var. (Pl. 16, figs. 2, 3)

Variety differing from the typical in the ornamentation of the surface which has the costae broken up into tooth-like projections throughout.

Holotype of variety (Cushman Coll. No. 24059) from the Eocene, Cliff under Hotel "Puerto Tarafa," Nuevitas, Camaguey Province, Cuba (Bermudez Sta. 157).

AMPHISTEGINA PINARENSIS Cushman and Bermudez, n. sp. (Pl. 16, figs. 10-12)

Test plano-convex, dorsal side flattened or slightly convex, ventral side strongly convex, periphery acute but not definitely keeled; chambers numerous, 20 or more in the adult whorl, low,

increasing very gradually in size as added; sutures indistinct on the dorsal side, slightly more distinct on the ventral, not depressed; wall with slightly raised areas above the middle of each chamber, more strongly raised on the ventral side; aperture a small, low opening on the basal margin of the last-formed chamber on the ventral side. Diameter 1.40-1.75 mm.; height 0.70-0.90 mm.

Holotype (Cushman Coll. No. 24066) from the Eocene, from Loma "Candela," S. of San Diego de los Banos, Pinar del Rio Province, Cuba (Bermudez Sta. 261).

This species differs from *A. lopeztrigo* Palmer in the much smoother surface with raised areas over the chambers, and lack of the large bosses of the central portion.

RECENT LITERATURE ON THE FORAMINIFERA

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

- Parker, F. L. and P. J. Bermudez. Eocene Species of the Genera *Bulimina* and *Buliminella* from Cuba.—*Journ. Pal.*, vol. 11, No. 6, Sept., 1937, pp. 513-516, pls. 58, 59.—12 species and varieties, 5 new species and 2 new varieties.
- Gravell, Donald W. and Marcus A. Hanna. The *Lepidocyclina texana* Horizon in the *Heterostegina* Zone, Upper Oligocene, of Texas and Louisiana.—*L. c.*, pp. 517-529, pls. 60-65.—6 new species.
- Hanna, G. D. and C. C. Church. Notes on *Marginulina vacavillensis* (Hanna).—*L. c.*, pp. 530, 531.—Notes and references are given on this and related species.
- Yabe, Hisakatsu and Kiyosi Asano. New Occurrence of *Rotaliatina* in the Pliocene of Java.—*Journ. Geol. Soc. Japan*, vol. 44, No. 523, April 20, 1937, pp. 39-41, text figs. 1-3.—A new species, *Rotaliatina globosa*.
- Asano, Kiyosi. A Pliocene Species of *Elphidium* from Japan.—*L. c.*, No. 527, August, 1937, pp. 787-790, text figs. 1, 2.—A new species, *E. ezoense* related to *E. oregonense* Cushman and Grant.

- Foraminifera from Siogama Bay, Miyagi Prefecture, Japan.—Saito Ho-on Kai Museum Research Bull. No. 13, August, 1937, pp. 109-119, pls. XV, XVI.—78 species listed, 2 new, *Pyrgo siogamaensis* and *Eponides orientalis*.
- Cushman, J. A., L. G. Henbest, and K. E. Lohman. Notes on a Core-sample from the Atlantic Ocean Bottom Southeast of New York City.—Bull. Geol. Soc. Amer., vol. 48, Sept. 1, 1937, pp. 1297-1306, 1 pl.—Notes on the foraminifera are given.
- Bermudez, Pedro J. Nuevas especies de Foraminiferos del Eoceno de las cercanías de Guanajay.—Mem. Soc. Cubana Hist. Nat., vol. XI, No. 4, Oct., 1937, pp. 237-248, pls. 20, 21.—11 new species and 1 new variety, and a new genus *Pinaria*, belonging to the family Ellipsoidinidae.
- Foraminiferos recientes colectados por el Dr. Luis Howell Rivero en Jamaica.—L. c., pp. 249-252.—Lists 73 species and varieties.
- Davies, L. M. and E. S. Pinfold. The Eocene Beds of the Punjab Salt Range.—Mem. Geol. Surv. India, n. ser., vol. XXIV, Mem. No. 1, 1937, pp. i-iii, 1-79, pls. I-VII.—The larger foraminifera are described with 12 new species and a new genus, *Sakesaria*, related to *Lockhartia*.
- Reichel, M. Etude sur les Alvéolines.—Mem. Soc. pal. Suisse, vols. LVII (pt.), LIX (pt.), 1936-1937, pp. 1-147, pls. I-XI, 29 text figs.—An exhaustive study of this group with excellent figures. The relationships to the Miliolidae are shown, and many structural characters are shown in detail. There are 18 species and subspecies, 12 new, and 2 new genera, *Ovalveolina* and *Subalveolina*.
- Ovey, C. D. Some Tertiary Foraminifera from Cyprus.—Journ. Roy. Micr. Soc., vol. LVII, 1937, pp. 106-134, 29 text figs.—Numerous species are given with notes and figures, 1 new, *Plectofrondicularia variabilis*.
- Flandrin, Jacques. Sur l'attribution à l'Oligocène d'une partie des terrains nummulitiques de la Kabylie du Djurdjura et de son prolongement occidental (département d'Alger).—Comptes rendus séances Acad. Sci., vol. 204, Jun. 14, 1937, pp. 1831-1833.—Notes occurrence of larger foraminifera.
- Flandrin, J. and F. Jacquet. Les Nummulites de l'Eocene moyen du Senegal.—Bull. Soc. Geol. France, ser. 5, vol. 6, 1936, pp. 363-373, pl. XXIV.—Several species figured, none new.
- Hecht, Franz E. Die Verwertbarkeit der Mikropaläontologie bei Erdölaufschlussarbeiten im norddeutschen Tertiär und Mesozoikum.—Senckenbergiana, vol. 19, 1937, pp. 200-225, text figs.—Foraminifera used in zoning.