CONTRIBUTIONS

FROM THE

CUSHMAN LABORATORY

FOR

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These contributions will be issued quarterly. They will contain short papers with plates, describing new forms and other interesting notes on the general research work on the foraminifera being done on the group by the workers in this laboratory. New literature as it comes to hand will be briefly reviewed.

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CONTRIBUTIONS FROM THE CUSHMAN LABORATORY FOR FORAMINIFERAL RESEARCH

27. SOME NEW FORAMINIFERA FROM THE UPPER EOCENE OF THE SOUTHEASTERN COASTAL PLAIN OF THE UNITED STATES

By Joseph A. Cushman

In the course of several years' work on the faunas of the Coastal Plain region of the United States, many new species of foraminifera have been found. Some of these have already been described, and a number of others are included in this present paper. Some of these show distinct relationships with other regions and have helped to show very conclusively that the species of the Upper Eocene are in many instances very close to species now living off the coast in this same region. The Eocene species in many cases are undoubtedly the ancestral forms of these recent ones. There is a very considerable difference in the faunas of this Upper Eocene in the shallow-water type characterized by the Ocala limestone of Florida, and the deeper-water sediments such as found in parts of Mississippi and Alabama. The connection between the Upper Eocene of the Gulf Coastal Plain especially with that of the Alazan of Mexico is also marked.

Descriptions of the species follow:

TEXTULARIA ADALTA Cushman, n. sp.
Plate 4, figs 2 *a*, *b*

Test elongate, slender, early portion tapering and compressed, adult portion thicker and with the sides nearly parallel, periphery subacute except in the last few chambers which are rounded; chambers numerous, the last 5 or 6 making up half the test, earlier ones indistinct, low and broad, later ones more inflated, higher; sutures distinct especially in the later portion where they are somewhat depressed, usually oblique; wall finely arenaceous, only slightly roughened; aperture a high arched opening in the central part of the base of the apertural face.

Maximum length 2 mm.

Type specimen (U. S. N. M. Coll. No. 354111) from 3½ miles N. E. of Brooklyn, Conecuh Co., Alabama.

TEXTULARIA OCALANA Cushman, n. sp.
Plate 4, figs. 3 *a*, *b*

Test very much compressed, sides nearly flat, apical end bluntly pointed, apertural end broadly rounded, periphery even, subacute; chambers few, low and broad, not inflated; sutures very slightly depressed, rather indistinct; wall finely arenaceous, smoothly finished.

Maximum length 0.70 mm.

Type specimen (U. S. N. M. Coll. No. 354112) from Ocala limestone, 1¼ miles S. of Newberry, Alachua Co., Florida.

This peculiarly shaped species is very rare, occurring only in the typical Ocala limestone at a few stations. Its very broad form with the sides very much compressed, and but very slightly convex, will distinguish this species from any other of the Vicksburg or Jackson species. It probably occurs at more stations, but the finer material of this phase of the Ocala is often not well preserved.

BOLIVINA ATTENUATA Cushman, n. sp.
Plate 4, fig. 4

Test very strongly compressed, broad, rapidly increasing in width with newly added chambers, in the type specimen about as broad as long; central portion slightly thickened; chambers comparatively few, distinct, elongate, curved backward strongly, the inner end of each with a slight backwardly pointing projection; sutures very distinct, limbate, the periphery of the chamber with a slight keel continuous with the suture; earliest chambers with a reticulate ornamentation, later ones smooth.

Length 0.40 mm.

Type specimen (U. S. N. M. Coll. No. 354121) from 1½ miles S. W. of Perdue Hill, Monroe Co., Alabama.

This species has a very broad test, much broader than any of the others of the Upper Eocene except perhaps *Bolivina frondea* Cushman, which it resembles in no other particular. The early ornamentation is suggestive of *B. caelata* Cushman, and the later portion with its peculiar backwardly projecting inner portion of the chamber is somewhat like *B. jacksonensis* Cushman.

BOLIVINA SPIRALIS Cushman, n. sp.
Plate 4, figs. 6 *a*, *b*

Test small, only slightly compressed, spirally twisted, periphery rounded; chambers numerous, distinct, last 5 chambers making up half the test; sutures strongly depressed, distinct; wall in the earlier chambers roughened and slightly spinose, later ones coarsely punctate.

Length 0.50 mm.

Type specimen (U. S. N. M. Coll. No. 354120) from Ingleside marl pit, Charleston, South Carolina.

This species in some respects resembles the recent Indo-Pacific *Bolivina tortuosa* H. B. Brady, but is much less compressed and has a roughened exterior, almost spinose in the young.

BOLIVINA GARDNERAE Cushman, n. sp.
Plate 4, figs. 7 *a*, *b*

Test elongate, compressed, slightly tapering from the rounded initial end, periphery rounded, test broadly oval in transverse section, sides nearly parallel; chambers numerous, slightly inflated, distinct; sutures distinct, depressed; wall coarsely perforate, without a definite arrangement of the perforations; aperture elongate.

Maximum length 0.40 mm.

Type specimen (U. S. N. M. Coll. No. 354119) from 5 miles N. of Millen, Jenkins Co., Georgia.

This species also occurs in other localities in the Upper Eocene from South Carolina, Georgia and Alabama. It also occurs in the Lower Vicksburg. It is more compressed, shorter, and broader than the related *Bolivina gracilis*, and the perforations have no definite arrangement.

BIFARINA DALLI Cushman, n. sp.
Plate 4, figs. 5 *a*, *b*

Test slightly compressed, elongate, slightly tapering from the rounded initial end, apertural end truncate; chambers few, distinct, inflated especially toward the apertural end; sutures distinct, compressed; wall ornamented with numerous fine but sharp costae on the earlier two thirds, the last-formed chambers smooth, finely punctate; aperture becoming terminal in the adult, elliptical or elongate oval.

Maximum length 0.55 mm.

Type specimen (U. S. N. M. Coll. No. 354118) from ½ mile S. E. of Melvin, Choctaw Co., Alabama.

This is a beautifully ornamented species. The later chambers in adults show it to be *Bifarina* in having the aperture terminal and the chamber occupying the entire width of the test. The species is named in honor of Dr. W. H. Dall, of the United States National Museum.

BULIMINELLA ALABAMENSIS Cushman, n. sp.

Plate 4, figs. 8 *a*, *b*

Test small, ovate, broadest in front view slightly above the middle, initial end pointed, apertural end broadly rounded, somewhat obliquely truncated, whole test of 1½ to 2 coils; chambers fairly distinct, not inflated; sutures distinct but not depressed; apertural face with a very large open area somewhat broadening toward the base which reaches to at least the middle of the test; wall very thin and transparent.

Length 0.22 mm.

Type specimen (U. S. N. M. Coll. No. 354123) from ¼ mile W. of Water Valley, Choctaw Co., Alabama.

This species differs from others of the genus in the peculiar large open area on the apertural side of the test, broadening toward the base which reaches to or below the middle line of the test. The apical end is acute. It is very distinct from the species recorded from the Lower Oligocene.

VULVULINA ADVENA Cushman, n. sp.

Plate 4, figs. 9 *a*, *b*

Test small, thin, much compressed, periphery acute but not keeled, early chambers alternating, later ones (as many as 5) uniserial; chambers rather high, gently sloping; sutures of the biserial portion flush with the surface, the whole early portion smooth, in the later portion the sutures slightly depressed; wall smoothly finished, each angle of the chambers with a short, spinose projection, even those of the uniserial portion; aperture elongate, terminal.

Length up to 1.25 mm.

Type specimen (U. S. N. M. Coll. No. 354134) from 3½ miles S. E. of Cullomburg, Alabama.

This is a very distinct species having a very white test, smooth, and shining, the material being very fine grained.

GAUDRYINA JACKSONENSIS Cushman, n. sp.

Plate 5, figs. 1 *a*, *b*

Test large, elongate, irregularly triangular in section, the angles subacute, triserial portion short, biserial portion angular, angles subacute, almost carinate; chambers distinct, very slightly inflated; sutures distinct, slightly depressed; wall composed of fine sand grains with a large amount of cement, surface smoothly finished; aperture semi-circular, in a re-entrant at the base of the apertural face of the last-formed chamber.

Maximum length 2 mm.

Type specimen (U. S. N. M. Coll. No. 354115) from Ingleside marl pit, Charleston, South Carolina.

This species also occurs in the Upper Eocene of Alabama and Mississippi, as well as in the Alazan clay of Mexico.

This is a striking species of the deeper water sediments of the Upper Eocene. It is apparently the direct ancestral form of the recent species, *Gaudryina atlantica* (Bailey), which is very abundant off the eastern coast of the United States. It is a dominant species in the Albatross dredgings at depths ranging from 67 to 210 fathoms. The recent species has carried the development farther in the loss of the angles in the last-formed chambers, the greater sharpness of the angles of earlier chambers, and the reduction of the early triserial stage. *G. atlantica* is also a larger species.

GAUDRYINA GARDNERAE Cushman, n. sp.

Plate 5, figs. 2 *a*, *b*

Test elongate, early portion triserial and forming a distinctly triangular test in section, the angles somewhat rounded, sides flattened or very slightly convex, later portion biserial, with straight, nearly parallel sides, somewhat polygonal in section; chambers rather indistinct, especially in the earlier portion, in the later portion more distinct and the sutures somewhat depressed; wall rather coarsely arenaceous; aperture rounded, deep, at the inner border of the last-formed chamber.

Length 0.85 mm.

Type specimen (U. S. N. M. Coll. No. 354114) from 1½ miles S. W. of Perdue Hill, Monroe Co., Alabama.

This resembles *Gaudryina triangularis* Cushman in some respects, and the Lower Oligocene specimens referred to that species may belong here.

VERNEUILINA SCULPTILIS Cushman, n. sp.

Plate 5, fig. 3

Test somewhat longer than broad, pyramidal, three sided, widest at about two-thirds its length, triangular in transverse section, sides flattened or even slightly convex, apical end tapering, in well preserved specimens ending in a short point, angles of the test acute; wall sculptured, the sutural lines strongly raised, the central line of each side of the test marked by a strongly raised costa; aperture on the inner border of the last-formed chamber.

Maximum length 0.50 mm.

Type specimen (U. S. N. M. Coll. No. 354117) from W. bank Pea River, Geneva Co., Alabama.

This is a beautifully sculptured species. The apical end is prolonged into a short spine.

VALVULINA OCALANA Cushman, n. sp.

Plate 5, figs. 4 *a*, *b*

Test elongate, early portion triangular in section, the chambers closely set, later and larger portions loosely coiled; chambers numerous, those of the early triserial portion indistinct, later portion with the chambers inflated and very distinct; sutures indistinct in the early portion, depressed and distinct in the later portion; wall arenaceous but smoothly finished when the specimens are well preserved; aperture rounded, in a deep reentrant of the apertural face, with an inwardly projecting toothlike plate above the opening.

Maximum length 1.5 mm.

Type specimen (U. S. N. M. Coll. No. 354113) from 2 miles S. E. of Ocala, Marion Co., Florida.

Valvulina ocalana is a very characteristic species of the shallow-water phase of the Upper Eocene especially of warm waters as developed in the Ocala limestone of Florida. Such deposits are not usually very well preserved as to their smaller fossils, but *V. ocalana* is a well characterized species recognizable even when the preservation would make impossible the specific identification of many other species. It is related to such species as *V. triangularis* d'Orbigny of the Eocene of the Paris Basin.

Valvulina ocalana is the direct ancestral form of a species now very abundant in shallow warm waters of coral reef conditions in the general West Indian region where it occurs in very

shallow water reefs of southern Florida, the Bahamas, Jamaica, etc. The recent species, *V. oviedoiana* d'Orbigny is a shorter, stouter form but with the same characteristic apertural features.

BULIMINA JACKSONENSIS Cushman, var. CUNEATA Cushman, n. var.

Variety differing from the typical in the larger number of costae (10 to 12), the more tapering form, and especially the very serrate character of the edge of the costae.

Length 1 mm.

Type specimen (U. S. N. M. Coll. No. 354122) from ½ mile S. E. of Melvin, Choctaw, Co., Alabama.

This variety which is distinct from the typical form has been found at but one station, but occurs abundantly there.

POLYMORPHINA JACKSONENSIS Cushman, n. sp.

Plate 5, figs. 5 *a*, *b*

Test fairly large for the genus, broad and compressed; periphery broadly rounded, base rounded; apertural end narrowed to a slightly produced, broad apertural end; chambers distinct, slightly inflated, elongate, unequally placed with reference to the vertical axis; sutures very slightly depressed, distinct; wall smooth; aperture radiate.

Maximum length 1.5 mm.

Type specimen (U. S. N. M. Coll. No. 354132) from near Blue Springs, Jackson Co., Florida.

The species is a characteristic one from the Upper Jackson, and I have specimens from North and South Carolina, Florida, Alabama, and Mississippi.

There are numerous species which this resembles in general characters, but none of them are sufficiently close so that this species from the Upper Eocene can be referred to them. This somewhat resembles *Polymorphina humboldti* Bornemann, as well as some of the species recorded from the Tertiary of the Australian region.

POLYMORPHINA JACKSONENSIS Cushman, var. COSTIFERA, Cushman, n. var.

Variety differing from the typical in the ornamentation of the test, which in the variety has numerous rounded, longtitudinal costae on the basal portion of the test, sometimes covering a large portion of the surface. As a rule the variety and the

typical form do not occur together, although both occur at Jackson, Mississippi, and a very few other stations.

Type specimen (U. S. N. M. Coll. No. 354133) from 1 mile E. of Beck, Covington Co., Alabama.

EXPLANATION OF PLATE 4

Figs. 1 *a-c.* *Lamarckina marylandica* Cushman, var. *yeguaensis* Cushman, n. var. X 65.
a, dorsal view; *b*, peripheral view; *c*, ventral view.
(See Vol. 2, pt. 1, p. 10.)

Figs. 2 *a, b.* *Textularia adalta* Cushman, n. sp. X 65.
a, front view; *b*, apertural view.

Figs. 3 *a, b.* *Textularia ocalana* Cushman, n. sp. X 65.
a, front view; *b*, apertural view.

Fig. 4 *Bolivina attenuata* Cushman, n. sp. X 65.
Front view.

Figs. 5 *a, b.* *Bifarina dalli* Cushman, n. sp. X 65.
a, front view; *b*, side view.

Figs. 6 *a, b.* *Bolivina spiralis* Cushman, n. sp. X 65.
a, front view; *b*, apertural view.

Figs. 7 *a, b.* *Bolivina gardnerae* Cushman, n. sp. X 65.
a, front view; *b*, apertural view.

Figs. 8 *a, b.* *Buliminella alabamensis* Cushman, n. sp. X 100.
a, side view; *b*, apertural view.

Figs. 9 *a, b.* *Vulvulina advena* Cushman, n. sp. X 65.
a, side view; *b*, apertural view.

EXPLANATION OF PLATE 5

Figs. 1 *a, b.* *Gaudryina jacksonensis* Cushman, n. sp. X 50.
a, front view; *b*, apertural view.

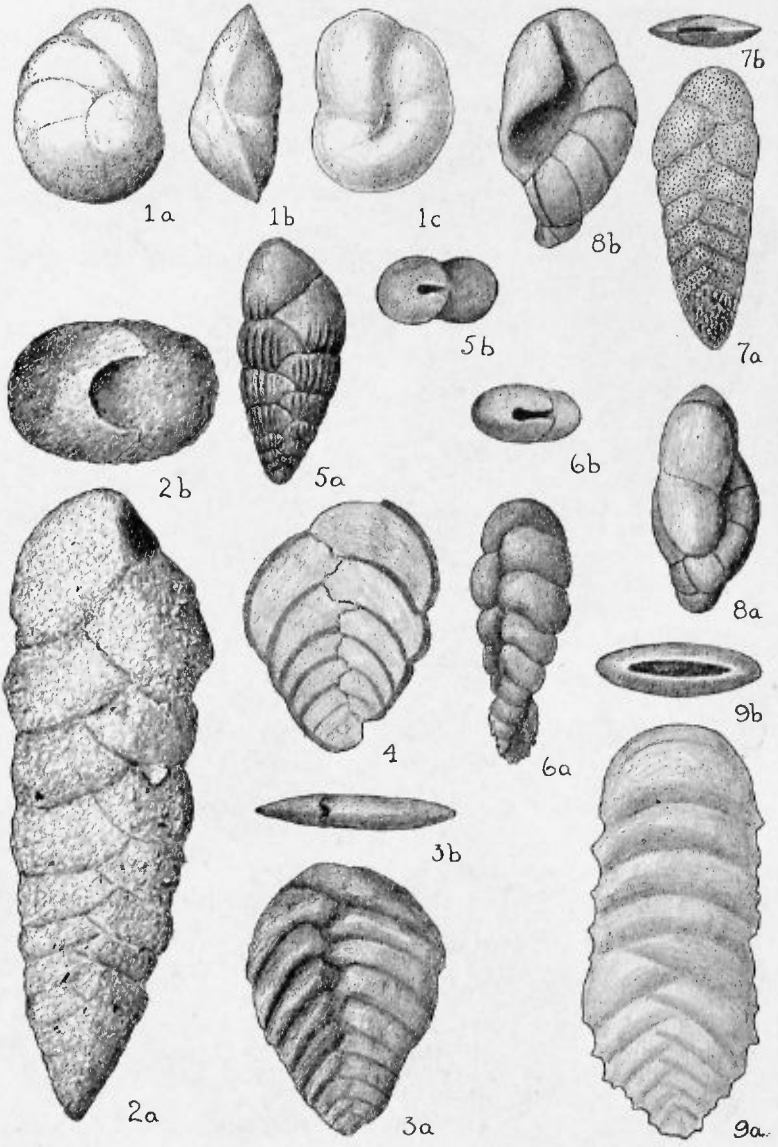
Figs. 2 *a, b.* *Gaudryina gardnerae* Cushman, n. sp. X 65.
a, front view; *b*, apertural view.

Fig. 3 *Verneuilina sculptilis* Cushman, n. sp. X 65.

Figs. 4 *a, b.* *Valvulina ocalana* Cushman, n. sp. X 65.
a, front view; *b*, apertural view.

Figs. 5 *a, b.* *Polymorphina jacksonensis* Cushman, n. sp. X 50.
a, front view; *b*, side view.

Figs. 6 *a-c.* *Lamarckina ripleyensis* Cushman. X 65.
a, dorsal view; *b*, ventral view; *c*, peripheral view.
(See Vol. 2, Pt. 1, p. 8.)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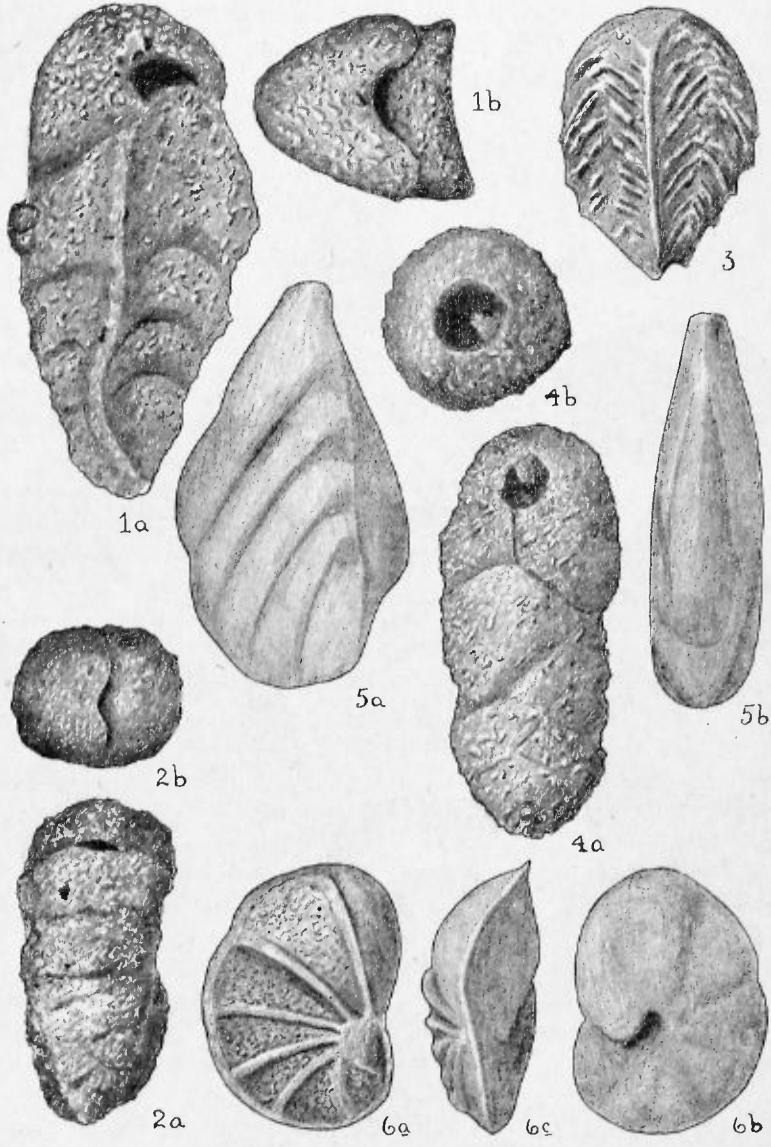
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6c

28. A NEW PLECTOFRONDICULARIA FROM THE PLIOCENE OF CALIFORNIA

By Joseph A. Cushman and Roscoe E. Stewart

In the Pliocene of California there is a species of *Plectofrondicularia* already referred to in Volume 1, Part 4, page 89. A further study of this species shows that it is new. Specimens with the apertural end perfectly preserved must be very rare as in all specimens seen the final chamber is broken away.

PLECTOFRONDICULARIA CALIFORNICA Cushman and Stewart, n. sp.

Plate 6, figs. 9-11

Test somewhat compressed, very elongate, narrow, usually bilaterally symmetrical, occasionally asymmetrical due to a slight curvature of the early portion, the broad faces concave, sides diverging uniformly from the initial end which is rounded, more in the megalospheric and less in the microspheric form, the greatest breadth of the test being made by the last-formed chamber, the peripheral portion with 3 sharp platelike carinae, one in the middle line, the other two lateral; chambers numerous, early ones biserial, later ones uniserial, low, 2 to 3 times as wide as high, increasing very slightly in relative height toward the apertural end; sutures slightly limbate, later ones very slightly depressed; wall smooth, with a short central costa on the earlier portion.

Length 1.50 mm.; breadth .35 mm.; thickness .15 mm.

Holotype (Cushman Coll. No. 5562) from 3260 feet, Torrance No. 7, Chanslor-Canfield Midway Oil Co., California.

In the Tertiary of America this genus is known from the Claiborne where there are very slender specimens referred to *Plectofrondicularia mexicana* (Cushman). This is biserial in the young. The Claiborne form is slightly more slender than the Mexican or Trinidad specimens, and there is more of a tendency to taper toward the apertural end. The last-formed chambers in the Claiborne form are also somewhat higher. These Claiborne specimens are from Liberty County, Texas, collected by Esther R. Applin.

The California Pliocene species, instead of having the sides parallel, is uniformly tapering throughout. The chambers are all low in comparison with *P. mexicana*, and do not, as in that species, elongate to any amount in the adult, but tend to keep the same relative proportions throughout.

29. SOME PLIOCENE BOLIVINAS FROM CALIFORNIA

By Joseph A. Cushman

The Pliocene of California or at least that part of it represented by the marine Fernando series is rich in foraminifera. The genera *Bolivina* and *Uvigerina* are especially abundant. They show that at the time of deposition of this series of sediments a rapid evolution of form was going on in these two genera. There are many forms with a more or less definite vertical range which may be distinguished in a careful study of well samples, especially cores, or in the outcrop material of the thick sediments of the Fernando.

The species of *Bolivina* are of especial interest as they belong to species which in most cases are living today in identical or slightly modified form in the cooler waters of the eastern Pacific along the western coasts of North and South America. In 1839 d'Orbigny described species from the west coast of South America which appear in the recent and late Tertiary collections of California, and the waters of adjacent regions. The fauna of the cold waters of our west coast is very different from that of other regions, and the foraminifera are no exception. *Bolivina plicata* recorded widely is not the same as that of d'Orbigny from the eastern Pacific, which in this particular region has a very definite geographical and geological distribution. The same is true of the other species noted here. A description of some of the more conspicuous forms follows:

BOLIVINA PLICATA d'Orbigny

Plate 6, figs. 1 *a*, *b*

Bolivina plicata d'Orbigny, Voy. Amér. Mérid., vol. 5, pt. 5, "Foraminifères," 1839, p. 62, pl. 8, figs. 8, 9.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 48.

Test small, thick, elongate, very slightly tapering, the periphery broadly rounded, initial end broadly rounded; chambers distinct, inflated; the sutures distinct, somewhat depressed, nearly straight across, horizontal when the test is placed with the aperture up; wall ornamented with 1 or 2 costae on each side, usually running the entire length of the test except for the last-formed chamber, the costae rounded at the surface and broad, the surface and sides very finely plicated with alternating

grooves and ridges somewhat oblique but nearly parallel to the costae themselves; wall finely perforate; aperture elongate, extending somewhat above the outline of the chamber due to the definite lip that is developed.

Length up to 0.5 mm.; breadth 0.15-0.20 mm.; thickness 0.08-0.10 mm.

D'Orbigny's type specimens were from the Pacific off Valparaiso, Chile, where he found it common "à de grandes profundeurs dans la mer." The species in its typical form extends up the west coast of America at least to the region off Central America where I have had it from depths of 730 to 428 fathoms. It occurs in well samples in the Pliocene of the Los Angeles Basin in rather typical form. The figured specimen is a recent one.

The peculiar plications figured by d'Orbigny are caused by alternating bands of thicker and thinner test forming plications at a slight angle to the costae.

BOLIVINA COSTATA d'Orbigny

Plate 6, fig. 2

Bolivina costata D'ORBIGNY, Voy. Amér. Mérid., vol. 5, pt. 4, "Foraminifères," 1839, p. 62, pl. 8, figs. 8, 9.

Test small, compressed, tapering, the periphery rounded, initial end broadly rounded in the megalospheric form, more pointed in the microspheric; chambers distinct, slightly if at all inflated; sutures distinct, oblique; wall ornamented with 5 to 7 costae on each side longitudinally continuous, of about equal size, the surface very thin and sharp, area between smooth, clearly perforate; aperture elongate, with a slight lip.

Length up to 0.75 mm.

D'Orbigny's types were from off Cobija, Peru.

The typical form with the characters described and figured by d'Orbigny occurs in the Pleistocene deposits of Lomita Quarry, Palos Verdes Hills, California, and in the eastern Pacific comes northward along the coast to at least the latitude of Central America.

In the Pliocene and Pleistocene of California this species is represented by the following varieties:

BOLIVINA COSTATA d'Orbigny, var. **INTERJUNCTA** Cushman, n. var.

Plate 6, fig. 3

Variety differing from the typical in the more elongate test, somewhat more compressed form, and especially in the orna-

mentation which in the early portion consists of several distinct costae as in the typical form but in the later portion these anastomose, and there are developed secondary transverse or oblique shorter costae connecting the primary ones.

Holotype (Cushman Coll. No. 5567) from Lomita Quarry, Palos Verdes Hills, California, collected by Donald D. Hughes. It also occurs in the Upper and Middle Fernando of Ventura County and at Timms Point, Santa Barbara County, California.

In the microspheric form the test is very acute, and the ornamentation much more strongly developed than in the megalospheric form shown here.

BOLIVINA COSTATA d'Orbigny, var. **BICOSTATA** Cushman, n. var.

Variety differing from the typical in having the two costae nearest the middle most strongly developed, and the others becoming obsolete in the adult portion, the sutures are somewhat limbate and raised above the surface.

Holotype (Cushman Coll. No. 5569) from the Pliocene of Timms Point, Santa Barbara, California. It also occurs in the Upper Fernando of Ventura County, and occurs in the well samples of the Los Angeles Basin.

This remotely resembles some of the specimens that have been assigned by authors to *Bolivina aenariensis* Costa. It is not that species but rather a variety of *B. costata.*

BOLIVINA ARGENTEA Cushman, n. sp.

Plate 6, fig. 5

Test elongate, very much compressed, periphery subacute, usually not keeled, the width after the first few chambers increasing slowly; chambers very distinct, narrow in the young, in the adult about 2½ times as long as broad; sutures oblique and curved, early ones limbate, later ones thin and somewhat depressed; wall very finely perforate, smooth except for the very base which occasionally has a trace of one or more costae on the proloculum and one or two following chambers; color of test light silvery gray, polished.

Length up to 0.80 mm.; breadth 0.40 mm.

Holotype (U. S. N. M. Coll. No. 20281) from *Lydonia* station 30, 7°01′N.; 81°48′W., in 428 fathoms. It also occurs further north along the west coast of America at least to Oregon. In the Upper Pliocene of California it occurs in typical form with the same silvery gray test in well preserved specimens.

BOLIVINA PUNCTATA d'Orbigny

Bolivina punctata D'ORBIGNY, Voy. Amér. Mérid., vol. 5, pt. 5, "Foraminifères," 1839, p. 63, pl. 8, figs. 10-12.

There are smooth compressed forms with very distinct perforations which strongly resemble d'Orbigny's species from the Upper and Middle Fernando, near Ventura, and from the Pleistocene of Lomita Quarry, Palos Verdes Hills, California. The types were from off the coast of Chile.

BOLIVINA SEMINUDA Cushman

Bolivina seminuda CUSHMAN, Bull. 71, U. S. Nat. Mus., pt. 2, 1911, p. 34, fig. 55 (in text).

Test elongate, subcylindrical, very slightly compressed, initial end rounded; chambers numerous, high, very slightly inflated; sutures not depressed but distinct; wall hyaline, finely punctate, the lower half of each chamber with rather coarse foramina, the upper half clear; aperture elongate, loop-shaded; transparent except the lower part which is whitish.

Length up to 1 mm.; breadth 0.25 mm.; thickness 0.20 mm.

The originals were from Bering Sea. Specimens are very common southward along the Pacific coast as far at least as Panama. Similar specimens occur in the Middle and Upper Fernando of the California Pliocene. Occasionally specimens have the upper clear portion of the chamber reduced or wanting, and the whole becomes distinctly perforate.

BOLIVINA HUGHESI Cushman, n. sp.

Plate 6, figs. 4 *a b*.

Test elongate, slender, very slightly compressed, early portion gently tapering, later portion with the sides almost parallel, whole test twisted strongly, periphery rounded; chambers numerous, 12 or more pairs in the adult increasing in height toward the apertural end; sutures distinct, later ones distinctly depressed; wall smooth, very finely perforate, opaque.

Length up to 1 mm.; breadth 0.30 mm.; thickness 0.25 mm.

Holotype (Cushman Coll. No. 5584) from the Pliocene of San Jose Hills, California, collected by Donald D. Hughes. It also occurs in the Upper Fernando of Ventura County, California.

There is a tendency to develop one or more lobes near the inner margin on the lower line of each chamber, a feature which

becomes stronger in some specimens at different horizons in well samples, and making the species tend toward the conditions seen in *Bolivina decussata* H. B. Brady.

BOLIVINA DECURTATA Cushman, n. sp.

Plate 6, figs. 7 *a*, *b*

Test small, short and broad, periphery rounded, about 10 pairs of chambers, increasing slightly in height as added; sutures distinct, slightly limbate, only slightly oblique, curved, the chambers meet with very little overlapping giving a nearly straight suture along the median line; wall very finely perforate, smooth, opaque; aperture loop-shaped.

Length 0.55-0.60 mm.; breadth 0.35-0.40 mm.; thickness 0.12-0.15 mm.

Holotype (Cushman Coll. No. 5587) from the Pliocene of San Jose Hills, California, collected by Donald D. Hughes. This short broad species while common at this locality has not been noted elsewhere. It occasionally shows a slight twist in the very early chambers.

BOLIVINA SUBADVENA Cushman, n. sp.

Plate 6, figs. 6 *a*, *b*

Test stout, small, slightly twisted, periphery subacute; chambers distinct, usually 8 to 10 pairs, inflated, especially the later ones; sutures distinct, later ones depressed; wall roughened by the very coarse perforations, in some forms making a fine reticulation; aperture a broad loop sub-terminal.

Length 0.65 mm.; breadth 0.25 mm.; thickness 0.12-0.15 mm.

Holotype (Cushman Coll. No. 5594) from the Pliocene of Timms Point, Santa Barbara, California. It also occurs in the Upper and Middle Fernando, and in the eastern Pacific along the coast at least from Oregon to Panama.

There are many varietal forms in the Pliocene of the Los Angeles Basin seen in well samples. The microspheric form is longer and much more tapering, the depression of the sutures and the inflation of the chambers much less, but the other characters are the same. The megalospheric proloculum is often very large in comparison with the size of the later chambers.

BOLIVINA SUBADVENA Cushman, var. SPISSA Cushman, n. var.

Plate 6, figs. 8 *a*, *b*

Variety differing from the typical in having the sutures distinctly limbate and thickened along the median portion; the periphery acute, even slightly carinate, the initial end occasionally with a very slight apical spine, and in the megalospheric form traces of costae on the proloculum.

Holotype (Cushman Coll. No. 5600) from the Pliocene of Timms Point, Santa Barbara, California. It also occurs in the Upper Fernando of Ventura County and at San Jose Hills, and in the Pleistocene of Lomita Quarry, Palos Verdes Hills as well as being a common variety in the Pliocene of wells in the Los Angeles Basin.

BOLIVINA PSEUDOBEYRICHI Cushman, n. sp.

Bolivina beyrichi REUSS, var. *alata* CUSHMAN (not Seguenza), Bull. 71, U. S. Nat. Mus., pt. 2, 1911, p. 35, figs. 57 *a*, *b*, (in text).

Test compressed, rather rapidly increasing in width, the chambers increasing in height as added, distinct, slightly inflated, periphery distinctly keeled, but those of each chamber distinct, the posterior angle produced and pointed; sutures distinct, depressed, slightly oblique, more strongly so in the earlier chambers; wall distinctly and coarsely perforate; aperture elliptical oval with a distinct raised lip.

Length 0.50-0.60 mm.; breadth 0.30-0.35 mm.; thickness 0.10-0.12 mm.

Holotype (U. S. N. M. Coll. No. 20282) from *Albatross* station H4025 in 536 fathoms near the Aleutian Islands. The species is widely distributed along the coast of the eastern Pacific extending along the coast southward at least to Panama at a depth of 300-500 fathoms where the water is cold. It also occurs in the upper part of the Pliocene of wells of the Los Angeles Basin. It is not at all the same as *B. beyrichi* from the Oligocene of Europe nor like the var. *alata* of Seguenza.

EXPLANATION OF PLATE 6

Figs. 1 *a-b*. *Bolivina plicata* d'Orbigny. X 65.
a, front view; *b*, side view.

Figs. 2 *a, b*. *Bolivina costata* d'Orbigny. X 65.
a, front view; *b*, side view.

Fig. 3 *Bolivina costata* d'Orbigny, var. *interjuncta* Cushman, n. var. X 65.

Figs. 4 *a, b*. *Bolivina hughesi* Cushman, n. sp. X 50.

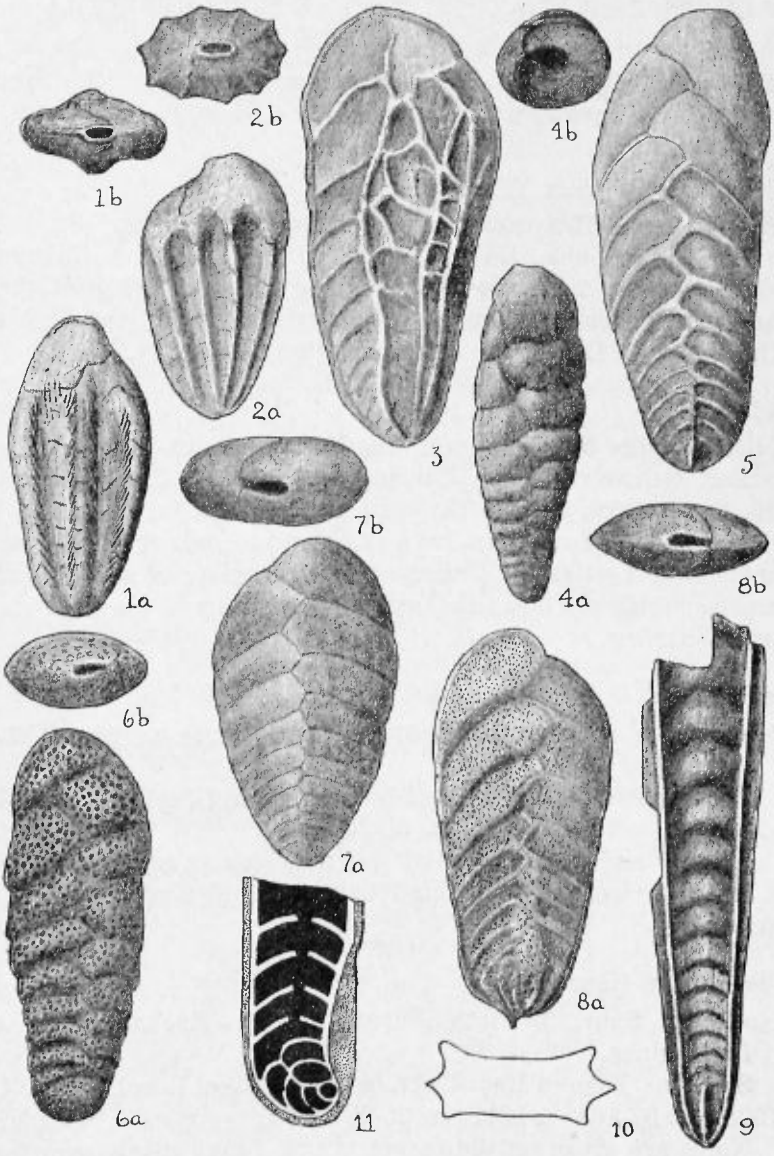
Fig. 5 *Bolivina argentea* Cushman, n. sp. X 80.

Figs. 6 *a, b*. *Bolivina subadvena* Cushman, n. sp. X 65.
a, front view; *b*, side view.

Figs. 7 *a, b*. *Bolivina decurtata* Cushman, n. sp. X 65.
a, front view; *b*, side view.

Figs. 8 *a, b*. *Bolivina subadvena* Cushman, n. sp., var. *spissa* Cushman, n. var. X 65.
a, front view; *b*, side view.

Figs. 9-11. *Plectofrondicularia californica* Cushman and Stewart, n. sp. Fig. 9. Front view, X 50. Fig. 10. Outline of end view, X 50. Fig. 11. Section of early portion of microspheric form X 75, dotted portion represents peripheral flange. Early chambers show a tendency to become coiled before taking on the biserial stage.


2b
1b
1a
2a
3
4b
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4a
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8b
6b
7a
8a
6a
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9

RECENT LITERATURE ON THE FORAMINIFERA

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

Roig, Mario Sanchez Y.

Breve Resena Historica de la Paleontologia Cubana.

Soc. Geog. Cuba., Habana, 1926, pp. 1-15, 6 pls. *Havana.*

This paper mentions works on the foraminifera of Cuba, and gives a plate of figures made up from those published in the Carnegie Institution of Washington, Publ. 291.

Koch, R.

Mitteltertiäre Foraminiferen aus Bulongan, Ost-Borneo.

Ber. Schweizerischen Paläontologischen Gesellschaft, vol. 19, No. 3, 1926, pp. 722-751, with 26 text figs. *Basel.*

Two hundred and fifty-five species and forms are listed from the Middle Tertiary of East Borneo. A number of new species and varieties are described and figured, some of them of unusual interest.

Koch, R.

Miogypsina staufferi, nov. spec., from North-western Venezuela.

Ber. Schweizerischen Paläontologischen Gesellschaft, vol. 19, No. 3, 1926, pp. 751-753, pl. 28. *Basel.*

Figures and descriptions of this new species are given with a short discussion of its relationships to other species of the genus.

Yabe, H. and Hanzawa, S.

Notes on Some Tertiary Foraminiferous Rocks from the Philippines.

Sci. Rep. Tohuku Imp. Univ., sec. ser. (Geol.), vol. 7, No. 4, 1925, pp. 97-109 (1-13), pls. 25-27 (1-3). *Sendai.*

Notes are given on the foraminiferal fauna of six samples with a list of the species found. Three plates show many excellent reproductions from photographs of sections, particularly of orbitoids. Three new species and a new variety are described.

Schenck, H. G. and Aguerrevere, S. E.

Morphologic Nomenclature of Orbitoidal Foraminifera.

Amer. Journ. Sci., ser. 5, vol. 11, 1926, pp. 251-256, with 3 text figs. *New Haven.*

A number of descriptive terms are defined which will help to make more precise the descriptions of this group of foraminifera. A number of text figures illustrate the terms used.

Franke, A.

Die Foraminiferen der pommerschen Kreide.

Abhandl. geol. pal. Instit. Univ. Griefswald, vol. 6, 1925, pp. 1-96, pls. 1-8. *Griefswald.*

This paper deals with the foraminifera of the Cretaceous of this part of Germany. A large number of species are given and illustrated. A number of new forms are described. The classification adopted is that of Rhumbler bringing the Globigerininae as the most highly developed group of the last family of the Rotaliidae. This is an important paper for comparison with the American Cretaceous.

Hofker, J.

Die Foraminiferen aus den senon Limburgens.

Overdr. Natuurhist. Maandblad, Jaarg. 15, No. 3, 1926, pp. 29, 30, 1 pl. *Limburg.*

This paper gives copious notes and numerous figures of *Amphistegina fleuriausi* d'Orbigny.

Nuttall, W. L. F.

The Larger Foraminifera of the Upper Ranikot Series (Lower Eocene) of Sind, India.

Geol. Mag., vol. 63, 1926, pp. 112-121, pls. 10, 11, text figs. 1-3. *London.*

A number of species of various genera are described and figured including a new species of *Assilina* and of *Dictyoconoides.*

Nuttall, W. L. F.

Three Species of Lepidocyclines from Western India and Persia.

Ann. Mag. Nat. Hist., ser. 9, vol. 17, 1926, pp. 330-337, pl. 13, text figs. 1, 2. *London.*

Two of the species are from the Oligocene, the other described as new from the Miocene. The plate consists of excellent photographic figures.

Nuttall, W. L. F.

A Revision of the Orbitoides of Christmas Island.

Quart. Journ. Geol. Soc., vol. 82, 1926, pp. 22-42, pls. 4, 5, text figs. 1-3. *London.*

A review of the orbitoid foraminifera from this locality including the genera *Lepidocyclina, Spiroclypeus, Miogypsina,* and *Discocyclina,* with full descriptions and two plates from photographed sections. Three new species are described.

Silvestri, A.

Sulla Diffusione Stratigrafiva del Genere "Chapmania" Silv. E. Prev.

Mem. Pont. Accad. Sci. Nuovi Lincei, vol. 8, 1925, pp. 31-60, pl. 1, text figs. 1-10. *Roma.*

Many notes on this genus are given both from the point of view of distribution, structure, and nomenclature. Several new forms are described and a new genus *Cushmania* proposed.

Van der Vlerk, I. M.

A Study of Tertiary Foraminifera from the "Tidoengsche Landen" (E. Borneo).

Wetenschappelijke Mededeelingen, No. 3, 1925, pp. 13-38, pls. 1-6, text figs. *a, b,* with map.

An important paper on the macroscopic foraminifera of East Borneo, containing eight new species and one new variety with figures and description of others. The paper is illustrated by reproductions from photographs, the sections of which are unusually clear.

Van der Vlerk, I. M.

Het Foraminiferen genus Spiroclypeus en zi jn beteekenis voor de stratigraphie van het Tertiair van den Indo-Australischen Archipel.

Verhandl. Geol.-Mijn. Gei. Ned. Kol. Geol. Ser., vol. 8, 1925, pp. 561-567, text figs. 1-3. *The Hague.*

A general paper on this genus, especially its stratigraphic relations. The figures give horizontal and vertical sections and the terminology used.

Silvestri, Alfredo

Comme possa determinarsi l'eta delle rocce compatte organogeniche.

Ann. R. Liceo Sci., 1923-25 (1925), pp. 207-211, pl. 6. *Milan.*

A short paper on the subcarboniferous with a plate of sections of *Fusulina* and *Bigenerina.*

Hofker, J.

Die Foraminiferen aus dem senon Limburgens.

Nat. Maan., Nat. Gen. Limburg, Jaarg. 15, No. 4, April 30, 1926, pp. 38-42, pls. 1, 2. *Limburg.*

A paper devoted to exhaustive descriptive details with figures of *Orbitoides Faujasi* de France.

Martinotti, A.

Alcune Forme Notevoli della Microfauna di Gorbio (Alpi Marittime).

Atti Soc. Ital. Sci. Nat., vol. 64, 1925, pp. 175-180, pl. 6. *Pavia.*

A short paper on Eocene material including figures from Texas material referred to *Clavulina triquetra* Reuss.