CONTRIBUTIONS FROM THE CUSHMAN LABORATORY FOR FORAMINIFERAL RESEARCH

196. NOTES ON SOME PLIOCENE AND PLEISTOCENE SPECIES OF BULIMINA AND BULIMINELLA

By JOSEPH A. CUSHMAN and FRANCES L. PARKER

A study of types and topotypes where possible of the species of *Bulimina* and *Buliminella* described from the Pliocene and Pleistocene has been undertaken in our work on this group. The known species are figured and descriptions given, as well as notes on those species not seen or possibly not belonging to these genera although described as such. A few new species and varieties are described and figured.

Some of the species named have been extensively used in the literature, but a study of original figures and descriptions in connection with topotype material shows them to be very different from much of the later material referred to them.

BULIMINA COSTATA d'Orbigny (Pl. 9, figs. 1, 2)

Bulimina costata D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 269, No. 1.—FORNASINI, Boll. Soc. Geol. Ital., vol. 20, 1901, p. 174, text fig. 1.

Test small, about twice as long as broad, microspheric form gradually tapering, megalospheric with the widest portion about half way up the test; chambers numerous, about 5 whorls in the adult form, distinct, with a slight overhang; sutures distinct, depressed; wall of upper part of last whorl smooth, otherwise ornamented with longitudinal costae usually broken at the sutures with a sharp point, occasionally crossing the suture,

perforate; aperture loop-shaped, narrow, with a distinct lip. Length 0.40-0.50 mm.; diameter 0.22-0.28 mm.

This species is very close to *B. buchiana* d'Orbigny but differs from it in the collared effect of the chambers and the breaking of the costae at the sutures. A similar form occurs with *B. buchiana* in the Vienna basin, and it may be that the differences are varietal only. At the present time, however, it seems best to regard the Pliocene form as a separate species.

This species occurs in the Pliocene of Garant near Nice, France; in the Pliocene of Italy at Castel Arquato; on the Savena River, at San Rufillo, near Bologna; and from clay pits at Gravitelli, near Messina. A very similar form occurs in the Pleistocene of Malaga, Spain. The figured specimens are from Castel Arquato, Italy.

d'Orbigny's types were from the Pliocene of Coroncina, Italy. It must be rare as we have failed to find it in the abundant material we have from that locality.

BULIMINA ECHINATA d'Orbigny (Pl. 9, figs. 3, 4)

Bulimina echinata D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 269, No. 5. —FORNASINI, Boll. Soc. Geol. Ital., vol. 20, 1901, p. 176, text fig. 2.

Test elongate, slightly tapering, usually about twice as long as broad; chambers numerous, 4 to 5 whorls, slightly inflated; sutures distinct, depressed; wall of upper part of test smooth, perforate, lower part covered with short, very fine and sharp spines, sometimes extending up over all but the upper part of the last-formed whorl, with occasional longer spines at the initial end; aperture loop-shaped, broad, with a well-defined lip usually to be seen only in very perfect specimens. Length 0.45-0.60 mm.; diameter 0.25-0.30 mm.

This species shows considerable resemblance to the *B. elongata* group, but differs from it in the much more spinose character and in the greater depression of the sutures. It seems probable that the various forms were derived from a common ancestor.

This species occurs in the Pliocene at Coroncina, Italy, where it is common. Two topotypes are figured.

Specimens in our collections are from the Pliocene of Italy, at Stazzano; Coroncina; and on the Savena River, at San Rufillo, near Bologna; and also from Garrubo, southern Spain.

BULIMINA OVATA d'Orbigny, var. APICULATA Egger (Pl. 9, fig. 5)

Bulimina ovata D'ORBIGNY, var. *apiculata* EGGER, Jahrg. 16, Nathist. Ver. Passau, 1895, p. 17, pl. 3, fig. 15.

Variety differing from the typical in having a short basal spine.

A single specimen was found in our material from the Pliocene of Castel Arquato, Italy, and is here figured.

BULIMINA PAGODA Cushman, var. HEBESPINATA R. E. and K. C. Stewart (Pl. 9, figs. 6, 7)

Bulimina pagoda CUSHMAN, var. *hebespinata* R. E. and K. C. STEWART, Journ. Pal., vol. 4, 1930, p. 63, pl. 8, figs. 3 *a*, *b*.

"Test tapering, broadest at the base of the last-formed whorl of chambers, pointed at the initial end; chambers distinct, considerably cut under at the base, especially in the case of the later ones; periphery of the chamber with a series of stout, blunt spines projecting outward and downward, spines commonly as extensions of rather indistinct short costae, which are occasionally broken up into irregularly arranged and indistinct, double rows of blunt spines, several spines to each chamber; wall thin, translucent, finely perforate, otherwise smooth. Length 0.40 mm; breadth 0.30 mm."

The types are from the Lower Pico at a drilling depth of 5,348 feet in the Miley H. & H. No. 1 well of the Richfield Oil Company of California, Rincon Oil Field, sec. 17, T. 3 N., R. 24 W., Ventura Co., California.

Through the kindness of Bradford C. Adams, we have specimens from the Pliocene of Canada de Aliso, 2.4 miles S., 88° E. of La Crosse Junction, Ventura Co., California, and also from the south side of Garney Boulevard, 100 yards W. of intersection with Atlantic Boulevard, Repetto Hills, Los Angeles, California.

Our figured specimen is from Canada de Aliso, and shows more details than the holotype which is also figured.

BULIMINA SUBCALVA Cushman and K. C. Stewart (Pl. 9, fig. 8)

Bulimina subcalva CUSHMAN and K. C. STEWART, in Cushman, Stewart and Stewart, Trans. San Diego Soc. Nat. Hist., vol. 6, 1930, p. 65, pl. 4, figs. 11 *a*, *b*.

Test slightly longer than broad, rapidly tapering from the acute initial end to the greatest width near the apertural end,

generally triserial; chambers numerous, inflated; sutures distinct, depressed; wall in the earlier chambers ornamented by distinct and rather plate-like costae, later chambers roughly granular or smooth, initial end of the test often with a distinct spine, especially in the microspheric form; aperture elongate, oval, rather large for the genus. Length 0.50 mm.; breadth 0.35 mm.

The types of this species are from Scotia Bluffs, about 160 yards southward from north line of SE¼ sec. 5, T. 1 N., R. 1 E., Humboldt Co., California.

We have specimens from numerous localities in the Pliocene of California: from Canada de Aliso, Ventura Co.; first gully N. of Lomita Quarry, Palos Verdes Hills; and Domingos Creek, 250 yards upstream from highway, sec. 24, T. 1 S., R. 3 W., Humboldt Co. There are very similar specimens in the collection from the Pliocene of Sepik River, Borneo. Our figured specimen is from the locality N. of Lomita Quarry.

BULIMINA SUBACUMINATA Cushman and R. E. Stewart (Pl. 9, fig. 9)

Bulimina subacuminata CUSHMAN and R. E. STEWART, in Cushman, Stewart and Stewart, Trans. San Diego Soc. Nat. Hist., vol. 6, 1930, p. 65, pl. 5, figs. 2, 3 *a*, *b*.

Test longer than broad, tapering rapidly from the acute and spinose initial end to the greatest width made by the last whorl of chambers, triserial; chambers distinct and depressed; wall distinctly perforate, ornamented by high, thin plates, longitudinally placed and in general in definite, longitudinal series from one chamber to another, the lower end of each costa often slightly produced into a definite angle; aperture elongate, ovate. Length 0.50 mm.; breadth 0.28 mm.

The types are from Bear River, NE¼ sec. 20, T. 1 N., R. 2 W., Humboldt Co., California.

We have specimens from the Pliocene of Canada de Aliso, Ventura Co., California, and a single specimen from the Pleistocene, Lomita Quarry, Palos Verdes Hills, 2 miles S. of Lomita, Los Angeles Co., California.

The holotype is refigured on our plate.

BULIMINA FOSSA Cushman and Parker, n. sp. (Pl. 9, fig. 10)

Test nearly twice as long as broad, tapering from the greatest breadth at the last-formed whorl, to the subacute initial end,

apertural end broadly rounded; chambers numerous, slightly inflated, in 6 or more whorls, increasing very gradually and rather regularly in size; sutures distinct, but only slightly depressed; wall with distinct, longitudinal costae, but only slightly raised, continuous across the sutures from the base to the lower part of the last-formed whorl, dividing as growth proceeds; aperture with a distinct, raised lip. Length of holotype 0.30 mm.; diameter 0.18 mm.

Holotype (Cushman Coll. No. 24644) from the Pliocene, in brown siltstone, 210 feet stratigraphically above base of first Pico sandstone, Canada de Aliso, 2.3 miles N. 75° E. of La Crosse Junction, Ventura Co., California.

This species differs from *B. inflata* Seguenza in the more elongate, tapering form, with the costae not broken at the sutures, not ending in spines, and less raised.

BULIMINA MARGINOSPINATA Cushman and Parker, n. sp. (Pl. 9, fig. 11)

Test fusiform, greatest breadth somewhat below the middle, nearly twice as long as broad, initial end acute, about 5 whorls in the adult; chambers distinct, somewhat inflated, the last three in the adult making up much the larger part of the test, increasing rapidly in size as added, much overlapping; sutures distinct, only slightly depressed; wall mostly smooth, finely perforate, with a small number of short spines at the basal margin of the chambers; aperture elongate, with a distinct, raised lip. Length 0.40-0.45 mm.; diameter 0.25-0.28 mm.

Holotype (Cushman Coll. No. 24643) from the Pliocene, first gully N. of Lomita Quarry, Palos Verdes Hills, Los Angeles Co., California.

This species differs from *Bulimina ovata* d'Orbigny in its more broadly fusiform shape, more tapering base, and shorter, broader chambers.

BULIMINA PAGODA Cushman, var. DENUDATA Cushman and Parker, n. var.
(Pl. 10, figs. 1, 2)

Variety differing from the typical in the nearly complete loss of spines, more fusiform shape, and much narrower test.

Holotype of variety (Cushman Coll. No. 24654) from the Pliocene, Canada Seca, 2,300 ft. stratigraphically above base of a bluish-gray shale, 3.6 miles S. 50° E. of La Crosse Junction, Ventura Co., California.

BULIMINA PAGODA Cushman, var. DEFORMATA Cushman and Parker, n. var.

(Pl. 10, fig. 3)

Variety differing from the typical in the reduced spines of the basal border of the chambers, in some specimens nearly crenulate and much cut under, the later chambers often seeming deformed and peculiarly twisted.

Holotype of variety (Cushman Coll. No. 24656) from the Pliocene, Charley Hill Gulch (Branch of Ryan's Slough), Center of W½ sec. 5, T. 4 N., R. 1 E., Humboldt Co., California.

BULIMINA INFLATA Seguenza (Pl. 10, figs. 4, 5)

Bulimina inflata SEGUENZA, Atti Accad. Gioenia Sci. Nat., ser. 2, vol. 18, 1862, p. 109 (24), pl. 1, fig. 9.

Test medium, tapering, widest at top, about 1½ times as long as broad, the last-formed whorl forming at least one-third that of the test; chambers numerous, 4 to 5 whorls, fairly distinct, these of last whorl inflated; sutures distinct in upper portion of test, somewhat depressed; wall smooth in the uppermost part of the last-formed chamber, otherwise costate, with numerous plate-like costae often broken at the sutures to terminate in spine-like points, coarsely perforate; aperture loop-shaped with a distinct lip. Length 0.45-0.55 mm.; diameter 0.30-0.40 mm.

This form bears a resemblance to both *B. buchiana* d'Orbigny and *B. costata* d'Orbigny. It differs from both in the shape of the test which tapers rapidly, and in the much larger portion of the test occupied by the last-formed whorl. There are also other less obvious differences.

Seguenza described this species from the Pleistocene of Sicily, and as we have no topotype material available, specimens have been figured from the Pliocene of Garrobo, Spain, and of the clay pits at Gravitelli near Messina, Italy.

These specimens seem to accord with Seguenza's figures and description. The species occurs at various other localities in the Pliocene of Italy.

There are many references in the literature to this species, both fossil and recent from various parts of the world. Most of these are obviously not the same as Seguenza's species.

BULIMINA ETNEA Seguenza (Pl. 10, figs. 6-9)

Bulimina etnea SEGUENZA, Atti Accad. Gioenia Sci. Nat., ser. 2, vol. 18, 1862, p. 108 (24), pl. 1, fig. 9.

Test medium, tapering, usually terminated by a small spine or spines, about twice as long as broad; chambers numerous, 4-7 whorls, distinct, those of last whorl inflated, in the adult forms with a distinct overhang in the last 1 or 2 whorls in the microspheric form, and sometimes throughout the test in the megalospheric; sutures distinct, depressed; wall smooth, polished, finely perforate, the overhanging chambers having a very slight scalloping along the edge, and occasional small spines; aperture a broad loop-shaped opening with a distinct lip.

We have specimens referable to this species from the Pliocene of Sicily. Similar specimens also occur in the Pliocene of Castel Arquato, Italy, and Monte Mario, near Rome, Italy.

Although Seguenza's figured specimen gives only the rear view of the species, our specimens seem to bear a close resemblance to his form. The species is a very variable one. Several specimens have been drawn in the hope of pointing out some of the variations—three from the Pliocene of Sicily and one from Castel Arquato, Italy.

BULIMINELLA CURTA Cushman, var. BASISPINATA R. E. and K. C. Stewart (Pl. 10, fig. 10)

Buliminella curta CUSHMAN, var. *basispinata* R. E. and K. C. STEWART, Journ. Pal., vol. 4, 1930, p. 63, pl. 8, fig. 6.

"Test spiral, tapering or fusiform, initial end bluntly pointed with a few small but distinct spines on the earliest chambers, thence increasing in diameter toward the broadest portion near the base of the last-formed chamber, periphery slightly lobulated; chambers numerous, 4 usually making up a coil in the adult, distinct, inflated; sutures distinct, somewhat depressed; wall smooth, very finely perforate; aperture comma-shaped, in a depression of the face of the last-formed chamber, usually with a tooth or plate at one side. Length 0.80 mm.; breadth 0.30 mm."

The types of the variety are from the Pliocene, upper Pico shales, Kalorama Canyon, Ventura Co., California.

The variety is larger than the typical, and has small but distinct spines on the earliest chambers.

BULIMINELLA MULTICAMERA Cushman and Parker, n. sp. (Pl. 10, figs. 11, 12)

Test elongate, about 2½ times as long as broad, tapering, greatest breadth toward the apertural end which is truncate, initial end rounded; chambers numerous, very elongate, with a slight tendency toward becoming irregularly biserial, little if at all inflated; sutures distinct, limbate, not depressed; wall smooth, very finely perforate; aperture rounded, slightly elongate, in a rather deep depression in the center of the base of the apertural face in the last-formed whorl. Length 0.40-0.45 mm.; breadth 0.15-0.18 mm.

Holotype (Cushman Coll. No. 24646) from the Pliocene of Castel Arquato, Italy.

This species differs from *Buliminella elegantissima* (d'Orbigny) in the more tapering and less fusiform shape, truncate apertural end, and tendency to an irregularly biserial arrangement of the chambers. The arrangement of the chambers is a peculiar one, tending slightly toward the biserial arrangement characteristic of *Robertina*.

EXPLANATION OF PLATE 9

FIGS.

1, 2. *Bulimina costata* d'Orbigny. × 90. Pliocene, Castel Arquato, Italy.

3, 4. *B. echinata* d'Orbigny. × 70. Pliocene, Coroncina, Italy.

5. *B. ovata* d'Orbigny, var. *apiculata* Egger. × 45. Pliocene, Castel Arquato, Italy.

6, 7. *B. pagoda* Cushman, var. *hebespinata* R. E. and K. C. Stewart. 6, × 90. Holotype. Pliocene, Humboldt Co., California. *a*, front view; *b*, apertural view. 7, × 45. Pliocene, Canada de Aliso, Ventura Co., California.

8. *B. subcalva* Cushman and K. C. Stewart. × 50. Pliocene, Palos Verdes Hills, California.

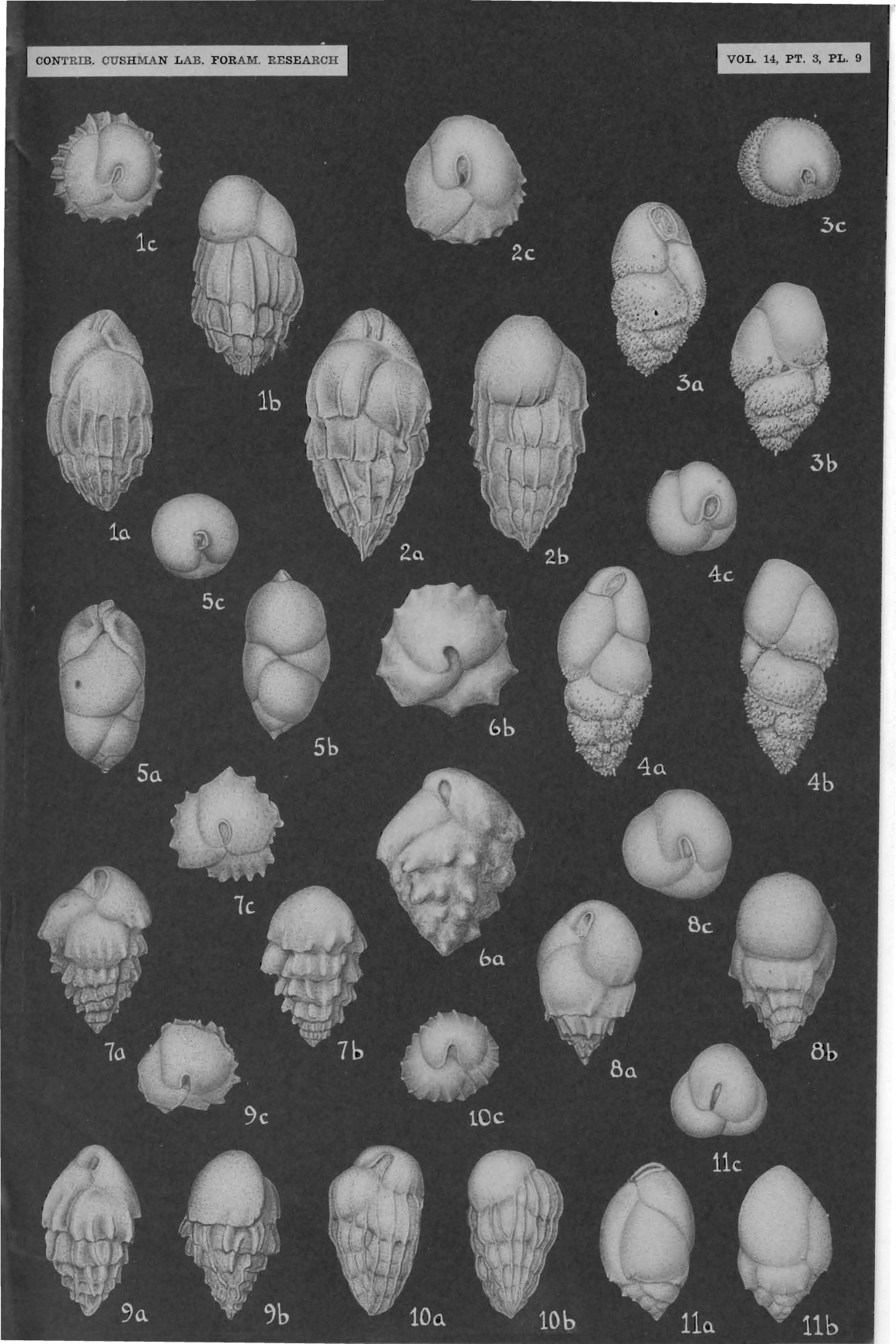
9. *B. subacuminata* Cushman and R. E. Stewart. × 70. Holotype. Pliocene, Humboldt Co., California.

10. *B. fossa* Cushman and Parker, n. sp. × 90. Holotype. Pliocene, Canada de Aliso, Ventura Co., California.

11. *B. marginospinata* Cushman and Parker, n. sp. × 70. Holotype. Pliocene, Palos Verdes Hills, California.

Unless otherwise noted, *a*, front view; *b*, rear view; *c*, apertural view.

Illustrations by Ann Shepard.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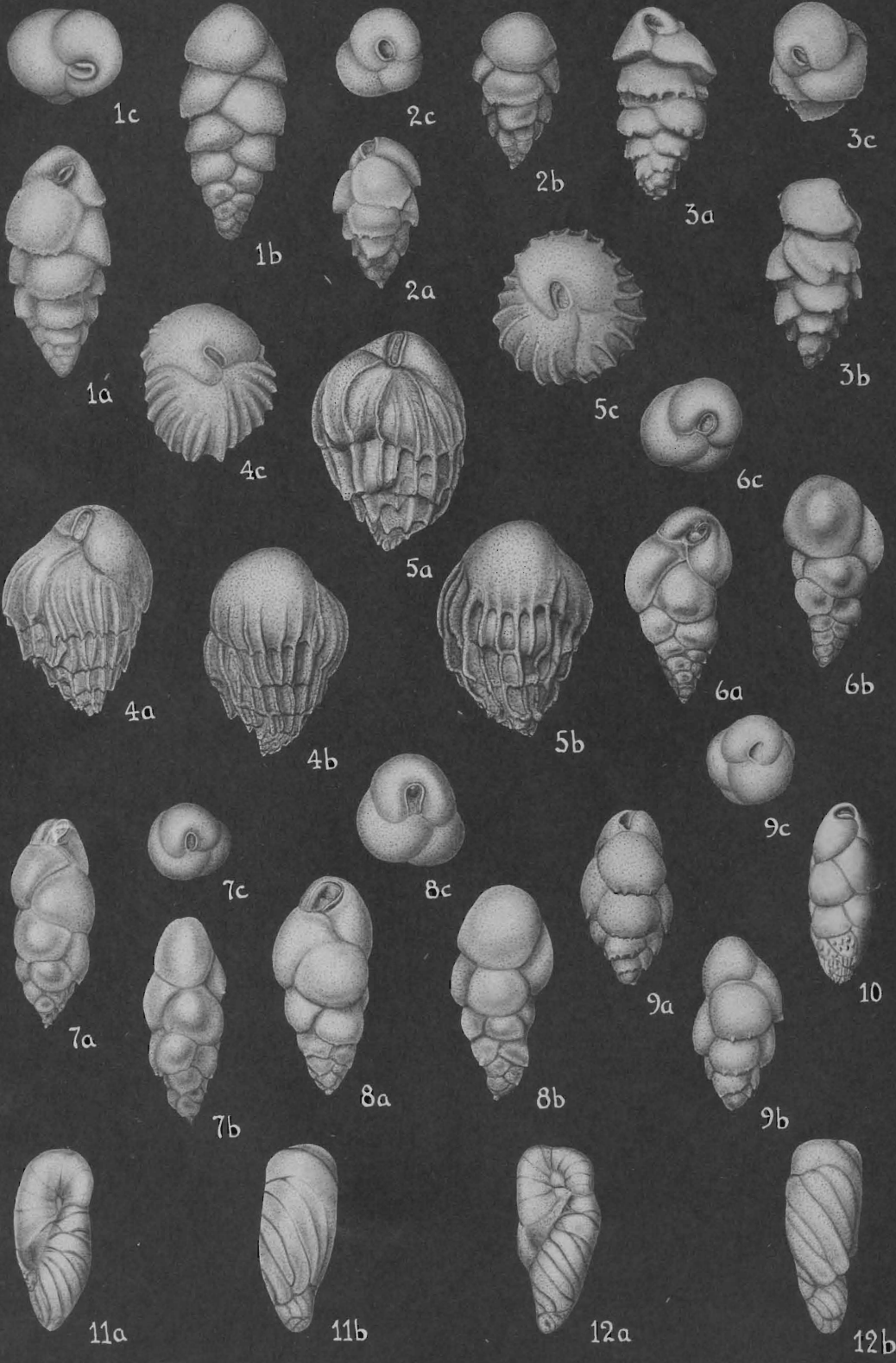
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8c
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8a
8b
9b
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11a
11b
12a
12b

PLIOCENE BULIMINAS

Bulimina semistriata d'Orbigny (Ann. Sci. Nat., vol. 7, 1826, p. 270, No. 15.—Fornasini, Boll. Soc. Geol. Ital., vol. 20, 1901, p. 176, text fig. 2). This is evidently the same as *B. ovata* d'Orbigny. Specimens we have from the Pliocene of Castel Arquato are identical with the Miocene ones from the Vienna Basin. Fine lines suggestive of striae can be seen in specimens from both localities.

Bulimina acanthia Costa (Atti Accad. Pont., vol. 7, 1856, pt. 2, p. 335, pl. 13, figs. 35, 36). The figure resembles the young stage of *B. marginata* d'Orbigny.

Bulimina acicula Costa (l. c., p. 336, pl. 22, fig. 6 *a*, A). Probably one of the Polymorphinidae.

Bulimina acuta Costa (l. c., p. 336, pl. 13, fig. 25; pl. 22, fig. 8). A homonym of *B. acuta* Reuss, 1851.

Bulimina cylindracea Costa (l. c., p. 265, pl. 15, fig. 10).= *Virgulina*.

Bulimina ellipsoides Costa (l. c., p. 265, pl. 15, fig. 9). The figure is poor, but this may be a synonym of *B. ovata* d'Orbigny.

Bulimina mammillata Costa (l. c., p. 335, pl. 18, figs. 16 *a*, A,

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EXPLANATION OF PLATE 10

FIGS.

1, 2. *Bulimina pagoda* Cushman, var. *denudata* Cushman and Parker, n. var. × 70. Pliocene, Canada Seca, Ventura Co., California. 1, Holotype. 2, Paratype.

3. *B. pagoda* Cushman, var. *deformata* Cushman and Parker, n. var. × 70. Holotype. Pliocene, Humboldt Co., California.

4, 5. *B. inflata* Seguenza. × 70. 4, Pliocene, southern Spain. 5, Pliocene, Messina, Italy.

6–9. *B. etnea* Seguenza. .6-8, × 70. 9, × 50. 6, 7, 9, Pliocene, Sicily. 8, Pliocene, Castel Arquato, Italy.

10. *Buliminella curta* Cushman, var. *basispinata* R. E. and K. C. Stewart. × 45. Holotype. Pliocene, Kalorama Canyon, Ventura Co., California.

11, 12. *B. multicamera* Cushman and Parker, n. sp. × 75. Pliocene, Castel Arquato, Italy. 11, Holotype. 12, Paratype. *a*, *a*, front views; *b*, *b*, rear views.

Unless otherwise noted, *a*, front view; *b*, rear view; *c*, apertural view.

Illustrations by Ann Shepard.

B). We have found no specimens referable to this species.

Bulimina pedunculata Costa (l. c., p. 334, pl. 18, figs. 13, 16 A, B). Indeterminate, but figure suggests that this may be a *Guttulina*.

Bulimina "peucetiae affinis" Costa (l. c., p. 336, pl. 18, figs. 15 *a*, A, B). Probably not a *Bulimina*.

Bulimina pitecusana Costa (l. c., pl. 15, fig. 5). Not described, figure inadequate for identification.

Bulimina pustulosa Costa (l. c., p. 264, pl. 15, figs. 6, 8). The figure somewhat resembles *Dorothia gibbosa* (d'Orbigny), but drawn as though perforate. Not identifiable.

Bulimina rhomboidalis Costa (l. c., pl. 13, fig. 24). Probably a *Uvigerina* or *Angulogerina*.

Bulimina affinis d'Orbigny, var. *striatula* Egger (Jahr. 16, Nathist. Ver. Passau, 1895, pl. 4, fig. 5). The figure is very poor, but suggests that it may be a synonym of *B. ovata* d'Orbigny.

Pleistocene Buliminas

Bulimina spinosa Seguenza (Atti Accad. Gioenia Sci. Nat., ser. 2, vol. 18, 1862, p. 23, pl. 1, figs. 8, 8 *a*). We have no available topotype material of this species. It somewhat resembles *B. elongata* d'Orbigny, var. *subulata* Cushman and Parker.

Bulimina minutissima J. Wright (In Reade, Proc. Liverpool Geol. Soc., vol. 9, 1902, p. 190, pl. 15, figs. 9-12). This is probably a *Ceratobulimina*.

NO. 197. THREE NEW ROTALIFORM FORAMINIFERA FROM THE LOWER OLIGOCENE AND UPPER EOCENE OF ALABAMA

By J. A. Cushman and J. B. Garrett

The following three species seem to be undescribed. They are useful as index fossils particularly for subsurface work in the Gulf Coastal Region of the United States.

LOCALITY DATA

Garrett Locality No. 30. Quarry of the Lone Star Cement Co., at St. Stephens Bluff, on the Tombigbee River, near St. Stephens, Alabama, very fossiliferous marl bed about 3 feet thick lying at base of about 80 feet of chalky Marianna limestone. This marl bed overlies a 10 foot bed of dark gray clay. Red Bluff, Oligocene age.

Garrett Locality No. 69. South side of a gullied hill lying about ¼ mile south of the site of old Cocoa Post Office, Choctaw Co., Alabama. This is about 2.5 miles east of Melvin, Alabama, on the road to Water Valley, and is the area in which Dr. C. Wythe Cooke collected. About 15 feet of ferruginous, very fossiliferous, Red Bluff clay is exposed near the top of the hill, with about 40 feet of light greenish-gray upper Jackson clays beneath.

Sample No. 69-E. Tan mottled clay just above base of Red Bluff Oligocene.

Sample No. 69-F. Light greenish-gray clay—lies stratigraphically 5 feet below No. 69-E. Uppermost Jackson Eocene age.

DISCORBIS COCOAENSIS Cushman and Garrett, n. sp. (Pl. 11, fig. 1)

Discorbis subaraucana CUSHMAN 1935 (not 1922), U. S. Geol. Survey Prof. Paper 181, 1935, p. 43, pl. 18, figs. 1 *a-c.*

Test somewhat unequally biconvex, dorsal side more convex than the ventral, ventral side slightly convex toward the periphery with the central part flattened or even slightly concave, umbilicate, periphery rounded; chambers 6 or 7 in the adult whorl, rapidly increasing in size as added, later ones slightly inflated; sutures curved, earlier ones strongly limbate, later ones slightly depressed; wall distinctly perforate; aperture low, extending from the periphery to the umbilicus, with a slight lip. Diameter 0.50-0.60 mm.; thickness 0.15-0.20 mm.

Holotype (Cushman Coll. No. 24690) from light greenish-gray clay, of uppermost Jackson Eocene age, south side of gullied hill about ¼ mile south of site of old Cocoa Post Office, Choctaw Co., Alabama. Garrett Locality 69-F.

This is distinct from the Recent species described from the Tortugas region of Florida. It differs from *Discorbis ocalana* Cushman in the larger number of chambers, distinctly limbate sutures, and conspicuously perforate wall.

Discorbis cocoaensis is diagnostic of upper Jackson Eocene

age, and is restricted to a thin zone at the very top of the Jackson.

CIBICIDES PIPPENI Cushman and Garrett, n. sp. (Pl. 11, fig. 2)

Test plano-convex, dorsal side flattened except the middle portion which is slightly umbonate, ventral side strongly convex, periphery strongly convex particularly toward the margin, somewhat flattened over the umbilical region; periphery subacute, with a distinct, thickened keel; chambers numerous, 11 or more in the adult whorl, increasing gradually in size as added, on the ventral side increasing gradually in breadth, but only slightly if at all in height, on the dorsal side increasing slightly in height but actually decreasing in breadth in the adult whorl, not inflated; sutures distinct, limbate throughout, on the ventral side gently curved in the earlier portion, becoming more strongly so in the later chambers, ending in a thickened area over the umbilical region, on the dorsal side strongly oblique in the earlier portion, becoming less oblique but somewhat sigmoid later, the inner end fusing in a raised border above the aperture; wall coarsely perforate; aperture extending from the periphery over onto the dorsal side. Diameter 0.80 mm.; thickness 0.30 mm.

Holotype (Cushman Coll. No. 24691) from marl bed of Red Bluff, lower Oligocene age, Quarry of Lone Star Cement Co., at St. Stephens Bluff, on Tombigbee River, near St. Stephens, Alabama. Garrett Locality No. 30.

This species is diagnostic of the Vicksburg Oligocene of the Gulf Coastal region. It occurs rarely in the Byram marl, but is common in the Marianna limestone and Red Bluff clay where it

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EXPLANATION OF PLATE 11

FIG.

1. *Discorbis cocoaensis* Cushman and Garrett, n. sp. × 45. Holotype.
2. *Cibicides pippeni* Cushman and Garrett, n. sp. × 38. Holotype.
3. *C. cookei* Cushman and Garrett, n. sp. × 38. Holotype.
4. *Pulvinulinella glabrata* Cushman, n. sp. × 115. Holotype.
5. *P. navarroana* Cushman, n. sp. × 60. Holotype.
6. *Globotruncana cretacea* Cushman, n. sp. × 90. Holotype.

In all figures, *a*, dorsal view; *b*, ventral view; *c*, peripheral view.

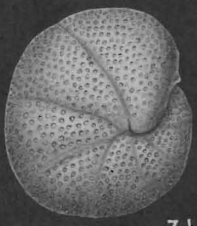
Illustrations by Ann Shepard.

1b

1c

1a

2a



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is one of the commonest fossils. The species like others of the genus is variable, but holds its specific characters well. It is not easily confused with other species of the genus in the Vicksburg Oligocene. It also occurs at Locality 69-E.

The species differs from *C. pseudoungerianus* (Cushman) in the larger number of chambers and more strongly limbate sutures.

CIBICIDES COOKEI Cushman and Garrett, n. sp. (Pl. 11, fig. 3)

Test unequally biconvex, dorsal side only slightly convex, ventral side strongly so, slightly if at all umbilicate on the ventral side, periphery rounded to subacute; chambers distinct, little if at all inflated, 7 to 8 in the adult whorl, increasing slowly in size on the dorsal side, more rapidly on the ventral side; sutures on the dorsal side strongly limbate, not depressed, strongly oblique, on the ventral side nearly radial, slightly curved, the last ones very slightly depressed, earlier ones somewhat limbate; wall very coarsely perforate, otherwise smooth; aperture peripheral, extending over onto both the ventral and dorsal sides, on the dorsal side with a slightly raised lip. Diameter 0.80 mm.; thickness 0.40 mm.

Holotype (Cushman Coll. No. 24692) from marl bed of Red Bluff, lower Oligocene age, Quarry of Lone Star Cement Co., at St. Stephens Bluff on Tombigbee River, near St. Stephens, Alabama. Garrett Locality No. 30.

This species differs from *C. lobatulus* (Walker and Jacob) as identified in the Jackson Eocene in the more rounded periphery,

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EXPLANATION OF PLATE 12

FIG.

1. *Anomalina semicomplanata* Cushman, n. sp. × 60. Holotype.
2. *Planulina austinana* Cushman, n. sp. × 55. Holotype.
3. *P. texana* Cushman, n. sp. × 48. Holotype.
4. *P. spissocostata* Cushman, n. sp. × 60. Holotype.
5. *Cibicides stephensoni* Cushman, n. sp. × 55. Holotype.
6. *C. berryi* Cushman, n. sp. × 68. Holotype.

In all figures, *a*, dorsal view; *b*, ventral view; *c*, peripheral view.

Illustrations by Ann Shepard.

more distinct and limbate sutures, and more convex dorsal side.

It has a range similar to that of *C. pippeni* and is diagnostic of the Vicksburg, occurring in the Marianna limestone and Red Bluff clay, but not, so far as seen, occurring in beds younger than the Marianna. It is not so common as *C. pippeni.* It also occurs at Garrett Locality 69-E.

NO. 198. SOME NEW SPECIES OF ROTALIFORM FORAMINIFERA FROM THE AMERICAN CRETACEOUS

By JOSEPH A. CUSHMAN*

The following species are placed on record so as to be available for workers on our American Cretaceous foraminifera preceding the publication of the work on the Cretaceous now nearly completed.

PULVINULINELLA GLABRATA Cushman, n. sp. (Pl. 11, fig. 4)

Test very small, trochoid, biconvex, ventral side umbilicate, periphery subacute; chambers distinct, about 6 in the adult whorl, of uniform shape, increasing very gradually in size as added, not inflated; sutures on the dorsal side slightly limbate, strongly oblique, very slightly curved, not depressed, on the ventral side nearly radial, slightly depressed; wall smooth and polished; aperture elongate, elliptical, in the axis of coiling, ventrally just below the periphery. Diameter 0.20-0.25 mm.; height 0.10 mm.

Holotype (Cushman Coll. No. 24648) from the Navarro group, Corsicana marl, ¼ mile W. of Kimbro, 2 miles S. of Manda, Travis Co., Texas.

The species occurs with a general Navarro range with a single record from the upper Taylor. It differs from *Pulvinulinella texana* Cushman in having no keel, fewer chambers, umbilicate ventral side and polished surface.

PULVINULINELLA NAVARROANA Cushman, n. sp. (Pl. 11, fig. 5)

Test biconvex, trochoid, periphery acute with a distinct keel; chambers fairly distinct, about 10 in the adult whorl, of rather

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uniform shape, increasing very gradually in size as added, not inflated; sutures distinctly limbate, strongly oblique on the dorsal side, ventrally nearly radial, somewhat sigmoid, ending in a clear umbonal area at the center; wall distinctly perforate, slightly granular; aperture narrow, elongate, in the plane of coiling, just ventral to the periphery. Diameter 0.50-0.55 mm.; height 0.20-0.22 mm.

Holotype (Cushman Coll. No. 24649) from the Navarro group, basal part of Kemp clay, branch of Mustang Creek, 1 mile WSW. of Noack, 900 feet downstream from road, Williamson Co., Texas.

The distribution of this species seems to be confined to the Navarro. It differs from *Pulvinulinella texana* Cushman in the larger number of chambers, and more distinctly limbate sutures which tend to become sigmoid on the ventral side, and much straighter on the dorsal side.

GLOBOTRUNCANA CRETACEA Cushman, n. sp. (Pl. 11, fig. 6)

Globotruncana arca CUSHMAN (not 1926), Tennessee Div. Geology Bull. 41, 1931, p. 59, pl. 11, figs. 6 *a-c*.—PLUMMER, Bull 3101, Univ. Texas, 1931, p. 195, pl. 13, figs. 7-9, 11.—CUSHMAN, Geol. Soc. America Bull., vol. 47, 1936, p. 419, pl. 1, figs. 14 *a-c*.—LOETTERLE, Nebraska Geol. Survey Bull., 2d ser., Bull. 12, 1937, p. 47, pl. 7, figs. 8 *a*, *b*.

Test plano-convex, dorsal side flattened, slightly convex or even slightly concave, ventral side convex, usually strongly so, periphery usually with a single keel, somewhat lobulate; chambers distinct, in the last-formed ones almost semicircular in dorsal view, slightly overlapping, ventrally somewhat inflated, the side in the later chambers often becoming more than 45°; sutures very distinct, dorsally strongly curved, conspicuously beaded and raised, ventrally slightly depressed; wall smooth and conspicuously but finely perforate over the chambers, but the border of each chamber raised, and the periphery somewhat spinose; sutures on the dorsal side beaded; aperture ventral, opening into the umbilical cavity which is often partially covered by a thin plate-like structure. Diameter 0.40-0.65 mm.; thickness 0.15-0.35 mm.

Holotype (Cushman Coll. No. 15253) from Selma chalk, 1½ miles W. of Sardis on Sardis-Henderson road, Henderson Co., Tennessee.

This species differs from *G. arca* (Cushman) in the fewer chambers in the whorl, flatter dorsal side, typically more convex

ventral side, more definitely oblique sides to the chambers on the ventral side, and differently shaped chambers.

The species like others of the genus is very variable, but is usually easily distinguished from the others of our Upper Cretaceous. It is often abundant in the Austin chalk and Taylor marl and ranges upward into the Neylandville marl, basal formation of the Navarro group.

ANOMALINA SEMICOMPLANATA Cushman, n. sp. (Pl. 12, fig. 1)

Anomalina complanata CUSHMAN (not REUSS), Tennessee Div. Geology Bull. 41, 1931, p. 60, pl. 11, figs. 7 *a-c*.—SANDIDGE, Amer. Mid. Nat., vol. 13, 1932, p. 368, pl. 31, figs. 30, 31.

Test planispiral, at least in the adult, much compressed, periphery subacute, earlier coils exposed on both sides at the center; chambers numerous, increasing very slowly in size as added, of nearly uniform shape, the later ones tending to become slightly inflated; sutures distinct, little if at all depressed, slightly limbate; wall smooth but conspicuously perforate, with a slight thickening in the central region at each side; aperture peripheral, extending slightly onto the dorsal side, with a slight lip. Diameter 0.50-0.65 mm.; thickness 0.15-0.18 mm.

Holotype (Cushman Coll. No. 15254) from Ripley (?) formation, 1½ miles W. of Sardis on Sardis-Henderson Road, Henderson Co., Tennessee.

A study of topotypes of *A. complanata* Reuss shows that it is a very different species from our American one. *A. semicomplanata* differs in having a subacute instead of very acute periphery, and in being much more umbonate.

In our material the species seems to be largely limited to the upper part of the Taylor marl and the Neylandville marl of the lower Navarro.

PLANULINA AUSTINANA Cushman, n. sp. (Pl. 12, fig. 2)

Test very much compressed, partially evolute on both sides, particularly so on the dorsal side, which is very slightly umbonate, ventral side slightly umbilicate, periphery subacute, lobulate; chambers distinct, somewhat inflated, of uniform shape, increasing very gradually in size as added, 8 to 10 in the adult whorl; sutures distinct, only slightly curved on the dorsal side, ventrally nearly radial, slightly depressed; wall smooth, finely but con-

spicuously perforate; aperture a low opening at the base of the last-formed chamber at the periphery, and extending over along the dorsal side. Diameter 0.50-0.55 mm.; thickness 0.18-0.22 mm.

Holotype (Cushman Coll. No. 24650) from lower part of Austin chalk, road cut, S. side U. S. highway 80, 2 feet above sidewalk, opposite Catholic School, 3.8 miles W. of Union Station, Dallas, Dallas Co., Texas.

The species seems to be limited to the Austin chalk. It differs from *P. taylorensis* (Carsey) Cushman in its smaller size, more lobulate periphery, more depressed sutures and lack of a peripheral keel.

PLANULINA TEXANA Cushman, n. sp. (Pl. 12, fig. 3)

Test much compressed, dorsal side usually flattened but with a central boss, partially evolute, ventral side somewhat less evolute, more convex, periphery subacute, not keeled; chambers distinct, especially those of the last whorl, strongly limbate, slightly raised, thickened toward the inner end, gently curved; wall finely but distinctly perforate, generally smooth except in the center where there is usually a raised, spiral ridge on the ventral side; aperture a narrow slit with a slightly overhanging lip. Diameter 0.55-0.65 mm.; thickness 0.18-0.22 mm.

Holotype (Cushman Coll. No. 24651) from lower part of the Taylor marl, N. fork of Sulphur Creek, 2.3 miles SE. of Gober, Fannin Co., Texas.

This species differs from *Planulina taylorensis* (Carsey) of which it may be the ancestral form, in the smaller size, less keeled and less lobulated periphery, sutures more ornamented, and the apertural lip less well developed. *P. texana* is characteristic of the Austin chalk and lower part of the Taylor marl.

PLANULINA SPISSOCOSTATA Cushman, n. sp. (Pl. 12, fig. 4)

Test trochoid, generally plano-convex, dorsal side flattened or even concave in the center, ventral side slightly convex but often somewhat umbilicate in the center, periphery subacute, somewhat evolute on the dorsal side, mostly involute on the ventral side; chambers of the last whorl distinct, those of the earlier whorls obscure, usually 14 to 16 in the final whorl, not inflated, the outer margin strongly raised and thickened on both sides, but more strongly so on the dorsal side, of rather uniform shape and

increasing very gradually in size as added; sutures of the last whorl distinct, others obscure, strongly curved; wall distinctly perforate, smooth except for the thickened margins of the chambers which form rounded, raised ridges; aperture a low opening at the inner margin of the last-formed chamber. Diameter 0.40-0.45 mm.; thickness 0.17-0.20 mm.

Holotype (Cushman Coll. No. 24652) from upper part of Taylor marl, 2.6 miles E. of Barry, on road to Corsicana, Navarro Co., Texas.

This species is close to *Anomalina clementiana* d'Orbigny, but differs in having the raised portions more prominent, a larger number of chambers, and a more acute periphery.

So far as seen in our material, this species is confined to the upper part of the Taylor marl and the Neylandville marl of the lower Navarro.

CIBICIDES STEPHENSONI Cushman, n. sp. (Pl. 12, fig. 5)

The types are from the Coon Creek tongue of the Ripley formation, Dave Weeks' place on Coon Creek, 3½ miles S. of Enville, 7½ miles N. of Adamsville and ⅛ mile E. of main Hendersonville—Adamsville road, McNairy Co., Tennessee. The holotype is redrawn on our plate.

Test trochoid, much compressed, dorsal side flattened or even slightly concave except for the slightly raised umbo, ventral side somewhat convex also with a central umbo surrounded by a deep groove, periphery subacute; chambers of the last whorl distinct, slightly inflated, 10 to 12 in the adult whorl, of rather uniform shape, increasing gradually in size as added; sutures on the dorsal side somewhat limbate, sometimes slightly raised, curved, ventrally slightly depressed; wall smooth, finely but distinctly perforate; aperture a low opening at the base of the last-formed chamber, with a slight lip. Diameter 0.55-0.65 mm.; thickness 0.27-0.30 mm.

Holotype (Cushman Coll. No. 24653) from the part of the Selma chalk equivalent in age to the Pecan Gap chalk member of the Taylor marl, upper end of bluff on Tombigbee River at Demopolis, Alabama.

This species differs from *Cibicides harperi* Sandidge in the smaller size, the more definitely raised costae, and the less acute periphery.

It occurs most commonly in the upper part of the Taylor marl, especially common in the Pecan Gap chalk member and ranging upward to the Neylandville marl and Saratoga chalk formations of the lower part of the Navarro group.

CIBICIDES BERRYI Cushman, n. sp. (Pl. 12, fig. 6)

Truncatulina coonensis W. BERRY, in Berry and Kelley, Proc. U. S. Nat. Mus., vol. 76, Art. 19, 1929, p. 12, pl. 3, figs. 1-3.

"Test free, biconvex, dorsal side less convex than ventral, peripheral margin slightly rounded and slightly subcarinate, chambers numerous, 9 to 10 in the last coil, involute on ventral side, sutures depressed, slightly distinct, wall punctate; aperture an arched opening at the base of the last formed chamber with a slit extending under the dorsal margin of the chambers."

"Diameter, 0.35 mm."