

CONTRIBUTIONS FROM THE CUSHMAN  
LABORATORY FOR FORAMINIFERAL RESEARCH

230. AMERICAN UPPER CRETACEOUS FORAMINIFERA  
BELONGING TO ROBULUS AND RELATED GENERA\*

By JOSEPH A. CUSHMAN

There are very abundant specimens throughout our Coastal Plain Cretaceous that are to be referred to *Robulus*, *Lenticulina*, or *Planularia*. These forms are, however, very difficult to work with as we do not have sufficient data to know what allowances should be made for variation. That these forms are very variable is certain, and the microspheric and megalospheric forms show very considerable differences. Some of the more striking species are evidently relatively restricted in their ranges, and it is, therefore, to be suspected that if all the species could be clearly defined after a study of abundant, well-preserved material, they would be useful as index fossils. A very few of the species are noted here, mainly those that have hitherto been recorded and figures of these are given. The many other forms have been left until further detailed study of the variations may be made by someone who may make comparisons with the many named European species.

Family LAGENIDAE

Genus ROBULUS Montfort, 1808

ROBULUS NAVARROENSIS (Plummer) (Pl. 15, fig. 1)

*Cristellaria navarroensis* PLUMMER, Univ. Texas Bull. 2644, 1927, p. 39,  
text fig. 4.

Test close-coiled throughout, thickness about  $\frac{1}{3}$  the diameter, umbonate, the distinctly limbate sutures fusing with the central boss, often slightly raised, periphery with a broad, thin keel; chambers 10 to 12 in number, very distinct, of uniform shape and very gradually increasing in size; sutures very distinct, limbate, curved; wall smooth, except that the sutures are often slightly raised near the umbo; aperture radial, with a ventral enlarged

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slit on the apertural face. Diameter 1.00 mm. or more; thickness at umbo about 0.35 mm.

This species is a characteristic one of the Navarro group especially above the Nacatoch sand. It is often very abundant. It is somewhat variable as is usual in species of this genus. The young stages are more easily confused with those of other species. It apparently grades into the following variety that occurs with it, particularly in the Corsicana marl.

**ROBULUS NAVARROENSIS** (Plummer), var. **EXTRUATUS** Cushman (Pl. 15, fig. 2)

*Robulus navarroensis* (PLUMMER), var. *extruatus* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 14, 1938, p. 31, pl. 5, fig. 1.

Variety differing from the typical in the sutures, which instead of fusing into the smooth umbo, are much raised, forming thickened ridges, especially at the inner ends, and the whole test tending slightly to uncoil.

The types of the variety are from the Corsicana marl of the Navarro group, Mexia highway at forks of Wortham road, 2.8 miles ESE. of Cooledge, Limestone Co., Texas.

This seems to be a varietal form of *R. navarroensis* and has a distinct keel. It also tends toward *R. spisso-costatus* in its ornamentation and may be a stage between the two. It is best developed in the Corsicana marl.

**ROBULUS PONDI** Cushman (Pl. 15, fig. 4)

*Robulus pondi* CUSHMAN, Tenn. Div. Geol., Bull. 41, 1931, p. 25, pl. 2, fig. 9.

Test of medium size for the genus, flattened at the umbos, close-coiled or occasionally becoming somewhat uncoiled, periphery with knob-like angles, slightly nodose, the interval between, slightly concave; chambers numerous, 10 to 12 in the final coil, distinct, of uniform shape and very slightly increasing in size as added; sutures distinct, nearly tangential, slightly curved, not noticeably depressed; wall smooth; aperture radiate, with usually a circular opening in addition on the upper end of the ventral face. Diameter up to 1.10 mm.

The types of this species are from the Selma chalk, 11½ miles W. of Sardis, on Sardis-Henderson road, Henderson Co., Tenn. It is most closely related to *R. nodosus* (Reuss) from the Cretaceous of Europe, but the nodes are much less developed and the number of chambers usually greater.

It seems to be a species characteristic of the upper Taylor and lower Navarro, represented especially in the Selma chalk of Tennessee. A few specimens apparently very close to this occur in the Prairie Bluff chalk and in the Arkadelphia marl.

**ROBULUS SPISSEO-COSTATUS** Cushman (Pl. 15, fig. 3)

*Robulus spisso-costatus* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 14, 1938, p. 32, pl. 5, fig. 2.

Test much compressed, close-coiled except toward the end in the adult, where it may become slightly evolute and expose the inner portion of the preceding coil, periphery subacute or with a slight, rounded keel; chambers numerous, 9 to 12 in the adult, increasing very gradually in size as added, of rather uniform shape throughout; sutures very distinct, curved, more strongly so toward the periphery, limbate, strongly raised, becoming thick and rounded toward the inner end and covering the umbo; wall, except for the raised sutures, smooth; aperture radiate, at the outer angle, with a supplementary slit ventrally. Diameter 1.00-1.65 mm.; thickness 0.45-0.55 mm.

The types of this species are from the Corsicana marl of the Navarro group, Mexia highway at forks of Wortham road, 2.8 miles ESE. of Cooledge, Limestone Co., Texas.

This species is a characteristic one of the upper part of the Navarro above the Nacatoch sand. It occurs in the Corsicana marl, Kemp clay, Arkadelphia marl, and also in the Prairie Bluff chalk and Selma chalk. It differs from *R. navarroensis* (Plummer) in not having a thin, flange-like keel and in the peculiarly raised sutures, becoming thick and rounded at the inner end.

**ROBULUS TAYLORENSIS** (Plummer) (Pl. 15, fig. 5)

*Astacolus taylorensis* PLUMMER, Univ. Texas Bull. 3101, 1931, p. 143, pl. 11, fig. 16; pl. 15, figs. 8-11.

*Cristellaria gibba* CARSEY (not D'ORBIGNY), Univ. Texas Bull. 2612, 1926 (1927), p. 37, pl. 5, fig. 4.

Test only moderately compressed, periphery subacute, but with only a slight keel, slightly evolute, particularly in the megalospheric form which tends to have one or two uncoiled chambers in rather rare adult forms, microspheric form more involute; chambers distinct, usually 8 or 9 in the adult whorl in the megalospheric form, 10 in the microspheric, increasing rather regularly in size as added, the last ones in the adult slightly inflated; sutures distinct, tangential, somewhat limbate, depressed

only in the last portion, very slightly if at all curved; wall smooth, translucent; aperture at the peripheral angle, radiate. Length 0.50-0.75 mm.; breadth 0.40-0.50 mm.; thickness 0.22-0.28 mm.

The type of this species is from the upper part of the Taylor marl near Taylor, Texas. In our material this species has occurred at a considerable number of stations, all in the Taylor marl, most of them in the lower portion, where, at some localities, it is very abundant. The occurrences in the upper part of the Taylor are rare. The species is somewhat closely related to *Marginalina stephensoni* Cushman. It is also related to the form described by Reuss as "*Cristellaria lituola*" from the Cretaceous of Bohemia.

**ROBULUS MÜNSTERI (Roemer) (Pl. 15, fig. 6)**

*Robulina münsteri* ROEMER, Verstein. norddeutsch. Oolith., Nachtrag, 1839, p. 48, pl. 20, fig. 29; Verstein. norddeutsch. Kreide, 1840-41, p. 98, pl. 15, fig. 30.

*Cristellaria münsteri* REUSS, Sitz. Akad. Wiss. Wien, vol. 46, 1862 (1863), p. 77, pl. 9, figs. 3, 4.

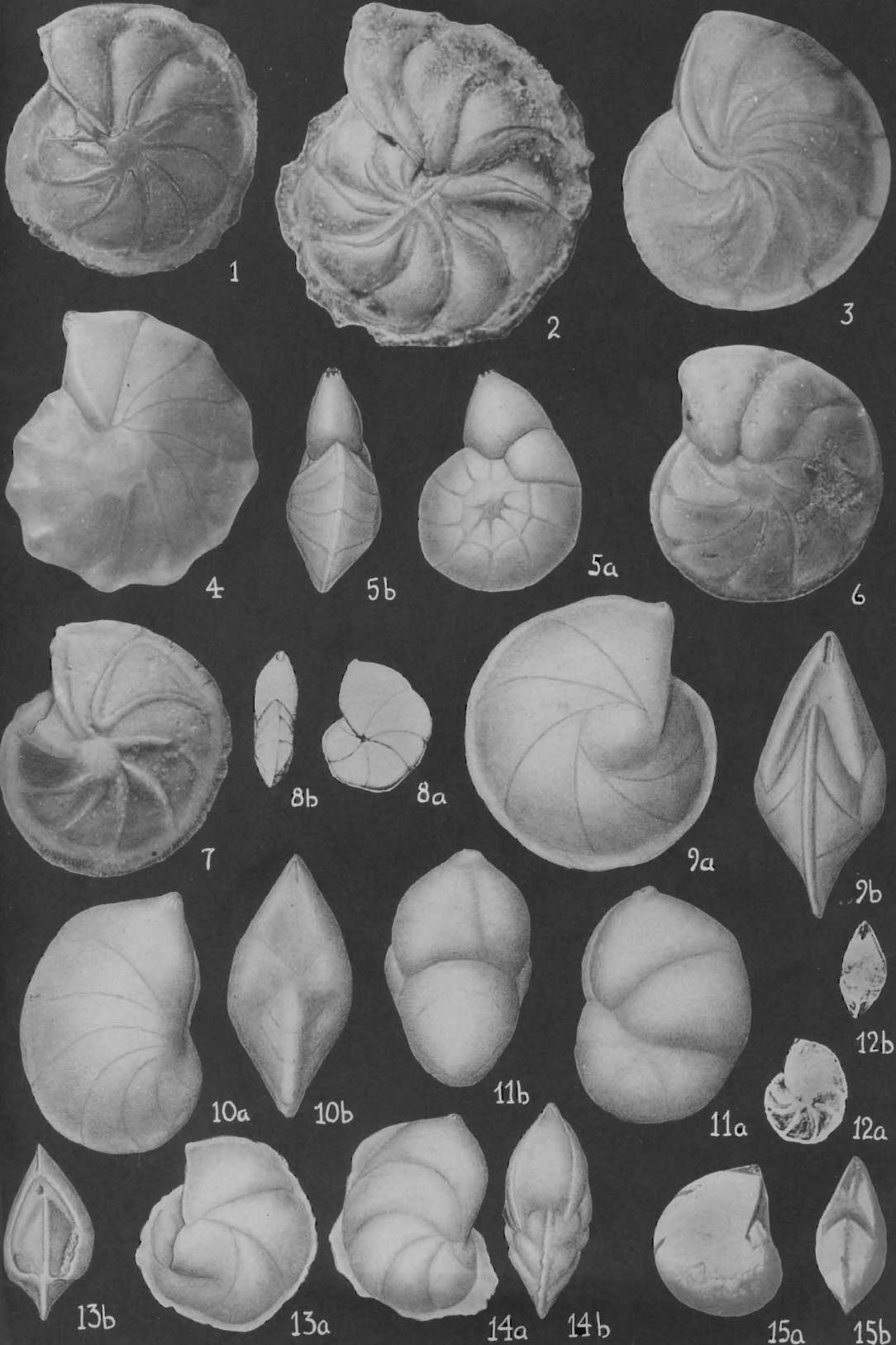
*Robulus münsteri* CUSHMAN, Journ. Pal., vol. 6, 1932, p. 334, pl. 50, fig. 2.

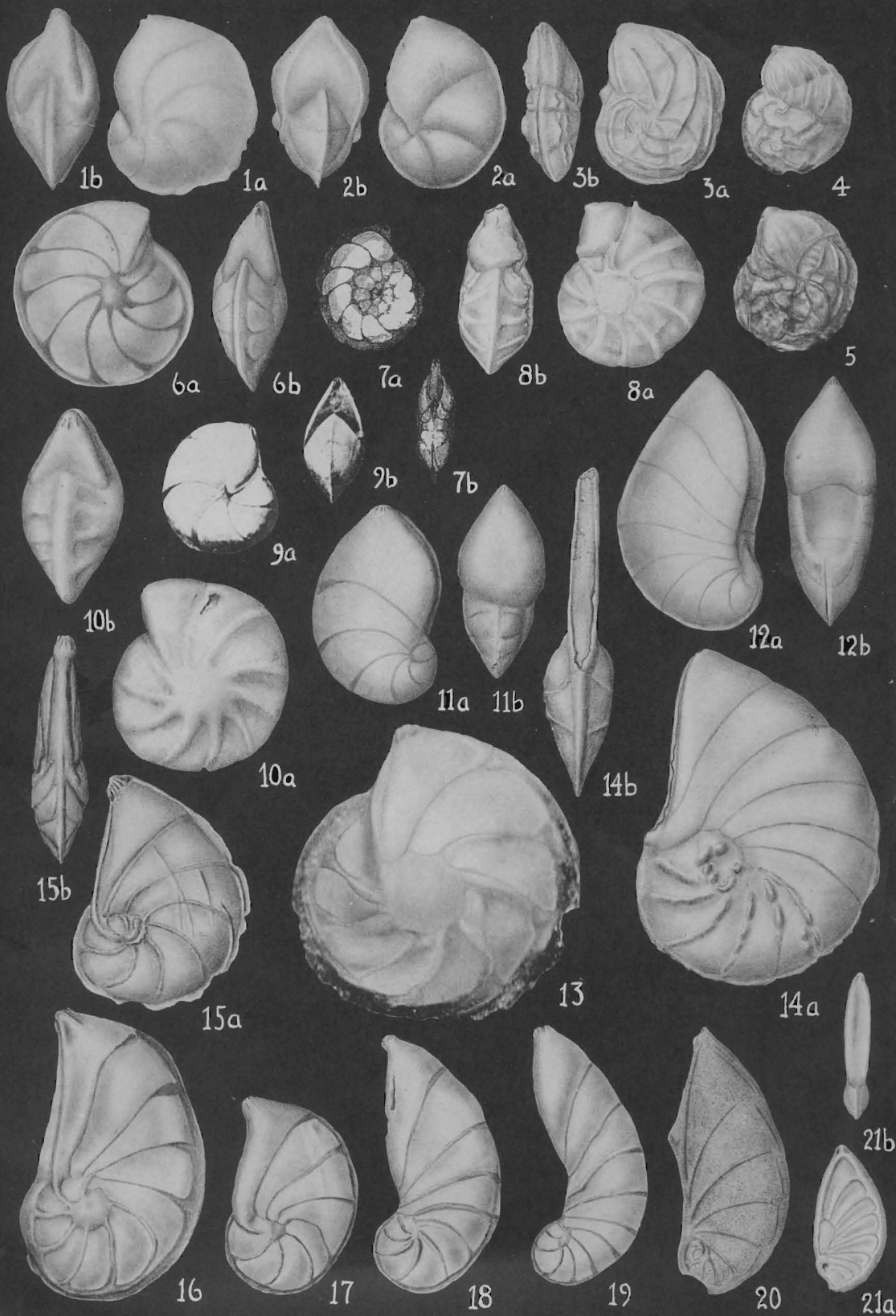
Test involute except for the last portion in the adult that may tend to become slightly evolute and show the preceding coil, compressed, umbonate, periphery sharply keeled; chambers distinct, of uniform shape and increasing very gradually in size, not in-

EXPLANATION OF PLATE 15

FIG. 1. *Robulus navarroensis* (Plummer). Corsicana marl, Travis Co., Tex. × 23. 2. *R. navarroensis* (Plummer), var. *extruatus* Cushman. Corsicana marl, Limestone Co., Tex. Holotype. × 20. 3. *R. spissocostatus* Cushman. Corsicana marl, Limestone Co., Tex. Paratype. × 23. 4. *R. pondi* Cushman. Upper Taylor marl, Milam Co., Tex. × 23. 5. *R. taylorensis* (Plummer). Lower Taylor marl, Fannin Co., Tex. × 33. 6. *R. münsteri* (Roemer). Ripley formation, Henderson Co., Tenn. × 30. 7. *R. pseudo-secans* Cushman. Selma chalk, Hardin Co., Tenn. × 23. 8. *R. isidis* (Schwager). Fort Hayes limestone, Nebraska. × 30. (After Loetterle.) 9. *R. macrodiscus* (Reuss). Cretaceous, Trinidad. × 25. (After Cushman and Jarvis.) 10. *R. discrepans* (Reuss). Cretaceous, Trinidad. × 25. (After Cushman and Jarvis.) 11. *R. oligostegius* (Reuss). Cretaceous, Trinidad. × 25. (After Cushman and Jarvis.) 12. *R. aldrichi* Sandidge. × 18. (After Sandidge.) 13. *R. sternalis* (Berthelin). Cretaceous, Trinidad. × 30. (After Cushman and Jarvis.) 14. *R. subalatus* (Reuss.) × 25. Cretaceous, Trinidad. (After Cushman and Jarvis.) 15. *R. alexanderi* Sandidge. × 25. (After Sandidge.)

In all figures: a, side view; b, peripheral view.





flated, 9 to 12 in the adult coil; sutures distinct, slightly limbate, tangential, slightly curved; wall smooth; aperture radiate, at the outer peripheral angle. Diameter up to 1.50 mm.; thickness 0.40-0.60 mm.

Specimens referred to this species occur in the upper and lower divisions of the Taylor marl and the upper portion of the Austin chalk of Texas and in the Selma chalk of Tennessee. There is considerable variation in this species if the specimens included really belong in one species.

**ROBULUS PSEUDO-SECANS** Cushman (Pl. 16, fig. 7)

*Robulus pseudo-secans* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 14, 1938, p. 32, pl. 5, fig. 3.

Test strongly umbonate, thence thinning to the periphery which is acute and keeled; chambers distinct, not inflated, 8 or 9 in the adult coil, of uniform shape, increasing gradually in size as added; sutures distinct, strongly limbate and raised, confluent with the highly rounded umbo, inner portion tangential, nearly straight, thence increasingly curved toward the periphery; wall, except for the raised portions, smooth; aperture radiate, at the peripheral angle. Diameter 1.00-1.40 mm.; thickness 0.65-0.80 mm.

The types are from Selma chalk, Jim Wilkin's property, 300 yards N. of Union Church, Hardin Co., Tenn. This somewhat resembles *R. secans* Reuss from the Gault of Europe, but has

EXPLANATION OF PLATE 16

FIGS. 1, 2. *Robulus williamsoni* (Reuss). × 30. 1, White chalk, Antigua, B. W. I. 2, Cretaceous, Trinidad. (After Cushman and Jarvis.) 3-5. *R. trinitatensis* Cushman and Jarvis. 3, Holotype. Cretaceous, Trinidad. × 45. (After Cushman and Jarvis.) 4, 5, Arkadelphia clay, Hempstead Co., Ark. 6. *R. stephensoni* Cushman. Holotype. × 20. Ripley formation, Henderson Co., Tenn. 7. *Lenticulina velascoensis* White. × 23. Velasco shale, Mexico. (After White.) 8. *L. kansasensis* Morrow. × 30. Fort Hays limestone, Kansas. Redrawn from holotype. 9. *L. jonesi* Sandidge. × 23. (After Sandidge.) 10. *L. sublaevis* Morrow. × 30. Fort Hays limestone, Kansas. Redrawn from holotype. 11. *L. navicula* (d'Orbigny). × 30. Cretaceous, Trinidad. (After Cushman and Jarvis.) 12. *L. nuda* (Reuss). × 42. Cretaceous, Trinidad. (After Cushman and Jarvis.) 13. *L. rotulata* Lamarck. × 23. Selma chalk, Union Co., Miss. 14. *Planularia advena* Cushman and Jarvis. × 12. Cretaceous, Trinidad. (After Cushman and Jarvis.) 15-19. *Planularia dissona* (Plummer). × 30. Corsicana marl, Limestone Co., Tex. Series showing stages in uncoiling. 20. *P. elongata* Ehrenberg. (After Ehrenberg.) 21. *P. tri-carinella* (Reuss). × 42. Pecan Gap chalk, Texas.

In all figures: a, side view; b, peripheral view.

fewer chambers and a smaller umbo. It differs from *Lenticulina kansasensis* in the same characters.

**ROBULUS ISIDIS (Schwager) (Pl. 15, fig. 8)**

*Robulus isidis* (SCHWAGER), LOETTERLE, Nebraska Geol. Survey Bull., 2nd ser., Bull. 12, 1937, p. 21, pl. 1, fig. 5.

Specimens from the Niobrara Cretaceous of Nebraska are referred to Schwager's species. The original material has not been seen and a copy of the figure given by Loetterle is illustrated on our plate.

**ROBULUS MACRODISCUS (Reuss) (Pl. 15, fig. 9)**

*Cristellaria macrodisca* REUSS, Sitz. Akad. Wiss. Wien, vol. 46, 1862 (1863), p. 78, pl. 9, fig. 5.—BERTHELIN, Mém. Soc. géol. France, ser. 3, vol. 1, 1880, p. 48, pl. 3 (26), figs. 6-11.

*Lenticulina macrodisca* WHITE, Journ. Pal., vol. 2, 1928, p. 198, pl. 28, fig. 7.

*Robulus macrodiscus* CUSHMAN and JARVIS, Proc. U. S. Nat. Mus., vol. 80, Art. 14, 1932, p. 23, pl. 7, fig. 3.—CUSHMAN, Bull. Geol. Soc. Amer., vol. 47, 1936, p. 416.

Specimens from the Upper Cretaceous of Trinidad and Mexico have been referred with some doubt to Reuss' species. Somewhat similar forms, with large prominent umbo and acute periphery which is often somewhat keeled, occurred in shales from the canyons of the Georges Bank.

**ROBULUS DISCREPANS (Reuss) (Pl. 15, fig. 10)**

*Robulina discrepans* REUSS, Sitz. Akad. Wiss. Wien, vol. 46, 1862 (1863), p. 78, pl. 9, fig. 7.

*Robulus discrepans* CUSHMAN and JARVIS, Proc. U. S. Nat. Mus., vol. 80, Art. 14, 1932, p. 23, pl. 7, fig. 4.

Specimens from the Upper Cretaceous, pit at Lizard Springs, near Guayaguayare, southeastern Trinidad, are referred to Reuss' species. The chambers are not inflated, but gradually increase in size as added. The periphery is subacute and the apertural face somewhat concave. The sutures are flush with the surface, strongly curved. The aperture has a supplementary slit in the median line of the apertural face.

**ROBULUS OLIGOSTEGIUS (Reuss) (Pl. 15, fig. 11)**

*Cristellaria oligostegia* REUSS, Sitz. Akad. Wiss. Wien, vol. 40, 1860, p. 213, pl. 8, fig. 8; vol. 46, 1862 (1863), p. 93, pl. 13, fig. 2.

*Robulus oligostegia* CUSHMAN and JARVIS, Proc. U. S. Nat. Mus., vol. 80, Art. 14, 1932, p. 22, pl. 6, figs. 8, 9.



Figures are given of a peculiar form referred to Reuss' species. It has a few tumid chambers, the later ones showing a slight tendency to uncoil and the aperture slightly protuberant. It is found in the Upper Cretaceous of Trinidad and in the Velasco shale of Mexico.

**ROBULUS STERNALIS** (Berthelin) (Pl. 15, fig. 13)

*Cristellaria sternalis* BERTHELIN, Mém. Soc. géol. France, ser. 3, vol. 1, 1880, p. 51, pl. 3 (26), fig. 2.

*Robulus sternalis* CUSHMAN and JARVIS, Proc. U. S. Nat. Mus., vol. 80, Art. 14, 1932, p. 22, pl. 6, fig. 11.

This species has been recorded from the Upper Cretaceous of Trinidad and similar forms occur in the Velasco shale of Mexico. There are but few chambers and a prominent umbo.

**ROBULUS WILLIAMSONI** (Reuss) (Pl. 16, figs. 1, 2)

*Cristellaria williamsoni* REUSS, Sitz. Akad. Wiss. Wien, vol. 44, 1861 (1862), p. 327, pl. 6, fig. 4.

*Lenticulina williamsoni* CUSHMAN and CHURCH, Proc. Calif. Acad. Sci., ser. 4, vol. 18, 1929, p. 503, pl. 36, figs. 13, 14.

*Robulus williamsoni* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 7, 1931, p. 37, pl. 5, fig. 2.—CUSHMAN and JARVIS, Proc. U. S. Nat. Mus., vol. 80, Art. 14, 1932, p. 22, pl. 6, fig. 7.

Figures are given of two slightly different forms from the Upper Cretaceous of Antigua and Trinidad that have been referred to Reuss' species.

**ROBULUS TRINITATENSIS** Cushman and Jarvis (Pl. 16, figs. 3-5)

*Robulus trinitatensis* CUSHMAN and JARVIS, Proc. U. S. Nat. Mus., vol. 80, Art. 14, 1932, p. 22, pl. 6, fig. 10.

Test close-coiled, compressed, periphery slightly keeled; chambers fairly distinct, 6 to 8 in number in the adult, not inflated; sutures fairly distinct, strongly curved, continuing into the umbilical region, strongly limbate, but not raised; wall ornamented by a series of obliquely curved costae, toward the periphery gradually becoming nearly parallel to the outer edge of the test, and continuous over the chambers; aperture at the peripheral angle, with a supplementary, elongate opening in the median line of the ventral face. Length 0.50 mm.; breadth 0.40 mm.; diameter 0.20 mm.

The types are from the Upper Cretaceous of Trinidad. This is a very interesting and unique species with its peculiar ornamentation, the heavy costae of the surface forming a continuous spiral

independent of the individual chambers. It is somewhat like *R. pseudo-costatus* (Plummer) from the lower Midway but is less ornate. A species very close to this, and perhaps identical, occurs in the Arkadelphia marl of Texas, and is here figured. This may be the ancestral form of the Midway species.

**ROBULUS SUBALATUS** (Reuss) (Pl. 15, fig. 14)

*Cristellaria subalata* REUSS, Denkschr. Akad. Wiss. Wien; vol. 7, 1854, p. 68, pl. 25, fig. 13; Sitz. Akad. Wiss. Wien, vol. 46, 1862 (1863), p. 76, pl. 8, fig. 10; pl. 9, fig. 1.

*Robulus subalatus* CUSHMAN and JARVIS, Proc. U. S. Nat. Mus., vol. 80, Art. 14, 1932, p. 23, pl. 7, figs. 1, 2.

Specimens from the Upper Cretaceous, pit at Lizard Springs, near Guayaguayare, southeastern Trinidad, have been referred to this species. Figures are given showing the forms that occur, one with the sutures slightly raised, the other without this character. Both forms have a very thin, broad keel.

**ROBULUS ALEXANDERI** Sandidge (Pl. 15, fig. 15)

*Robulus alexanderi* SANDIDGE, Amer. Midland Nat., vol. 13, 1932, p. 313, pl. 29, figs. 1, 2.

"Test close-coiled, strongly convex, peripheral margin subacute; apertural face triangular, slightly impressed; chambers few, 8 in number; sutures indistinct in early stages, very slightly raised between last few chambers, gracefully curving away from aperture, earlier apertures partially visible at periphery; wall smooth; aperture at the peripheral angle, radiate, with lower part extending as a slit into the apertural face. Diameter of holotype 0.70 mm."

The types of this species are from the Ripley formation of Bartons Bluff, on the Tombigbee River, Ala. The type figures of this species give little in the way of details.

**ROBULUS ALDRICHI** Sandidge (Pl. 15, fig. 12)

*Robulus aldrichi* SANDIDGE, Journ. Pal., vol. 6, 1932, p. 272, pl. 42, figs. 3, 4.

"Test close-coiled, somewhat elongate, moderately compressed, umbonate, peripheral margin distinct, bordered by a narrow rim, chambers gently curving, 8 or 9 in the last whorl, sutures limbate in early part of coil, later becoming smooth, curving outward from central boss; wall smooth; apertural face flat, triangular, bordered by a narrow rim; aperture at the apical angle, oval, with

a few radial striations around the peripheral edge, lower portion extending into the apertural face. Diameter of holotype, 0.70 mm.

"This remarkably characteristic representative of Montfort's early genus is closely related to *Cristellaria degolyeri* Plummer described from the Texas Midway. The rimmed, bead-like periphery, and the very definite variation in the type of the aperture are the chief means of differentiation. This occurrence of the robuline representative in the Ripley leads to speculation regarding the ancestry of the Midway form."

The types of this species are from the Ripley formation, lower part of Red Bluff, just north of the boundary between Wilcox and Dallas counties at the Alabama River, Ala.

**ROBULUS STEPHENSONI** Cushman (Pl. 16, fig. 6)

*Robulus navarroensis* CUSHMAN (not PLUMMER), Tenn. Div. Geol., Bull. 41, 1931, p. 25, pl. 2, fig. 8.

*Robulus stephensoni* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 15, 1939, p. 90, pl. 16, figs. 2, 3.

Test close-coiled throughout, somewhat umbonate, thence thinning to the acute, slightly keeled periphery, which has a narrow keel; chambers distinct, 8 to 10 in the adult coil, of rather uniform size and shape; sutures distinct, strongly limbate, slightly curved, not depressed; wall smooth and unornamented; aperture at the peripheral angle, radiate with a distinct, ventral slit. Diameter 2.00 mm. or more; thickness 0.35-0.65 mm.

The type is from Selma chalk, 1½ miles W. of Sardis, on Sardis-Henderson road, Henderson Co., Tenn. This species does not have as curved sutures, nor as well developed a keel as *R. navarroensis* (Plummer). There are fewer chambers, also. It seems to be an ancestral form of the Navarro species and occurs mostly below the Nacatoch sand.

**Genus LENTICULINA** Lamarck, 1804

The main distinction between this genus and *Robulus* is in the aperture. This is not always easily determined in poorly preserved fossil material and, therefore, the generic position of many species is difficult to determine. There are so many species already named in the European Cretaceous that a study of these is necessary before applying names to most of our American Cretaceous forms.

## LENTICULINA JONESI Sandidge (Pl. 16, fig. 9)

*Lenticulina jonesi* SANDIDGE, Journ. Pal., vol. 6, 1932, p. 273, pl. 42, figs. 1, 2.

"Test close-coiled, somewhat longer than broad, periphery acute, sometimes slightly keeled; chambers comparatively few, usually 6 to 8 in the last whorl, slightly curving, somewhat inflated; sutures gently curving lines, sometimes slightly impressed, especially between the last few chambers; wall smooth; apertural face rounded, not sharply truncate, triangular in its general shape; aperture at the peripheral angle, somewhat protruding, radiate. Diameter of holotype, 0.75 mm.

"This species has been established to care for the many forms occurring in the Ripley which resemble in their general appearance *L. gibba*, but which cannot be grouped with it because of their persistently different apertural face. Whereas *L. gibba* has a truncate apertural face with a rimmed margin, that of *L. jonesi* is inflated and rounded. It resembles in some respects Cushman's *L. d'orbigny*, but differs from that form in the shape of the apertural face, in having slightly curving chambers and sutures, and in being smaller. *Robulina subangulata* of Reuss is a closely related species, found in the Cretaceous of Europe, from which the Ripley form is differentiated only by the character of its aperture."

The types of this species are from the Ripley formation, basal beds at Rocky Bluff, 1 mile above Prairie Bluff on Alabama River, Ala.

A somewhat similar form occurs in the upper Taylor marl and lower Navarro of Texas, and, although I have not seen the types of this species, the two may be the same.

## LENTICULINA KANSASSENSIS Morrow (Pl. 16, fig. 8)

*Lenticulina kansasensis* MORROW, Journ. Pal., vol. 8, 1934, p. 189, pl. 30, fig. 23.—LOETTERLE, Nebraska Geol. Survey Bull., 2nd ser., Bull. 12, 1937, p. 22, pl. 1, fig. 6.

"Test involute, sides strongly convex, thickness almost half the diameter, periphery even, sharp; sutures limbate, curved, meeting the periphery obliquely, elevated into narrow, sharp ridges which die out before reaching the periphery, fusing at the center in a distinct boss; chambers 10 to 12 in final whorl; wall smooth except for the raised sutures; apertural face triangular, narrow, joining the preceding whorl in a sharp contact; aperture

elliptical, at the apex of the apertural face. Diameter of holotype, 0.76 mm.; thickness, 0.34 mm.

"*Lenticulina kansasensis* is distinguished from *L. sublaevis* by its stronger and more curved sutures, its slightly more compressed form, and its more elongate apertural face. The surface ornamentation is somewhat like that of *Cristellaria degolyeri* Plummer, a Midway species, but the Kansas species lacks a ragged keel and has several more chambers in the last whorl.

"This species is very common in the basal Niobrara and has been found at several localities but apparently does not occur in other members.

"Holotype from SE.  $\frac{1}{4}$  sec. 12, T. 12 S., R. 17 W., Ellis Co., Kansas."

The holotype has been redrawn on our plate. It is a partially eroded specimen and does not show the surface characters well. I have, therefore, hesitated to identify any of our Coastal Plain Cretaceous with this. The above description and notes are copied from the original. Loetterle records it from the Fort Hays limestone member of Niobrara formation of Kansas, Nebraska, and South Dakota.

LENTICULINA NAVICULA (d'Orbigny) (Pl. 16, fig. 11)

*Cristellaria navicula* D'ORBIGNY, Mém. Soc. géol. France, ser. 1, vol. 4, 1840, p. 27, pl. 2, figs. 19, 20.—REUSS, Verstein. böhm. Kreide., pt. 1, 1845, p. 34, pl. 12, fig. 27.

*Lenticulina navicula* CUSHMAN and JARVIS, Proc. U. S. Nat. Mus., vol. 80, Art. 14, 1932, p. 24, pl. 7, fig. 5.

d'Orbigny described this species from the Cretaceous chalks of the Paris Basin, and Reuss and others have recorded it from the Cretaceous of central Europe. Specimens from Trinidad and from the Velasco shale of Mexico seem to agree very well with those of Europe and may be identified with d'Orbigny's species. The chambers are distinct but not inflated, the periphery subacute, the sutures flush with the surface but strongly curved, and the apertural face convex without any supplementary slit, so that this species may be included in Lamarck's genus. There is a tendency in the later chambers toward uncoiling. The measurements of the figured specimen are as follows: length 0.90 mm.; breadth 0.55 mm.; thickness 0.40 mm.

## LENTICULINA NUDA (Reuss) (Pl. 16, fig. 12)

*Cristellaria nuda* REUSS, Sitz. Akad. Wiss. Wien, vol. 44, 1861 (1862), p. 328, pl. 6, figs. 1-3.

*Lenticulina nuda* CUSHMAN and JARVIS, Contr. Cushman Lab. Foram. Res., vol. 4, 1928, p. 96, pl. 14, fig. 2; Proc. U. S. Nat. Mus., vol. 80, Art. 14, 1932, p. 24, pl. 7, fig. 6.

Both in Trinidad and Mexico forms occur in the Upper Cretaceous that are referred to Reuss' species. There is apparently no supplementary aperture, and the form should probably be referred to *Saracenaria*.

## LENTICULINA SUBLAEVIS Morrow (Pl. 16, fig. 10)

*Lenticulina sublaevis* MORROW, Journ. Pal., vol. 8, 1934, p. 189, pl. 30, figs. 14, 20.—LOETTERLE, Nebraska Geol. Survey Bull., 2nd ser., Bull. 12, 1937, p. 22, pl. 1, fig. 7.

"Test relatively large, involute, sides equally and strongly convex, thickness about  $\frac{1}{2}$  the diameter, periphery simple, keeled or very sharply rounded; sutures limbate, gently curved, slightly raised, fusing at the center in a broad smoothly rounded boss; chambers 10 to 12 in final whorl; wall smooth except for the slightly raised sutures; apertural face triangular, convex, fusing into the outer wall of the preceding chamber; aperture circular, at the apex of the apertural face. Diameter of holotype 0.84 mm.; thickness 0.44 mm.

"There is some variation in the strength of the sutures, some specimens appearing almost smooth. *Lenticulina sublaevis* lacks the prominent, raised sutures shown by *L. kansasensis*, which makes the chambers less distinct and the sides of the test more nearly smooth. The sutures are usually not curved so strongly and meet the periphery at a higher angle than in our other species. *L. sublaevis* lacks the more complicated aperture of

## EXPLANATION OF PLATE 17

FIGS. 1, 2. *Uvigerina pigmea* d'Orbigny. 1 a, b, opposite sides. (After d'Orbigny.) 2, Model No. 67. 3. *U. pigmea* d'Orbigny, var. *asperula* A. Silvestri.  $\times 40$ . (After A. Silvestri.) 4. *U. striata* Costa. (After Costa.) 5. *U. gemmaeformis* Schwager. (After Schwager.) 6. *U. nitidula* Schwager. (After Schwager.) 7. *U. crassicosata* Schwager. (After Schwager.) 8. *U. hispida* Schwager. (After Schwager.) 9. *U. proboscidea* Schwager. (After Schwager.) 10. *U. rugulosa* Reuss. (After Reuss.) 11, 12. *U. trigona* Seguenza. 11, 12, opposite sides. (After Seguenza.) 13. *U. baccalis* Schwager. (After Schwager.) 14. *U. globosa* Karrer. (After Karrer.)



1a



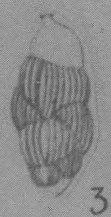
1b



4b



2



3



4a



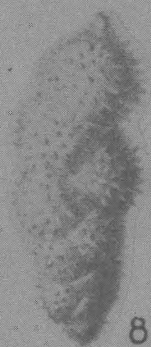
5



6



7



8



9



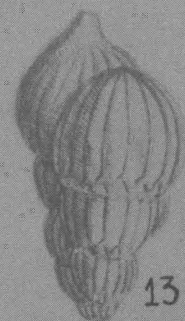
10



11



12



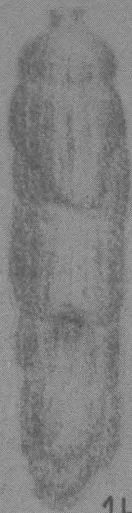
13



14



1a



1b



2a



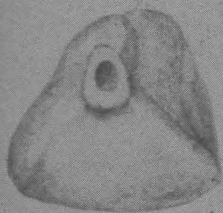
2b



3a



3b



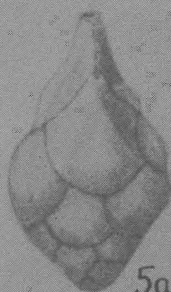
4b



5b



4a



5a



6



7



*Robulus*, thus making comparisons with species of this otherwise similar genus unnecessary.

"This species is also restricted to the basal Niobrara where it is common at several localities.

"Holotype from SE.  $\frac{1}{4}$  sec. 12, T. 12 S., R. 17 W., Ellis Co., Kans."

The holotype has been redrawn on our plate. There are numerous specimens in the lower part of our section that may be identical with this species, but they are often not well preserved in the more chalky formations. Loetterle records the species from the Fort Hays limestone member of Niobrara formation of Kansas, Nebraska, and South Dakota.

LENTICULINA ROTULATA Lamarck (Pl. 16, fig. 18)

Very many forms have been referred to Lamarck's species. From our Coastal Plain material, I have referred to this species those forms with a distinct umbo, slightly curved, tangential sutures, and usually a distinct keel. A number of figures are given on our plate which are referred here. Such forms are found in the basal Navarro, throughout the Taylor marl, and into the Austin chalk.

LENTICULINA VELASCOENSIS White (Pl. 16, fig. 7)

*Lenticulina velascoensis* WHITE, Journ. Pal., vol. 2, 1928, p. 199, pl. 28, fig. 8.

"Test flattened, lenticular, with depressed umbos of clear shell material, through which chambers of the inner whorls may be seen; usually about 10 chambers to the last volution; sutures flush, curved; periphery keeled, denticulate due to breaking; aperture oval, obscurely radiate. Diameter of type specimen 0.60 mm.; thickness 0.25 mm."

The types are from the Upper Cretaceous, Velasco shale, of Mexico.

EXPLANATION OF PLATE 18

FIG. 1. *Uvigerina bononiensis* Fornasini.  $\times 105$ . (After Fornasini.)  
 2. *U. uncinata* Mariani. (After Mariani.) 3. *U. canariensis* d'Orbigny, f. *distoma* DeAmicis.  $\times 43$ . (After DeAmicis.) 4. *Angulogerina hughesi* (Galloway and Wissler.)  $\times 135$ . a, side view; b, apertural view. (After Galloway and Wissler.) 5. *A. baggi* (Galloway and Wissler.)  $\times 80$ . a, side view; b, apertural view. (After Galloway and Wissler.) 6. *A. semitrigona* (Galloway and Wissler.)  $\times 93$ . (After Galloway and Wissler.) 7. *A. fijiensis* Cushman.  $\times 105$ . (After Cushman.)

Genus *PLANULARIA* DeFrance, 1824*PLANULARIA ADVENA* Cushman and Jarvis (Pl. 16, fig. 14)*Planularia advena* CUSHMAN and JARVIS, Proc. U. S. Nat. Mus., vol. 80, Art. 14, 1932, p. 24, pl. 8, figs. 1, 2.

Test large, much compressed, periphery acute and slightly keeled; chambers distinct, low and broad, uniformly increasing in breadth as added, but with the height remaining nearly the same throughout, the later ones becoming much elongate; sutures limbate, in the early portion raised and somewhat irregularly beaded, later becoming entirely so, and in the last-formed portion even slightly depressed; wall, except for the umbilicus, which is beaded, and the raised sutures, smooth; aperture at the peripheral angle, radiate. Length 5.00 mm.; breadth 3.00 mm.; thickness, in the umbonal region, 0.90 mm.; at the middle of the last-formed chamber, 0.35 mm.

The types are from Upper Cretaceous, pit at Lizard Springs, near Guayaguayare, southeastern Trinidad, where it is rather common.

This is a large and striking species with a distinctive ornamentation. The greatest breadth is formed early in the development of the test in the umbonal region, after which it becomes complanate and much thinner.

*PLANULARIA DISSONA* (Plummer) (Pl. 16, figs. 15-19)*Astacolus dissonus* PLUMMER, Univ. Texas Bull. 3101, 1931, p. 145, pl. 11, figs. 17, 18; pl. 15, figs. 2-7.*Cristellaria reniformis* CARSEY (not D'ORBIGNY), Univ. Texas Bull. 2612, 1926 (1927), p. 37, pl. 3, fig. 2.

Test very strongly compressed, thickest in the umbonal region, early portion coiled, later portion in the megalospheric form uncoiling, periphery variable with a thin keel in the earliest portion, largely disappearing in uncoiled specimens, but in coiled ones usually persisting throughout, and distinctly flanged; chambers distinct, increasing very rapidly in size, becoming elongate in the adult, slightly inflated in the later portion in uncoiled forms, very variable in number; sutures distinct, slightly limbate, occasionally somewhat raised, slightly depressed in later portion of uncoiled forms, earlier ones usually more strongly curved than later ones; wall usually smooth, but in some specimens with a few weak costae, generally parallel to the periphery; aperture radiate, at the peripheral angle, slightly protruding. Length

0.80-1.30 mm.; breadth 0.40-0.80 mm.; thickness 0.20-0.30 mm.

This is an exceedingly variable species as the series of figures on our plate will show. It is an excellent index fossil for that portion of the Navarro above the Nacatoch sand, including the Corsicana marl, Kemp clay, and Arkadelphia marl. It is often very abundant in the Corsicana marl.

*PLANULARIA ELONGATA* Ehrenberg (Pl. 16, fig. 20)

*Planularia elongata* EHRENBURG, Mikrogeologie, 1854, pl. 32, pt. ii, fig. 10.—CUSHMAN, Journ. Pal., vol. 1, 1928, p. 216, pl. 35, fig. 10.

Under this name Ehrenberg figures an elongate form which evidently belongs in this genus. His material is from the American Cretaceous "Schreib-Kreide des Mississippi-Gebietes." This resembles *P. dissona* (Plummer), but its identity must remain in doubt.

*PLANULARIA TRICARINELLA* (Reuss) (Pl. 16, fig. 21)

*Cristellaria tricarinella* REUSS, Sitz. Akad. Wiss. Wien, vol. 46, 1862 (1863), p. 68, pl. 7, fig. 9.

*Planularia tricarinella* CUSHMAN, Journ. Pal., vol. 6, 1932, p. 334, pl. 50, figs. 5, 6.

Test much compressed, the sides nearly parallel, the outer periphery rounded or somewhat truncate, often with three distinct keels, one median and one at each side; chambers distinct, somewhat uncoiled in the adult, increasing in length as added, height remaining about the same throughout; sutures distinct, raised above the surface, fusing at the periphery into the thickened peripheral margin; wall finely perforate; aperture radiate, at the peripheral angle. Length up to 1.00 mm.; breadth 0.30-0.50 mm.; thickness 0.10-0.20 mm.

Reuss described this species from the Cretaceous of Europe and our species is apparently the same. Brady used this name in the *Challenger* report for a Recent species which is not identical and the name has been used in a similar way by later authors following Brady.

The species so far as seen occurs in our material only from the Pecan Gap chalk member of the Taylor marl at its type locality, near Pecan Gap, Texas.

231. NOTES ON THE SPECIES OF *UVIGERINA* AND  
*ANGULOGERINA* DESCRIBED FROM THE PLIOCENE  
AND PLEISTOCENE

By JOSEPH A. CUSHMAN and RUTH TODD

The numerous species of *Uvigerina* and *Angulogerina* that have been described from the Pliocene and Pleistocene are here reviewed. The type figures have been copied and, where possible, additional specimens have been figured. Where the descriptions are not in English we have made rather free translations or condensed the authors' notes into descriptive form.

Two new species are described and figured.

*UVIGERINA PIGMEA* d'Orbigny (Pl. 17, figs. 1, 2; pl. 19, fig. 1)

*Uvigerina pigmea* D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 269, pl. 12, figs. 8, 9.—CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 6, 1930, p. 62, pl. 9, figs. 14-20.

This species has already been considered in some detail in these Contributions in the 1930 reference above. Although the species has been very widely recorded, a comparison of the figures with typical material shows that most of them have not been correctly identified. Copies of d'Orbigny's original figures are given and a photograph of the Model lacking the spinosity of the last chambers which would be almost impossible to show on a plaster cast. A toptype specimen is figured. We have material which seems to be typical from Castel Arquato, Italy, and the lower Pliocene of Bordj Menaïel Prov., Algiers.

*UVIGERINA PIGMEA* d'Orbigny, var. *ASPERULA* A. Silvestri (Pl. 17, fig. 3)

*Uvigerina pygmaea* D'ORBIGNY, var. *asperula* A. SILVESTRI, Mem. Pont. Accad. Nuovi Lincei, vol. 17, 1900, p. 277, pl. 6, fig. 95.

According to Silvestri's original description this variety, described from the Neogene of the Tiber Valley, Italy, is distinguished by having both the early and later chambers ornamented by minute short spines. The length of Silvestri's figured specimen is 0.96 mm.

In a large series of specimens of *U. pigmea* the spinose character is variable and most of our specimens are closer to the

figure of var. *asperula* than to that given by d'Orbigny. According to the new rules of nomenclature this varietal name cannot be used as Czjzek had already described a *U. asperula*. It is probable that these forms are all to be included under *U. pigmea* d'Orbigny.

UVIGERINA RUGOSA d'Orbigny

*Uvigerina rugosa* D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 269, No. 1.

This was recorded without description or figures as fossil from the region of Siena, Italy. It remains a *nomen nudem*.

UVIGERINA STRIATA Costa (Pl. 17, fig. 4)

*Uvigerina striata* COSTA, Atti Accad. Pontaniana, vol. 7, fas. 2, 1856, p. 266, pl. 15, fig. 3.—SEGUENZA, Atti Accad. Gioenia Sci. Nat., ser. 2, vol. 18, 1862, p. 26.

Costa described under this name a species from the marl of Casimicciola on Ischia Island, Italy, but as d'Orbigny had already used this name in 1839 for a Recent species, the name is invalid. The length is given as 0.6 to 1.00 mm. We have had no material which we could refer to Costa's form.

UVIGERINA TRIGONA Seguenza (Pl. 17, figs. 11, 12)

*Uvigerina trigona* SEGUENZA, Atti Accad. Gioenia Sci. Nat., ser. 2, vol. 18, 1862, p. 110 (26), pl. 2, figs. 1, 1 a.

Copies of the original figures are given. The types are from the Pleistocene clays in the vicinity of Catania, Sicily. We have specimens showing that this is an *Angulogerina* and probably identical with *A. angulosa* (Williamson).

UVIGERINA RUGULOSA Reuss (Pl. 17, fig. 10; pl. 19, fig. 2)

*Uvigerina rugulosa* REUSS, Bull. Acad. Roy. Sci. Belg., ser. 2, vol. 15, 1863, p. 153, pl. 3, fig. 43.

Test very small, elongate-oval, base obtuse; chambers unequal, rather large, earlier ones indistinct; sutures distinct; wall with fine longitudinal costae interrupted at the sutures, most conspicuous on the earlier whorls; aperture at the end of a very short, tubular neck. Reuss' specimens were from the Pliocene (Crag) of Anvers, Belgium.

We have specimens from the Crag of Anvers, one of which is here figured.

UVIGERINA GEMMAEFORMIS Schwager (Pl. 17, fig. 5)

*Uvigerina gemmaeformis* SCHWAGER, Novara-Exped., Geol. Theil II, 1866, p. 247, pl. 7, fig. 92.—CUSHMAN, Bernice P. Bishop Museum Bull. 119, 1934, p. 125, pl. 15, fig. 7.

Test oblong, ovate, circular or rounded triangular in cross-section, the lower part evenly pointed, the upper end slightly truncate. Chambers somewhat arched, oblong, slightly oblique, —sometimes more or less angular, extending down at the sides, regularly increasing in size; spire triserial; costae longitudinal, testiform, curved, with broad intervening spaces. Sutures incised, curved. Aperture at the end of a slender tube, in a flaring form, rising from the plane or slightly incised projection of the last chamber. Wall of medium thickness, with small foramina. Length 0.7 mm.

We have failed to find this species in our original material from Kar Nicobar.

UVIGERINA NITIDULA Schwager (Pl. 17, fig. 6; pl. 19, figs. 11-13)

*Uvigerina nitidula* SCHWAGER, *Novara-Exped.*, Geol. Theil II, 1866, p. 248, pl. 7, fig. 93.—KARRER, in von Drasche, *Frag. Geol. Insel Luzon*, 1878, p. 94.—CUSHMAN, Bernice P. Bishop Museum, Bull. 119, 1934, p. 125, pl. 15, fig. 6.—CUSHMAN, *Journ. Geol. Soc. Japan*, vol. 46, No. 546, 1939, p. 151 (41), pl. 10 (6), fig. 12.

Test oblong, elliptical, the end almost truncate. Chambers arched, about as broad as high, in the lower part somewhat smaller; spire triserial, often inclined. In the upper part small, filiform costae run lengthwise, separated by rather broad intermediate spaces, in the upper part sometimes scarcely visible. From the summit of the last chamber a slender cylindrical tube rises with the aperture at its enlarged, flaring end. Wall vitreous, perforated by small, thickly set foramina. Length 0.6 mm.

Our figured specimens are from the Pliocene marl about 1¾ mi. SSE. of Suva P. O., Fiji.

UVIGERINA CRASSICOSTATA Schwager (Pl. 17, fig. 7)

*Uvigerina crassicostata* SCHWAGER, *Novara-Exped.*, Geol. Theil II, 1866, p. 248, pl. 7, fig. 94.—KARRER, in von Drasche, *Frag. Geol. Insel Luzon*, 1878, p. 94.—KOCH, *Bericht Schweiz. Pal. Ges.*, vol. 18, 1923, p. 353.—CUSHMAN, Bernice P. Bishop Museum, Bull. 119, 1934, p. 125, pl. 15, fig. 8.—YABE and ASANO, *Science Rep. Tohoku Imp. Univ.*, ser. 2, (Geol.), vol. 19, No. 1, 1937, p. 123 (37).

Test short, almost ovate, lower part with a short point, sometimes blunt. Chambers large, gently arched, somewhat broader than high, arranged triserially. Costae over the entire test, except the top, thick, moderately high, lamellose, sometimes flexuose, with rather broad intervening spaces, increasing in number upward by additional inserted ones. Sutures curved, rather inconspicuous. Aperture at the end of a short tube, the upper part enlarged into a saucer-shaped mouth, rising from the slightly

twisted depression of the final chamber. Wall of medium thickness, perforated by slender, radiate, closely set tubules. Length 1.3 mm.

**UVIGERINA HISPIDA Schwager** (Pl. 17, fig. 8; pl. 19, fig. 10 [?])

*Uvigerina hispida* SCHWAGER, *Novara-Exped.*, Geol. Theil II, 1866, p. 249, pl. 7, fig. 95.—Koch, Bericht Schweiz. Pal. Ges., vol. 18, 1923, p. 353.—CUSHMAN, Bernice P. Bishop Museum Bull. 119, 1934, p. 126, pl. 15, fig. 9.—CUSHMAN, Journ. Geol. Soc. Japan, vol. 46, No. 546, 1939, p. 151 (41), pl. 10 (6), figs. 7, 8.

Test elongate, slightly compressed laterally, upper part strongly so, lower part somewhat narrow and blunt. Chambers arched, initial end spirally arranged, slightly inflated, posterior ones circular in section, usually alternately inflated, separated by deep, incised sutures, the surface with coarse bristles. The final chamber twisted, pointed, and strongly erect, the upper part rather narrow, bearing the large, smooth, rounded aperture. Wall of medium thickness, perforated by small, radiate foramina. Length 1.2 mm.

**UVIGERINA PROBOSCIDEA Schwager** (Pl. 17, fig. 9; pl. 19, figs. 3-9)

*Uvigerina proboscidea* SCHWAGER, *Novara-Exped.*, Geol. Theil II, 1866, p. 250, pl. 7, fig. 96.—KARRER, in von Drasche, Frag. Geol. Insel Luzon, 1878, p. 94.—CUSHMAN, Bernice P. Bishop Museum, Bull. 119, 1934, p. 126, pl. 15, fig. 10; Journ. Geol. Soc. Japan, vol. 46, No. 546, 1939, p. 151 (41), pl. 10 (6), fig. 13 (?).

Test short, upper part elongated into a point, lower part more or less sacciform, also rather acute. Chambers spirally arranged, generally 2 or 3 in a single whorl, initial end only slightly chambered, later becoming more strongly so, sometimes hemispherical, separated by incised, conspicuous, curved sutures; wall set with slender spines. The final chamber prolonged upward in the form of a beak, more or less turned toward the outside, bearing at the end a smooth, rounded aperture. Wall, in addition to the spines, perforated by fine pores. Length 0.6 mm.

From the study of material from the type locality at Kar Nicobar and a study of the original figures and descriptions it is difficult to be sure of these two species, *U. hispida* and *U. proboscidea*. The first seems to have an elongate test in the adult, very loosely coiled, with comparatively large spines; while the other, *U. proboscidea*, is smaller, has a more fusiform test, and a very finely spinose surface. Specimens comparable to *U. proboscidea* occur at various late Tertiary localities, but ones that can be definitely referred to *U. hispida* occur very rarely if at

all in our material. Therefore until the actual type specimens can be studied in greater detail it is difficult to be sure of the actual distinctions between these two species.

UVIGERINA BACCALIS Schwager (Pl. 17, fig. 13)

*Uvigerina baccalis* SCHWAGER, Boll. R. Com. geol. Ital., vol. 9, 1878, p. 523, pl. 1, fig. 9.

According to the original figure and description this species has a peculiar surface ornamentation consisting of longitudinal costae which bifurcate toward the base of each chamber. The species also has a radiate aperture. The figure shows a biserial arrangement of the test throughout. We have found no specimens in our Italian Pliocene material that has anything like this type of ornamentation. The form, with a maximum length of 0.6 mm., was described from the Tertiary of Stretto in Sicily.

UVIGERINA GLOBOSA Karrer (Pl. 17, fig. 14)

*Uvigerina globosa* KARRER, in von Drasche, Frag. Geol. Insel Luzon, 1878, p. 94, pl. 5, fig. 20.—CUSHMAN and EDWARDS, Contr. Cushman Lab. Foram. Res., vol. 15, 1939, p. 37.

This species described from the Tertiary of the Philippines may be Pliocene or older. It was noted in these Contributions in the above reference. Karrer's figure is reproduced on our plate.

UVIGERINA BONONIENSIS Fornasini (Pl. 18, fig. 1; pl. 19, figs. 14-16)

*Uvigerina bononiensis* FORNASINI, Boll. Soc. geol. Ital., vol. 7, 1888, p. 48, pl. 3, figs. 12, 12 a; Riv. Ital. Pal., vol. 4, 1898, p. 27, pl. 1, figs. 1-8.

According to the figures and meager description this is an elongate and compressed form with very fine costae. The inner ends of the chambers form distinct angles and the sutures are somewhat curved upwards. This species is probably related to *U. parkeri* Karrer and *U. compressa* Cushman but does not have as sharp costae and the chambers do not overhang as in the

EXPLANATION OF PLATE 19

All figures  $\times 60$ .

FIG. 1. *Uvigerina pigmea* d'Orbigny. Pliocene. Coroncina, near Siena, Italy. 2. *U. rugulosa* Reuss. Pliocene. Near Antwerp, Belgium. 3-9. *U. proboscidea* Schwager. 3-5, Pliocene. Fiji. 6-9, Pliocene. Lower Pico. First gully N. of Lomita Quarry, Palos Verdes Hills, California. 10. *U. hispida* (?) Schwager. Pliocene. Fiji. 11-13. *U. nitidula* Schwager. Pliocene. Fiji. 14-16. *U. bononiensis* Fornasini. 14, 15, Pliocene. Attavilla, Italy. 16, Pliocene. Castel Arquato, Italy. 17. *Angulogerina hughesi* (Galloway and Wissler). Pliocene. Rustic Canyon, Santa Monica, Calif. 18. *A. semitrigona* (Galloway and Wissler). Topotype. Pleistocene. Lomita Quarry, Palos Verdes Hills, Calif. 19. *A. baggi* (Galloway and Wissler). Topotype. Pleistocene. Lomita Quarry, Palos Verdes Hills, Calif.







Miocene species. Length of Fornasini's figured specimen: 0.65 mm. The type locality is the marl of Ponticello of Savena, near Bologna, Italy.

**UVIGERINA UNCINATA** Mariani (Pl. 18, fig. 2)

*Uvigerina uncinata* MARIANI, Atti Soc. Ital. Sci. Nat., vol. 31, 1888, p. 119, pl. 1, fig. 7.

From the figure and description this is a slender species with numerous thin costae frequently ending at the suture lines in curved, inward-turned spurs. No indication of size is given and we have found no material we could identify with it. It was described from the Pliocene of Savona, Italy.

**UVIGERINA CANARIENSIS** d'Orbigny, forma **DISTOMA** DeAmicis (Pl. 18, fig. 3)

*Uvigerina canariensis* D'ORBIGNY, forma *distoma* DEAMICIS, Atti Soc. Tosc. Sci. Nat., vol. 14, 1894, p. 29, pl. 2, fig. 5; Nat. Sicil., Anno XIV, 1895, p. 112.

As DeAmicis has suggested, this is probably an abnormal form. Double-apertured specimens occur rarely in other species. The form was described from the lower Pliocene, white marl of Bonfornello, near Termini Imerese in Sicily. The dimensions of the type specimen are 1.292 mm. and 0.561 mm.

**ANGULOGERINA BAGGI** (Galloway and Wissler) (Pl. 18, fig. 5; pl. 19, fig. 19)

*Uvigerina baggi* GALLOWAY and WISSLER, Journ. Pal., vol. 1, 1927, p. 75, pl. 11, fig. 19.

*Angulogerina baggi* CAMPBELL, Journ. Entom. and Zool., vol. 27, 1935, p. 46, text fig. 8.

"Test short, thick, fusiform, lower half conical, tapering abruptly from the short initial end, later half triangular, with slightly concave sides; chambers few, the last three composing one-half of the test, slightly inflated; sutures distinct, not depressed, of clear shell material; wall smooth, very finely perforate; aperture situated at the end of a fairly short neck with a phialine lip. Length of the type specimen, 0.45 mm.; diameter, 0.28 mm." The type locality for this and the two following species

**EXPLANATION OF PLATE 20**

Figures  $\times 60$  unless otherwise noted.

FIGS. 1-3. *Uvigerina peregrina* Cushman, var. *latalata* R. E. and K. C. Stewart. 1. Holotype.  $\times 67$ . (After R. E. and K. C. Stewart.) 2, 3, Paratypes. 4-11. *U. juncea* Cushman and Todd, n. sp. 4, Holotype. 5-11, Paratypes. Pliocene, Timms Point, Calif. 12, 13. *U. yabei* Asano.  $\times 20$ . (After Asano.) 14, 15. *U. substriata* Asano.  $\times 20$ . (After Asano.) 16-22. *U. rutila* Cushman and Todd, n. sp. 16, Holotype. 17, Paratype. Lower Pliocene. Bordj Menaïel, Algiers. 18, Pliocene. San Ruffillo, near Bologna, Italy. 19, 20, Pliocene. Garrobo, southern Spain. 21, Pliocene (?) Bahna, Roumania. 22, Pliocene. Near Nice, France.

is the Lomita Quarry in the Palos Verdes Hills of southern California. The age of the deposit is lower San Pedro, Pleistocene. A toptype specimen is figured.

ANGULOGERINA HUGHESI (Galloway and Wissler) (Pl. 18, fig. 4; pl. 19, fig. 17)

*Uvigerina hughesi* GALLOWAY and WISSLER, Journ. Pal., vol. 1, 1927, p. 76, pl. 12, fig. 5.

*Angulogerina hughesi* CUSHMAN, STEWART, and STEWART, Trans. San Diego Soc. Nat. Hist., vol. 6, 1930, p. 70, pl. 5, fig. 16.

"Test fusiform, subtriangular in cross-section in the later portion, early portion conical; chambers numerous, early ones inflated, later ones flattened so as to produce a triangular outline; sutures distinct, depressed; wall smooth, the apical end in some specimens provided with a few obscure costae; aperture terminal, oval, with a thickened lip and very short neck. Length of the type specimen, 0.48 mm."

Our specimen from Rustic Canyon, Santa Monica, California, seems to be identical.

ANGULOGERINA SEMITRIGONA (Galloway and Wissler) (Pl. 18, fig. 6; pl. 19, fig. 18)

*Uvigerina semitrigona* GALLOWAY and WISSLER, Journ. Pal., vol. 1, 1927, p. 77, pl. 11, fig. 21.

*Angulogerina semitrigona* CAMPBELL, Journ. Entom. and Zool., vol. 27, 1935, p. 46, text fig. 9.

"Test short, thick, fusiform, lower half conical, tapering abruptly from the sharp initial point in the microspheric form, later half triangular; chambers few, the last three composing one-half of the test, very slightly inflated; sutures distinct, slightly depressed, of clear shell material; wall ornamented with about ten rows of low costae to a side, which are not continuous beyond the sutures, very finely perforate; aperture at the end of a very short neck with a phialine lip. Length of the type specimen, 0.43 mm.; diameter, 0.25 mm."

Our figured toptype specimen seems to be a more nearly adult form than the figured type specimen.

UVIGERINA PEREGRINA Cushman, var. LATALATA R. E. and K. C. Stewart

(Pl. 20, figs. 1-3)

*Uvigerina peregrina* CUSHMAN, var. *latalata* R. E. and K. C. STEWART, Journ. Pal., vol. 4, 1930, p. 66, pl. 8, fig. 7.

"Test elongate, 2 to 2½ times as long as broad, widest portion varying between the middle and the apertural end, ends rounded; chambers fairly numerous, inflated, distinct; sutures depressed; wall ornamented with longitudinal costae, usually 5 or 6 in a full grown chamber, which are discontinuous from chamber to chamber and usually so offset as to line up with the intracostal spaces

of adjacent chambers, high and very thin and characteristically somewhat broadly spread out like a wing or fan with scalloped edges, toward the apertural end of the test becoming broken up into spinose or irregular short portions, the wall between the costae varying from granular to smooth; aperture circular at the end of a distinct cylindrical neck, often finely spinose and with a phialine lip. Length up to 0.85 mm.; breadth up to 0.40 mm.

"The types are from the upper Pico of the mud pits at the Dent Mud Plant about  $1\frac{1}{2}$  mi. N. of Ventura and  $\frac{1}{2}$  mi. E. of Ventura Avenue at the head of Franklin Lane, Ventura Co., Calif."

Two paratypes are here figured.

ANGULOGERINA FIJIENSIS Cushman (Pl. 18, fig. 7)

*Angulogerina fijiensis* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 7, 1931, p. 31, pl. 4, fig. 11; Bernice P. Bishop Museum, Bull. 119, 1934, p. 127, pl. 16, fig. 1.

See Volume 7, Part 2, of these Contributions for the original description of this species from the Pliocene of the Island of Vitilevu, Fiji.

UVIGERINA YABEI Asano (Pl. 20, figs. 12, 13)

*Uvigerina yabei* ASANO, Journ. Geol. Soc. Japan, vol. 45, No. 538, 1938, p. 613, pl. 17 (6), figs. 1, 2.

"Test elongate, subcylindrical, tapering at apical end, composed of numerous chambers with several distinct longitudinal costae except last-formed chambers; aperture with a short neck and distinct phialine lip. Length up to 1.5 mm.

"Holotype from the Pliocene of Wakimoto, Oga Peninsula, Akita prefecture.

"The present form is similar to *U. tenuistriata* Reuss, but differs in less number of costae. Furthermore the last few chambers are not ornamented with costae."

UVIGERINA SUBSTRIATA Asano (Pl. 20, figs. 14, 15)

*Uvigerina substriata* ASANO, Journ. Geol. Soc. Japan, vol. 45, No. 538, 1938, p. 614, pl. 17 (6), figs. 21, 22.

"Test subcylindrical, composed of 5 or 6 whorls; chambers numerous, inflated; sutures distinct, gently curved, depressed; wall striated only near sutures; aperture at end of a short neck and surrounded by a phialine lip. Length up to 1.8 mm.

"Holotype from the Plio-Pleistocene of Sanuki-mati, Kimitugun, Tiba prefecture.

"This new species is very distinct in sutures crossed by numerous fine striae."

## UVIGERINA JUNCEA Cushman and Todd, n. sp. (Pl. 20, figs. 4-11)

Test elongate, slender, rounded in section, rapidly tapering at the initial end, later portion tending to become biserial, periphery lobulate; chambers large, high, inflated; sutures distinct, incised, gently curved; wall usually ornamented by narrow, low, widely spaced costae, about 10 to a chamber, those of each chamber independent of adjacent ones, best developed on the middle part of the test, often degenerating into longitudinal rows of fine spines toward the apertural end, some individuals having a finely spinose or granular surface throughout; aperture surrounded by a flaring lip at the end of a short neck. Length 0.60-0.78 mm.; diameter 0.20-0.25 mm.

Holotype (Cushman Coll. No. 37827) from the Pliocene, Timms Point, Calif.

This species differs from *U. modeloensis* Cushman and Kleinpell in the ornamentation of the surface, consisting of longitudinal costae over the early portion, later spinose, and the somewhat more slender, elongate test. Our species may have been derived from the Miocene one.

## UVIGERINA RUTILA Cushman and Todd, n. sp. (Pl. 20, figs. 16-22)

Test small, about  $1\frac{1}{2}$  times as long as broad, rounded triangular in section, greatest thickness about the middle, base blunt in the megalospheric forms and often slightly spinose; chambers large, high, distinct, slightly inflated, strongly overlapping, those of the last whorl comprising about  $\frac{1}{2}$  the test; sutures distinct, depressed, strongly curved; wall vitreous, finely perforate, ornamented by narrow, low costae, 8 or 10 to a chamber, separated by comparatively broad interspaces, interrupted at the sutures, often most strongly developed toward the base, and varying much in development among individuals, some being almost smooth; aperture with a slight lip, at the end of a short, fragile neck. Length 0.50-0.70 mm.; diameter 0.30-0.45 mm.

Holotype (Cushman Coll. No. 37821) from the lower Pliocene, Bordj Menaiel, Algiers. It also occurs in the Pliocene at San Ruffillo, near Bologna, Italy, at Garrobo, southern Spain, at Bahna, Roumania, and near Nice, France.

This species differs from *U. urnula* d'Orbigny, var. *semiornata* d'Orbigny in having a broader form in the adult, the costae continuous over the whole test, and the tendency to become spinose at the base. The neck in our species is very delicate and easily broken away from the test.