# CONTRIBUTIONS
## FROM THE
# CUSHMAN LABORATORY
## FOR
# FORAMINIFERAL RESEARCH

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VOLUME 22, PART 2
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## Contents



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# CUSHMAN LABORATORY FOR FORAMINIFERAL RESEARCH

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# 276. THE GENUS *SIGMOILINA* AND ITS SPECIES

By Joseph A. Cushman

In the following pages the results are given of a study of available material, Recent and fossil, that seems to belong to *Sigmoilina*. A study of actual specimens shows that more than one species have been included under some of the specific names, and these are separated and given new names. Original descriptions and type figures of most of the known species and varieties are reproduced.

The range of the genus is throughout the Tertiary and in the present oceans. Unlike most of the Miliolidae, the species of *Sigmoilina* are mostly found in fairly deep water, although some occur in warm, tropical waters. The genus was developed from *Quinqueloculina* by the addition of planispiral chambers not in one plane but in a sigmoid manner.

### Genus SIGMOILINA Schlumberger, 1887

Genotype: *Planispirina sigmoidea* H. B. Brady

*Sigmoilina* Schlumberger, Bull. Soc. Zool. France, vol. 12, 1887, p. 118.—Cushman, Bull. 71, U. S. Nat. Mus., pt. 6, 1917, p. 60; Smithsonian Misc. Coll., vol. 77, No. 4, 1925, p. 53.—Galloway and Wissler, Journ. Pal., vol. 1, 1927, p. 39.—Cushman, Special Publ. 1, Cushman Lab. Foram. Res., 1928, p. 150; Bull. 104, U. S. Nat. Mus., pt. 6, 1929, p. 48; Bull. 161, pt. 1, 1932, p. 45; Special Publ. 4, Cushman Lab. Foram. Res., 1933, p. 149; Foraminifera, 3rd Ed., 1940, p. 165.

*Spiroloculina* (part), *Planispirina* (part), *Quinqueloculina* (part), and *Miliolina* (part) of authors.

Test with the early chambers quinqueloculine, later ones added in planes slightly more than 180° from one another, making a continuously revolving spiral, in transverse section giving a sigmoid appearance; wall often with an outer arenaceous layer; aperture rounded, with a simple tooth.—Tertiary, Recent.

The known species are given, grouped in geologic sequence, and a few doubtful forms are listed at the end.

## CRETACEOUS SPECIES

**SIGMOILINA? PAPYRACEA (Burrows, Sherborn, and Bailey)** (Pl. 5, fig. 1)

*Spiroloculina papyracea* Burrows, Sherborn, and Bailey, Journ. Roy. Micr. Soc., 1890, p. 551, pl. 8, fig. 1.

*Sigmoilina papyracea* Cushman and Todd, Special Publ. 11, Cushman Lab. Foram. Res., 1944, p. 76.

This species was named from a single broken specimen of which less than half of the original was present. The only description consists of the

following: "The lower half of a thin and much compressed form from the red chalk of Flamborough Head." In some respects their figure, which is copied on our plate, suggests *Sigmoilina* but without more evidence it must be left very doubtful.

## EOCENE SPECIES

**SIGMOILINA sp. Cushman and Barksdale** (Pl. 5, fig. 2)

*Sigmoilina* sp. CUSHMAN and BARKSDALE, Contr. Dept. Geol., Stanford Univ., vol. 1, No. 1, 1930, p. 62, pl. 11, fig. 1.

The figure shows a species of *Sigmoilina* but the few available specimens did not give the complete characters and were not sufficiently well preserved to give the details necessary for a complete description. The species is from the Eocene, Martinez formation, west side of Martinez, Contra Costa Co., Calif.

**SIGMOILINA sp. Cushman and Siegfus** (Pl. 5, fig. 3)

*Sigmoilina* sp. CUSHMAN and SIEGFUS, Trans. San Diego Soc. Nat. Hist., vol. 9, 1942, p. 404, pl. 15, fig. 18.

A reëxamination of the specimens from the Eocene, Kreyenhagen shale, of California shows that it is very evidently a *Sigmoilina.* It is an arenaceous form with a large proportion of cement and unlike any of the known species. However a full description cannot be given until better specimens are available.

**SIGMOILINA INCONSPICUA Howe** (Pl. 5, fig. 4)

*Sigmoilina inconspicua* HOWE, Geol. Bull. 14, Louisiana Geol. Survey, 1939, p. 36, pl. 2, figs. 16-18.

"Test very small, fragile, elongate, compressed; chambers narrow, rounded in transverse section, arranged in a faintly sigmoid pattern; sutures distinct, curved; wall smooth; aperture tiny, rounded, with a distinct neck." Holotype, length 0.35 mm.; breadth 0.17 mm.

The types of this species are from the Claiborne Eocene, Cook Mountain formation, Winn Parish, Louisiana. This seems to be the oldest species that can be fully described.

## OLIGOCENE SPECIES

**SIGMOILINA ORINOCOENSIS Hedberg** (Pl. 5, fig. 5)

*Sigmoilina orinocoensis* HEDBERG, Journ. Pal., vol. 11, 1937, p. 669, pl. 90, fig. 13.—FRANKLIN, l. c., vol. 18, 1944, p. 308, pl. 45, fig. 4.

"Test small, stout, sigmoid in cross section. Chambers few; sides covered with fine arenaceous matter so that only last two chambers are distinct. Periphery broadly rounded to truncate. Last chamber projecting at apertural end. Aperture elliptical with a blunt tooth. Holotype, length, 0.52 mm.; width, 0.36 mm.; thickness, 0.25 mm."

The types are from the Oligocene, middle zone of the Carapita formation, in Venezuela.

**SIGMOILINA OLIGOCENICA Cushman, n. sp.** (Pl. 5, fig. 6)

*Sigmoilina tenuis* NUTTALL (not CZJZEK), Journ. Pal., vol. 6, 1932, p. 9, pl. 1, fig. 4.—FRANKLIN, l. c., vol. 18, 1944, p. 308, pl. 45, fig. 5.

Test strongly compressed, less than twice as long as broad, periphery rounded, earlier portion quinqueloculine, later nearly planispiral but somewhat sigmoid; chambers distinct, rounded in transverse section, projecting slightly at the base; sutures fairly distinct, slightly depressed; wall smooth, matte, very finely pitted; aperture in the adult terminal, with a very short neck. Length 0.50-0.70 mm.; breadth 0.30-0.38 mm.; thickness 0.08-0.10 mm.

Holotype (Cushman Coll. No. 46244) from the lower Oligocene, Red Bluff clay, Red Bluff, on Chickasawhay River, Hiwannee, Miss.

This species differs from *S. tenuis* (Czjzek) in the relatively broader test, shorter neck, and dull, matte surface. Specimens are common at the type locality and it also occurs in the Byram marl, at Pearl River, just above bridge at Byram, Miss. A series of specimens from the Oligocene, Alazan shale, of western Asuncion, Vera Cruz, Mexico, one of which was figured by Nuttall, comes within the measurements and ratios of this species. The specimen figured from the Cipero marl of Trinidad as "*Sigmoilina tenuis* (Czjzek)" (Cushman and Stainforth, Special Publ. 14, Cushman Lab. Foram. Res., 1945, p. 21, pl. 2, fig. 19) has the surface of our species but in some ways is more similar to *S. tenuis*, especially in the relatively longer and narrower test. There are a number of records without figures of "*Sigmoilina tenuis*" from the Oligocene of Venezuela and Cuba which may be our species but no specimens are available to determine this at the present time. Reuss records *S. tenuis* (Czjzek) from the Oligocene of Hermsdorf, Germany, and his figures are of a slender type resembling that species. However we have a series of specimens from Hermsdorf which have the broader ratio and the matte surface of *S. oligocenica* n. sp. Reuss also figures the species from the Oligocene of Pietzpuhl, Germany. Some of his figures resemble *S. tenuis* and others are much like *S. oligocenica*. I have not been able to find this species in our material from Pietzpuhl.

**SIGMOILINA CHAPMANI Cushman, n. sp.** (Pl. 5, figs. 7-9)

*Sigmoilina celata* CHAPMAN (not COSTA), Journ. Linn. Soc. Zool., vol. 30, 1907, p. 21, pl. 2, fig. 41.—HERON-ALLEN and EARLAND, Journ. Roy. Micr. Soc., 1924, p. 133.

Test about twice as long as broad, slightly projecting and rounded at the basal end, periphery subacute, strongly biconvex in end view; chambers rather indistinct; sutures indistinct; wall arenaceous, of fine sand grains of

fairly uniform size and the surface of the test rather smoothly finished; aperture terminal, rounded, with a distinct, slender neck, slight lip, and very small tooth. Length 0.65-0.77 mm.; breadth 0.30-0.38 mm.; thickness 0.18-0.23 mm.

Holotype (Cushman Coll. No. 46248) from the Oligocene, Balcombian, lower beds at Muddy Creek, Victoria, Australia.

This species differs from *S. celata* (Costa) in the much more slender test, smoother surface, and more extended apertural end. We also have specimens from the Balcombian of Altona Bay Coal Shaft, Victoria, Australia, and from the Janjukian, Polyzoal marl, overlying limestone, Filter Quarries, Batesford, Victoria, Australia. Specimens referred to *S. celata* (Costa) from the Pliocene of Humboldt Co., Calif. (Cushman, Stewart, and Stewart, Trans. San Diego Soc. Nat. Hist., vol. 6, 1930, p. 52, pl. 2, fig. 3) are very similar.

**SIGMOILINA SIGMOIDEA (H. B. Brady), var. COMPRESSA Cushman, n. var.**
(Pl. 5, figs. 10-12)

*Sigmoilina sigmoidea* CHAPMAN (not H. B. BRADY), Journ. Linn. Soc. Zool., vol. 30, 1907, p. 20, pl. 2, fig. 40.—HERON-ALLEN and EARLAND, Journ. Roy. Micr. Soc., 1924, p. 133. —CRESPIN, Bull. 9 (Pal. Ser. No. 4), Commonwealth of Australia, Min. Res. Survey, (mimeographed), 1943, p. 83 (list).

Variety differing from the typical in its much more compressed test and more acute periphery.

Holotype of variety (Cushman Coll. No. 46243) from the Oligocene, Balcombian, of Grice's Creek, Victoria, Australia.

This variety from the Tertiary of Australia seems quite distinct from the Atlantic form and may be a distinct species. Specimens also occur in our material from the Balcombian of Muddy Creek, Victoria, Australia, and from the Janjukian, Green marl, Bird Rock Cliffs, Torquay, Victoria, Australia.

## MIOCENE SPECIES

**SIGMOILINA TENUIS (Czjzek)** (Pl. 5, figs. 13-15)

*Quinqueloculina tenuis* CZJZEK, Haidinger's Nat. Abhandl., vol. 2, 1847, p. 149, pl. 13, figs. 31-34.—REUSS, Denkschr. Akad. Wiss. Wien, vol. 1, 1850, p. 385, pl. 50, fig. 8.

*Spiroloculina tenuis* MACFADYEN, Geol. Survey Egypt, 1930 (1931), p. 43, pl. 1, fig. 2.

*Sigmoilina tenuis* CUSHMAN and TODD, Special Publ. 15, Cushman Lab. Foram. Res., 1945, p. 10, pl. 2, fig. 4.

*Spiroloculina tenuissima* REUSS, Sitz. Akad. Wiss. Wien, vol. 55, pt. 1, 1867, p. 71, pl. 1, fig. 11.

*Spiroloculina berchtoldsdorfensis* KARRER, Abhandl. k. k. geol. Reichs., vol. 9, 1877, p. 375, pl. 16*a*, fig. 10.

*Sigmoilina elliptica* GALLOWAY and WISSLER, Journ. Pal., vol. 1, 1927, p. 39, pl. 7, fig. 2.

Test compressed, more than twice as long as broad, periphery rounded, earlier portion quinqueloculine, later tending to become planispiral but

still somewhat sigmoid; chambers distinct, rounded in transverse section, distinctly projecting at the base; sutures distinct, slightly depressed; wall smooth, polished, very finely pitted; aperture in the adult terminal, with a distinct, slender neck and distinct lip. Length 0.50-0.58 mm.; breadth 0.25-0.28 mm.; thickness 0.08 mm.

The types of this species were from the Miocene of the Vienna Basin. Numerous topotypes in our collection fit the description and figures. Reuss' species "*Spiroloculina tenuissima,*" also from the Vienna Basin, seems to be similar. I examined Karrer's types of *S. berchtoldsdorfensis* and found it to be a *Sigmoilina* and a synonym of *S. tenuis.* There are many records for *S. tenuis,* both Recent and fossil, mostly without figures, and without seeing the original material it is difficult to be certain of their true specific identity. *S. tenuis* may be distinguished by its smooth, polished surface, length usually more than twice the breadth, and the slender neck with a distinct lip.

The Miocene specimens from Buff Bay, Jamaica, seem typical. Other Vienna Basin Miocene species also occur in the Buff Bay Miocene. An examination of topotypes of *S. elliptica* from the Pleistocene of Lomita Quarry, and other specimens from the Pliocene of Timms Point, California, seems to show that these are very similar to *S. tenuis* in the shape and relative length of the test, the distinct neck and polished surface. A few Recent specimens from the Pacific also are close to *S. tenuis.*

**SIGMOILINA ASPERULA (Karrer)** (Pl. 5, figs. 16-18)

*Spiroloculina asperula* KARRER, Sitz. Akad. Wiss. Wien, vol. 58, pt. 1, 1868, p. 136, pl. 1, fig. 10.

*Sigmoilina asperula* CUSHMAN and TODD, Special Publ. 11, Cushman Lab. Foram. Res., 1944, p. 74.

The types of this species were seen in the Museum at Vienna in 1932. The species seems to belong in *Sigmoilina.* The types are from the Miocene of Kostej. The species, from the type figure, is finely arenaceous. A copy of the type figure is given on our plate. A specimen from Kostej that agrees fairly well with the type specimens is figured.

Specimens from the Oligocene, Balcombian, of Grice's Creek, Victoria, Australia, are very similar. One of these is figured.

**SIGMOILINA MIOCENICA Cushman, n. sp.** (Pl. 5, figs. 19-22)

*Sigmoilina tenuis* CUSHMAN (not CZJZEK), Contr. Cushman Lab. Foram. Res., vol. 5, 1929, p. 81, pl. 12, figs. 12-14; Bull. 4, Florida State Geol. Survey, 1930, p. 22, pl. 2, fig. 8.—CUSHMAN and PONTON, Bull. 9, 1932, p. 51.—CUSHMAN and CAHILL, U. S. Geol. Survey Prof. Paper 175-A, 1933, p. 11, pl. 3, fig. 1.

Test compressed, slightly more than 1½ times as long as broad, the central quinqueloculine portion much thicker than the last-formed por-

tion which tends to become flattened but sigmoid, periphery broadly rounded; chambers distinct, strongly inflated; sutures strongly depressed; wall smooth, polished, slightly matte due to the finely pitted surface; aperture terminal, with almost no neck. Length 0.40-0.60 mm.; breadth 0.28-0.38 mm.; thickness 0.10-0.13 mm.

Holotype (Cushman Coll. No. 46231) from the Miocene, *Arca* zone of the Choctawhatchee marl, 100 ft. below falls, near head of Vaughan Creek, sec. 27, T. 2 N., R. 19 W., Walton Co., Fla. Specimens also occur in other localities in the Florida Miocene. Specimens from the Miocene of Manta, Ecuador, and from beds of similar age, sea cliff, S. 55° E. of Cemetery of Aguide, District of Zemorra, Venezuela, are very similar but do not develop the adult chambers as fully as in the types.

This species differs from *S. tenuis* in the relatively broader test, much less developed apertural neck, and the thicker chambers with a more strongly sigmoid test. The young stages resemble *S. tenuis* very much and this species may have been derived from the European one.

**SIGMOILINA TCHOKRAKENSIS** Gherke

*Sigmoilina tchokrakensis* GHERKE, Problems of Paleontology, Moscow Univ., vol. 4, 1938, pp. 308, 322, pl. 3, figs. 1-18.

"Externally the test may be quinqueloculine, sigmoiline or spiroloculine, more or less elongate (except for one form), greatly varying in length. In the majority of cases it is 2.5-2.8 times longer than broad. Commonly the test is somewhat flattened, but in forms having broad oval or rounded outline it is quite flat. The peripheral margin commonly rounded, compressed. Wall rough. The base of the last formed chamber

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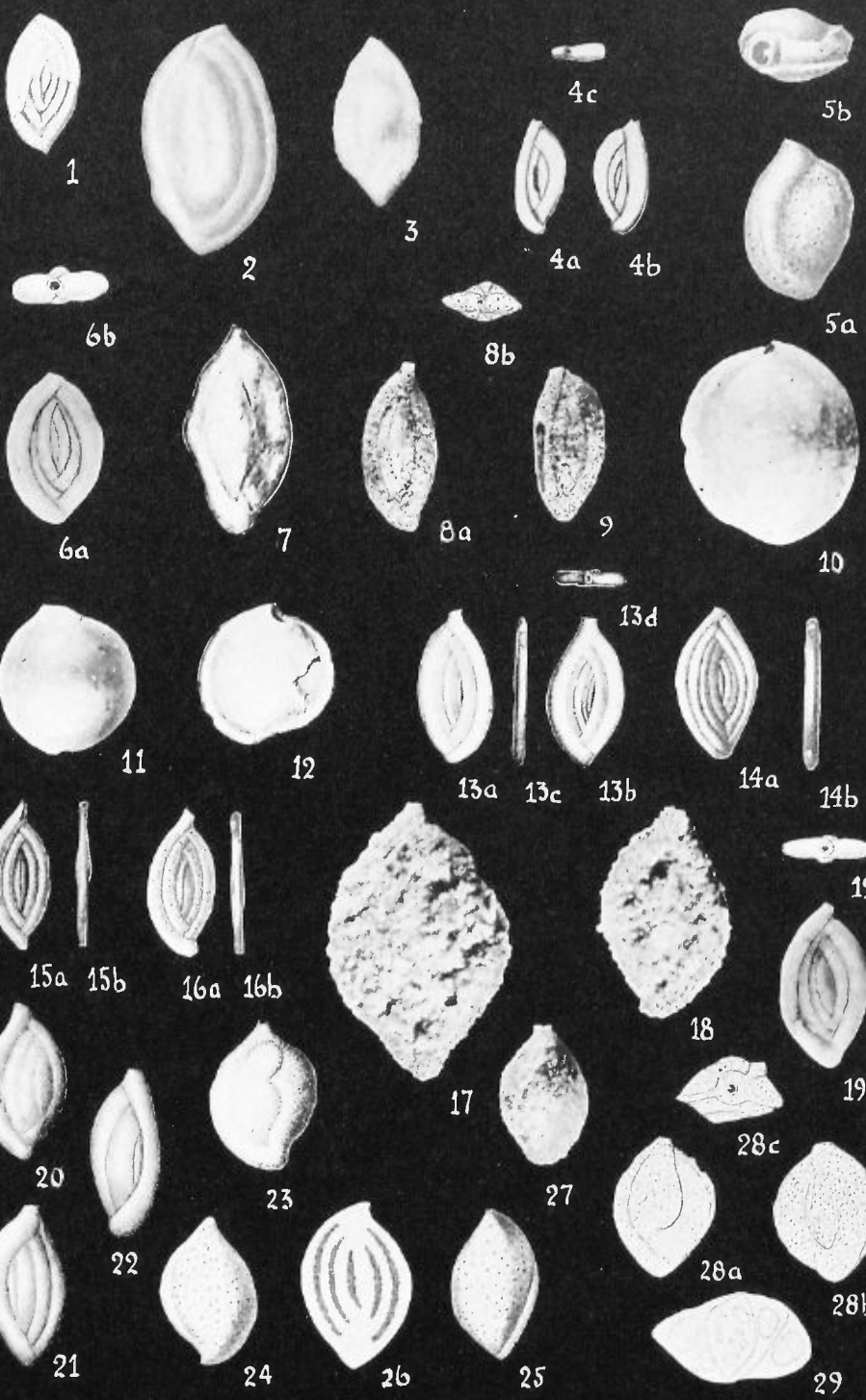
EXPLANATION OF PLATE 5

FIG. 1. *Sigmoilina? papyracea* (Burrows, Sherborn, and Bailey). (After Burrows, Sherborn, and Bailey). × 50. 2. *S.* sp. Cushman and Barksdale. (After Cushman and Barksdale). × 45. 3. *S.* sp. Cushman and Siegfus. (After Cushman and Siegfus). × 30. 4. *S. inconspicua* Howe. (After Howe). × 45. *a, b,* opposite sides; *c,* apertural view. 5. *S. orinocoensis* Hedberg. (After Hedberg). × 65. *a,* front view; *b,* apertural view. 6. *S. oligocenica* Cushman, n. sp. Holotype. × 45. *a,* front view; *b,* apertural view. 7-9. *S. chapmani* Cushman, n. sp. 7, (After Chapman). × 45. 8, Holotype. × 35. *a,* front view; *b,* apertural view. 9, Paratype. × 35. 10-12. *S. sigmoidea* (H. B. Brady), var. *compressa* Cushman, n. var. 10, Holotype. × 35. 11, Paratype. × 35. 12, (After Chapman). × 28. 13-15. *S. tenuis* (Czjzek). 13, (After Czjzek). *a, b,* opposite sides; *c,* peripheral view; *d,* apertural view. 14, "*S. tenuissima* Reuss." (After Reuss). *a,* front view; *b,* peripheral view. 15, "*S. berchtoldsdorfensis* Karrer." (After Karrer). *a,* front view; *b,* peripheral view. 16-18. *S. asperula* (Karrer). 16, (After Karrer). *a,* front view; *b,* peripheral view. 17, Specimen from Kostej. × 30. 18, Specimen from Australia. × 30. 19-22. *S. miocenica* Cushman, n. sp. 19, Holotype. × 40. *a,* front view; *b,* apertural view. 20-22, Specimens from Venezuela and Ecuador. × 45. 23-29. *S. celata* (Costa). 23-26, (After Costa). 26, Vertical section. 27, Specimen from Castel Arquato, Italy. × 40. 28, 29, (After Silvestri). *a, b,* opposite sides; *c,* apertural view. 29, Transverse section.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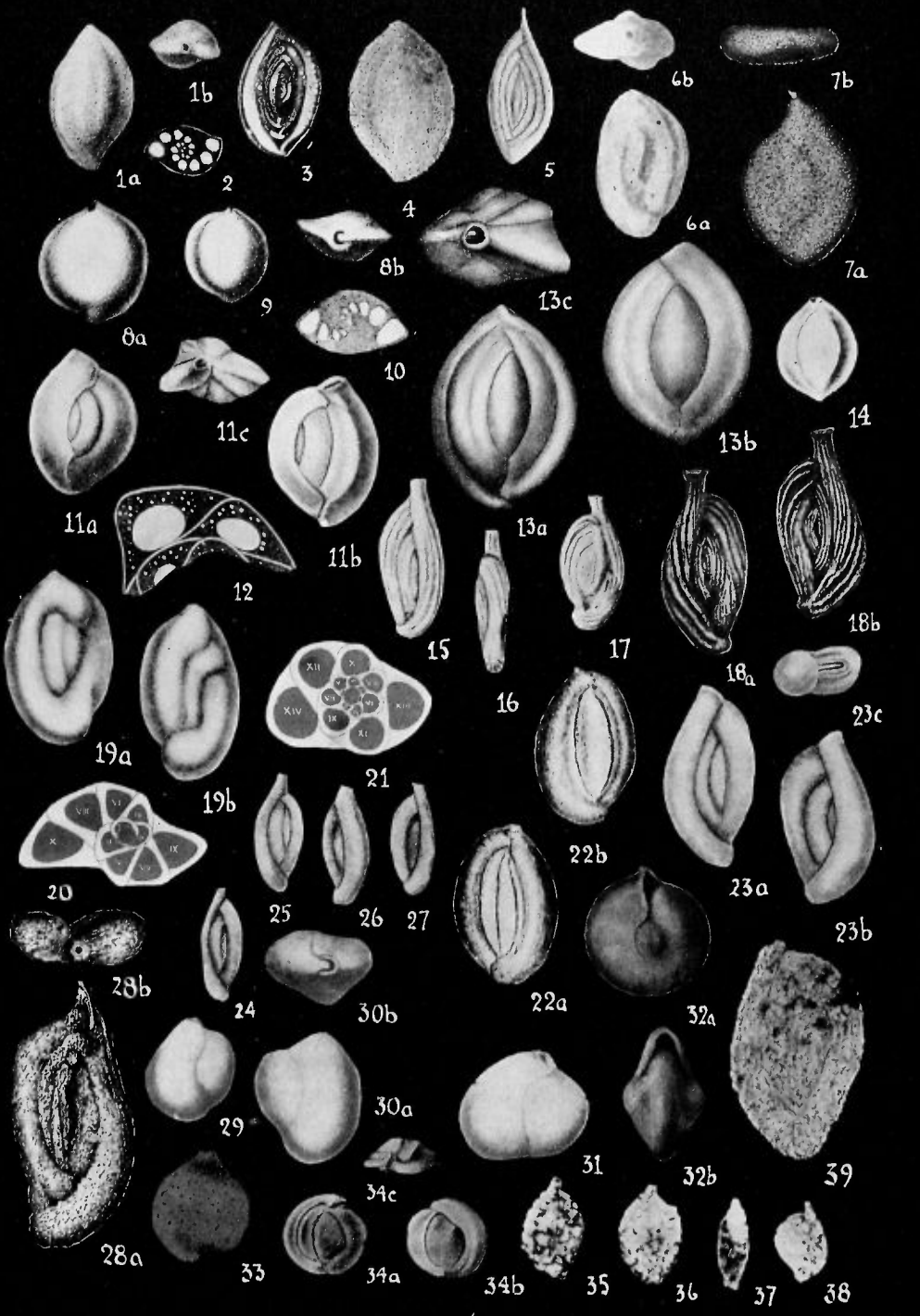
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does not ordinarily project and is not inflated, the apertural end always narrow, forming a short rather thin neck. Sutures slightly depressed. The lateral walls of chambers are expanded and as thin plates slightly drive upon adjoining chambers. Aperture small, rounded, oval or bean-shaped, always devoid of tooth.

"The arrangement of chambers in elongate forms is typically sigmoiline. In flat and broad individuals only earliest ones are so arranged, while the later formed chambers are arranged in the same plane (similarly to Spiroloculina). The number of chambers visible on each outer side ranges between 2-3 and many.

"Length: minimum 0.20, ordinary 0.35-0.70, maximum 0.75
Breadth: minimum 0.06, ordinary 0.12-0.35, maximum 0.40"

"The diagrammatic representation of the variation of the species is shown on the scheme four. The greatest variation is observed with regard to the flatness and breadth of the test, as well as with regard to the number of chambers visible on the sides. In accordance with these characters the species is subdivided into a number of forms. Most of them can be arranged in a consecutive row, beginning with very narrow and long forms and ending in very broad and flat, spiroloculine, ones. Only one form does not seem to fit in and is distinguished from the typical form by a more inflated test (f. *inflata*). All forms pass over into one another

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EXPLANATION OF PLATE 6

FIGS. **1-4.** *Sigmoilina schlumbergeri* A. Silvestri. 1-3, (After H. B. Brady). × 27. 1*a*, front view; 1*b*, apertural view. 2, Transverse section. 3, Vertical section. 4, Specimen from off Ireland. × 30. **5.** *S. foliacea* (Schwager). (After Schwager). **6.** *S. formosana* Nakamura. (After Nakamura). × 15. *a*, front view; *b*, apertural view. **7.** *S. arenaria* (H. B. Brady). (After H. B. Brady). *a*, front view; *b*, apertural view. **8-10.** *S. sigmoidea* (H. B. Brady). (After H. B. Brady). 8, 9, × 20. 8*a*, front view; 8*b*, apertural view. 10, Section. × 15. **11-13.** *S. edwardsi* (Schlumberger). 11, 12, (After Schlumberger). 11*a*, *b*, opposite sides; 11*c*, apertural view. × 24. 12, Transverse section of outer part of test. × 300. 13, Specimen from the Pacific. (After Cushman). × 50. *a*, *b*, opposite sides; *c*, apertural view. **14.** *S. edwardsi* (Schlumberger), var. *acuta* Chapman and Parr. (After Chapman and Parr). × 20. **15-18.** *S. costata* Schlumberger. 15-17, (After Heron-Allen and Earland). 18, (After Schlumberger). × 45. *a*, *b*, opposite sides. **19-20.** *S. herzensteini* Schlumberger (After Schlumberger). 19*a*, *b*, opposite sides. × 40. 20, Transverse section. × 70. **21.** *S. macarovi* Schlumberger. (After Schlumberger). Transverse section. × 50. **22.** *S. ovata* Sidebottom. (After Sidebottom). × 37. *a*, *b*, opposite sides. **23.** *S. syrtica* Martinotti. (After Martinotti). × 45. *a*, *b*, opposite sides; *c*, apertural view. **24-27.** *S. mediterranea* Martinotti. (After Martinotti). × 45. **28.** *S. arenata* (Cushman). (After Cushman). × 70. *a*, front view; *b*, apertural view. **29-31.** *S. obesa* Heron-Allen and Earland. (After Heron-Allen and Earland). × 25. 30*a*, front view; 30*b*, apertural view. **32.** *S. umbonata* Heron-Allen and Earland. (After Heron-Allen and Earland). × 32. *a*, front view; *b*, apertural view. **33.** *S. latissima* Chapman. (After Chapman). × 10. **34.** *S. australis* (Parr). (After Parr). × 25. *a*, *b*, opposite sides; *c*, apertural view. **35-39.** *S. flintii* Cushman, n. sp. 35-38, (After Flint). 39, Holotype. × 30.

by means of intermediate types. This gradation can be followed up in the equally sized tests and in the material derived from a single sample. Insofar as internal structure is concerned there are gradations observed from the typically sigmoiline forms up to almost completely spiroloculine ones. It is noteworthy that the transverse section of well developed sigmoiline forms does not fit in the section of those forms in which the sigmoidal spire is more completely uncoiled."

This species was described from the middle Miocene of the Caucasus region of Russia. The species has been separated into six forms as follows: *angusta* (pp. 311, 322, pl. 3, fig. 1); *media* (pp. 311, 323, pl. 3, figs. 2, 3, 11); *compressa* (pp. 312, 323, pl. 3, figs. 4, 13, 18); *plana* (pp. 315, 323, pl. 3, figs. 5, 6, 14-17; pl. 2, fig. 9); *circularis* (pp. 315, 323, pl. 3, fig. 7); and *inflata* (pp. 315, 323, pl. 3, figs. 8-10).

## PLIOCENE SPECIES

**SIGMOILINA CELATA (Costa)** (Pl. 5, figs. 23-29)

*Spiroloculina celata* COSTA, Mem. Accad. Sci. Napoli, vol. 2, 1855 (1857), p. 126, pl. 1, fig. 14; Atti Accad. Pont., vol. 7, pt. 2, 1856, pl. 26, fig. 5.

*Planispirina celata* TERRIGI, Mem. Com. Geol. Ital., vol. 4, pt. 1, 1891, p. 67, pl. 1, figs. 5, 6.

*Sigmoilina celata* A. SILVESTRI, Mem. Pont. Accad. Nuovi Lincei, vol. 22, 1904, p. 268, text figs. 12-14.

*Quinqueloculina asperula* SEGUENZA, Atti Accad. Gioenia Sci. Nat., ser. 2, vol. 18, 1862, p. 120, pl. 2, fig. 6.

Test slightly longer than broad, basal end rounded or very slightly angled, apertural end very slightly projecting, thickness at least one half the breadth, peripheral angle subacute or somewhat rounded; chambers in the adult sigmoid, hardly visible from one another; sutures indistinct; wall distinctly arenaceous but composed of rather fine grains, surface finely granular; aperture terminal, rounded, usually with a very small tooth. Length 0.65-0.85 mm.; breadth 0.42-0.53 mm.; thickness 0.20-0.28 mm.

The types of this species are from the Pliocene of Sicily. The name has been extensively used but there is much confusion in regard to the specific characters due to the inadequate type figure. The specific name has been applied to arenaceous specimens from Eocene to Recent.

In the typical *S. celata* the angles of the chambers are visible, the test is comparatively broad and thick. It is fairly common in the Pliocene of the Mediterranean region.

**SIGMOILINA SCHLUMBERGERI A. Silvestri** (Pl. 6, figs. 1-4)

*Planispirina celata* H. B. BRADY (not COSTA), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 197, pl. 8, figs. 1-4—FLINT, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 303, pl. 47, fig. 5.

*Planispirina celata* SCHLUMBERGER (not COSTA), Bull. Soc. Zool. France, vol. 12, 1887, p. 481, text figs. 6, 7; pl. 7, figs. 12-14 (*Sigmoilina (Planispirina) celata* in explanation of plate).

*Sigmoilina celata* WRIGHT (not COSTA), Ann. Mag. Nat. Hist., ser. 6, vol. 4, 1889, p. 447 (list); Proc. Roy. Irish Acad., ser. 3, vol. 1, 1891, p. 464.—CHASTER, First Rep't Southport Soc. Nat. Sci., 1890-91 (1892), p. 56.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 81.—CUSHMAN, Bull. 104, U. S. Nat. Mus., pt. 6, 1929, p. 48.—GALLOWAY and MORREY, Bull. Amer. Pal., vol. 15, 1929, p. 8, pl. 3, fig. 4.—CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 5, 1929, p. 82.

*Sigmoilina schlumbergeri* A. SILVESTRI, Mem. Pont. Accad. Nuovi Lincei, vol. 22, 1904, p. 267.—CUSHMAN, Bull. 104, U. S. Nat. Mus., pt. 6, 1929, p. 49, pl. 11, figs. 1-3.—THALMANN, Eclogae geol. Helvetiae, vol. 25, 1932, p. 297.—BERMUDEZ, Mem. Soc. Cubana Hist. Nat., vol. 9, 1935, p. 164.—CUSHMAN and HENBEST, U. S. Geol. Survey Prof. Paper 196-A, 1940, pl. 9, fig. 6.—PALMER, Mem. Soc. Cubana Hist. Nat., vol. 14, 1940, p. 125, pl. 17, figs. 15, 16.—CUSHMAN and STAINFORTH, Special Publ. 14, Cushman Lab. Foram. Res., 1945, p. 21, pl. 2, fig. 20.—CUSHMAN and TODD, Special Publ. 15, 1945, p. 11, pl. 2, fig. 3.—PALMER, Bull. Amer. Pal., vol. 29, No. 115, 1945, p. 31.

*Sigmoilina celata* (COSTA), var. *schlumbergeri* CUSHMAN, Bull. 104, U. S. Nat. Mus., pt. 6, 1929, p. 49, pl. 11, figs. 1-3.—CORYELL and RIVERO, Journ. Pal., vol. 14, 1940, p. 324.

Test about 1½ times longer than broad, only slightly compressed, biconvex in end view, periphery subacute to somewhat rounded, base broadly rounded; chambers obscured, base strongly curved; sutures indistinct; wall arenaceous, of rather coarse grains, with a rough surface; aperture small, terminal, occasionally with a very short neck. Length 0.65-0.85 mm.; breadth 0.42-0.45 mm.; thickness 0.33-0.40 mm.

This species is a common one in the Atlantic and in the late Tertiary of southern Europe. Specimens very similar to the Recent ones occur in the Miocene and Oligocene of the West Indian region, Venezuela, and Ecuador. Very similar specimens are figured by LeRoy from the late Tertiary of the Dutch East Indies (Colorado School Mines Quart., vol. 36, No. 1, pt. 2, 1941, p. 72, pl. 7, figs. 31, 32).

**SIGMOILINA FOLIACEA (Schwager)** (Pl. 6, fig. 5)

*Spiroloculina foliacea* SCHWAGER, Boll. Com. Geol. Ital., vol. 9, 1878, p. 529, pl. 1, fig. 20.

*Sigmoilina foliacea* CUSHMAN and TODD, Special Publ. 11, Cushman Lab. Foram. Res., 1944, p. 75.

This species, the types of which are from the Tertiary of Stretto, Sicily, may be a *Sigmoilina* but no specimens are available for study. The type figure is copied on our plate.

**SIGMOILINA FORMOSANA Nakamura** (Pl. 6, fig. 6)

*Sigmoilina formosana* NAKAMURA, Jap. Journ. Geol. Geogr., vol. 14, Nos. 2-3, 1937, p. 136, pl. 10, fig. 10.

*Sigmoilina celata* CUSHMAN (not COSTA), Bull. 71, U. S. Nat. Mus., pt. 6, 1917, p. 61, pl. 24, fig. 1.

"Test free, broadly oval or elliptical in front view, somewhat pointed on both ends, about one and a half times as long as broad, in side view narrow, compressed; chambers numerous; sutures usually indistinct; apertural end sometimes produced into a cylindrical neck; wall composed of cemented sand grains, rather smoothly finished; aperture terminal, rounded. Length 1.5 mm."

"This species is tolerably variable in its general outline and in some specimens a close resemblance is found to *Massilina*. It differs from *S. schlumbergeri* Silvestri in having more compressed and broader test."

The types of this species are from the Pliocene of Formosa.

A reëxamination of our Pacific material seems to place specimens formerly referred to *S. celata* (Costa) in the above reference into *S. formosana* Nakamura. These specimens are from *Nero* stations 1260, lat. 32° 56′ 15″ N., long. 140° 50′ 00″ E., 2,080 fms.; and 1301, lat. 28° 33′ 00″ N., long. 142° 14′ 00″ E., 1,088 fms.; *Albatross* station D4957, off Japan, lat. 32° 36′ N., long. 132° 23′ E., in 437 fms.; and *Tuscarora* station 58, lat. 26° 52′ N., long. 142° 21′ E., in 814 fms.

## RECENT SPECIES

### SIGMOILINA ARENARIA (H. B. Brady) (Pl. 6, fig. 7)

*Spiroloculina arenaria* H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 153, pl. 8, fig. 12.—Cushman, Bull. 71, U. S. Nat. Mus., pt. 6, 1917, p. 36; Bull. 100, vol. 4, 1921, p. 411, pl. 81, fig 3.

*Sigmoilina? arenaria* Cushman and Todd, Special Publ. 11, Cushman Lab. Foram. Res., 1944, p. 74.

"Test oblong or oval, complanate; extremities obtusely angular or slightly rounded, peripheral edge rounded; segments few and broad, indistinct externally. Aperture small, circular, with milioline tongue; situated in a slightly produced shelly neck. Exterior sandy; length, 1/15 inch (1.7 mm.)."

The three *Challenger* stations given are off Kandavu, Fiji Islands, 210 fms.; off Raine Island, Torres Strait, 185 fms.; and in the Philippines, 95 fms. Brady's figured specimen is from off Fiji.

Other references, except those given in the synonymy, are either not the same or are without figures and therefore subject to doubt until the originals may be studied. The neck is evidently very small and slender and the periphery rounded. I have had very similar specimens from the Philippine region but not elsewhere.

### SIGMOILINA SIGMOIDEA (H. B. Brady) (Pl. 6, figs. 8-10)

*Planispirina sigmoidea* H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 197, pl. 2, figs. 1-3, text fig. 5*c*.—H. B. Brady, Parker, and Jones, Trans. Zool. Soc. London, vol. 12, 1888, p. 216, pl. 40, fig. 16.—Woodward, The Observer, vol. 4, 1893,

p. 77.—FLINT, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 302, pl. 47, fig. 6.—?HERON-ALLEN and EARLAND, Trans. Linn. Soc. London, ser. 2, vol. 11, 1916, p. 216, pl. 39, figs. 32-34.

*?Sigmoilina sigmoidea* CHAPMAN, Proc. Zool. Soc. London, 1895, p. 11.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 80.—CUSHMAN, Bull. 104, U. S. Nat. Mus., pt. 6, 1929, p. 50, pl. 11, figs. 5, 6.—THALMANN, Eclogae geol. Helvetiae, vol. 25, 1932, p. 295.—CUSHMAN, Amer. Journ. Sci., vol. 239, 1941, p. 139, pl. 6, figs. 10-12.

"Test free, oblong, with slightly projecting or pointed ends, the two faces unequally convex, peripheral edge thin, and slightly rounded; composed of numerous segments, two to each convolution, arranged on the milioline plan, the aperture alternately at either end of the shell. Segments seldom exceeding twelve in number, arched longitudinally, and set on at the outer margin of the alternate sides — the inner margin of the wall of each segment spreading over one lateral surface of the test, whilst the lateral extension of its successor in its turn covers the opposite side. Aperture a curved transverse orifice in the prominence at the anterior end of the shell. Length $\frac{1}{30}$th inch (0.85 mm.)."

All of Brady's *Challenger* records for this species were from the Atlantic and typical specimens have been recorded by later writers from the Atlantic area. Other records from the Tertiary of Australia seem different and belong in *Sigmoilina sigmoidea* (H. B. Brady), var. *compressa* n. var.

**SIGMOILINA EDWARDSI (Schlumberger)** (Pl. 6, figs. 11-13)

*Planispirina (Sigmoilina) edwardsi* SCHLUMBERGER, Bull. Soc. Zool. France, vol. 12, 1887, p. 483 (113), pl. 7, figs. 15-18; text fig. 8.

*Sigmoilina edwardsi* HERON-ALLEN and EARLAND, Trans. Zool. Soc. London, vol. 20, 1915, p. 584, pl. 45, figs. 19-21.—SIDEBOTTOM, Journ. Roy. Micr. Soc., 1918, p. 9.—MARTINOTTI, Atti Soc. Ital. Sci. Nat., vol. 59, 1920, p. 276.—HERON-ALLEN and EARLAND, Bull. Soc. Sci. Hist. Nat. Corse, 1922, p. 123; British Antarctic Exped., Zoology, vol. 6, 1922, p. 71; Trans. Zool. Soc. London, vol. 22, 1926, p. 69 (list).—CUSHMAN, Bull. 161, U. S. Nat. Mus., pt. 1, 1932, p. 45, pl. 11, fig. 9.

Test slightly longer than broad, somewhat sigmoid in end view, periphery subacute; chambers in the young fairly distinct, in the highly polished adult somewhat obscured; sutures flush with the surface, usually indistinct; wall smooth, usually highly polished; aperture rounded, sometimes with a slight tooth. Length 0.50-0.65 mm.; breadth 0.40-0.45 mm.; thickness 0.30-0.35 mm.

The types are from off the Canary Islands and the measurements given by Schlumberger are length 0.86 mm.; breadth 0.65 mm.; thickness 0.43 mm. This is somewhat larger than our specimens from the Pacific.

The above references without figures may not be identical. They include the Kerimba Archipelago; east coast of Australia; off Tripoli; off Corsica; the Antarctic; and the Suez Canal.

I have had specimens from a number of stations in the Pacific, noted in the last reference, one of which is figured on our plate. The section given by Schlumberger shows this to be a true *Sigmoilina*.

**SIGMOILINA EDWARDSI (Schlumberger), var. ACUTA Chapman and Parr** (Pl. 6, fig. 14)

*Sigmoilina edwardsi* (Schlumberger), var. *acuta* Chapman and Parr, Australasian Antarctic Exped., ser. C, vol. 1, pt. 2, 1937, p. 132, pl. 9, fig. 33.

"Test small, resembling *S. edwardsi* in general form and character of aperture, but with the periphery compressed and acute. Length, 0.7 mm.; diameter 0.46 mm."

The types are from the Antarctic. The type figure is copied.

**SIGMOILINA COSTATA Schlumberger** (Pl. 6, figs. 15-18)

*Sigmoilina costata* Schlumberger, Mem. Soc. Zool. France, vol. 6, 1893, p. 203, pl. 1, figs. 51, 52, text fig. 4.—Sidebottom, Mem. Proc. Manchester Lit. Philos. Soc., vol. 48, No. 5, 1904, p. 6.—Earland, Journ. Quekett Micr. Club, ser. 2, vol. 9, 1905, p. 193. —Sidebottom, Mem. Proc. Manchester Lit. Philos. Soc., vol. 54, No. 16, 1910, p. 3. —Wright, Proc. Belfast Nat. Field Club, 1910-11, Appendix, p. 12, pl. 2, figs. 2-4.—Martinotti, Atti Soc. Ital. Sci. Nat., vol. 59, 1920, p. 274, text fig. 45.—Heron-Allen and Earland, Bull. Soc. Sci. Hist. Nat. Corse, 1922, p. 123, pl. 2, figs. 19-22.

Test twice as long as broad, periphery rounded, basal end curved, projecting apertural end with a fairly long neck; chambers distinct, inflated, circular or somewhat angled in cross section, in the adult arranged in a broadly sigmoid form; sutures distinct, strongly depressed; wall ornamented with a few longitudinal costae becoming fewer and somewhat obliquely curved toward the base of the chamber; aperture circular at the end of a stout neck, with a slight lip and small tooth. Length 0.63 mm.; breadth 0.30 mm.; thickness 0.10 mm.

The types of this species are from the Gulf of Marseilles. It is recorded from the Mediterranean off the Island of Delos; Bay of Palermo, Sicily; off Tripoli; and off Corsica. It is also recorded from off the British Isles and from the Pleistocene of Ireland.

**SIGMOILINA HERZENSTEINI Schlumberger** (Pl. 6, figs. 19, 20)

*Sigmoilina herzensteini* Schlumberger, Mem. Soc. Zool. France, vol. 7, 1894, p. 240, pl. 3, figs. 5, 6; text fig. 2.—Cushman, Special Publ. 4, Cushman Lab. Foram. Res., 1933, pl. 14, fig. 8; Foraminifera, 3rd Ed., 1940, pl. 14, fig. 8.

The original figures are reproduced on our plate. The types are from dredgings in the Arctic in the Okhotsk Sea. The test as drawn has a peculiar form but the transverse section shows it to be definitely a *Sigmoilina*. We have not had any material of this or of the following species.

**SIGMOILINA MACAROVI Schlumberger** (Pl. 6, fig. 21)

*Sigmoilina macarovi* Schlumberger, Mem. Soc. geol. France, vol. 7, 1894, p. 241, text figs. 3, 4.

The types of this species are also from the Okhotsk Sea. No figures of

the exterior are given and, with only the two transverse sections and no detailed description, its specific characters are very uncertain. There are no other records.

**SIGMOILINA OVATA Sidebottom** (Pl. 6, fig. 22)

*Sigmoilina ovata* SIDEBOTTOM, Mem. Proc. Manchester Lit. Philos. Soc., vol. 48, No. 5, 1904, p. 6, pl. 2, figs. 12, 13, text fig. 1.—HERON-ALLEN and EARLAND, Trans. Zool. Soc. London, vol. 20, 1915, p. 584, pl. 45, figs. 16-18.—SIDEBOTTOM, Journ. Roy. Micr. Soc., 1918, p. 9, pl. 2, figs. 3, 4.—MARTINOTTI, Atti Soc. Ital. Sci. Nat., vol. 59, 1920, p. 276.—HERON-ALLEN and EARLAND, British Antarctic Exped., Zoology, vol. 6, 1922, p. 70; Trans. Zool. Soc. London, vol. 22, 1926, p. 69 (list); Journ. Roy. Micr. Soc., 1924, p. 133.

"The test in outline is an irregular oval, showing generally five chambers, but occasionally six, and there is a slight flattening on one side. Semi-opaque shell substance shows along the margin of the embracing chambers. The tooth varies from a small projection to the well-known T-shape. The section shows the arrangement of the chambers. M. Schlumberger kindly assisted me in the verification of this form. Common."

The types are from off the Island of Delos in the Mediterranean.

I have a considerable amount of material from off Delos kindly sent me by Sidebottom some years ago but have failed to find any specimens. The other records for the species are given in the synonymy. It is probable that they do not all represent this species. The localities include the Kerimba Archipelago; east coast of Australia; off Tripoli; off New Zealand; Suez Canal; and Miocene of Filter Quarry, Victoria, Australia.

**SIGMOILINA MEDITERRANEA Martinotti** (Pl. 6, figs. 24-27)

*Sigmoilina mediterranea* MARTINOTTI, Atti Soc. Ital. Sci. Nat., vol. 59, 1920, p. 275, pl. 11 (2), figs. 13-16, text figs. 46-50.

The types of this species are from the Mediterranean, off Tripoli. I have searched the material from Tripoli sent me by Dr. Martinotti but have failed to find specimens that could be referred to this species. From the sections given it seems questionable as to whether this species should be placed here or in *Massilina*. The type figures are copied on our plate.

**SIGMOILINA SYRTICA Martinotti** (Pl. 6, fig. 23)

*Sigmoilina syrtica* MARTINOTTI, Atti Soc. Ital. Sci. Nat., vol. 59, 1920, p. 273, pl. 11 (2), figs. 11, 12, 19; text fig. 44.

This species was described from material from off Tripoli and recorded as very rare. I have failed to find typical specimens in our material that would compare with the sectioned specimen figured by Martinotti, although rare specimens similar to figs. 11 and 12 were found but had not progressed beyond the quinqueloculine stage. From the transverse section this should be a *Sigmoilina*.

**SIGMOILINA ARENATA (Cushman)** (Pl. 6, fig. 28)

*Spiroloculina arenata* CUSHMAN, Proc. U. S. Nat. Mus., vol. 59, 1921, p. 63, pl. 14, fig. 17; Publ. 311, Carnegie Instit. Washington, 1922, p. 62; Publ. 344, 1926, p. 80; Bull. 104, U. S. Nat. Mus., pt. 6, 1929, p. 44, pl. 9, fig. 5.—BERMUDEZ, Mem. Soc. Cubana Hist. Nat., vol. 9, 1935, p. 163.—CUSHMAN, Smithsonian Misc. Coll., vol. 99, No. 9, 1941, p. 4.
*Sigmoilina arenata* CUSHMAN and TODD, Special Publ. 11, Cushman Lab. Foram. Res., 1944, p. 74.

Test compressed, periphery rounded; chambers fairly distinct, broadest toward the basal end and gradually narrowing toward the apertural end, giving a peculiar shape to the test with a slight S-curve at each side; sutures of the later portion distinct, depressed; wall roughened with an exterior coating of calcareous grains on a very irregular base, very variable in the size and amount of the grains; aperture with a distinct neck, slight lip and small, circular opening. Length 0.50-0.75 mm.; breadth 0.25-0.35 mm.; thickness 0.12-0.15 mm.

The types of this species are from shallow water of Montego Bay, Jamaica. It is a common species in shallow, warm waters of the West Indian region. From the arrangement of the chambers it seems to belong in *Sigmoilina.*

**SIGMOILINA UMBONATA Heron-Allen and Earland** (Pl. 6, fig. 32)

*Sigmoilina umbonata* HERON-ALLEN and EARLAND, British Antarctic Exped., Zoology, vol. 6, 1922, p. 71, pl. 1, figs. 7, 8.

"Test free, minute, circular in outline with a raised central boss on each face. Edge rounded. Aperture a minute slit. Surface smooth and polished, especially on the bosses.

"Dimensions: - Breadth .20-.30 mm.; thickness, .20 mm.

"This obscure little form, which occurs in some numbers at several Antarctic stations, presents features analagous to *S. sigmoidea,* but differs in its circular outline and the raised central bosses. The possibility of its representing the initial stage of a large Miliolid must not be overlooked, but no specimens representing a transition between this and any Miliolid occurring at the same Station have been observed."

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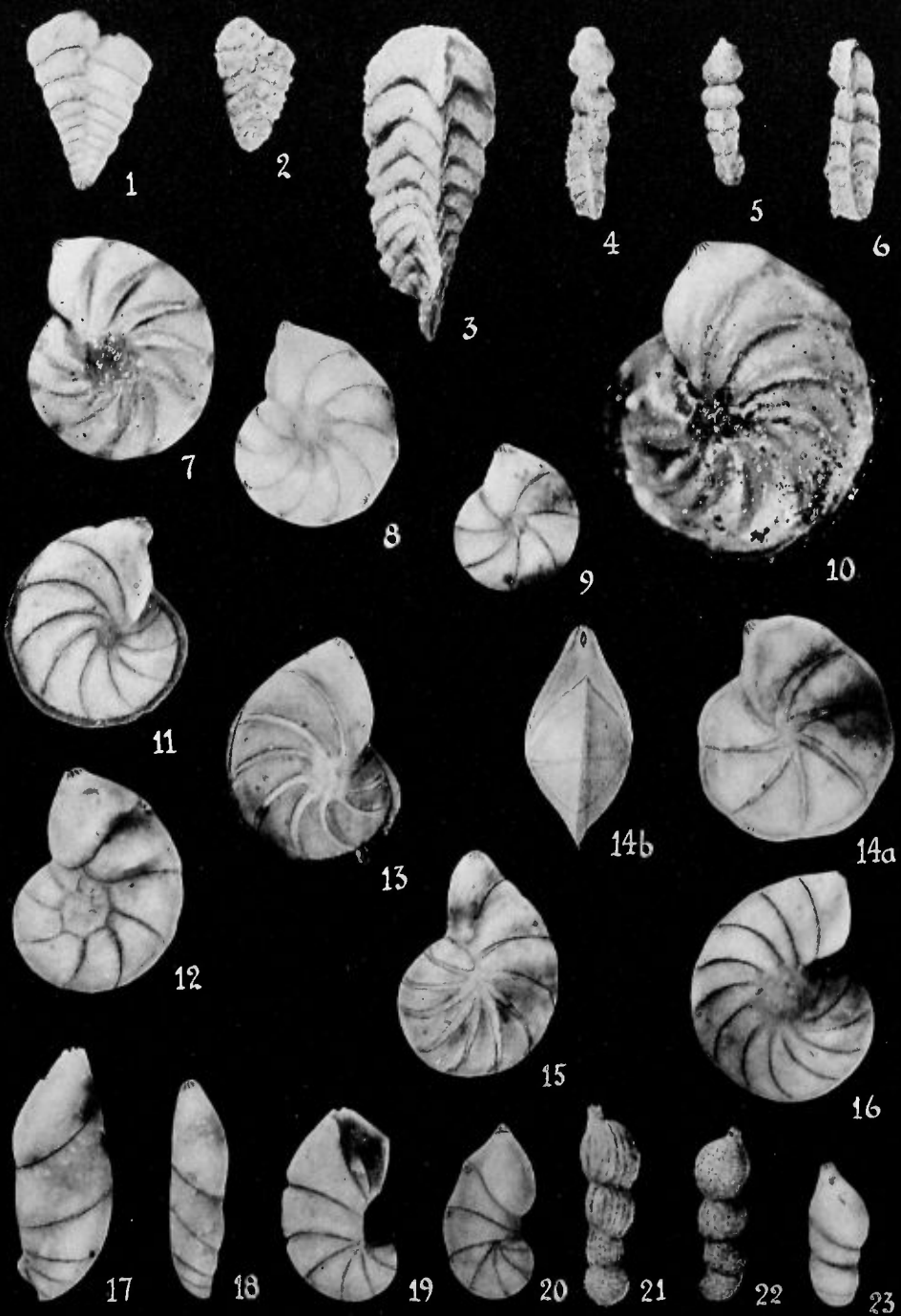
EXPLANATION OF PLATE 7

FIG. 1. *Spiroplectammina laevis* (Roemer), var. *cretosa* Cushman. × 54. 2. *Textularia plummerae* Lalicker, var. × 54. 3-6. *Clavulinoides midwayensis* Cushman. × 15. 3, Microspheric. 4-6, Megalospheric. 7. *Robulus midwayensis* (Plummer). × 27. 8. *R. alabamensis* Cushman. × 40. 9. *R.* cf. *inornatus* (d'Orbigny). × 40. 10. *R. pseudo-mamilligerus* (Plummer). × 27. 11. *R. turbinatus* (Plummer). × 40. 12. *R. wilcoxensis* Cushman and Ponton, var. *dissentia* Cushman and Todd, n. var. × 54. Holotype. 13. *R. degolyeri* (Plummer). × 40. 14. *R. arkansasana* Cushman and Todd, n. sp. × 27. *a,* side view; *b,* peripheral view. Holotype. 15, 16. *R.* sp. 15, × 40. 16, × 27. 17. *Marginulina eximia* Neugeboren. × 40. 18. *M.* cf. *dubia* Neugeboren. × 54. 19, 20. *M.* cf. *hamata* (Franke). × 40. 21, 22. *M.* sp. × 40. 23. *M.* cf. *subrecta* Franke. × 54.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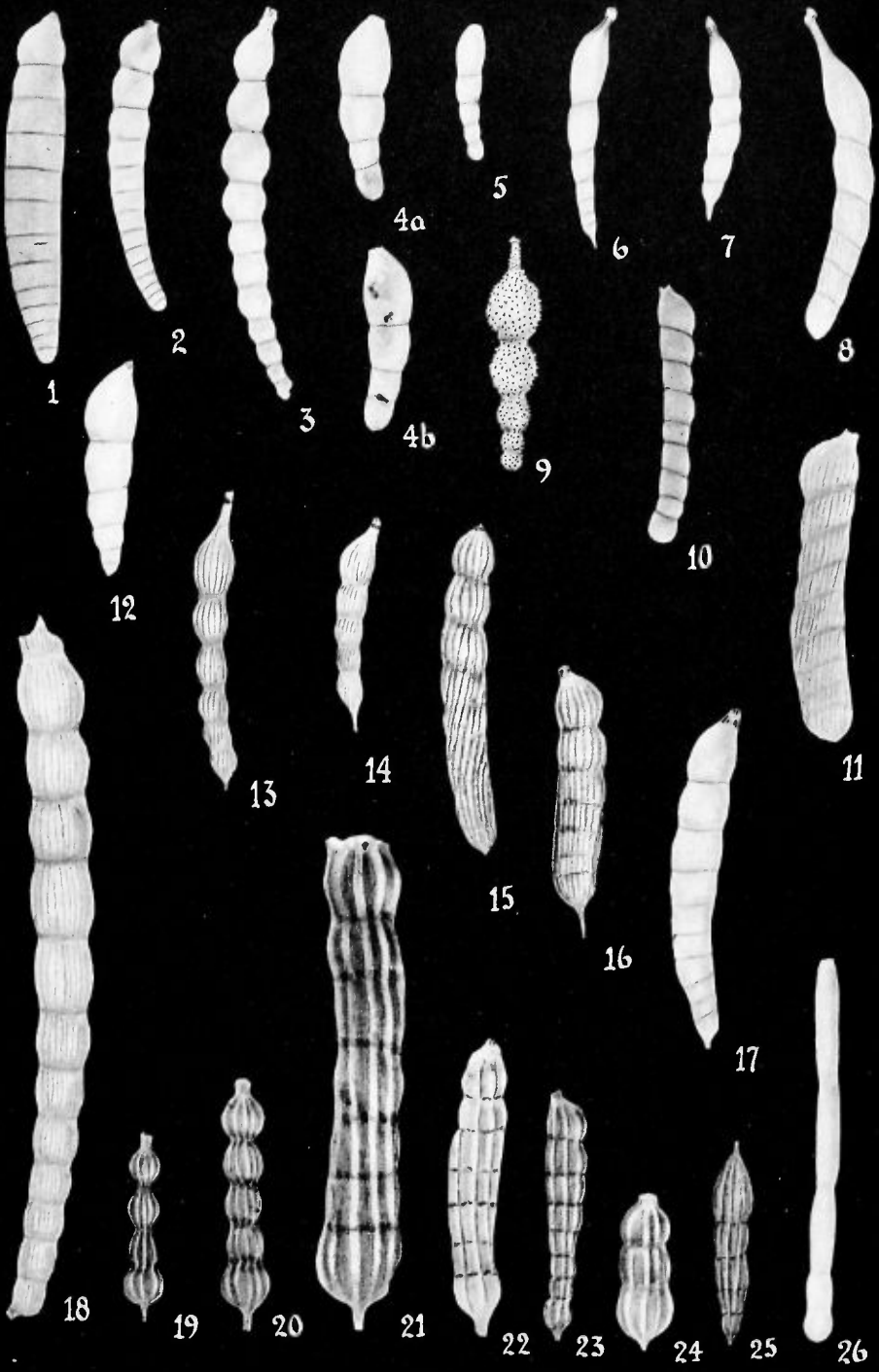
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The generic position of this species must remain in doubt until additional specimens are found to give more of the needed details of its structure and relationships.

**SIGMOILINA OBESA Heron-Allen and Earland** (Pl. 6, figs. 29-31)

*Sigmoilina obesa* HERON-ALLEN and EARLAND, *Discovery* Reports, vol. 4, 1932, p. 320, pl. 7, figs. 1-4.—EARLAND, l. c., vol. 7, 1933, p. 49; vol. 10, 1934, p. 50; vol. 13, 1936, p. 22, pl. 1, figs. 2-4.

"Test free, porcellanous, broadly oval in side view with the aboral end somewhat projecting, elliptical in end view. Two chambers only, visible externally, the final chamber occupying nearly three-quarters of the visible surface, separated by a curved sutural line nearly flush with the surface of the test. The two surfaces are inequilaterally convex and the peripheral edge broadly rounded. Walls thick and devoid of ornament, the surface usually dull, but sometimes polished, though never to the same extent as in *Sigmoilina sigmoidea* (Brady). Aperture, a curved slit furnished with a simple tooth.

"Both megalospheric and microspheric forms have been observed, the former as usual being the most abundant. Externally there is no very great difference except in size, the megalospheric form ranging up to 0.80 mm. in length and 0.70 mm. in breadth as compared with 1.45 mm. and 1.20 mm. for the length and breadth of the microspheric. In section, the megalospheric form shows only 2-3 pairs of chambers following the proloculum, while the microspheric has about 7-8 pairs.

"*Sigmoilina obesa* is a fairly distinctive species, its nearest ally is unquestionably *S. sigmoidea* (Brady), but it can hardly be confused with that species externally, while, in section, the sigmoid curves of the two species are quite distinctive."

All the records for this species are from the Antarctic.

**SIGMOILINA AUSTRALIS (Parr)** (Pl. 6, fig. 34)

*Miliolina subrotunda* H. B. BRADY (not *Vermiculum subrotundum* MONTAGU), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, pl. 5, figs. 10, 11.

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## EXPLANATION OF PLATE 8

FIG. 1. *Dentalina gardnerae* (Plummer). × 27. 2. *D. colei* Cushman and Dusenbury. × 27. 3. *D. plummerae* Cushman. × 27. 4, 5. *D. eocenica* Cushman. × 54. 4*a*, *b*, opposite sides. 6, 7. *D. nasuta* Cushman. × 54. 8. *D. naheolensis* Cushman and Todd. × 54. 9. *D. aculeata* d'Orbigny. × 40. 10. *D.* sp. A. × 40. 11. *Vaginulina* sp. A. × 40. 12. *Dentalina* cf. *mucronata* Neugeboren. × 54. 13, 14. *D. pseudo-nasuta* Cushman and Todd, n. sp. × 40. 13, Holotype. 14, Paratype. 15, 16. *D.* sp. B. 15, Microspheric. × 25. 16, Megalospheric. × 40. 17. *D.* sp. C. × 40. 18. *D. pseudo-obliquestriata* (Plummer). × 54. 19,20. *Nodosaria latejugata* Gümbel. × 15. 21-24. *N. affinis* Reuss. 22, 23, × 27. 21, 24, × 15. 25. *N.* cf. *amphioxys* Reuss. × 40. 26. *N.* (?) *longiscata* d'Orbigny. × 54.

*Quinqueloculina australis* PARR, Proc. Roy. Soc. Victoria, vol. 44 (n. ser.), pt. 1, 1932, p. 7, pl. 1, fig. 8.

*Sigmoilina australis* PARR, l. c., vol. 56 (n. ser.), pt. 2, 1945, p. 197.

"Test in front view rounded, as long as broad; chambers roughly triangular in transverse section, especially in the early portion of the test, with the wall thickened on the outside angle; periphery subangular, but occasionally rounded; sutures distinct, not depressed; surface smooth; aperture semi-circular, with a tooth of the same shape a little in front of the aperture.

"Length up to 0.5 mm.; thickness, 0.24-0.3 mm."

The types are from 7 miles east of Cape Pillar, Tasmania, in 100 fms. It has been recorded from several other localities in this same general region. Brady's specimens were from off East Moncoeur Island, Bass Strait, in 38 fms.

A series of topotypes from Parr are in our collection. The species is not as typical a *Sigmoilina* as some of the other species.

**SIGMOILINA LATISSIMA Chapman** (Pl. 6, fig. 33)

*Sigmoilina latissima* CHAPMAN, Trans. Roy. Soc. So. Australia, vol. 65, 1941, p. 187, pl. 8, fig. 8.

"Test broadly ovate, complanate, with surface encrusted by cement and fine sand. Exterior showing slight undulations indicating the sigmoiline arrangement of the interior. Contour not so tumid as in *S. schlumbergeri* Silvestri, not so spiroloculine as in *?Spiroloculina arenaria* Brady. Aperture small, at the end of a short tube, but as long as in the latter form, with which, however, it may be related. Length, 1.83 mm.; breadth, 1.6 mm.; thickness, 0.44 mm."

The types of this species are from the continental shelf of the southeast coast of Australia.

The type figure and description are copied from Chapman.

**SIGMOILINA FLINTII Cushman, n. sp.** (Pl. 6, figs. 35-39)

*Spiroloculina arenaria* FLINT (not H. B. BRADY), Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 297, pl. 43, fig. 1.

Test compressed, one side slightly concave, the other convex, periphery rounded, basal end rounded to subacute; chambers obscured, but rounded in transverse section; sutures indistinct; wall coarsely arenaceous with fairly large grains but neatly cemented; aperture rounded, with a distinct neck projecting beyond the periphery. Length 0.90-1.00 mm.; breadth 0.65-0.70 mm.; thickness 0.37-0.40 mm.

Holotype (Cushman Coll. No. 46239) from *Albatross* station D2641, lat. 25° 11′ 30″ N., long. 80° 10′ 00″ W., in 60 fms.

This species differs from *S. schlumbergeri* Silvestri in the larger aperture, more definite neck, more compressed test, and coarser material of the wall. Our specimens are from the same station as those figured by Flint.

## SPECIES OF DOUBTFUL GENERIC POSITION

*Sigmoilina sidebottomi* MARTINOTTI, Atti Soc. Ital. Sci. Nat., vol. 59, 1920, p. 280, pl. 11 (2), fig. 29, text figs. 59-61.

The sections given seem to show that this species is triloculine from the earliest stages. It would appear to resemble *Flintina* in its general characters.

*Spiroloculina lapidigera* HOWCHIN and PARR, Trans. Roy. Soc. So. Australia, vol. 62, 1938, p. 294, pl. 15, fig. 10.

This species was described from the upper Pliocene of Adelaide, South Australia. We have a single specimen from the lower Pliocene (Kalimnan), near Hamilton, Victoria, Australia, and it seems to have at least some of the characters of *Sigmoilina*.

There are a few species that have been transferred to *Sigmoilina* from other genera but, except for those already noted in the synonymy of the species treated in this paper, they do not seem to belong in this genus.

## 277. A FORAMINIFERAL FAUNA FROM THE PALEOCENE OF ARKANSAS*

BY JOSEPH A. CUSHMAN and RUTH TODD

Very little is recorded in regard to the Paleocene foraminifera as they occur in Arkansas. In the course of his work, Mackenzie Gordon, Jr. collected some very rich and excellently preserved Paleocene material from the following locality: about 1000 feet S. of Roosevelt Rd. viaduct, 200 feet E. of RR. tracks, in small gully heading E., just upstream from small abandoned bridge, NE¼ NW¼ sec. 16, T. 1 N., R. 12 W., Little Rock, Ark.

As this material was from an area some distance away from the previously recorded Paleocene faunas and as it contained numerous new species and varieties and other forms not previously recorded from the Paleocene, it seemed worth while to place the fauna on record. Com-

* Published by permission of the Director, Geological Survey, United States Department of the Interior.

parisons have been made with the faunas of other areas in the notes under the species, and references are given to those papers which record faunas related to this.

## Family TEXTULARIIDAE

### Genus SPIROPLECTAMMINA Cushman, 1927

**SPIROPLECTAMMINA LAEVIS (Roemer), var. CRETOSA Cushman** (Pl. 7, fig. 1)

*Spiroplectammina laevis* (ROEMER), var. *cretosa* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 8, 1932, p. 87, pl. 11, fig. 3.—JENNINGS, Bull. Amer. Pal., vol. 23, No. 78, 1936, p. 12, pl. 1, fig. 2.—CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 16, 1940, p. 52, pl. 9, fig. 3.—CUSHMAN and TODD, l. c., vol. 18, 1942, p. 25, pl. 5, fig. 1.—CUSHMAN, l. c., vol. 20, 1944, p. 2, pl. 1, fig. 4; p. 84.—CUSHMAN and DEADERICK, Journ. Pal., vol. 18, 1944, p. 329, pl. 50, fig. 6.

*Spiroplectammina semicomplanata* PLUMMER (part) (not CARSEY), Univ. Texas Bull. 3101, 1931, p. 129, pl. 8, fig. 8 (not fig. 7).

This variety is known from the Upper Cretaceous of Texas, ranging from the upper part of the Austin chalk through beds of Taylor and Navarro age. It is also recorded from the Marlbrook marl of Arkansas; the lower part of the Mooreville tongue of the Selma chalk of Mississippi; and the Mount Laurel sand and Navesink marl of New Jersey. It has been recorded from the Paleocene of Alabama. Typical specimens occur in our Arkansas material.

### Genus TEXTULARIA Defrance, 1824

**TEXTULARIA PLUMMERAE Lalicker, var.** (Pl. 7, fig. 2)

A few specimens in the Arkansas material are similar to this species known from the Paleocene but are all small. They may possibly represent a distinct variety but more specimens are needed before the relationships can be settled definitely.

## Family VERNEUILINIDAE

### Genus CLAVULINOIDES Cushman, 1936

**CLAVULINOIDES MIDWAYENSIS Cushman** (Pl. 7, figs. 3-6)

*Clavulinoides midwayensis* CUSHMAN, Special Publ. 6, Cushman Lab. Foram. Res., 1936, p. 21, pl. 3, figs. 9, 15; Special Publ. 7, 1937, p. 126, pl. 18, figs. 8, 9; Contr. Cushman Lab. Foram. Res., vol. 16, 1940, p. 53, pl. 9, fig. 6.—APPLIN and JORDAN, Journ. Pal., vol. 19, 1945, p. 131 (list).

*Clavulina angularis* PLUMMER (not D'ORBIGNY), Univ. Texas Bull. 2644, 1926 (1927), p. 70, pl. 3, figs. 4, 5.

This characteristic species is abundant in the Arkansas Paleocene. It is found also in the Paleocene of Texas, Alabama, and Tennessee, and in Paleocene well samples from Florida. The microspheric and megalospheric forms are quite different in appearance, as shown on our plate. The megalospheric form is much more common.

## Family LAGENIDAE

### Genus ROBULUS Montfort, 1808

**ROBULUS MIDWAYENSIS (Plummer)** (Pl. 7, fig. 7)

*Cristellaria midwayensis* PLUMMER, Univ. Texas Bull. 2644, 1926 (1927), p. 95, pl. 13, fig. 5.

*Robulus midwayensis* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 16, 1940, p. 55, pl. 9, fig. 12.—TOULMIN, Journ. Pal., vol. 15, 1941, p. 579, pl. 78, fig. 23; text fig. 2G. —CUSHMAN and TODD, Contr. Cushman Lab. Foram. Res., vol 18, 1942, p. 26, pl. 5, figs. 4, 5.—COOPER, Journ. Pal., vol. 18, 1944, p. 351, pl. 55, figs. 22, 23.—CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 20, 1944, p. 33, pl. 5, fig. 15.

*Lenticulina midwayana* ISRAELSKY, Proc. 6th Pac. Sci. Congress, 1939, p. 573, pl. 2, figs. 7, 8.

This characteristic Paleocene fossil is common in the Arkansas material. Other records include the Salt Mountain limestone and Naheola formation of Alabama and it occurs also in the Wilcox group. It is recorded from the Paleocene Porters Creek formation of Illinois and from the Eocene of California. Records from later Tertiary beds do not seem to be of typical material.

**ROBULUS PSEUDO-MAMILLIGERUS (Plummer)** (Pl. 7, fig. 10)

*Cristellaria pseudo-mamilligera* PLUMMER, Univ. Texas Bull. 2644, 1926 (1927), p. 98, pl. 7, fig. 11.

*Robulus pseudo-mamilligerus* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 16, 1940, p. 55, pl. 9, fig. 16.

This characteristic species, known from the Paleocene of Texas and Alabama, occurs in typical form in our Arkansas material.

**ROBULUS ALABAMENSIS Cushman** (Pl. 7, fig. 8)

*Robulus alabamensis* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 20, 1944, p. 33, pl. 5, fig. 13.

This species, described from the Paleocene, Coal Bluff marl member of the Naheola formation, of Alabama, occurs in very typical form in the Arkansas Paleocene.

**ROBULUS TURBINATUS (Plummer)** (Pl. 7, fig. 11)

*Cristellaria turbinata* PLUMMER, Univ. Texas Bull. 2644, 1926 (1927), p. 93, pl. 7, fig. 4; pl. 13, fig. 2.

*Robulus turbinatus* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 16, 1940, p. 55, pl. 9, fig. 17.

This species was described from the Paleocene, Midway, of Texas and recorded also from the Paleocene of Alabama. Specimens are not common in the Arkansas material but are typical.

**ROBULUS DEGOLYERI (Plummer)** (Pl. 7, fig. 13)

*Cristellaria degolyeri* PLUMMER, Univ. Texas Bull. 2644, 1926 (1927), p. 97, pl. 7, fig. 7.

*Robulus degolyeri* BANDY, Journ. Pal., vol. 18, 1944, p. 368, pl. 60, fig. 5.

Our specimens from the Paleocene of Arkansas are very similar to

those described and figured from the Midway of Texas. Similar specimens were figured by Bandy from the middle Eocene of Oregon.

**ROBULUS cf. INORNATUS (d'Orbigny)** (Pl. 7, fig. 9)

A few specimens may be referred to this species, originally described from the Miocene of the Vienna Basin. It is widely recorded, but a glance at the published figures shows that several different forms have been included under this name.

**ROBULUS WILCOXENSIS Cushman and Ponton, var. DISSENTIA Cushman and Todd, n. var.** (Pl. 7, fig. 12)

Variety differing from the typical form in the deeply incised sutures, more umbonate center, which is frequently ornamented with small bead-like elevations, and the more inflated chambers.

Holotype of variety (Cushman Coll. No. 46283) from the Paleocene, about 1000 feet S. of Roosevelt Rd. viaduct, 200 feet E. of RR. tracks, in small gully heading E., just upstream from small abandoned bridge, NE¼ NW¼ sec. 16, T. 1 N., R. 12 W., Little Rock, Ark.

This variety is common in this material and shows a considerable amount of variation.

**ROBULUS ARKANSASANA Cushman and Todd, n. sp.** (Pl. 7, fig. 14)

Test close coiled, strongly umbonate, periphery acute but not keeled, very slightly lobulate; chambers distinct, very slightly inflated, seven or eight in the adult coil, increasing very gradually and uniformly in size as added; sutures distinct, strongly limbate, curved, raised, broadest near the umbo where they tend to fuse; wall smooth except for the raised sutures; aperture at the peripheral angle of the last-formed chamber, slightly projecting, with a distinct median slit extending slightly down the apertural face. Diameter 1.25-1.50 mm.; thickness 0.65-0.75 mm.

Holotype (Cushman Coll. No. 46286) from the Paleocene, about 1000 feet S. of Roosevelt Rd. viaduct, 200 feet E. of RR. tracks, in small gully heading E., just upstream from small abandoned bridge, NE¼ NW¼ sec. 16, T. 1 N., R. 12 W., Little Rock, Ark.

This species differs from *Robulus midwayensis* (Plummer) in the fewer chambers, slightly lobulate margin, and less prominent sutural development. The species is common in the Arkansas material.

**ROBULUS sp.** (Pl. 7, figs. 15, 16)

Rare specimens of a peculiar form with numerous chambers and tending to become slightly uncoiled in the adult were found in this material. Two of them are figured on our plate.

## Genus MARGINULINA d'Orbigny, 1826

**MARGINULINA EXIMIA Neugeboren** (Pl. 7, fig. 17)

(For references, see these Contributions, vol. 20, 1944, p. 35.)

The types of this species are from the Miocene of Lapugy, Hungary. Specimens very similar to the type figures are common in the Paleocene material of Arkansas. Microspheric and megalospheric specimens differ in relative thickness and amount of inflation of the later chambers, but all show the strongly oblique sutures and the initial coiled portion is compressed. Similar specimens have been recorded from the Wilcox Eocene of Alabama, the Eocene of Washington and California, from cores taken in the western Atlantic, and from the Paleocene of Alabama.

**MARGINULINA cf. DUBIA** Neugeboren (Pl. 7, fig. 18)

Specimens closely resembling this species, described from the Miocene of Lapugy, Hungary, are common in the Arkansas material. Specimens vary considerably in the number of chambers and relative size of the later chambers.

**MARGINULINA cf. SUBRECTA** Franke (Pl. 7, fig. 23)

The single specimen figured may be an immature specimen of this species described by Franke from the Paleocene of Denmark.

**MARGINULINA cf. HAMATA (Franke)** (Pl. 7, figs. 19, 20)

A few specimens in the Arkansas material are similar in form to this species, described by Franke from the Paleocene of Denmark. Our specimens are much smaller than the European ones.

**MARGINULINA sp.** (Pl. 7, figs. 21, 22)

Rare specimens in the Arkansas material resemble the species described from the Eocene of the *Atlantis* submarine cores as *Vaginulina atlantisae* Cushman (Contr. Cushman Lab. Foram. Res., vol. 15, 1939, p. 59, pl. 10, figs. 23-26). One of our figured specimens shows a slight coiling at the base while the other, a megalospheric one, does not.

## Genus DENTALINA d'Orbigny, 1826

**DENTALINA GARDNERAE (Plummer)** (Pl. 8, fig. 1)

*Marginulina gardnerae* Plummer, Univ. Texas Bull. 2644, 1926 (1927), p. 106, pl. 5, fig. 11.

*Dentalina (?) gardnerae* Cushman, Contr. Cushman Lab. Foram. Res., vol. 16, 1940, p. 57, pl. 10, figs. 10-12.—Toulmin, Journ. Pal., vol. 15, 1941, p. 585, pl. 79, fig. 15. —Cushman and Todd, Contr. Cushman Lab. Foram. Res., vol. 18, 1942, p. 29, pl. 5, figs. 11, 12.

This is a common species in the Paleocene, with the types from Texas. It is recorded from Alabama from the Naheola formation and Salt Mountain limestone as well as from the Wilcox group above the Salt Mountain limestone.

**DENTALINA COLEI Cushman and Dusenbury** (Pl. 8, fig. 2)

*Vaginulina legumen* (Linne), var. *elegans* Cole (not d'Orbigny), Bull. Amer. Pal.,

vol. 14, No. 51, 1927, p. 21, pl. 3, figs. 10, 11.—PLUMMER, Univ. Texas Bull. 2644, 1926 (1927), p. 110, pl. 6, fig. 1.

*Dentalina colei* CUSHMAN and DUSENBURY, Contr. Cushman Lab. Foram. Res., vol. 10, 1934, p. 54, pl. 7, figs. 10-12.—PARR, Journ. Roy. Soc. W. Australia, vol. 24, 1937-38, p. 76, pl. 1, fig. 8—TOULMIN, Journ. Pal., vol. 15, 1941, p. 584, pl. 79, fig. 12.—BECK, l. c., vol. 17, 1943, p. 598, pl. 105, fig. 18.—CURRAN, Bull. Amer. Assoc. Petr. Geol., vol. 27, 1943, pp. 1378, 1381 (lists).—MARTIN, Stanford Univ. Publ., Univ. Ser., Geol. Sci., vol. 3, No. 3, 1943, p. 10 (list).—CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 20, 1944, p. 37, pl. 5, figs. 25-28.

This species has been widely recorded from the Eocene and is common in the Paleocene material from Arkansas.

**DENTALINA PLUMMERAE Cushman** (Pl. 8, fig. 3)

*Dentalina plummerae* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 16, 1940, p. 57, pl. 10, figs. 7-9, 19?

The types of this species are from the Midway of Alabama. Very typical specimens occur in the Arkansas material. The extended aperture is a characteristic feature.

**DENTALINA EOCENICA Cushman** (Pl. 8, figs. 4, 5)

*Nodosaria pauperata* PLUMMER (not D'ORBIGNY), Univ. Texas Bull. 2644, 1926 (1927), p. 79, pl. 4, fig. 11.

*Dentalina* cf. *pauperata* CUSHMAN and TODD, Contr. Cushman Lab. Foram. Res., vol. 18, 1942, p. 29, pl. 5, figs. 17, 18.

*Dentalina eocenica* CUSHMAN, l. c., vol. 20, 1944, p. 36, pl. 6, fig. 1.

The types of this species are from the Paleocene, Coal Bluff marl member of the Naheola formation, of Alabama. It also occurs in the Midway of Texas. The species is very rare in the Arkansas material and the figured specimen is an only partially developed one.

**DENTALINA NASUTA Cushman** (Pl. 8, figs. 6, 7)

*Dentalina nasuta* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 15, 1939, p. 57, pl. 10, figs. 10, 11.

Rare specimens in the Arkansas material seem to be identical with this species, described from the Eocene of cores taken in the western Atlantic.

**DENTALINA NAHEOLENSIS Cushman and Todd** (Pl. 8, fig. 8)

*Dentalina delicatula* CUSHMAN, var. *naheolensis* CUSHMAN and TODD, Contr. Cushman Lab. Foram. Res., vol. 18, 1942, p. 30, pl. 5, figs. 14, 15.

*Dentalina naheolensis* CUSHMAN, l. c., vol. 20, 1944, p. 35, pl. 5, fig. 17.

This species was described from the Paleocene Naheola formation of Alabama. Typical specimens occur in the Arkansas material.

**DENTALINA PSEUDO-OBLIQUESTRIATA (Plummer)** (Pl. 8, fig. 18)

*Nodosaria pseudo-obliquestriata* PLUMMER, Univ. Texas Bull. 2644, 1926 (1927), p. 87, pl. 4, fig. 18.

*Dentalina pseudo-obliquestriata* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 16, 1940, p. 58, pl. 10, fig. 18.—CUSHMAN and TODD, l. c., vol. 18, 1942, p. 28, pl. 5, fig. 10. —MARTIN, Stanford Univ. Publ., Univ. Ser., Geol. Sci., vol. 3, No. 3, 1943, p. 10 (list).

Our specimens from the Arkansas Paleocene are not entirely typical in comparison with paratypes from Texas. There seems to be some variation in the species and we have placed a number of specimens under this name.

**DENTALINA cf. MUCRONATA Neugeboren** (Pl. 8, fig. 12)

Very rare specimens are similar to this species. Specimens very much like these have been recorded from the Naheola formation of Alabama and the Midway of Texas.

**DENTALINA PSEUDO-NASUTA Cushman and Todd, n. sp.** (Pl. 8, figs. 13, 14)

*Dentalina* cf. *pungens* CUSHMAN (not REUSS), Contr. Cushman Lab. Foram. Res., vol. 15, 1939, p. 57, pl. 10, fig. 9.

Test small, elongate, slender, initial end with a single long spine, apertural end produced; chambers distinct, inflated, increasing very gradually in width as added, becoming more inflated in the adult portion; sutures distinct, somewhat depressed, slightly oblique; wall ornamented with numerous low costae, often slightly oblique on the earlier chambers; aperture terminal, slightly on the concave side of the test, radiate, projecting and tapering to a pointed end. Length 0.65-1.05 mm.; breadth 0.10-0.16 mm.

Holotype (Cushman Coll. No. 46313) from the Paleocene, about 1000 feet S. of Roosevelt Rd. viaduct, 200 feet E. of RR. tracks, in small gully heading E., just upstream from small abandoned bridge, NE¼ NW¼ sec. 16, T. 1 N., R. 12 W., Little Rock, Ark.

This species differs from *Dentalina nasuta* Cushman in the ornamented surface, more inflated chambers, and less oblique sutures.

Specimens very similar to these were recorded as "*Dentalina* cf. *pungens* Reuss" from the Eocene of cores from the western Atlantic.

**DENTALINA ACULEATA d'Orbigny** (Pl. 8, fig. 9)

*Dentalina aculeata* D'ORBIGNY, Mém. Soc. géol. France, ser. 1, vol. 4, 1840, p. 13, pl. 1, figs. 2, 3.

A few specimens similar to that figured resemble d'Orbigny's species from the Cretaceous of France.

**DENTALINA sp. A** (Pl. 8, fig. 10)

A number of specimens of a smooth, slender form with slightly inflated chambers seem to be undescribed.

**DENTALINA sp. B** (Pl. 8, figs. 15, 16)

A very few distinctive specimens appear to be new. They are covered by high, sharp costae throughout, the costae tending to be slightly oblique. The early part of the test bears a spine and is somewhat compressed. The later chambers become increasingly inflated, and the sutures more constricted.

**DENTALINA sp. C** (Pl. 8, fig. 17)

A few specimens similar to that figured are very slightly compressed and appear to be undescribed.

## Genus NODOSARIA Lamarck, 1812

**NODOSARIA AFFINIS Reuss** (Pl. 8, figs. 21-24)

(For references, see these Contributions, vol. 18, 1942, p. 58.)

This species is widely distributed in the Upper Cretaceous and Tertiary. Typical specimens of the megalospheric form are common. We have figured also smaller specimens with some of the characters of *Dentalina*. These may possibly belong to another species.

**NODOSARIA LATEJUGATA Gümbel** (Pl. 8, figs. 19, 20)

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

The various later references to Gümbel's species are not given, as many of them are without figures and those figured show a wide range of form. The types were from the lower Eocene of Bavaria. Topotypes from Gotzreuther Graben near Siegsdorf are very similar to our specimens but somewhat larger. Such forms as those figured are not rare in the Arkansas material.

**NODOSARIA cf. AMPHIOXYS Reuss** (Pl. 8, fig. 25)

Numerous specimens seem closer to this species than to *N. oligotoma* Reuss. The costae are continuous and are higher and thinner, extending out at the base of the test into one or more spines. It has been recorded as "*Nodosaria oligotoma* Reuss" from the Midway of Texas and Alabama. The types are from the Cretaceous of Saxony.

**NODOSARIA (?) LONGISCATA d'Orbigny** (Pl. 8, fig. 26)

A few specimens resemble this species, described by d'Orbigny from the Miocene of the Vienna Basin and widely recorded in the Tertiary of various regions. It has already been recorded from the Paleocene, Midway group, of Texas and Alabama. The apertural end is almost always broken but one specimen in this Paleocene material from Arkansas seems to suggest that it may belong to *Chrysalogonium*. More and better preserved specimens are needed to make the generic position certain.

## Genus CHRYSALOGONIUM Schubert, 1907

**CHRYSALOGONIUM ARKANSASANUM Cushman and Todd, n. sp.** (Pl. 9, figs. 1, 2)

*Chrysalogonium* cf. *texanum* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 16, 1940, p. 60, pl. 10, fig. 14.

Test very elongate, nearly straight to slightly curved, very slightly tapering, widest toward the apertural end, initial end with a short spine; chambers distinct, numerous, slightly inflated, averaging about twice as long as broad, increasing very slightly in relative length as added; su-

tures distinct, very slightly depressed; wall smooth; aperture terminal, cribrate, raised in a blunt cone. Length up to 3.75 mm.; diameter up to 0.25 mm.

Holotype (Cushman Coll. No. 46333) from the Paleocene, about 1000 feet S. of Roosevelt Rd. viaduct, 200 feet E. of RR. tracks, in small gully heading E., just upstream from small abandoned bridge, NE¼ NW¼ sec. 16, T. 1 N., R. 12 W., Little Rock, Ark.

This species resembles *C. texanum* Cushman but differs in the larger size, less elongate chambers, more prominent and rounded apertural end.

The species is fairly common in the Arkansas material and also occurs in the Paleocene, Midway group, of Alabama.

**CHRYSALOGONIUM EOCENICUM Cushman and Todd, n. sp.** (Pl. 9, figs. 3-5)

Test elongate, slender, distinctly curved, tapering, widest toward the apertural end, initial end subacute; chambers distinct, numerous, slightly inflated, slightly longer than broad in the adult, increasing little in relative length as added; sutures distinct, depressed and slightly oblique in the earlier portion; wall smooth; aperture terminal, cribrate, little if at all projecting above the contour of the chamber. Length up to 1.25 mm.; breadth up to 0.15 mm.

Holotype (Cushman Coll. No. 46338) from the Paleocene, about 1000 feet S. of Roosevelt Rd. viaduct, 200 feet E. of RR. tracks, in small gully heading E., just upstream from small abandoned bridge, NE¼ NW¼ sec. 16, T. 1 N., R. 12 W., Little Rock, Ark.

This species resembles *C. laeve* Cushman and Bermúdez from the Eocene of Cuba but is much smaller, the chambers much shorter, and the aperture projecting little if at all above the contour of the chamber.

The species is common in this material.

### Genus PSEUDOGLANDULINA Cushman, 1929

**PSEUDOGLANDULINA MANIFESTA (Reuss)** (Pl. 9, figs. 6-9)

(For references, see these Contributions, vol. 19, 1943, p. 58.)

This is a very common species in the Arkansas Paleocene material. It is widely distributed in the uppermost Cretaceous of Europe and America and occurs in the Paleocene, Midway group, and lower Eocene, Wilcox group, of the Gulf Coastal Plain in Texas, Alabama, and Florida. The two forms figured on our plate, one with a broadly rounded base and large proloculum representing the megalospheric form, the other with a very pointed base and minute proloculum followed by a series of chambers rapidly increasing in size representing the microspheric form, probably represent a single species. The adult chambers seem identical. Similar specimens have been recorded from the Midway group of Ala-

bama (Cushman, Contr. Cushman Lab. Foram. Res., vol. 16, 1940, p. 60, pl. 11, figs. 2, 3).

**PSEUDOGLANDULINA PYGMAEA (Reuss)** (Pl. 9, figs. 10, 11)

*Glandulina pygmaea* REUSS, Haidinger's Nat. Abhandl., vol. 4, pt. 1, 1851, p. 22, pl. 1, fig. 3.

*Pseudoglandulina pygmaea* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 16, 1940, p. 60, pl. 11, fig. 4.

*Nodosaria (Glandulina) comata* PLUMMER (not BATSCH), Univ. Texas Bull. 2644, 1926 (1927), p. 76, pl. 4, fig. 7.

The finely costate species here figured is common in the Arkansas material. It has already been recorded from the Paleocene, Midway group, of Texas and Alabama and occurs in the uppermost Cretaceous of America and Europe.

## Genus LINGULINA d'Orbigny, 1826

**LINGULINA cf. WILCOXENSIS Cushman and Ponton** (Pl. 9, fig. 12)

The single specimen figured is the only one found in this Arkansas material. It is not a complete specimen and resembles in shape and size the early portion of this species known previously only from the Wilcox Eocene.

## Genus VAGINULINA d'Orbigny, 1826

**VAGINULINA ROBUSTA Plummer** (Pl. 9, figs. 15-19)

*Vaginulina robusta* PLUMMER, Univ. Texas Bull. 2644, 1926 (1927), p. 112, pl. 6, fig. 4; pl. 13, fig. 3.—CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 16, 1940, p. 61, pl. 10, figs. 1-4.—CUSHMAN and RENZ, l. c., vol. 18, 1942, p. 6, pl. 2, figs. 1, 2.—CUSHMAN and TODD, l. c., vol. 18, 1942, p. 32, pl. 5, figs. 21, 22.—COOPER, Journ. Pal., vol. 18, 1944, p. 351, pl. 55, figs. 16, 17.—APPLIN and JORDAN, l. c., vol. 19, 1945, p. 132 (list).

This characteristic species of the Paleocene, originally described from Texas, has been since found in the Paleocene of Alabama, Florida, Illinois, and Trinidad. There is a considerable amount of variation in the sutural ornamentation, some specimens being nearly smooth, others with high ridges, and occasional specimens with the raised ridges distinctly beaded. Both microspheric and megalospheric specimens are shown on our plate.

**VAGINULINA LONGIFORMA (Plummer)** (Pl. 9, figs. 13, 14)

*Cristellaria longiforma* PLUMMER, Univ. Texas Bull. 2644, 1926 (1927), p. 102, pl. 13, fig. 4.

*Vaginulina longiforma* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 20, 1944, p. 38, pl. 6, figs. 11-13.

This species was described from the Paleocene, Midway group, of Texas and is also found in the Coal Bluff marl member of the Naheola formation of Alabama. There is a considerable amount of variation in the sutural characters, as in the previous species. Only a few specimens

were found in the Arkansas material and these represent the very young stages.

**VAGINULINA PLUMOIDES Plummer** (Pl. 9, fig. 20)

*Vaginulina plumoides* PLUMMER, Univ. Texas Bull. 2644, 1926 (1927), p. 113, pl. 6, fig. 6.—CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 16, 1940, p. 61, pl. 9, fig. 26. —CUSHMAN and RENZ, l. c., vol. 18, 1942, p. 6, pl. 1, fig. 6.

This is another characteristic Paleocene species. Originally described from the Midway group of Texas, it is also found in the Paleocene of Alabama and Trinidad. Specimens are rare in the Arkansas Paleocene material but are typical.

**VAGINULINA sp. A** (Pl. 8, fig. 11)

Rare specimens of a compressed, faintly costate form may be new but are too few to warrant description.

## Genus PALMULA Lea, 1833

**PALMULA BUDENSIS (Hantken)** (Pl. 9, figs. 21, 22)

*Flabellina budensis* HANTKEN, Mitth. Jahrb. K. geol. Anstalt, vol. 4, 1875 (1881), p. 44, pl. 4, fig. 17.

*Frondicularia budensis* PLUMMER, Univ. Texas Bull. 2644, 1926 (1927), p. 116, pl. 5, fig. 5.

*Palmula* cf. *budensis* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 16, 1940, p. 62, pl. 10, figs. 5, 6.—CUSHMAN and TODD, l. c., vol. 18, 1942, p. 33, pl. 6, fig. 3.

This species was described by Hantken from the upper Eocene of Hungary. In a search of material from his localities no specimens were found that were the same, but he records it as rare. Our specimens from Arkansas are very much like Hantken's figures and the size is approximately the same. It has been recorded from the Midway of Texas and Alabama.

## Genus FRONDICULARIA Defrance, 1826

**FRONDICULARIA NAHEOLENSIS Cushman and Todd** (Pl. 9, fig. 23)

*Frondicularia naheolensis* CUSHMAN and TODD, Contr. Cushman Lab. Foram. Res., vol. 18, 1942, p. 33, pl. 6, figs. 5, 6.

A number of specimens in the Paleocene material from Arkansas seem identical with this species, described from the Naheola formation of Alabama. It is probable that the specimens from the Midway of Texas referred by Mrs. Plummer to "*Frondicularia archiaciana* d'Orbigny, var. *strigillata* Bagg" (Univ. Texas Bull. 2644, 1926 (1927), p. 114, pl. 5, fig. 2) belong in *F. naheolensis*.

**FRONDICULARIA sp. A** (Pl. 9, fig. 24)

Two specimens, one of which is figured, represent a very different species from the preceding but not enough specimens are available for specific determination.

### Genus LAGENA Walker and Jacob, 1798

**LAGENA cf. APICULATA Reuss** (Pl. 9, fig. 25)

A few specimens of the form figured occur in the Arkansas material. A similar form is figured by Mrs. Plummer from the Paleocene, Midway group, of Texas (Univ. Texas Bull. 2644, 1926 (1927), p. 75, pl. 4, fig. 6).

**LAGENA cf. LAEVIS (Montagu)** (Pl. 9, fig. 26)

A few specimens, all very similar, were found in our material and seem to be close to this species. They seem identical with specimens referred to this name from the type locality of the Naheola formation (Cushman and Todd, Contr. Cushman Lab. Foram. Res., vol. 18, 1942, p. 34, pl. 6, fig. 4).

**LAGENA sp. A** (Pl. 9, fig. 27)

A few specimens similar to the one figured were found in the Arkansas material. They are costate and, when well preserved, have an exceptionally long, slender neck. It is difficult to assign them to a known species.

## Family POLYMORPHINIDAE

### Genus GUTTULINA d'Orbigny, 1839

**GUTTULINA PROBLEMA d'Orbigny** (Pl. 10, fig. 1)

Specimens probably of this very widely recorded species are common in the Arkansas Paleocene material.

**GUTTULINA HANTKENI Cushman and Ozawa** (Pl. 10, fig. 2)

(For references, see these Contributions, vol. 18, 1942, p. 34.)

Specimens, apparently of this species, which has already been recorded from the Naheola formation of Alabama and elsewhere in the Eocene, occur in considerable numbers in the Arkansas Paleocene.

### Genus GLOBULINA d'Orbigny, 1839

**GLOBULINA GIBBA d'Orbigny** (Pl. 10, fig. 3)

(For references, see these Contributions, vol. 20, 1944, p. 39.)

This species is very widely recorded. It has been found in the Paleocene of Texas, Alabama, and Trinidad, and is common in the Arkansas Paleocene.

**GLOBULINA ROTUNDATA (Bornemann)** (Pl. 10, fig. 4)

(For references, see U. S. Geol. Survey Prof. Paper 181, 1935, p. 27.)

Specimens are rather rare in the Arkansas material. The specimens, one of which is figured, usually have a fistulose growth at the apical end of the test. Similar specimens occur in the Coal Bluff member of the Naheola formation.

**GLOBULINA cf. MINUTA (Roemer)** (Pl. 10, fig. 5)

A few specimens in the Arkansas material are close to this species.

Genus PYRULINA d'Orbigny, 1839

PYRULINA cf. CYLINDROIDES (Roemer) (Pl. 10, fig. 6)

Several specimens, showing a considerable amount of variation, may be assigned to this species. It has been recorded from the Paleocene, Coal Bluff marl member of the Naheola formation, of Alabama (Cushman, Contr. Cushman Lab. Foram. Res., vol. 20, 1944, p. 40, pl. 6, fig. 23).

PYRULINA EXTENSA (Cushman) (Pl. 10, fig. 7)

(For references, see Special Publ. 14, Cushman Lab. Foram. Res., 1945, p. 33.)

A few specimens with an elongate form, slightly hispid surface, and very long, slender neck seem to belong to this species. A very similar specimen is figured by Palmer and Bermúdez from the Oligocene of Cuba (Mem. Soc. Cubana Hist. Nat., vol. 10, 1936, p. 283, pl. 14, fig. 17).

Genus PSEUDOPOLYMORPHINA Cushman and Ozawa, 1928

PSEUDOPOLYMORPHINA sp. A (Pl. 10, fig. 8)

The single specimen figured seems to belong in this genus. Its nearest species is *P. subcylindrica* (Hantken) but the two differ in a number of characters.

Genus SIGMOMORPHINA Cushman and Ozawa, 1928

SIGMOMORPHINA SEMITECTA (Reuss), var. TERQUEMIANA (Fornasini)

(For references and figures, see these Contributions, vol. 19, 1943, p. 37; vol. 21, 1945, p. 90.)

This variety is apparently very rare in the Arkansas material. It is widely recorded and was found in the Paleocene, Naheola formation, of Alabama.

SIGMOMORPHINA WILCOXENSIS Cushman (Pl. 10, fig. 9)

(For references, see these Contributions, vol. 20, 1944, p. 41.)

A few specimens seem to belong to this species known from the Wilcox Eocene and the Paleocene of Alabama.

Genus POLYMORPHINA d'Orbigny, 1826

POLYMORPHINA CUSHMANI Plummer (Pl. 10, fig. 10)

*Polymorphina cushmani* PLUMMER, Univ. Texas Bull. 2644, 1926 (1927), p. 125, pl. 6, fig. 9; pl. 15, fig. 1.—CUSHMAN and OZAWA, Proc. U. S. Nat. Mus., vol. 77, Art. 6, 1930, p. 117, pl. 30, fig. 8.

This species was described from the Paleocene, Midway group, of Texas. It seems to be an index species for beds of this age. Typical specimens are common in the Paleocene from Little Rock, Ark.

POLYMORPHINA sp. A (Pl. 10, fig. 11)

A single specimen of a species somewhat resembling *P. advena* (Cushman) and *P. frondea* Cushman was found in the Paleocene material from Arkansas. It is probably the same as that figured and recorded as "*Polymorphina* sp." from the Paleocene of Alabama (Cushman, Contr. Cushman Lab. Foram. Res., vol. 16, 1940, p. 64, pl. 11, fig. 8). This seems

to be a new species but more specimens are needed to justify a full description.

### Genus RAMULINA Rupert Jones, 1875

**RAMULINA cf. ACULEATA (d'Orbigny)** (Pl. 10, fig. 12)

A number of specimens from the Arkansas Paleocene seem to be close to this species. They show considerable variation. Similar specimens have been recorded from the Paleocene of Alabama.

### Genus BULLOPORA Quenstedt, 1856

**BULLOPORA CHAPMANI (Plummer)** (Pl. 10, figs. 13, 14)

*Vitriwebbina chapmani* PLUMMER, Univ. Texas Bull. 2644, 1926 (1927), p. 128, pl. 8, fig. 2.

*Bullopora chapmani* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 16, 1940, p. 64, pl. 11, figs. 10, 11.

Specimens of very typical form are present in the Arkansas material. The species was described from the Paleocene, Midway group, of Texas and is also recorded from the Midway of Alabama.

## Family HETEROHELICIDAE

### Genus GÜMBELINA Egger, 1899

**GÜMBELINA MIDWAYENSIS Cushman** (Pl. 10, fig. 15)

*Gümbelina midwayensis* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 16, 1940, p. 65, pl. 11, fig. 15.

The types of this species are from the Paleocene, Midway group, of Alabama. Rare specimens in the Arkansas material are very similar when compared with the types.

### Genus EOUVIGERINA Cushman, 1926

**EOUVIGERINA EXCAVATA Cushman** (Pl. 10, fig. 16)

*Eouvigerina excavata* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 16, 1940, p. 66, pl. 11, fig. 18.—CUSHMAN and TODD, l. c., vol. 18, 1942, p. 35, pl. 6, figs. 20, 21.—CUSHMAN, Amer. Journ. Sci., vol. 242, 1944, p. 10, pl. 1, fig. 18; Contr. Cushman Lab. Foram. Res., vol. 20, 1944, p. 42, pl. 7, fig. 7.

This species was described from the Paleocene, Midway group, of Alabama. It is found also in the Wilcox Eocene, Bashi formation, of Alabama. Typical specimens are common in the Arkansas material.

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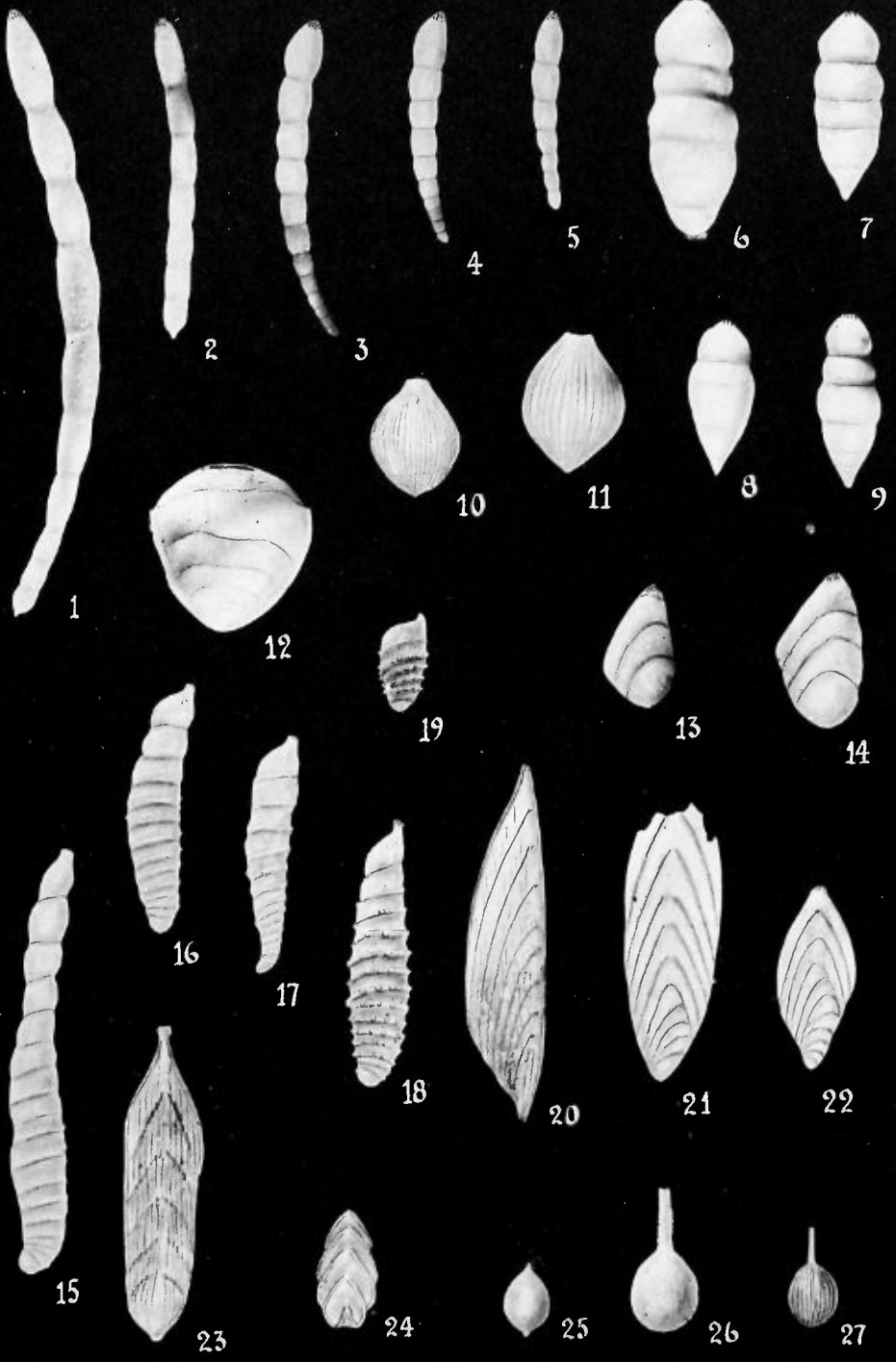
## EXPLANATION OF PLATE 9

FIGS. 1, 2. *Chrysalogonium arkansasanum* Cushman and Todd, n. sp. × 22. 1, Holotype. 2, Paratype. 3-5. *C. eocenicum* Cushman and Todd, n. sp. × 40. 3, Holotype. 4, 5, Paratypes. 6-9. *Pseudoglandulina manifesta* (Reuss). × 40. 6, Megalospheric. 7-9, Microspheric. 10, 11. *P. pygmaea* (Reuss). × 40. 12. *Lingulina* cf. *wilcoxensis* Cushman and Ponton. × 15. 13, 14. *Vaginulina longiforma* (Plummer), juv. × 40. 15-19. *V. robusta* Plummer. 15-17, × 22. 18, 19, × 15. 17, Microspheric. 20. *V. plumoides* Plummer. × 40. 21-22. *Palmula budensis* (Hantken). × 40. 23. *Frondicularia naheolensis* Cushman and Todd. × 40. 24. *F.* sp. A. × 40. 25. *Lagena* cf. *apiculata* Reuss. × 40. 26. *L.* cf. *laevis* (Montagu). × 40. 27. *L.* sp. A. × 40.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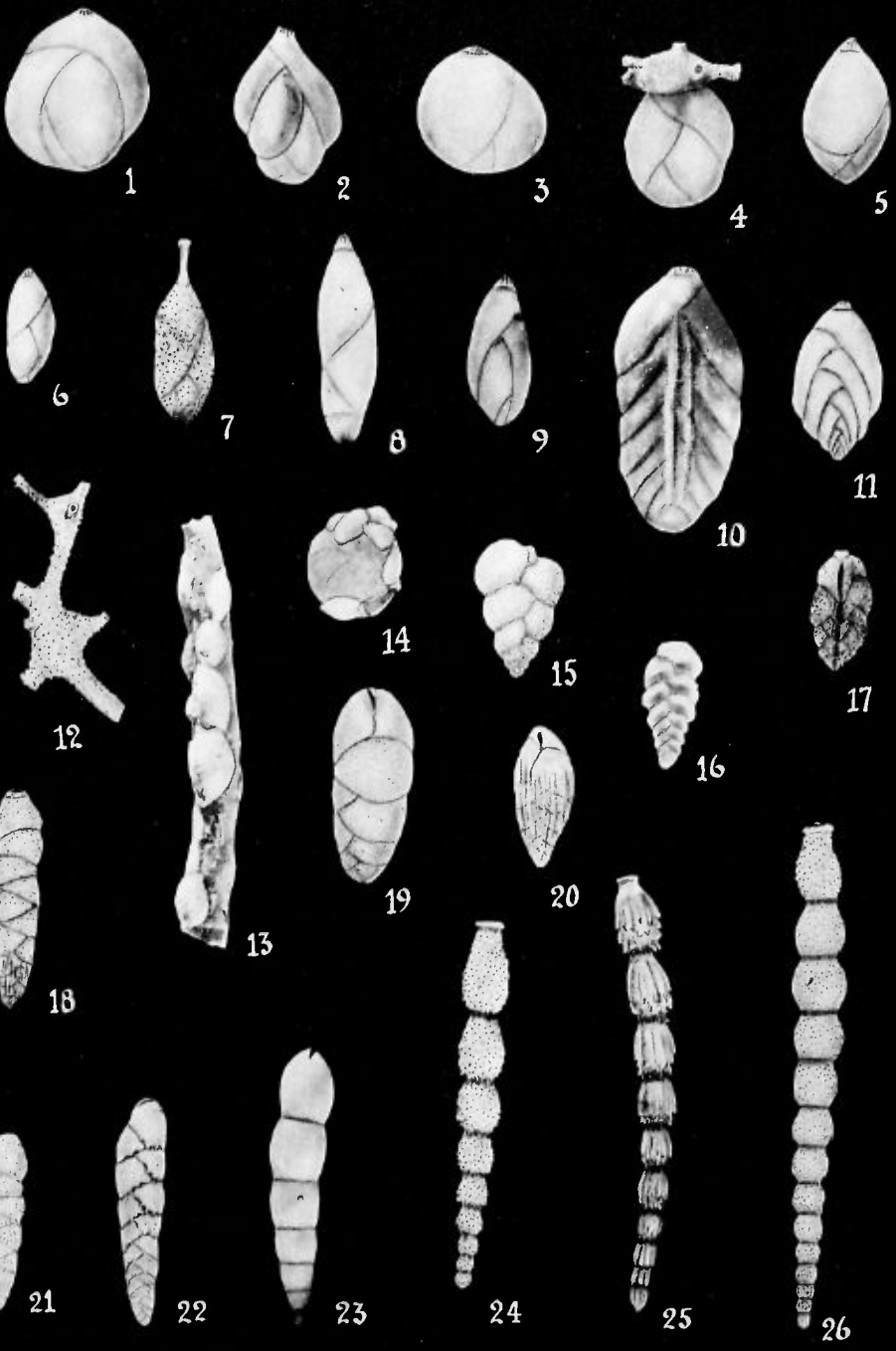
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### Genus PSEUDOUVIGERINA Cushman, 1927

**PSEUDOUVIGERINA NAHEOLENSIS Cushman and Todd** (Pl. 10, fig. 17)

*Pseudouvigerina naheolensis* CUSHMAN and TODD, Contr. Cushman Lab. Foram. Res., vol. 18, 1942, p. 36, pl. 6, figs. 18, 19.—CUSHMAN, Amer. Journ. Sci., vol. 242, 1944, p. 11, pl. 1, figs. 15, 16.

This species was described from the Paleocene, Naheola formation, of Alabama and also recorded from the Wilcox Eocene, Bashi formation, of Alabama. Specimens are fairly common in the Paleocene of Arkansas.

### Genus SIPHOGENERINOIDES Cushman, 1927

**SIPHOGENERINOIDES ELEGANTA (Plummer)** (Pl. 10, fig. 18)

*Siphogenerina eleganta* PLUMMER, Univ. Texas Bull. 2644, 1926 (1927), p. 126, pl. 8, fig. 1.

*Siphogenerinoides eleganta* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 16, 1940, p. 66, pl. 11, fig. 17.—CUSHMAN and RENZ, l. c., vol. 18, 1942, p. 8.—COOPER, Journ. Pal., vol. 18, 1944, p. 351, pl. 54, fig. 14.—CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 20, 1944, p. 42, pl. 7, fig. 8.

This seems to be a key species for the Paleocene. It was described from the Midway group of Texas and has been recorded from the Paleocene of Trinidad, the Porters Creek formation of Illinois, and the Coal Bluff member of the Naheola formation of Alabama. It is very common in the Paleocene material from Arkansas.

## Family BULIMINIDAE

### Genus BULIMINA d'Orbigny, 1826

**BULIMINA CACUMENATA Cushman and Parker** (Pl. 10, fig. 20)

*Bulimina cacumenata* CUSHMAN and PARKER, Contr. Cushman Lab. Foram. Res., vol. 12, 1936, p. 40, pl. 7, fig. 3.—CUSHMAN, l. c., vol. 16, 1940, p. 67, pl. 11, fig. 20.—CUSHMAN and TODD, l. c., vol. 18, 1942, p. 37.

This very small but distinctive species was described from the Paleocene, Midway group, of Texas and has been recorded from the Paleocene, Naheola formation, of Alabama. It occurs in typical form in the Paleocene material from Arkansas.

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## EXPLANATION OF PLATE 10

FIG. 1. *Guttulina problema* d'Orbigny. × 40. 2. *G. hantkeni* Cushman and Ozawa. × 40. 3. *Globulina gibba* d'Orbigny. × 40. 4. *G. rotundata* (Bornemann). × 40. 5. *G.* cf. *minuta* (Roemer). × 40. 6. *Pyrulina* cf. *cylindroides* (Roemer). × 40. 7. *P. extensa* (Cushman). × 40. 8. *Pseudopolymorphina* sp. A. × 40. 9. *Sigmomorphina wilcoxensis* Cushman. × 40. 10. *Polymorphina cushmani* Plummer. × 15. 11. *P.* sp. A. × 54. 12. *Ramulina* cf. *aculeata* (d'Orbigny). × 40. 13, 14. *Bullopora chapmani* (Plummer). × 22. 15. *Gümbelina midwayensis* Cushman. × 100. 16. *Eouvigerina excavata* Cushman. × 54. 17. *Pseudouvigerina naheolensis* Cushman and Todd. × 54. 18. *Siphogenerinoides eleganta* (Plummer). × 40. 19. *Bulimina (Desinobulimina) quadrata* Plummer. × 40. 20. *B. cacumenata* Cushman and Parker. × 100. 21. *Loxostomum plummerae* Cushman. × 40. 22. *L. applinae* (Plummer). × 40. 23. *Nodosarella paleocenica* Cushman and Todd, n. sp. × 40. Holotype. 24. *Ellipsonodosaria plummerae* Cushman. × 54. 25. *E. midwayensis* Cushman and Todd, n. sp. × 22. Holotype. 26. *E. paleocenica* Cushman and Todd, n. sp. × 40. Holotype.

**BULIMINA (DESINOBULIMINA) QUADRATA Plummer** (Pl. 10, fig. 19)

*Bulimina (Ellipsobulimina) quadrata* PLUMMER, Univ. Texas Bull. 2644, 1926 (1927), p. 72, pl. 4, figs. 4, 5.—JENNINGS, Bull. Amer. Pal., vol. 23, No. 78, 1936, p. 30, pl. 3, fig. 19.—ALBRITTON and PHLEGER, Journ. Pal., vol. 11, 1937, p. 352.—CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 16, 1940, p. 67, pl. 11, fig. 21.—APPLIN and JORDAN, Journ. Pal., vol. 19, 1945, p. 131 (list).

This species was described from the Paleocene, Midway group, of Texas and has been recorded from the Paleocene of Alabama and Florida and the Cretaceous of New Jersey. Typical specimens are common in the Arkansas Paleocene material.

## Genus LOXOSTOMUM Ehrenberg, 1854

**LOXOSTOMUM APPLINAE (Plummer)** (Pl. 10, fig. 22)

*Bolivina applinae* PLUMMER, Univ. Texas Bull. 2644, 1926 (1927), p. 69, pl. 4, fig. 1.

*Loxostoma applinae* CUSHMAN, Special Publ. 9, Cushman Lab. Foram. Res., 1937, p. 173, pl. 20, fig. 20; Contr. Cushman Lab. Foram. Res., vol. 16, 1940, p. 68, pl. 11, fig. 23.

The types of this species are from the Paleocene, Midway group, of Texas and it also occurs in the Paleocene of Alabama. It is very common in the Arkansas Paleocene material. A few specimens recorded from the Cretaceous and Tertiary do not seem to be identical with the Paleocene species.

**LOXOSTOMUM PLUMMERAE Cushman** (Pl. 10, fig. 21)

*Loxostomum plummerae* CUSHMAN, Special Publ. 6, Cushman Lab. Foram. Res., 1936, p. 59, pl. 8, fig. 13; Special Publ. 7, 1937, p. 174, pl. 20, fig. 21.

This species was described from the Paleocene, Midway group, of Texas and has not been recorded elsewhere. Typical specimens occur in some numbers in the Arkansas Paleocene but are not as common as the preceding species.

## Family ELLIPSOIDINIDAE

### Genus NODOSARELLA Rzehak, 1895

**NODOSARELLA PALEOCENICA Cushman and Todd, n. sp.** (Pl. 10, fig. 23)

Test small, elongate, often slightly curved, tapering from the very narrow initial end to the greatest width formed by the last one or two chambers, rounded in section; chambers distinct, later ones inflated, increasing rather rapidly in size and height as added, in the adult slightly longer than broad; sutures distinct, in the later portion depressed; wall smooth; aperture terminal, narrow, elongate, with a slightly raised lip at one side. Length up to 1.00 mm.; breadth 0.20-0.23 mm.

Holotype (Cushman Coll. No. 46408) from the Paleocene, about 1000 feet S. of Roosevelt Rd. viaduct, 200 feet E. of RR. tracks, in small gully heading E., just upstream from small abandoned bridge, NE¼ NW¼ sec. 16, T. 1 N., R. 12 W., Little Rock, Ark.

This species differs from *N. subnodosa* (Guppy) in the smaller size,

more elongate and less inflated chambers, and less depressed sutures. It is rather rare in the Arkansas material.

### Genus ELLIPSONODOSARIA A. Silvestri, 1900

**ELLIPSONODOSARIA PLUMMERAE Cushman** (Pl. 10, fig. 24)

*Nodosaria zagrinensis* PLUMMER (not BAGG), Univ. Texas Bull. 2644, 1926 (1927), p. 85, pl. 4, fig. 16.

*Ellipsonodosaria plummerae* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 16, 1940, p. 69, pl. 12, figs. 4, 5.—COOPER, Journ. Pal., vol. 18, 1944, p. 352, pl. 54, figs. 18, 19.

This species is known from the Paleocene, Midway group of Texas and Alabama, and the Porters Creek formation of Illinois. It is a common species in the Paleocene of Arkansas.

**ELLIPSONODOSARIA MIDWAYENSIS Cushman and Todd, n. sp.** (Pl. 10, fig. 25)

*Nodosaria spinulosa* PLUMMER (not *Nautilus spinulosus* MONTAGU), Univ. Texas Bull. 2644, 1926 (1927), p. 84, pl. 4, fig. 19.

Test elongate, slender, arcuate, gradually tapering from the acute initial end to the greatest width at the last-formed chamber, initial end with one or more distinct, short spines; chambers distinct, pyriform in shape, greatest width near the base, sides tapering but convex; sutures distinct, strongly depressed; wall ornamented with numerous, plate-like longitudinal costae ending in two series of spinose projections near the base of the chambers, in the earlier portion often with the costae continuous over several chambers; aperture terminal, with a very short neck and distinct lip. Length 2.00-2.60 mm.; breadth 0.25-0.30 mm.

Holotype (Cushman Coll. No. 46412) from the Paleocene, about 1000 feet S. of Roosevelt Rd. viaduct, 200 feet E. of RR. tracks, in small gully heading E., just upstream from small abandoned bridge, NE¼ NW¼ sec. 16, T. 1 N., R. 12 W., Little Rock, Ark.

This species is common in the Paleocene of Arkansas and is identical with specimens from the Midway of Texas. It differs from *E. alexanderi* Cushman in the high, plate-like costae with spinose projections only near the base of the chambers, which are more pyriform in shape.

**ELLIPSONODOSARIA PALEOCENICA Cushman and Todd, n. sp.** (Pl. 10, fig. 26)

*Ellipsonodosaria* sp. CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 16, 1940, p. 70, pl. 12, figs. 1, 2.

Test elongate, slender, straight, tapering very gradually from the very narrow initial end to the greatest breadth near the apertural end; chambers distinct, inflated, numerous, as many as 14 in the adult, increasing very gradually in size as added, strongly inflated, subspherical; sutures distinct, strongly depressed throughout; wall nearly smooth or slightly hispid in the earliest portion, in the last two or three chambers with a trace of very short spines; aperture terminal with a short neck and dis-

tinct lip, with a short tooth at one side of the opening. Length 1.50-1.90 mm.; breadth 0.20-0.25 mm.

Holotype (Cushman Coll. No. 46415) from the Paleocene, about 1000 feet S. of Roosevelt Rd. viaduct, 200 feet E. of RR. tracks, in small gully heading E., just upstream from small abandoned bridge, NE¼ NW¼ sec. 16, T. 1 N., R. 12 W., Little Rock, Ark.

This species is fairly common in the Paleocene of Arkansas and occurs also in the Paleocene of Alabama. It differs from *E. plummerae* Cushman in the shorter, more inflated chambers and smoother surface.

## Family ROTALIIDAE

### Genus VALVULINERIA Cushman, 1926

**VALVULINERIA ALLOMORPHINOIDES (Reuss)** (Pl. 11, fig. 1)

(For references, see these Contributions, vol. 16, 1940, p. 70.)

This species has a wide distribution in the Upper Cretaceous and has been recorded from the Paleocene, Midway group, of Texas and Alabama. It is common in the Paleocene of Arkansas.

### Genus GYROIDINA d'Orbigny, 1826

**GYROIDINA SUBANGULATA (Plummer)** (Pl. 11, figs. 2-4)

*Rotalia soldanii* (D'ORBIGNY), var. *subangulata* PLUMMER, Univ. Texas Bull. 2644, 1926 (1927), p. 154, pl. 12, fig. 1.

*Gyroidina subangulata* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 16, 1940, p. 71, pl. 12, fig. 7.—CUSHMAN and RENZ, l. c., vol. 18, 1942, p. 11, pl. 2, fig. 18.—APPLIN and JORDAN, Journ. Pal., vol. 19, 1945, p. 132 (list).

This species, originally described from the Paleocene, Midway group, of Texas, is recorded also from the Paleocene of Alabama, Florida, and Trinidad. It is very common in the Paleocene material from Arkansas.

### Genus EPONIDES Montfort, 1808

**EPONIDES cf. HAIDINGERII (d'Orbigny)** (Pl. 11, figs. 5, 6)

A few specimens from the Arkansas material resemble this species. They are similar to the one figured by Mrs. Plummer from the Midway of Texas as "*Truncatulina tenera* H. B. Brady" (Univ. Texas Bull. 2644, 1926 (1927), p. 146, pl. 9, fig. 5).

### Genus SIPHONINA Reuss, 1850

**SIPHONINA PRIMA Plummer** (Pl. 11, figs. 7, 8)

*Siphonina prima* PLUMMER, Univ. Texas Bull. 2644, 1926 (1927), p. 148, pl. 12, fig. 4.—CUSHMAN, Proc. U. S. Nat. Mus., vol. 72, Art. 20, 1927, p. 2, pl. 2, fig. 4.—JENNINGS, Bull. Amer. Pal., vol. 23, No. 78, 1936, p. 33, pl. 4, fig. 3.—CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 16, 1940, p. 71, pl. 12, fig. 10.—CUSHMAN and TODD, l. c., vol. 18, 1942, p. 40, pl. 7, figs. 16, 17; vol. 19, 1943, p. 69, pl. 12, fig. 6.

This species is abundant in the Paleocene material from Arkansas. It was described from the Midway group of Texas and recorded from the

Naheola formation of Alabama. It also occurs in the upper part of the Upper Cretaceous.

## Family CASSIDULINIDAE

### Genus PULVINULINELLA Cushman, 1926

**PULVINULINELLA OBTUSA (Burrows and Holland)** (Pl. 11, figs. 9, 10)

(For references, see these Contributions, vol. 21, 1945, p. 101.)

This species is very common in the Arkansas material. It is known from the Paleocene of Texas, Alabama, and Trinidad, and in the Wilcox Eocene it is recorded from Alabama and Virginia. The types are from the Eocene of England.

**PULVINULINELLA CULTER (Parker and Jones), var. MIDWAYANA Cushman and Todd, n. var.** (Pl. 11, fig. 12)

*Pulvinulinella culter* (PARKER and JONES), var. *mexicana* CUSHMAN (not COLE), Contr. Cushman Lab. Foram. Res., vol. 16, 1940, p. 72, pl. 12, fig. 12.

Variety differing from the typical form in the much smaller size, fewer chambers, and less developed peripheral flange.

Holotype of variety (Cushman Coll. No. 46426) from the Paleocene, about 1000 feet S. of Roosevelt Rd. viaduct, 200 feet E., of RR. tracks, in small gully heading E., just upstream from small abandoned bridge, NE¼ NW¼ sec. 16, T. 1 N., R. 12 W., Little Rock, Ark.

This variety is very common in the Paleocene of Arkansas and Alabama. The Texas form referred to "*Truncatulina culter* Parker and Jones" by Mrs. Plummer (Univ. Texas Bull. 2644, 1926 (1927), p. 147, pl. 10, fig. 1) is probably our variety.

## Family CHILOSTOMELLIDAE

### Genus ALLOMORPHINA Reuss, 1850

**ALLOMORPHINA TRIGONA Reuss** (Pl. 11, figs. 11, 15)

*Allomorphina trigona* REUSS, Denkschr. Akad. Wiss. Wien, vol. 1, 1850, p. 380, pl. 48, fig. 14; vol. 25, 1865, p. 156; Sitz. Akad. Wiss. Wien, vol. 55, pt. 1, 1867, p. 97.—PLUMMER, Univ. Texas Bull. 2644, 1926 (1927), p. 129, pl. 8, fig. 5.

There are numerous other records for this species but mostly without figures. The types were from the Miocene of Austria. Mrs. Plummer has recorded and figured the species from the Paleocene, Midway group, of Texas. A number of specimens in our material from Arkansas seem to be the same. The younger stages are similar to Reuss' figures but the adult is more like the type figures of *A. macrostoma* Karrer, published a few years later and also from the Miocene of the Vienna Basin. A series of specimens from localities in the Vienna Basin seems to show that both of these specific names may possibly refer to one species.

### Genus PULLENIA Parker and Jones, 1862

**PULLENIA QUINQUELOBA (Reuss), var. ANGUSTA Cushman and Todd**

(For references and figures, see these Contributions, vol. 19, 1943, p. 10, pl. 2, figs. 3, 4.)

The types of this variety are from the Paleocene, Midway group, of Texas. It also occurs in the Midway of Alabama and the Aragon formation of Mexico. It is rather rare in the Arkansas material.

## Family GLOBIGERINIDAE

### Genus GLOBIGERINA d'Orbigny, 1826

#### GLOBIGERINA PSEUDOBULLOIDES Plummer

(For references and figures, see these Contributions, vol. 18, 1942, p. 43, pl. 8, figs. 3, 4.)

This species is very common in our Arkansas material. It is also common in the Midway group of Texas and Alabama.

#### GLOBIGERINA TRILOCULINOIDES Plummer

(For references and figures, see these Contributions, vol. 20, 1944, p. 48, pl. 8, fig. 4.)

This species is also very common in the Arkansas material. It is found in the Paleocene of Texas and Alabama and elsewhere in the Eocene.

## Family ANOMALINIDAE

### Genus ANOMALINA d'Orbigny, 1826

#### ANOMALINA ACUTA Plummer (Pl. 11, figs. 13, 14)

*Anomalina ammonoides* Reuss, var. *acuta* Plummer, Univ. Texas Bull. 2644, 1926 (1927), p. 149, pl. 10, fig. 2.

*Anomalina acuta* Glaessner, Problems of Paleontology, Moscow Univ., vols. 2-3, 1937, p. 386, pl. 5, fig. 40.—Toulmin, Journ. Pal., vol. 15, 1941, p. 608, pl. 82, figs. 9, 10.—Cushman and Renz, Contr. Cushman Lab. Foram. Res., vol. 18, 1942, p. 12, pl. 3, fig. 6.—Cooper, Journ. Pal., vol. 18, 1944, p. 353, pl. 54, figs. 3-5.

The types of this species are from the Midway of Texas. It has been recorded from the Paleocene of Illinois and Trinidad, from the Wilcox Eocene of Alabama, and from the Tertiary of the Caucasus region. From the figures it may be suspected that more than one species is included under this name. It is common in the Arkansas material.

#### ANOMALINA MIDWAYENSIS (Plummer) (Pl. 11, figs. 18, 19)

*Truncatulina midwayensis* Plummer, Univ. Texas Bull. 2644, 1926 (1927), p. 141, pl. 9, fig. 7; pl. 15, fig. 3.

*Anomalina midwayensis* Cushman, Contr. Cushman Lab. Foram. Res., vol. 16, 1940, p. 73, pl. 12, fig. 18.—Cooper, Journ. Pal., vol. 18, 1944, p. 354, pl. 54, figs. 15-17.

The types of this species are from the Paleocene, Midway group, of Texas. It is also recorded from the Midway of Alabama and Porters Creek formation of Illinois. It is very common in the Paleocene material from Arkansas.

#### ANOMALINA cf. CLEMENTIANA (d'Orbigny) (Pl. 11, figs. 16, 17)

Rare specimens in the Paleocene of Arkansas, two of which are figured, are very similar to this species, which is common in the Upper Cretaceous of Europe and America. These may possibly be reworked specimens

from Cretaceous beds, but other species in the fauna do not indicate reworking.

Genus CIBICIDES Montfort, 1808

**CIBICIDES PRAECURSORIUS (Schwager)** (Pl. 11, figs. 20, 21)

(For references, see these Contributions, vol. 20, 1944, p. 49.)

This is a common species in the Paleocene and Wilcox Eocene of America. The types are from the middle Eocene of Egypt. It is common in the Paleocene of Arkansas.

**CIBICIDES VULGARIS (Plummer)** (Pl. 11, figs. 22, 23)

*Truncatulina vulgaris* PLUMMER, Univ. Texas Bull. 2644, 1926 (1927), p. 145, pl. 10, fig. 3.

*Cibicides vulgaris* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 16, 1940, p. 73, pl. 12, fig. 21.

The only previous records for this species are from the Paleocene, Midway group, of Texas and Alabama. It is fairly common in the Paleocene of Arkansas.

## 278. SOME NEW SPECIES AND VARIETIES OF FORAMINIFERA FROM THE PLIOCENE OF TIMMS POINT, CALIFORNIA

By J. A. CUSHMAN and H. B. GRAY

The following species and varieties occurring in material collected by the junior author seem to be undescribed:

**MASSILINA PULCHRA Cushman and Gray, n. sp.** (Pl. 12, fig. 1)

Test strongly compressed, periphery acute or slightly keeled, early portion quinqueloculine, adult planispiral; chambers distinct, very slightly inflated, in the adult planispiral portion with the final chamber less than a half coil in length; sutures distinct, slightly depressed; wall ornamented with costae which are distinctly oblique to the periphery and slightly curved; aperture oblong with a large, narrow tooth and a slightly thickened lip. Diameter up to 2.15 mm.; thickness up to 0.40 mm.

Holotype (Cushman Coll. No. 44211) from the Pliocene of Timms Point, near San Pedro, California.

This species differs from *M. gunteri* Cushman and Ponton from the Miocene of Florida which it somewhat resembles in the larger planispiral portion, more acute periphery, and the more oblique and more curved costae.

**ROBULUS PSEUDOCASSIS Cushman and Gray, n. sp.** (Pl. 12, fig. 2)

Test strongly compressed, periphery with a broad, transparent keel;

chambers distinct, little if at all inflated, increasing very gradually and evenly in size as added, front border distinctly curved; sutures strongly limbate and raised, curved, thickened at the inner end and strongly raised to form a pointed boss; wall between the sutures smooth; aperture at the outer peripheral angle, radiate, with a distinct median opening extending slightly along the middle of the excavated apertural face. Length of holotype 1.65 mm.; breadth 1.30 mm.; thickness 0.45 mm.

Holotype (Cushman Coll. No. 46457) from the Pliocene of Timms Point, near San Pedro, California.

This species differs from *R. jamaicensis* Cushman and Todd in the larger size, and less developed central bosses.

**DENTALINA CALIFORNICA** Cushman and Gray, n. sp. (Pl. 12, figs. 3-5)

Test elongate, slender, of nearly uniform diameter throughout, slightly arcuate, initial end terminating in a short spine; chambers few, of rather uniform size and shape, the proloculum longer than any of the succeeding chambers; sutures slightly depressed, strongly oblique; wall smooth; aperture terminal, radiate. Length 0.85-1.15 mm.; diameter 0.11-0.14 mm.

Holotype (Cushman Coll. No. 44218) from the Pliocene of Timms Point, near San Pedro, California.

This species differs from *D. communis* d'Orbigny in the fewer chambers and especially in the very large proloculum. It is fairly common in the Timms Point material.

**VAGINULINA SUBBADENENSIS** Cushman and Gray, n. sp. (Pl. 12, figs. 6, 7)

*Vaginulina badenensis* Bagg (not d'Orbigny), Bull. 513, U. S. Geol. Survey, 1912, p. 63, pl. 18, fig. 5.

*Vaginulina legumen* Bagg (not Linné), l. c., p. 63, pl. 18, figs. 6, 7.

*Vaginulina legumen* (Linné), var. *arquata* Bagg (not H. B. Brady), l. c., p. 64, pl. 18, fig. 8.

Test elongate, tapering, ventral side convex, dorsal side concave, initial end with a single, stout spine; chambers distinct but not inflated, in-

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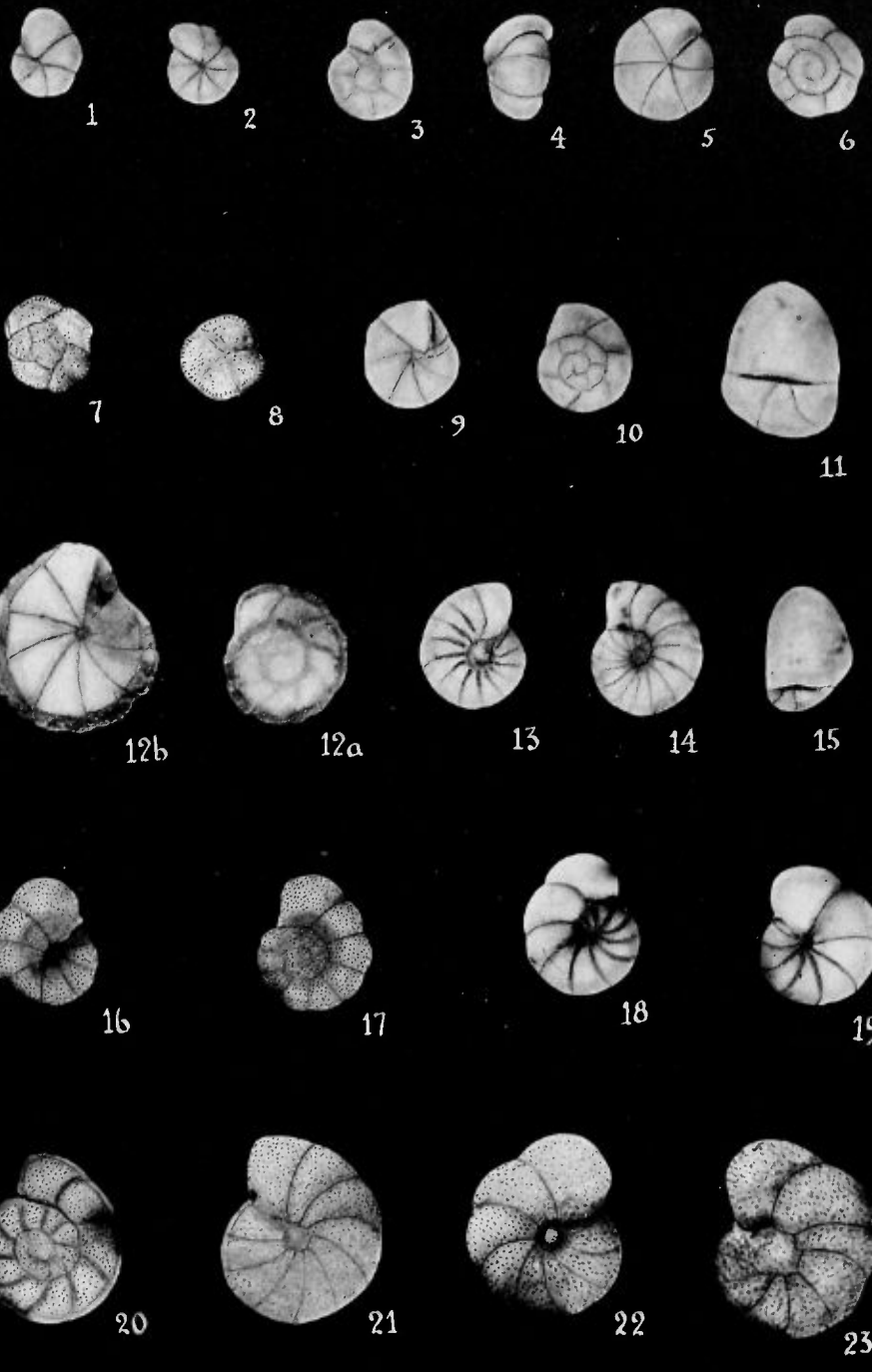
EXPLANATION OF PLATE 11

Fig. 1. *Valvulineria allomorphinoides* (Reuss). × 40. 2-4. *Gyroidina subangulata* (Plummer). × 40. 2, Ventral view. 3, Dorsal view. 4, Peripheral view. 5, 6. *Eponides* cf. *haidingerii* (d'Orbigny). × 40. 5, Ventral view. 6, Dorsal view. 7, 8. *Siphonina prima* Plummer. × 54. 7, Dorsal view. 8, Ventral view. 9, 10. *Pulvinulinella obtusa* (Burrows and Holland). × 40. 9, Ventral view. 10, Dorsal view. 11, 15. *Allomorphina trigona* Reuss. × 40. 12. *Pulvinulinella culter* (Parker and Jones), var. *midwayana* Cushman and Todd, n. var. Holotype. 12*a*, Dorsal view, × 40. 12*b*, Ventral view, × 54. 13, 14. *Anomalina acuta* Plummer. × 54. 13, Ventral view. 14, Dorsal view. 16, 17. *A.* cf. *clementiana* (d'Orbigny). × 40. 16, Ventral view. 17, Dorsal view. 18, 19. *A. midwayensis* (Plummer). × 40. 18, Dorsal view. 19, Ventral view. 20, 21. *Cibicides praecursorius* (Schwager). × 40. 20, Dorsal view. 21, Ventral view. 22, 23. *C. vulgaris* (Plummer). × 40. 22, Ventral view. 23, Dorsal view.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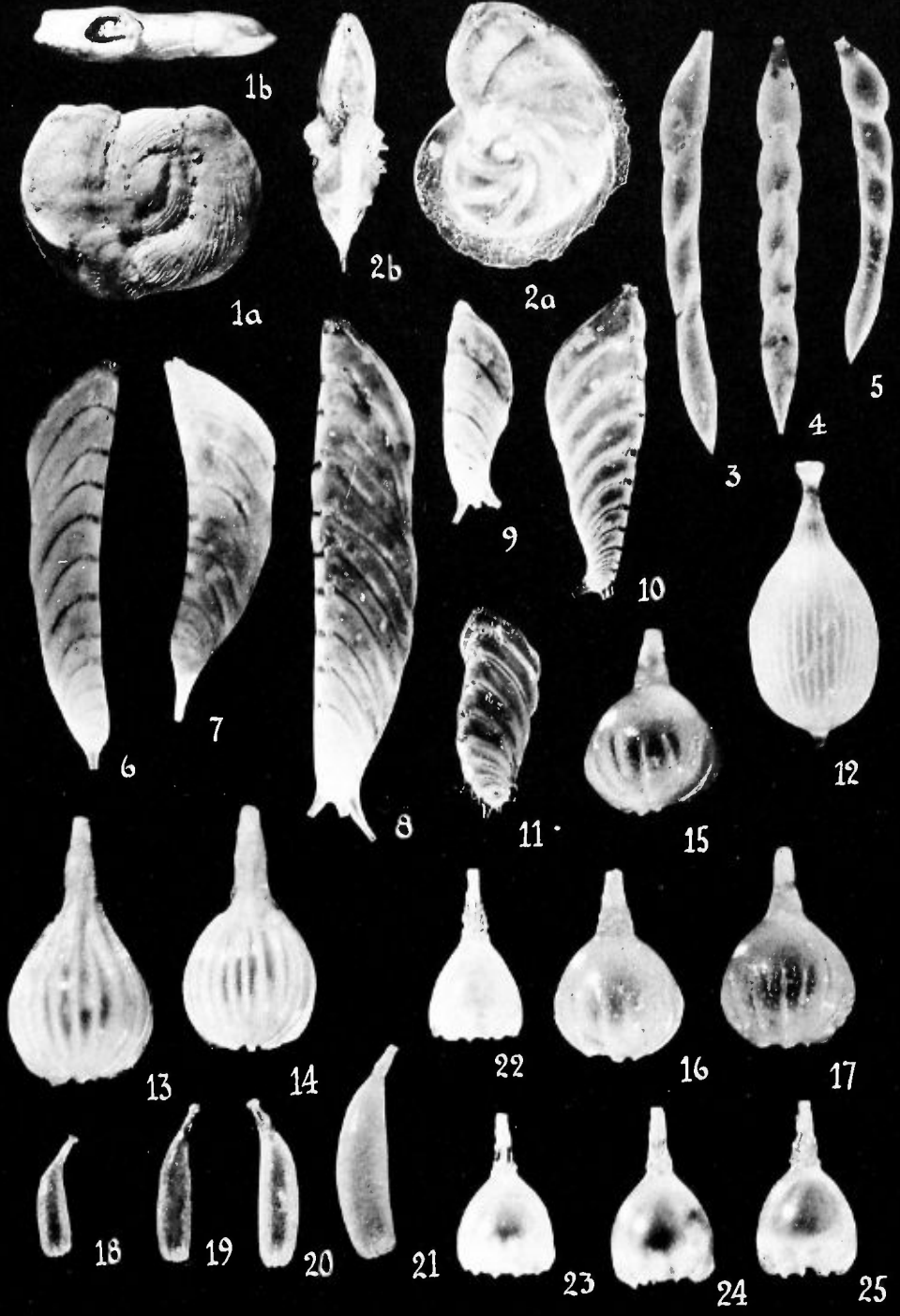
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creasing gradually in breadth but very little in height as added; sutures distinct, limbate, oblique and curved toward the ventral side; wall smooth; aperture terminal, radiate. Length up to 5.00 mm.; breadth 1.00-1.15 mm.

Holotype (Cushman Coll. No. 44212) from the Pliocene of Timms Point, near San Pedro, California.

This species differs from *V. badenensis* d'Orbigny in the relatively broader test, much more oblique sutures, and the sutures not raised. Bagg figured specimens of this species under several names as noted above, and his original material has been studied. Our specimens have been compared with topotypes of d'Orbigny's species and are quite distinct.

**VAGINULINA SUBBADENENSIS Cushman and Gray, n. sp., var. ACULEATA Cushman and Gray, n. var.** (Pl. 12, figs. 8-10)

Variety differing from the typical in the straight or slightly convex dorsal side and the initial end with two or three stout, divergent spines.

Holotype of variety (Cushman Coll. No. 44216) from the Pliocene of Timms Point, near San Pedro, California.

This variety somewhat resembles *V. spinigera* H. B. Brady in the basal spines but in our variety they are much shorter, the test is much more flattened, and the sutures very much oblique.

**VAGINULINA SUBBADENENSIS Cushman and Gray, n. sp., var. SERRULATA Cushman and Gray, n. var.** (Pl. 12, fig. 11)

Variety differing from the typical in the relatively shorter, broader test, the base with several short spines which tend to fuse into a keel.

Holotype of variety (Cushman Coll. No. 44217) from the Pliocene of Timms Point, near San Pedro, California.

This variety seems to be quite distinct from the preceding.

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## EXPLANATION OF PLATE 12

FIG. 1. *Massilina pulchra* Cushman and Gray, n. sp. × 18. *a*, side view; *b*, apertural view. 2. *Robulus pseudocassis* Cushman and Gray, n. sp. × 18. *a*, side view; *b*, peripheral view. 3-5. *Dentalina californica* Cushman and Gray, n. sp. × 60. 3, 5, Side views; 4, peripheral view. 3, Holotype. 4, 5, Paratypes. 6, 7. *Vaginulina subbadenensis* Cushman and Gray, n. sp. × 15. 6, Holotype. 7, Paratype. 8-10. *V. subbadenensis* Cushman and Gray, n. sp., var. *aculeata* Cushman and Gray, n. var. × 15. 8, Holotype. 9, 10, Paratypes. 11. *V. subbadenensis* Cushman and Gray, n. sp., var. *serrulata* Cushman and Gray, n. var. × 15. Holotype. 12. *Lagena sulcata* (Walker and Jacob), var. *apiculata* Cushman. × 110. 13, 14. *L. sulcata* (Walker and Jacob), var. *laevicostata* Cushman and Gray, n. var. × 80. 13, Holotype. 14, Paratype. 15-17. *L. pliocenica* Cushman and Gray, n. sp., var. *timmsana* Cushman and Gray, n. var. × 85. 15, Holotype. 16, 17, Paratypes. 18-21. *L. flexa* Cushman and Gray, n. sp. × 70. 21, Holotype. 18-20, Paratypes. 22-25. *L. pliocenica* Cushman and Gray, n. sp. × 60. 22, Holotype. 23-25, Paratypes.

**LAGENA PLIOCENICA Cushman and Gray, n. sp.** (Pl. 12, figs. 22-25)

Test with the main portion roughly triangular in longitudinal section, the sides slightly convex and the greatest width near the base, wall of the middle portion smooth but with a fine granular appearance and nearly opaque, base with a few raised costae radiating out from the center of the lower face, apertural end with an elongate, tapering neck ornamented with longitudinal costae, occasionally tending to become slightly spiral. Length 0.30-0.40 mm.; diameter 0.25-0.28 mm.

Holotype (Cushman Coll. No. 44221) from the Pliocene of Timms Point, near San Pedro, California.

This species differs from typical *L. crenata* Parker and Jones in the much coarser costae, with a larger portion on the lateral faces of the test, and in the longitudinal costae of the neck.

**LAGENA PLIOCENICA Cushman and Gray, n. sp., var. TIMMSANA Cushman and Gray, n. var.** (Pl. 12, figs. 15-17)

Variety differing from the typical in the more globular body of the test, the sides curving inward toward the base without a definite angle and the surface smooth and translucent above the costate portion.

Holotype of variety (Cushman Coll. No. 44222) from the Pliocene of Timms Point, near San Pedro, California.

This variety may be easily distinguished from the typical form when the two are seen together.

**LAGENA SULCATA (Walker and Jacob), var. APICULATA Cushman** (Pl. 12, fig. 12)

The figured specimen is fairly typical of this variety except that the costae are less raised. Our specimens have a tendency to vary in the direction of forms that have been referred to *L. striata* (d'Orbigny), var. *strumosa* Reuss.

**LAGENA SULCATA (Walker and Jacob), var. LAEVICOSTATA Cushman and Gray, n. var.** (Pl. 12, figs. 13, 14)

Variety differing from the typical in the elongate, tapering neck and the much higher plate-like costae of which a few continue along the neck to the apertural end.

Holotype of variety (Cushman Coll. No. 44227) from the Pliocene of Timms Point, near San Pedro, California.

This variety seems to be quite distinct in our material.

**LAGENA FLEXA Cushman and Gray, n. sp.** (Pl. 12, figs. 18-21)

Test elongate, distinctly bent toward the apertural end, base truncate, apertural end tapering, sides nearly parallel; wall distinctly but finely perforate, the base with very short costae, apertural end with a tapering neck, turning to one side, with a slight lip. Length 0.28-0.40 mm.; diameter 0.10-0.15 mm.

Holotype (Cushman Coll. No. 44228) from the Pliocene of Timms Point, near San Pedro, California.

This species is a very thin-walled and delicate form, easily broken. It differs from *L. perlucida* (Montagu) in the more cylindrical test and the definite bending to one side at the apertural end.

## RECENT LITERATURE ON THE FORAMINIFERA

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

**Keijzer, F.** On a new genus of arenaceous foraminifera from the Cretaceous of Texas. —Proc. Ned. Akad. v. Wetensch., vol. XLV, No. 10, 1942, pp. 1016, 1017, text figs. *a-j*.—Describes a new genus, *Coskinolinoides* (genotype *C. texanus* n. sp.), from the Lower Cretaceous, Walnut formation, of Texas.

**Bolli, Hans.** Zur Stratigraphie der Oberen Kreide in den höheren helvetischen Decken. —Eclogae Geologicae Helvetiae, vol. 37, No. 2, 1944 (Feb. 28, 1945), pp. 218-328, pl. IX, text figs. 1-6.—Includes a portion on *Globotruncana* with numerous species and subspecies figured, the following new: *Globotruncana alpina* n. sp.; *G. helvetica* n. sp.; *G. lapparenti lapparenti* n. subsp.; *inflata* n. subsp.; *coronata* n. subsp.; *G. leupoldi* n. sp.

**Plummer, Helen Jeanne.** Smaller Foraminifera in the Marble Falls, Smithwick, and Lower Strawn Strata around the Llano Uplift in Texas.—Univ. Texas Publ. 4401, Dec. 1945, pp. 209-271, pls. 15-17.—Forty species and subspecies are recorded, mostly described and figured, of which 15 are new: *Thuramminoides sphaeroidalis* n. sp.; *Hyperammina clavacoidea* n. sp.; *H. elegantissima* n. sp.; *Hyperamminoides expansus* n. sp.; *Reophax bendensis* n. sp.; *R. emaciatus* n. sp.; *R. expatiatus* n. sp.; *R. minutissimus* n. sp.; *R. tumidulus* n. sp.; *Glomospira articulosa* n. sp.; *Haplophragmoides confragosus* n. sp.; *Endothyra distensa* n. sp.; *Endothyranella armstrongi* Plummer, subsp. *sobrina* n. subsp.; *Bigenerina perexigua* n. sp.; *Cribrostomum marblense* n. sp.; and two genera are erected: *Thuramminoides* (genotype *T. sphaeroidalis* n. sp.) and *Glomospirella* (genotype *Glomospira umbilicata* Cushman and Waters).

**ten Dam, A.** Sur une microfaune maestrichtienne dans un nodule phosphaté d'Oot-marsum (Pays-Bas).—Comptes rendus Soc. Géol. France, Dec. 3, 1945, p. 221.—Species of foraminifera are listed from a reworked Cretaceous pebble found in strata of Oligocene age.

**ten Dam, A. and Ernest Schijfsma.** Sur un genre nouveau de la famille des Lagenidae. —L. c., Dec. 17, 1945, pp. 233, 234.—The genus *Tricarinella* ten Dam and Schijfsma n. gen. (genotype *Rhabdogonium excavatum* Reuss) ranges from upper Jurassic to the lower Tertiary. A number of other species originally placed in *Dentalinopsis, Frondicularia, Rhabdogonium,* and *Triplasia* are included in the new genus.

**Loeblich, Alfred R., Jr.** Foraminifera from the Type Pepper Shale of Texas.—Journ. Pal., vol. 20, No. 2, March, 1946, pp. 130-139, pl. 22, text figs. 1-3.—Twelve new

species are described and figured as follows: *Reophax pepperensis* n. sp.; *Ammodiscus planus* n. sp.; *Glomospira watersi* n. sp.; *Haplophragmoides platus* n. sp.; *Ammomarginulina bellensis* n. sp.; *Ammobaculites obscurus* n. sp.; *A. polythalamus* n. sp.; *Spiroplectammina* sp.; *Ammobaculoides plummerae* n. sp.; *Textularia adkinsi* n. sp.; *Verneuilina perplexa* n. sp.; and *Trochammina wickendeni* n. sp.

**Thompson, M. L.** Permian Fusulinids from Afghanistan.—L. c., pp. 140-157, pls. 23-26, text fig. 1.—A new genus *Afghanella* (genotype *A. schencki* n. sp.) is erected and the following new species described: *Yangchienia haydeni* n. sp.; *Schwagerina furoni* n. sp.; *Polydiexodina afghanensis* n. sp.; and *Afghanella schencki,* n. sp.

**Stuckey, Charles W., Jr.** Some Textulariidae from the Gulf Coast Tertiary.—L. c., pp. 163-165, pl. 29.—Four species are described and figured, the following new: *Spiroplectammina howei* n. sp.; *Textularia seligi* n. sp.

**Thalmann, Hans E.** Bibliography and Index to New Genera, Species, and Varieties of Foraminifera for the year 1944.—L. c., pp. 172-183.

Micropaleontology of Upper Cretaceous and Paleocene in Western Ecuador.—Bull. Amer. Assoc. Petr. Geol., vol. 30, No. 3, March, 1946, pp. 337-347, 1 fig. (map). —Many species of foraminifera are listed.

**Cushman, Joseph A.** A Rich Foraminiferal Fauna from the Cocoa Sand of Alabama. —Special Publ. No. 16, Cushman Lab. Foram. Res., April 16, 1946, 40 pp., 8 pls. —There are 113 species and varieties recorded, nearly all figured, of which 9 are new: *Spiroplectammina mississippiensis* (Cushman), var. *distincta* n. var.; *Karreriella lalickeri* n. sp.; *Robulus inusitatus* n. sp.; *Marginulina lalickeri* n. sp.; *Dentalina cooperensis* Cushman, var. *gracilescata* n. var.; *Bolivina gracilis* Cushman and Applin, var. *incisurata* n. name; *B. alazanensis* Cushman, var. *primaeva* n. var.; *Cancris cocoaensis* n. sp.; *Cassidulinoides howei* n. sp.

The Species of Foraminifera Named and Figured by Fichtel and Moll in 1798 and 1803.—Special Publ. No. 17, April, 1946, 16 pp., 4 pls.—These species are mostly figured from the original work with some actual specimens figured for comparison.

A Supplement to the Monograph of the Foraminiferal Family Verneuilinidae.—Special Publ. No. 7A, May, 1946, 43 pp., 4 pls.—This gives the many new references to the species in the Verneuilinidae and reproduces the figures and descriptions of the species and varieties that have been erected since the publication of Special Publ. No. 7 in 1937.

J. A. C.