ARKADELPHIA FORAMINIFERIDA

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I. Abstract

The prolific foraminiferal fauna of the upper Cretaceous Arkadelphia Marl (southwestern Arkansas) is described and illustrated. Previous literature on the Foraminiferida of the Arkadelphia is scattered and confused. All 118 known species from the formation are re-described and numerous taxonomic revisions are made to correct generic assignments in conformity with modern usage. Twenty-four other species-groups which have been reported from the Arkadelphia by earlier writers are reviewed and discussed. It is suggested that most of these are erroneously attributed to this horizon. A range chart and a brief discussion of the faunal zones within the formation are included.

The fauna of the Arkadelphia indicates that it may be correlated with the Navarro Formation of Texas, The Monmouth Formation of Maryland, the Navesink and Mount Laurel formations of New Jersey and the Maestrichtian group of the Senonian stage of the European Cretaceous.

II. Introduction

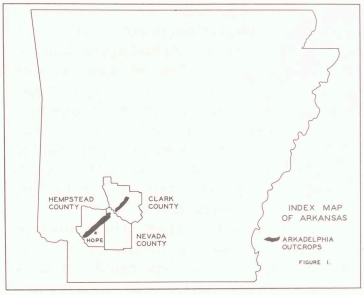
The upper Cretaceous Arkadelphia Marl of southwest Arkansas is prolific in microfossils. The Foraminiferida are distinctive and can be used to identify the formation both in surface and in subsurface occurrences.

Arkadelphia outcrops, 6.4 miles north of Hope, Hempstead County, Arkansas, afford the best exposed, most complete known surface section of the formation (see figure 1). These exposures consist of approximately 57 feet of marls and sandstones. The greatest known thickness (160 feet) is in the subsurface.

The previous literature concerning the fauna of the Arkadelphia is scattered and confused. All species known to the writer from this formation are re-described and other reported species are listed and discussed. A range chart and a brief discussion of faunal zones are included. The Ostracoda of the Arkadelphia have been the subject of an earlier paper (Skinner, 1956).

III. Procedure

The field work and geological reconnaissance required for this study were accomplished in 1952 and 1953. The specific outcrop of Arkadelphia Marl to be studied was selected, the section was measured and samples were collected at six-inch intervals from the unconformable contact with the underlying Nacatoch Sand to the top of the Arkadelphia where it is unconformably overlain by the Midway Formation. The samples were obtained either from fresh surface exposures or by hand auguring where fresh exposures were not available.



The samples were washed by the double decantation method and the specimens were picked and mounted on faunule slides. The identified species were photographed with a Leitz Aristophot camera mounted over a Leitz Ortholux microscope at a magnification of 48 or 24 diameters, depending on the size of the specimens.

The hypotypes illustrated in this paper have been deposited in the United States National Museum (USNM), Washington, D. C.

IV. Stratigraphy

The name "Arkadelphia shales" was first used by Hill (1888, p. 53) for "blue clays and yellow sands, consisting of alternating bands of these materials, varying from one-eighth of an inch to one foot in thickness," exposed near Arkadelphia, Clark County, Arkansas. Hill believed these shales to be Tertiary in age. Harris (1894, p. 15) later identified equivalent exposures in Hemp-

stead and Clark counties as Cretaceous sediments. Veatch (1906, p. 28) designated "the dark, laminated clays which overlie the Nacatoch sand" as the Arkadelphia shales. This usage, somewhat modified from the original description, is accepted. Seven feet of poorly exposed Arkadelphia Marl at Arkadelphia and 22 feet of well exposed sandy marl underlain by a hard, basal sandy limestone north of Hope, Hempstead County, Arkansas, were described by Dane (1929). The latter exposures supplemented by hand augured samples, with a total thickness of approximately 57 feet, are the subject of the present study.

The Arkadelphia Marl, the youngest formation in Arkansas of the upper Cretaceous (Gulfian), consists chiefly of dark gray and black marls and marly clay, weathering light gray and containing some beds of hard, dense, calcareous, and highly fossiliferous gray sandstone, gray sandy clay, sandy limestone, dense concretionary limestone, and white impure chalk. The fresh surface commonly appears distinctly laminated or stratified.

The Arkadelphia overlies the Nacatoch Sand with clear unconformity. The base of the Arkadelphia where observed by the writer is channeled distinctly at the contact with the Nacatoch Sand, indicating a chronological break separating the two units. Lenses of hard, calcareous, fossiliferous, fucoidal sandstone mark the base in the area studied. The basal portion of the formation is not well exposed and was observed and sampled 18 feet below the surface in a water well. The Paleocene Midway Formation unconformably overlies the Arkadelphia with a thin limestone at the base of the Midway.

The Arkadelphia Marl weathers readily and good exposures are uncommon. The Arkadelphia permits development of a relatively low, smooth topography covered with brown sedge grass, briar thickets, some scrub oaks and pines, a contrast to the adjoining pine-clad hills of the Nacatoch Sand.

The microfauna is sparsely distributed in the lower, more sandy portion of the Arkadelphia, but is preserved in abundance in the upper portion.

V. Summary

1. One hundred and forty-two species-groups of Foraminiferida from seventy genus-groups have been reported from the Arkadelphia. One hundred and eighteen species-groups were recovered from the measured section sampled by the writer. These have been illustrated and described.

2. The previous literature concerning the fauna of the Arkadelphia and its equivalents is scattered and confused. It is attempted here to summarize the earlier works by revising the fauna to conform to modern usage, and to re-describe all known species which are present in the formation. Twenty-four species have been reported which were not recovered by the writer. It is likely that most of these represent misidentified forms. These are as follows:

Reophax difflugiformis H. B. Brady
Gaudryina (Siphogaudryina) stephensoni Cushman
Clavulinoides compressus (Cushman)
Plectina watersi Cushman
Lenticulina (Lenticulina) jonesi Sandidge
Marginulina navarroana Cushman
Marginulina silicula (Plummer)
Chrysalogonium granti (Plummer)
Citharina navarroana (Cushman)
Pseudofrondicularia lanceola (Reuss)
Bolivinita costifera Cushman
Bolivina incrassata Reuss
Bolivina decurrens (Ehrenberg)
Siphogenerinoides brevispinosa Cushman
Bulimina prolixa Cushman and Parker
Tubitextularia cretacea (Cushman)
Planoglobulina acervulinoides (Egger)
Globotruncana arca (Cushman)
Globotruncana canaliculata (Reuss)
Globorotalia membranacea (Ehrenberg)
Anomalina nelsoni W. Berry
Stilostomella alexanderi (Cushman)
Pullenia minuta Cushman
Cibicides subcarinatus Cushman and Deaderick

3. The Foraminiferida of the Arkadelphia Marl indicate that it may be correlated with the Navarro Formation of Texas, the Monmouth Formation of Maryland, the Navesink and Mount Laurel formations of New Jersey and the Maestrichtian group of the Senonian stage of the European Cretaceous. The Ostracoda of the Arkadelphia support these correlations.

4. The faunal content of the Arkadelphia samples is influenced strongly by the presence of sandy zones and euhedral crystals of selenite in the basal portion of the formation. The marked scarcity of individuals, species, and genera in the basal samples appears to be related to a sandy environment and the presence of the selenite crystals suggests that secondary alteration may

have destroyed some of the fossils in the lower portion. A marked increase in forms is noted about 17 or 18 feet above the base and the abundant and well preserved fauna which is characteristic of the Arkadelphia is present throughout the remainder of the sequence.

5. Forty-nine of the species present in the Arkadelphia are restricted to the Navarro and equivalents. Twelve of these are characteristic of only the Arkadelphia and the upper Navarro and serve as index fossils:

Ammobaculites arenatus Cushman
Ammobaculites texanus Cushman
Gaudryina deadericki Cushman
Gaudryina navarroana Cushman
Gaudryinella pseudoserrata extensa Cushman
Pseudoclavulina arenata (Cushman)
Planularia deadericki Cushman
Marginulina curvatura Cushman
Pseudofrondicularia arkadelphiana (Cushman)
Bulimina arkadelphiana Cushman and Parker
Gyroidina arkadelphiana Cushman
Globotruncana gansseri Bolli

Thus, relatively few species are restricted to the Arkadelphia. Most Navarro species range from their first appearance throughout the remainder of the Navarro, becoming extinct at the close of the Cretaceous. Thus, only the few species which first appear in Arkadelphia time are distinctive of the Arkadelphia and equivalents.

6. Many Arkadelphia species are long-ranging and occur at many localities. An example is *Globotruncana cretacea* Cushman, which has been reported from at least 23 formations and 73 localities.

7. Taxonomic revisions have been made as follows: 1) *Robulus* is considered a subgenus of *Lenticulina* Lamarck, 2) *Darbyella* Howe and Wallace is emended to include species with a robuline aperture, and 3) at least ten species have been removed to other genera from their previous assignments.

VI. Acknowledgments

The writer is indebted to many individuals who have contributed to this study. Sincere appreciation is extended to all, especially the following: Dr. R. W. Harris who first introduced the writer to micropaleontology; Dr. Carl C. Branson, Dr. Alfred R. Loeblich, Jr., and Dr. Harold E. Vokes who assisted in solving taxonomic problems; and, the editorial committeemen for their careful editing and many helpful suggestions.

Special gratitude is extended to Judith Miller Skinner for compiling the index to synonymies; and, to the Tulane University Council on Research for financial assistance to visit the United States National Museum and compare the Arkadelphia material with the Cushman Collection.

VII. Description of Foraminiferida

The Loeblich and Tappan classification of the Foraminiferida (1961a) is followed in the systematic descriptions.

Order Foraminiferida Zborzewski, 1834

Superfamily Ammodiscacea Reuss, 1862

Family Ammodiscidae Reuss, 1862

Subfamily Ammodiscinae Reuss, 1862

Genus Ammodiscus Reuss, 1862

Ammodiscus Reuss, 1862, Akad. Wiss. Wien, Math.-naturw. Kl., Sitzb., vol. 44 (Jahrgang 1861), p. 365.

Type species: Ammodiscus infimus Bornemann, 1874, (not *Orbis infimus* Strickland, 1846). Subsequent designation by Loeblich and Tappan, 1954, emended, 1961b. *Gender:* masculine.

Discussion: For a complete discussion of *Ammodiscus* Reuss, see Loeblich and Tappan (1961b).

Ammodiscus cretaceus (Reuss)
Pl. I, fig. 3

Operculina cretacea Reuss, 1845, Versteiner. böhm. Kreidefm., pt. 1, p. 35, pl. 13, figs. 64, 65.
Cornuspira cretacea (Reuss). Reuss, 1860, Akad. Wiss. Wien, Math.-naturw. Kl., Sitzb., vol. 40, p. 177, pl. 1, fig. 1.
Cornuspira involvens (Reuss). W. Berry, 1929, (*not* Reuss), *in* Berry and Kelley, U. S. Natl. Mus., Proc., vol. 76, art. 19, p. 15, pl. 1, fig. 15.
Ammodiscus cretacea (Reuss). Cushman, 1934, Cushman Lab. Foram. Res., Contr., vol. 10, pt. 2, p. 45.
Ammodiscus cretaceus (Reuss). Cushman and Todd, 1943, Cushman Lab. Foram. Res., Contr., vol. 19, pt. 3, p. 51, pl. 9, fig. 1.
Ammodiscus cretaceus (Reuss) Cushman. Cushman, 1946, U. S. Geol. Survey, Prof. Paper 206, p. 17, pl. 1, fig. 35. (synonymy).
Ammodiscus cretaceus (Reuss). Frizzell, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 59, pl. 1, fig. 15.

Diagnosis: Test planispiral, the many whorls closely coiled, slightly involute, commonly with

distinct radial creases or constrictions and typically distorted in fossilization; tubular second chamber increases gradually and uniformly in size, suture distinct, depressed; wall agglutinated, composed of extremely fine particles with an excess of cement, smooth, appearing polished, normally white and fairly thick; aperture, the open end of the tubular chamber.

Figured specimen: USNM 639431, maximum diameter 0.625 mm, collected 10 feet below the top of the Arkadelphia marl. Compared with plesiotypes in USNM: well within the range of variation.

Discussion: This species is widely distributed in the upper Cretaceous of North America. It has been reported from Manitoba, Canada; Estado de San Luis Potosi, Mexico; the Austin and Taylor groups of Texas; the Navarro (age) of Texas, Arkansas and Tennessee; and, the Pierre shale of Nebraska. In Europe it is reported from the lower Cretaceous Gault to the upper Cretaceous Senonian, but is considered most characteristic of the Turonian and lower Senonian (Cushman, 1946).

A. cretaceus (Reuss) was first noted in the samples 22 feet above the base of the Arkadelphia marl.

Superfamily Lituolacea Lamarck, 1809

Family Aschemonellidae Eimer and Fickert, 1899

Subfamily Reophacinae Cushman, 1910

Genus Reophax Montfort, 1808

Reophax Montfort, 1808, Conch. Syst., vol. 1, p. 331.

Type species: Reophax scorpiurus Denys de Montfort, 1808. Original designation. *Gender:* feminine.

Discussion: Proteonina fusiformis Williamson, the type species (subsequent designation, Rhumbler, 1904, p. 244) of *Proteonina* Williamson, 1858, has been shown to be multilocular (Brady, 1884, p. 291; Loeblich and Tappan, 1955, p. 8), and *Proteonina* has been suppressed (Loeblich and Tappan) as a junior synonym of *Reophax* Montfort.

Reophax difflugiformis H. B. Brady

Reophax difflugiformis H. B. Brady, 1879, Quart. Jour. Micros. Sci., vol. 19, p. 51, pl. 4, figs. 3a, b.

?Haplophragmium lagenarium Berthelin, 1880, Soc. Géol. France, Mém., sér. 3, tome 1, no. 5, p. 21, pl. 1, figs. 2a, b.

Reophax difflugiformis H. B. Brady. H. B. Brady, 1882, Roy. Soc. Edin., Proc., vol. 11, p. 715.

Reophax difflugiformis H. B. Brady. H. B. Brady, 1884, Challenger, Rept., Zoology, vol. 9, p. 289, pl. 30, figs. 1-3 (*not* figs. 4, 5).

Proteonina difflugiformis lagenarium (Berthelin). Millett, 1899, Roy. Micros. Soc., Jour., p. 253 *(partim).*

Proteonina difflugiformis (H. B. Brady). Rhumbler, 1904, Archiv. Protistenk., vol. 3, p. 245 *(partim).*

Proteonina difflugiformis-lagenarium (Berthelin). Rhumbler, 1904, Archiv. Protistenk., vol. 3, p. 246, fig. 80c.

Proteonina difflugiformis (H. B. Brady). Cushman, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 15 *(partim).* (synonymy).

Reophax difflugiformis H. B. Brady. Barker, 1960, Soc. Econ. Paleont. Mineral., Spec. Pub. 9, p. 62, pl. 30, figs. 1-3 (*not* fig. 4).

Reophax difflugiformis H. B. Brady. Skinner, 1961, Jour. Paleontology, vol. 35, no. 6, p. 1239.

Diagnosis: Test free, a single, undivided chamber, rounded or oval in transverse section; wall agglutinated, composed of fine quartz grains firmly cemented on a chitinous base, exterior nearly smooth; aperture simple, terminal, elevated on a short produced neck.

Reophax difflugiformis arenulata Skinner
Pl. I, fig. 1

Reophax difflugiformis H. B. Brady. H. B. Brady, 1884, Challenger, Rept., Zoology, vol. 9, p. 290, pl. 30, fig. 5 (*not* figs. 1-4).

Reophax difflugiformis H. B. Brady. Flint, 1899, U. S. Natl. Mus., Rept. (for 1897), pt. 1, p. 272, pl. 16, fig. 2.

Proteonina difflugiformis (H. B. Brady). Cushman, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 15 *(partim),* pl. 1, figs. 7, 8. (synonymy, *partim).*

Proteonina atlantica Cushman. Parker (*not* Cushman), 1952, Harvard, Mus. Comp. Zool., Bull., vol. 106, no. 9, p. 393, pl. 1 fig. 2.

Proteonina atlantica Cushman. Bandy (*not* Cushman), 1953, Jour. Paleontology, vol. 27, no. 2, p. 177, pl. 21, figs. 5a, b.

Proteonina difflugiformis (H. B. Brady). Frizzell, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 57, pl. 1, fig. 4.

Reophax atlantica (Cushman). Barker, 1960, Soc. Econ. Paleont. Mineral., Spec. Pub. 9, p. 62, pl. 30, fig. 5.

Proteonina difflugiformis (H. B. Brady). *auct.* (*partim*).

Reophax difflugiformis arenulata Skinner, 1961, Jour. Paleontology, vol. 35, no. 6, p. 1239.

Diagnosis: This form differs from the typical subspecies in that the test is larger and the wall is composed of relatively coarse sand grains. The neck is less pronounced in many specimens but others have been seen with a quite prominent neck.

Figured specimen: USNM 639432, length 0.26 mm, maximum diameter 0.24 mm, collected 17 feet above the base of the Arkadelphia marl.

Discussion: The Arkadelphia form is coarsely arenaceous with a clearly defined neck. It is probable that the neck is partially obscured on some specimens due to the coarseness of the wall. This subspecies is rare in the Arkadelphia, and the typical subspecies is not known from the formation.

Reophax texana Cushman and Waters

Pl. I, fig. 2

Reophax texana Cushman and Waters, 1927, Cushman Lab. Foram. Res., Contr., vol. 2, pt. 4, p. 82, pl. 10, fig. 2.
Reophax texanus Cushman and Waters. Cushman, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 16, pl. 1, figs. 18-20. (synonymy).
Reophax texana Cushman and Waters. Frizzell, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 58, pl. 1, fig. 13.

Diagnosis: Test generally rectilinear or somewhat arcuate, uniserial; chambers subspherical to spherical, slightly overlapping; wall agglutinated, of coarse angular sand grains with a minimum of cement, firmly fixed, surface somewhat roughened; aperture small, rounded or angled, central and terminal.

Figured specimen: USNM 639433, length 1.50 mm, maximum diameter 0.40 mm, collected 32 feet above the base of the Arkadelphia marl. Compared with the holotype in USNM: typical.

Discussion: This species occurs throughout the Gulf Coast, limited to the Navarro and equivalents. It is reported from the Kemp clay and Corsicana marl of Texas and the Prairie Bluff chalk of Mississippi and Alabama.

Family Lituolidae Lamarck, 1809

Subfamily Haplophragmoidinae Maync, 1952

Genus Haplophragmoides Cushman, 1910

Haplophragmoides Cushman, 1910, U. S. Natl. Mus., Bull. 71, pt. 1, p. 99.

Type species: Nonionina canariensis d'Orbigny, 1839. Original designation [cited as *Haplophragmium canariense* d'Orbigny]. *Gender:* masculine.

Haplophragmoides calculus Cushman and Waters

Pl. I, fig. 4

Haplophragmoides calculus Cushman and Waters, 1927, Cushman Lab. Foram. Res., Contr., vol. 2, pt. 4, p. 83, pl. 10, figs. 5a, b.
Haplophragmoides calculus Cushman and Waters. Cushman, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 19, pl. 2, figs. 11, 12. (synonymy).
Haplophragmoides calculus Cushman and Waters. Frizzell, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 59, pl. 1, figs. 26a, b.

Diagnosis: Test closely coiled, planispiral, quite strongly compressed, periphery slightly lobulate; chambers and sutures indistinct; wall agglutinated, of coarse sand grains with a considerable amount of cement, but roughly finished on the exterior; color typically dark greenish-black or iron-stained; aperture simple, basal.

Figured specimen: USNM 639434, maximum diameter 0.44 mm, collected 16 feet above the base of the Arkadelphia. Compared with the holotype in USNM: typical, but smaller and unstained.

Discussion: This species is common in the upper Navarro and equivalents in the Gulf Coast. Cushman (1946, p. 20) reports similar forms from the upper Taylor and Austin which may be immature individuals of *Ammobaculites*.

Haplophragmoides glaber Cushman and Waters

Pl. 1, fig. 5

Haplophragmoides glabra Cushman and Waters, 1927, Cushman Lab. Foram. Res., Contr., vol. 2, pt. 4, p. 83, pl. 10, figs. 6a, b.
Haplophragmoides glabra Cushman and Waters. Cushman, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 20, pl. 2, figs. 16, 17. (synonymy).
Haplophragmoides glaber Cushman and Waters. Frizzell, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 60, pl. 1, figs. 31a, b.

Diagnosis: Test closely coiled, planispiral, somewhat compressed, umbilicate, periphery rounded; chambers fairly distinct, 7 to 10 in the last-formed coil of the adult form, rounded; sutures slightly curved, slightly depressed; wall agglutinated, finely arenaceous, smoothly finished; color dark gray to white; aperture simple, basal.

Figured specimen: USNM 639435, maximum diameter 0.375 mm, collected 21 feet above the base of the Arkadelphia. Compared with the holotype in USNM: compares favorably.

Discussion: This species is common in the lower Arkadelphia. It apparently is

characteristic of the upper Navarro and equivalents in Arkansas and Texas. It also has been reported from Saskatchewan.

HAPLOPHRAGMOIDES RUGOSUS Cushman and Waters

Pl. I, fig. 6

Haplophragmoides rugosa CUSHMAN and WATERS, 1927, Cushman Lab. Foram. Res., Contr., vol. 2, pt. 4, p. 83, pl. 10, figs. 4a, b.
Haplophragmoides rugosa Cushman and Waters. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 20, pl. 2, figs. 18, 19. (synonymy).
Haplophragmoides rugosus Cushman and Waters. FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 60, pl. 2, figs. 2a, b.

Diagnosis: Test closely coiled, planispiral, slightly compressed, deeply umbilicate, periphery broadly rounded; 5 to 7 chambers in the last-formed coil, subspherical; sutures slightly depressed, radial; wall agglutinated, composed of coarse but rather neatly fitted angular sand grains; color normally dark; aperture simple, basal.

Figured specimen: USNM 639564, maximum diameter, 0.54 mm, collected from 16 feet above the base. Compared with the holotype in USNM: average specimen.

Discussion: This species is common in the Arkadelphia and is widely distributed in the Navarro and equivalents. Similar specimens are reported from the upper Taylor.

HAPLOPHRAGMOIDES EXCAVATUS Cushman and Waters

Pl. I, fig. 7

Haplophragmoides excavata CUSHMAN and WATERS, 1927, Cushman Lab. Foram. Res., Contr., vol. 2, pt. 4, p. 82, pl. 10, figs. 3a, b.
Haplophragmoides excavata Cushman and Waters. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 21, pl. 2, figs. 13-15. (synonymy).
Haplophragmoides excavatus Cushman and Waters. FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 60, pl. 1, figs. 30a, b.

Diagnosis: Test closely coiled, planispiral, strongly compressed, periphery subacute; chambers distinct, 10 in the last-formed coil of the adult form, the borders of each chamber distinctly thickened, the central portion markedly depressed; sutures straight, radial, somewhat obscured; wall agglutinated, finely arenaceous, with a moderate amount of cement, smoothly finished; color light gray to white; aperture simple, basal.

Figured specimen: USNM 639436, maximum diameter 0.425 mm, collected 16 feet above the base. Compared with the holotype in USNM: typical.

Discussion: This form is common in the Arkadelphia marl and in the Kemp clay of Texas (Cushman, 1946, p. 21). It is also reported from the Taylor group of Texas. Examination of the holotypes of *H. glaber* Cushman and Waters and *H. excavatus* Cushman and Waters suggests to the writer that the two forms are conspecific and that the test of *H. excavatus* merely is collapsed.

Genus AMMOBACULITES Cushman, 1910

Ammobaculites CUSHMAN, 1910, U. S. Natl. Mus., Bull. 71, pt. 1, p. 114.

Type species: Spirolina agglutinans d'Orbigny, 1846. Original designation [cited as *Ammobaculites agglutinans* (d'Orbigny)]. *Gender:* masculine.

AMMOBACULITES ARENATUS Cushman

Pl. I, fig. 8

Ammobaculites arenata CUSHMAN, 1933, Cushman Lab. Foram. Res., Contr., vol. 9, pt. 3, p. 50, pl. 5, fig. 4.
Ammobaculites arenatus Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 22, pl. 3, fig. 5.

Diagnosis: Test elongate, strongly compressed; chambers and sutures indistinct, juvenarium closely coiled, adult rectilinear; wall agglutinated, composed of angular, coarse fragments with considerable cement, roughly finished; aperture obscure, but seems to be typical of genus.

Figured specimen: USNM 639437, length 0.65 mm, breadth 0.45 mm, collected 19 feet above the base. Compared with the holotype in USNM: typical, but later chambers broken off in this specimen.

Discussion: This species is reported only from the Arkadelphia marl. It is rare.

AMMOBACULITES COPROLITHIFORMIS (Schwager)

Pl. I, fig. 9

Haplophragmium coprolithiforme SCHWAGER, 1867, Benecke's Geogn.-päleont. Beitr., bd. 1, heft 3, p. 654, pl. 34, fig. 3.
Ammobaculites coprolithiforme (Schwager). CUSHMAN, 1927, Royal Soc. Canada, Trans., ser. 3, vol. 21, sec. 4, p. 130, pl. 1, figs. 6, 7.
Ammobaculites coprolithiformis (Schwager) Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 22, pl. 3, fig. 9 (*not* figs. 7, 8). (synonymy).
Ammobaculites coprolithiformis (Schwager). FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 61, pl. 2, figs. 15a, b.

Diagnosis: Test elongate, juvenarium closely coiled, adult chambers rectilinear, uniform in width, circular in transverse section; sutures distinct, depressed; wall agglutinated, composed of coarse sand grains but smoothly finished; aperture of adult simple, rounded, terminal.

Figured specimen: USNM 639438, length 0.575 mm, breadth 0.275 mm, collected 19 feet above the base. Compared with plesiotypes in USNM: plesiotypes vary through a wide range but the Arkadelphia form agrees with the type description and compares favorably with the plesiotypes.

Discussion: This species ranges throughout the upper Cretaceous from the Eagle Ford group to the upper Navarro and equivalents, and is widely distributed in the Gulf Coast. It also is reported from Europe, western Canada and Trinidad.

AMMOBACULITES TEXANUS Cushman

Pl. I, fig. 10

Ammobaculites texana CUSHMAN, 1933, Cushman Lab. Foram. Res., Contr., vol. 9, pt. 3, p. 50, pl. 5, fig. 3.
Ammobaculites texanus Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 23, pl. 3, figs. 22, 23.
Ammobaculites texanus Cushman. FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 63, pl. 3, fig. 3. (synonymy).

Diagnosis: Test large, compressed, periphery rounded and lobulate, umbilicus excavated in the partially evolute adult form; chambers 5 or 6 in the last-formed coil of juvenarium, increasing in number in the adult as chambers become slightly inflated and more distinct; sutures indistinct, slightly depressed; wall agglutinated, composed of large grains with considerable cement, roughly finished in early stages, but becoming smoother in the adult; aperture obscured. Diameter of holotype 2.65 mm, thickness 0.60 mm.

Figured specimen: USNM 639439, length 1.175 mm, breadth 1.00 mm, collected 19 feet above the base. Compared with holotype in USNM: typical, but somewhat immature (with the adult stage incomplete).

Discussion: This species is known only from the Arkadelphia marl of Arkansas and the Corsicana marl of Texas.

Family TEXTULARIIDAE Ehrenberg, 1839

Subfamily SPIROPLECTAMMININAE Cushman, 1927

Genus BOLIVINOPSIS Yakovlev, 1891

Bolivinopsis YAKOVLEV, 1891, Soc. nat. Univ. Imp. Kharkov, Trav., vol. 24, p. 349.

Type species: Bolivinopsis capitata Yakovlev, 1891. Monotypic. *Gender:* masculine.

Discussion: Recent authors (Sigal *in* Piveteau, 1952; Pokorný, 1958) consider *Bolivinopsis* Yakovlev an agglutinated form and the senior synonym of *Spiroplectammina* Cushman. However, Pokorný (1958, vol. I, p. 193) suggests that "it is *not impossible* that *Bolivinopsis* and *Spiroplectammina* are two independent isomorphous genera".

BOLIVINOPSIS ROSULA (Ehrenberg)

Pl. V, fig. 8

Spiroplecta rosula EHRENBERG, 1854, Mikrogeologie, pl. 32, fig. 26. [The species-group name is a noun in apposition.]
Spiroplectoides rosula (Ehrenberg). CUSHMAN, 1927, Cushman Lab. Foram. Res., Contr., vol. 3, pt. 1, p. 62, pl. 13, figs. 9a, b.
Bolivinopsis rosula (Ehrenberg). MACFADYEN, 1933, Roy. Micros. Soc., Jour., vol. 53, p. 141.
Bolivinopsis rosula (Ehrenberg) Macfadyen. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 101, pl. 44, figs. 4-8. (synonymy).
Bolivinopsis rosula (Ehrenberg). FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 108, pl. 15, fig. 11.

Diagnosis: Test exceptionally elongate, quite slender, compressed; juvenarium closely coiled, planispiral, adult chambers biserial, of uniform size and shape, numerous; sides of test parallel; sutures distinct, extending obliquely backward; wall agglutinated, composed of fine particles, smoothly finished; aperture subterminal.

Figured specimen: USNM 639440, length (broken) 0.50 mm, breadth 0.15 mm, collected 8 feet below the top. Compared with numerous plesiotypes in USNM: compares favorably.

Discussion: This species is quite rare in the Arkadelphia. It is widely distributed through the Austin, Taylor, and Navarro and equivalents of Texas, Arkansas, Mississippi and Alabama.

Genus SPIROPLECTAMMINA Cushman, 1927

Spiroplectammina CUSHMAN, 1927, Cushman Lab. Foram. Res., Contr., vol. 3, pt. 1, p. 23.

Type species: Textularia agglutinans d'Orbigny var. *biformis* Parker and Jones, 1865. Original designation [cited as *Spiroplecta biformis* Parker and Jones]. *Gender:* feminine.

Discussion: Recent authors consider *Spiroplectammina* Cushman a junior synonym

of *Bolivinopsis* Yakovlev (see above discussion of *Bolivinopsis*).

Spiroplectammina semicomplanata (Carsey)

Pl. I, fig. 11

Textularia semicomplanata Carsey, 1926, Texas Bur. Econ. Geol., Univ. Texas, Bull. 2612, p. 25, pl. 3, fig. 4.
Textularia carinata var. *expansa* Plummer, 1927, Texas Bur. Econ. Geol., Univ. Texas, Bull. 2644, p. 67, pl. 3, fig. 3.
Spiroplectammina semicomplanata (Carsey). Plummer, 1931, Texas Bur. Econ. Geol., Univ. Texas, Bull. 3101, p. 129, pl. 8, fig. 7 (*not* fig. 8).
Spiroplectammina semicomplanata (Carsey) Plummer. Cushman, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 28, pl. 6, figs. 5-14. (synonymy).
Spiroplectammina semicomplanata (Carsey). Frizzell, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 67, pl. 4, figs. 18a, b.

Diagnosis: Test elongate, tapering, greatest breadth near the apertural end, thickest in the middle, periphery subacute, slightly lobulate; chambers distinct, not inflated, fairly high and overlapping, outer end broadly rounded, apertural face flattened; sutures distinct, slightly depressed, gently curved backward; wall agglutinated, finely arenaceous, smoothly finished, thin and delicate; aperture, a low narrow opening at the base of the apertural face.

Figured specimen: USNM 639441, length 0.34 mm, breadth 0.19 mm, collected two feet above the base. Compared with topotypes in USNM: typical.

Discussion: This form was described from a Navarro exposure on Onion Creek, near Austin, Texas, where most specimens including the holotype are crushed due to the thin delicate wall. The species is characteristic of the Navarro and equivalents and is recorded from the upper Taylor (Cushman, 1946). Similar forms occur in other parts of the Cretaceous.

Spiroplectammina semicomplanata juncea Cushman

Pl. I, fig. 12

Spiroplectammina anceps (Reuss). Cushman, 1931, (*not* Reuss), Jour. Paleontology, vol. 5, p. 299, pl. 34, figs. 2a, b.
Spiroplectammina semicomplanata (Carsey), var. *juncea* Cushman, 1932, Cushman Lab. Foram. Res., Contr., vol. 8, pt. 4, p. 95, pl. 11, figs. 10a, b.
Spiroplectammina semicomplanata (Carsey) Plummer var. *juncea* Cushman. Cushman, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 29, pl. 6, fig. 15.

Diagnosis: This form differs from the typical subspecies in the quite elongate test with sides subparallel for most of the length; chambers numerous, spiral juvenarium clearly visible.

Figured specimen: USNM 639442, length 0.54 mm, breadth 0.19 mm, collected two feet above the base. Compared with holotype in USNM: typical, but smaller.

Discussion: The elongate subspecies has been recovered from the Saratoga chalk, the Nacatoch sand and the Selma chalk in addition to the Arkadelphia.

Family Trochamminidae Schwager, 1877

Genus Trochammina Parker and Jones, 1859

Trochammina Parker and Jones, 1859, Ann. Mag. Nat. Hist., ser. 3, vol. 4, p. 347.

Type species: Nautilus inflatus Montagu, 1808. Monotypic. *Gender:* feminine.

Trochammina texana Cushman and Waters

Pl. II, figs. 7, 8

Trochammina texana Cushman and Waters, 1927, Cushman Lab. Foram. Res., Contr., vol. 2, pt. 4, p. 85, pl. 11, figs. 8a-c.
Trochammina texana Cushman and Waters. Cushman, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 50, pl. 15, figs. 4, 5. (synonymy).
Trochammina texana Cushman and Waters. Frizzell, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 79, pl. 7, figs. 21a-c.

Diagnosis: Test trochoid, compressed, planoconvex; dorsal side flat or slightly concave; ventral side slightly convex, umbilicate; six chambers in the last-formed coil, adult chambers more distinct than earlier chambers; the dorsal borders of the adult chambers raised circumventing the central concave portion, the greatest ventral thickness is near the umbilical angle of each chamber; sutures on the dorsal side indistinct except between last two or three chambers, on the ventral side distinct and depressed; wall agglutinated, finely arenaceous, smoothly finished; aperture basal and ventral.

Figured specimen: USNM 639443, maximum diameter 0.50 mm, collected 16 feet above the base. Compared with the holotype in USNM: holotype is flatter and more delicate.

Discussion: This species is common in the upper Navarro and equivalents of the Gulf Coast.

TROCHAMMINA GYROIDES Cushman and Waters

Pl. II, figs. 9, 10

Trochammina gyroides CUSHMAN and WATERS, 1927, Cushman Lab. Foram. Res., Contr., vol. 2, pt. 4, p. 84, pl. 10, figs. 8a, b.
Trochammina gyroides Cushman and Waters. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 50, pl. 15, figs. 6a, b.
Trochammina gyroides Cushman and Waters. FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, pl. 7, figs. 16a, b.

Diagnosis: Test trochoid, thick, dorsal side flattened, ventral side strongly convex, periphery subacute; chambers distinct, normally six in the last-formed coil; sutures less distinct on the dorsal side where they are slightly depressed and gently curved; sutures radial, deeply depressed on the ventral side; wall agglutinated, finely arenaceous with much cement, smoothly finished; aperture ventral, narrow.

Figured specimen: USNM 639444, maximum diameter 0.50 mm, collected 8 feet below the top of the Arkadelphia. Compared with the holotype in USNM: compares favorably.

Discussion: The test of this species is much thicker than that of *T. texana* Cushman and Waters. It is common in the Arkadelphia.

Family ATAXOPHRAGMIIDAE Schwager, 1877

Subfamily VERNEUILININAE Cushman, 1911

Genus GAUDRYINA d'Orbigny, 1839

Gaudryina D'ORBIGNY, *in* DE LA SAGRA, 1839, Hist. Phys. Pol. Nat. Cuba, Foraminifères, p. 109.

Type species: Gaudryina rugosa d'Orbigny, 1840. Subsequent designation, Cushman, 1911. *Gender:* feminine.

Subgenus GAUDRYINA *sensu stricto*

GAUDRYINA (GAUDRYINA) DEADERICKI Cushman

Pl. I, fig. 13

Gaudryina deadericki CUSHMAN, 1947, Cushman Lab. Foram. Res., Contr., vol. 23, pt. 3, p. 56, pl. 13, figs. 8-10.
Gaudryina deadericki Cushman. CUSHMAN, 1949, U. S. Geol. Surv., Prof. Paper 221-A, p. 2, pl. 1, figs. 12, 13.

Diagnosis: Test small, juvenarium triserial, adult entirely biserial, much compressed, initial end subacute, periphery serrate; chambers increase rapidly in size as added, later ones slightly overlapping; sutures distinct, depressed, nearly straight, strongly oblique; wall agglutinated, finely arenaceous, smoothly finished; aperture elongate, basal at the inner margin of the last-formed chamber, a low opening in juvenarium, extending well into the apertural face in the adult test.

Figured specimen: USNM 639445, length 0.675 mm, breadth 0.38 mm, collected 8 feet below the top. Compared with the holotype and paratypes in USNM: typical.

Discussion: This species is known only from the Arkadelphia marl.

GAUDRYINA (GAUDRYINA) NAVARROANA Cushman

Pl. I, figs. 14, 18

Gaudryina navarroana CUSHMAN, 1932, Cushman Lab. Foram. Res., Contr., vol. 8, pt. 4, p. 98, pl. 11, figs. 15, 16.
Gaudryina navarroana Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 33, pl. 7, figs. 17a-c.
Gaudryina (Gaudryina) navarroana Cushman. FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 71, pl. 5, fig. 27.

Diagnosis: Test elongate, juvenarium triserial and sharply triangular, the edges bluntly angled, fusiform in front view; adult chambers biserial, somewhat compressed, lobed; sutures fairly distinct in juvenarium, distinct and depressed in adult; wall agglutinated, coarsely arenaceous, but smoothly finished; aperture, a deep re-entrant in the inner margin of the last-formed chamber with raised, rounded margins.

Figured specimens: USNM 639446 (fig. 14), length 0.69 mm, breadth 0.40 mm; USNM 639447 (fig. 18); collected 10 feet below the top. Compared with the holotype and paratypes in USNM: satisfactory, though not typical.

Discussion: This species is characteristic of the upper Navarro beds. It is distinguished by numerous triserial chambers contrasting with the few, somewhat flattened chambers of the short biserial stage. The thin wall of the test collapses easily and the sutures commonly appear as raised ridges.

Subgenus SIPHOGAUDRYINA Cushman, 1935

Siphogaudryina CUSHMAN, 1935, Smithsonian Misc. Colln., vol. 91, no. 21, p. 3.

Type species: Gaudryina stephensoni Cushman, 1928. Original designation. *Gender:* feminine.

GAUDRYINA (SIPHOGAUDRYINA) STEPHENSONI Cushman

Gaudryina stephensoni CUSHMAN, 1928, Cushman Lab. Foram. Res., Contr., vol. 4, pt. 4, p. 108, pl. 16, figs. 6-8.
Gaudryina (Siphogaudryina) stephensoni Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 35, pl. 8, figs. 8-11. (synonymy).
Gaudryina (Siphogaudryina) stephensoni Cushman. CUSHMAN, 1949, U. S. Geol. Surv., Prof. Paper 221-A, p. 3.
Gaudryina (Siphogaudryina) stephensoni Cushman. FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 71, pl. 5, figs. 24, 25.

Discussion: This species, reported by Cushman (1949) from the Arkadelphia, was not identified from the samples studied by the writer. The holotype and paratypes in USNM were examined.

Genus GAUDRYINELLA Plummer, 1931

Gaudryinella PLUMMER, 1931, Amer. Midland Nat., vol. 12, p. 341.

Type species: Gaudryinella delrioensis Plummer, 1931. Original designation. *Gender:* feminine.

GAUDRYINELLA PSEUDOSERRATA Cushman

Pl. I, fig. 15

Gaudryinella pseudoserrata CUSHMAN, 1932, Cushman Lab. Foram. Res., Contr., vol. 8, pt. 4, p. 99, pl. 11, figs. 20. 21.
Gaudryinella pseudoserrata Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 36, pl. 8, figs. 15-21. (synonymy).
Gaudryinella pseudoserrata Cushman. FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 72, pl. 5, figs. 30, 31a, b.

Diagnosis: Test elongate, earliest portion triserial, then becoming biserial and somewhat compressed, adult stage tending to become uniserial; chambers distinct, becoming inflated and lobulate; sutures distinct, later ones deeply depressed; wall agglutinated, coarsely arenaceous, later portion of many specimens roughly finished; adult aperture rounded and subterminal.

Figured specimen: USNM 639448, length 0.56 mm, breadth 0.25 mm, collected 10 feet below the top. Compared with the holotype and paratypes in USNM: compares favorably, but smaller.

Discussion: This species is common and widely distributed in the Navarro and equivalents. There is considerable variation in the shape of the later chambers and the range of coarseness of the wall.

GAUDRYINELLA PSEUDOSERRATA EXTENSA Cushman

Pl. I, fig. 16

Gaudryinella pseudoserrata var. *extensa* CUSHMAN, 1949, U. S. Geol. Surv., Prof. Paper 221-A, p. 3, pl. 1, figs. 15-17.

Diagnosis: This subspecies differs from the typical form in the smaller size, the more slender outline, and in the presence of more uniserial chambers in the adult test.

Figured specimen: USNM 639449, length 0.663 mm, breadth 0.175 mm, collected 8 feet below the top. Compared with the holotype and paratypes in USNM: typical.

Discussion: This subspecies is known only from the Arkadelphia marl. It is common and a guide fossil for the formation.

Genus PSEUDOCLAVULINA Cushman, 1936

Pseudoclavulina CUSHMAN, 1936, Cushman Lab. Foram. Res., Spec. Pub. 6, p. 16.

Type species: Clavulina clavata Cushman, 1926. Original designation. *Gender:* feminine.

PSEUDOCLAVULINA ARENATA (Cushman)

Pl. I, fig. 17

Clavulina arenata CUSHMAN, 1933, Cushman Lab. Foram. Res., Contr., vol. 9, pt. 3, p. 54, pl. 6, figs. 5a, b.
Pseudoclavulina arenata (Cushman). CUSHMAN, 1937, Cushman Lab. Foram. Res., Spec. Pub. 7, p. 110, pl. 15, figs. 28a, b.
Pseudoclavulina arenata (Cushman) Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 37, pl. 9, fig. 9a, b.

Diagnosis: Test elongate, cylindrical; juvenarium triserial, somewhat triangular in cross-section; adult test uniserial; chambers somewhat indistinct, rather uniform in size except the final chamber which is typically longer; sutures indistinct, slightly depressed; wall agglutinated, coarsely arenaceous, surface rough; aperture terminal, rounded, without a neck.

Figured specimen: USNM 639450, length 0.75 mm, breadth 0.20 mm, collected 16 feet above the base. Compared with the holotype and paratypes in USNM: typical.

Discussion: This small, roughly finished species is known only from the Arkadelphia marl in Hempstead County, Arkansas, where it is abundant.

Genus CLAVULINOIDES Cushman, 1936

Clavulinoides CUSHMAN, 1936, Cushman Lab. Foram. Res., Spec. Pub. 6, p. 20.

Type species: Clavulina trilatera Cushman, 1926. Original designation. *Gender:* masculine.

CLAVULINOIDES COMPRESSUS (Cushman)

Clavulina compressa CUSHMAN, 1928, Cushman Lab. Foram. Res., Contr., vol. 4, pt. 3, p. 61, pl. 8, figs. 1a-c, 2.
Clavulinoides compressa (Cushman). CUSHMAN, 1937, Cushman Lab. Foram. Res., Spec. Pub. 7, p. 123, pl. 17, figs. 7-13.
Clavulinoides compressa (Cushman) Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 39, pl. 10, figs. 1-7. (synonymy).
Clavulinoides compressus (Cushman). FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 72, pl. 5, figs. 36a, b.

Discussion: This species, reported by Cushman (1937) from the Arkadelphia, was not identified from the samples studied by the writer. The holotype in the USNM was examined. Some specimens of *Gaudryina navarroana* Cushman are strongly compressed above the juvenarium and resemble immature individuals of *Clavulinoides compressus* (Cushman). These specimens are clearly biserial, however, and should not be confused with this species (see pl. I, fig. 18).

CLAVULINOIDES INSIGNIS (Plummer)

Pl. I, figs. 19, 20

Tritaxia tricarinata (Reuss). CARSEY, 1926, Texas Bur. Econ. Geol., Univ. Texas, Bull. 2612, p. 27, pl. 6, figs. 4a, b (not *Textularia tricarinata* Reuss, 1844).
Clavulina insignis PLUMMER, 1931, Texas Bur. Econ. Geol., Univ. Texas, Bull. 3101, p. 138, pl. 8, figs. 1-4.
Clavulinoides insignis (Plummer). CUSHMAN, 1937, Cushman Lab. Foram. Res., Spec. Pub. 7, p. 124, pl. 17, figs. 14-17.
Clavulinoides insignis (Plummer) Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 39, pl. 10, figs. 8-11. (synonymy).
Clavulinoides insignis (Plummer). FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 73, pl. 6, figs. 1a, b, 2a, b.

Diagnosis: Test free, triangular throughout; form of megalospheric test subparallel or slightly expanding, of microspheric test broadening rapidly toward apertural end; chambers distinct, in adult microspheric test low and broad and deeply concave, in adult megalospheric test somewhat higher and slightly concave, angles sharply keeled; sutures distinct, slightly depressed in the uniserial portion; wall agglutinated, finely arenaceous with much cement, smoothly finished; aperture terminal and trilobed with the lobes pointing toward the peripheral angles, with a slight neck in the megalospheric form.

Figured specimens: USNM 639451, microspheric (fig. 19); USNM 639452, megalospheric (fig. 20), length 1.15 mm, breadth 0.54 mm, collected 9 feet above the base. Compared with numerous identified specimens in USNM: compare favorably.

Discussion: This species is common in the upper Navarro of Texas and equivalents in Arkansas, Alabama, and Mississippi. It is evidently derived from forms such as *C. trilaterus concavus* (Cushman) from the Taylor group (Cushman, 1946, p. 40). *C. insignis* (Plummer) is characterized by the strong peripheral keels and the sharp distinction between the juvenarium and the adult chambers. The shape and size of the microspheric and megalospheric forms differ markedly.

Subfamily VALVULININAE Berthelin, 1880

Genus MARSSONELLA Cushman, 1933

Marssonella CUSHMAN, 1933, Cushman Lab. Foram. Res., Contr., vol. 9, pt. 2, p. 36.

Type species: Gaudryina oxycona Reuss, 1860. Original designation. *Gender:* feminine.

MARSSONELLA OXYCONA (Reuss)

Pl. I, fig. 21

Gaudryina oxycona REUSS, 1860, Akad. Wiss. Wien, Math.-naturw. Kl., Sitzb., vol. 40, p. 229, pl. 12, fig. 3a-c.
Marssonella oxycona (Reuss). CUSHMAN, 1933, Cushman Lab. Foram. Res., Contr., vol. 9, pt. 2, p. 36, pl. 4, figs. 13a, b.
Marssonella oxycona (Reuss) Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 43, pl. 12, figs. 3-5. (synonymy, *partim*).
Marssonella oxycona (Reuss). FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 75, pl. 6, figs. 17a, b.

Diagnosis: Test conical, gradually tapering or broadly flaring; earliest whorl with four or five chambers, later reduced to three, then two in the adult, rounded in transverse section; chambers distinct, not inflated, simple; sutures distinct, normally flush with the exterior surface; wall agglutinated, coarsely or finely arenaceous with larger quartz grains at the surface, smoothly finished or slightly roughened; aperture a broad, low opening at the inner margin of the last-formed chamber with a valvular, toothlike median projection.

Figured specimen: USNM 639453, length 0.65 mm, maximum diameter 0.432 mm, collected 8 feet below the top. Compared with numerous identified specimens in USNM: compares favorably, but smaller.

Discussion: This species is characteristic of the upper Cretaceous of Europe and is reported from the lower Cretaceous Gault. In North America it ranges from the Austin through Navarro groups and is widely distributed in the Gulf Coast. It also is reported from the Navesink marl and Mt. Laurel sand of New Jersey and the Mal Paso shale of Peru.

Genus DOROTHIA Plummer, 1931

Dorothia PLUMMER, 1931, Texas Bur. Econ. Geol., Univ. Texas, Bull. 3101, p. 130.

Type species: Gaudryina bulletta Carsey, 1926. Original designation. *Gender:* feminine.

DOROTHIA BULLETTA (Carsey)

Pl. I, fig. 22

Gaudryina bulletta CARSEY, 1926, Texas Bur. Econ. Geol., Univ. Texas, Bull. 2612, p. 28, pl. 4, fig. 4.

Dorothia bulletta (Carsey). PLUMMER, 1931, Texas Bur. Econ. Geol., Univ. Texas, Bull. 3101, p. 132, pl. 8, figs. 13-17.

Dorothia bulletta (Carsey) Plummer. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 46, pl. 12, figs. 21-26. (synonymy).

Dorothia bulletta (Carsey). FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 75, pl. 6, figs. 19a, b.

Diagnosis: Test subcylindrical, base tapering or broadly rounded, sides subparallel, rounded in transverse section; juvenarium with five chambers to a volution, reducing to three and to two in the adult; chambers distinct, slightly inflated and overlapping in adult stage; sutures distinct, slightly depressed; wall agglutinated arenaceous with much cement, smoothly finished; aperture a low, broad opening at the inner margin of the last-formed chamber.

Figured specimen: USNM 639454, length 0.825 mm, maximum diameter 0.350 mm, collected 8 feet below the top. Compared with numerous identified specimens in USNM: compares favorably.

Discussion: This species is common in the Navarro and Taylor and equivalents of the Gulf Coast. It is reported also from South Dakota, Nebraska, New Jersey, Colombia, and the Georges Bank Canyons (Navarro age) in the Atlantic Ocean.

DOROTHIA CONULA (Reuss)

Pl. I, fig. 23

Textularia conulus REUSS, 1844, Geogn. Skizzen Böhmen, II: Die Kreidegebilde. . ., Prague: C. W. Medau, vol. 2, p. 215.

Textularia conulus Reuss. REUSS, 1845, Versteiner. böhm. Kreidefm., pt. 1, p. 38, pl. 8, fig. 59; pl. 13, fig. 75.

Dorothia conula (Reuss). CUSHMAN, 1937, Cushman Lab. Foram. Res., Spec. Pub. 8, p. 76, pl. 8, figs. 11-17.

Dorothia conula (Reuss) Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 44, pl. 12, figs. 12-14. (synonymy).

Dorothia conulus (Reuss). FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 75, pl. 6, figs. 21a, b.

Diagnosis: Test short and stout, strongly tapering, rounded in section or somewhat compressed; juvenarium with five or six chambers to a volution, reducing to three and to two in the adult; adult chambers few in number, slightly inflated with slightly depressed, horizontal sutures; wall agglutinated, finely arenaceous, smoothly finished; aperture an elongate, low opening at the inner margin of the last-formed chamber.

Figured specimen: USNM 639455, length 0.90 mm, maximum diameter 0.450 mm, collected 8 feet below the top. Compared with numerous identified specimens in USNM: compares favorably.

Discussion: This species is characteristic of the Turonian of Europe and occurs in the lower Senonian (Cushman, 1946). It occurs in the Taylor and Navarro and equivalents in Arkansas and Texas.

Genus PLECTINA Marsson, 1878

Plectina MARSSON, 1878, Naturw. Ver., Neu-Vorpommern u. Rügen, Greifswald, Mitt., Berlin, Jahrg. 10, p. 160.

Type species: Gaudryina ruthenica Reuss, 1851. Subsequent designation [Cushman, 1933, cited as *Plectina ruthenica* (Reuss)]. *Gender:* feminine.

?PLECTINA WATERSI Cushman

Plectina watersi CUSHMAN, 1933, Cushman Lab. Foram. Res., Contr., vol. 9, pt. 3, p. 57, pl. 7, figs. 1a-d.

Plectina watersi Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 47, pl. 13, figs. 6, 7?-10, *not* 11, 12.

Plectina watersi Cushman. FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 76, pl. 6, figs. 25a, b.

Discussion: This species is stated to be characteristic of the Navarro beds (Cushman, 1946). However, there is some confusion regarding its precise identification. Cushman (1946) reports the species from

the Arkadelphia, but specimens which appear to agree with his descriptions do not agree with the holotype and paratypes of *Plectina watersi* Cushman in the USNM. Conversely, they are indistinguishable from two of the paratypes of *Goesella rugulosa* Cushman in the USNM which were collected from the Arkadelphia. A plastogamous (?) Arkadelphia specimen (see Plate II, fig. 2) has a clearly subterminal aperture and appears to agree with Cushman's interpretation of *Plectina watersi* Cushman.

Genus GOESELLA Cushman, 1933

Goësella CUSHMAN, 1933, Cushman Lab. Foram. Res., Contr., vol. 9, pt. 2, p. 34.

Type species: Clavulina rotundata Cushman, 1913. Original designation. *Gender:* feminine.

GOESELLA RUGULOSA Cushman

Pl. II, figs. 4, 5

Goësella rugulosa CUSHMAN, 1933, Cushman Lab. Foram. Res., Contr., vol. 9, pt. 3, p. 55, pl. 6, figs. 7a-d.
Goësella rugulosa Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 47, pl. 13, figs. 13a-d. (synonymy).
?, Plectina watersi Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 47, pl. 13, figs. 11, 12, *not* 6-10.
Goësella rugulosa Cushman. FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 76, pl. 6, figs. 26a, b.

Diagnosis: Test elongate, juvenarium rapidly enlarging, adult portion subcylindrical; normally four chambers to a volution in the juvenarium, reducing to three, then two, and in the adult nearly uniserial; sutures slightly depressed, fairly distinct; wall agglutinated, arenaceous, juvenarium smoothly finished, adult chambers somewhat rougher; adult aperture terminal, rounded, without a neck.

Figured specimens: USNM 639456 (fig. 4), length 0.85 mm, diameter 0.40 mm; USNM 639457 (fig. 5); collected 8 feet below the top. Compared with the holotype in the USNM: agree.

USNM 639458 (fig. 1) and USNM 639459 (fig. 3) are identical to paratypes in the USNM of *G. rugulosa* Cushman from the Arkadelphia, but are more similar to Arkadelphia specimens referred by Cushman to *Plectina watersi* Cushman than to the holotype of *Goesella rugulosa* Cushman. They are identified here as *?Goesella rugulosa* Cushman.

Superfamily MILIOLACEA Ehrenberg, 1839

Family MILIOLIDAE Ehrenberg, 1839

Subfamily QUINQUELOCULININAE Cushman, 1917

Genus QUINQUELOCULINA d'Orbigny, 1826

Quinqueloculina D'ORBIGNY, 1826, Ann. Sci. Nat., sér. 1, tome 7, p. 301.

Type species: Serpula seminulum Linné, 1758. Subsequent designation, Parker and Jones, 1859 [cited as *Quinqueloculina seminulum* (Linné)]. *Gender:* feminine.

QUINQUELOCULINA sp.

Pl. II, fig. 6

Diagnosis: Test elongate; chambers distinct, somewhat rounded, apertural end projecting; sutures distinct, slightly depressed; wall porcellanous, smooth; aperture rounded, terminal.

Figured specimen: USNM 639460, length 0.550 mm, breadth 0.338 mm, collected 8 feet below the top.

Discussion: This form is rare in the Arkadelphia. It differs from *Quinqueloculina antiqua angusta* Franke, 1928, which has angular chambers and which is reported from the Taylor and Navarro of the Gulf Coast.

Superfamily NODOSARIACEA Ehrenberg, 1839

Family NODOSARIIDAE Ehrenberg, 1839

Subfamily LAGENINAE Reuss, 1862

Genus LAGENA Walker and Jacob, 1798

Lagena WALKER and BOYS, 1784, Testacea minuta rariora, nuperrime detecta in arena littoris Sandvicensis, J. March: London, p. 2 [Subgenus of *Serpula*].
Lagena WALKER and JACOB, 1798, *in* Kanmacher's ed. of Adams's Essays Micros., p. 634.

Type species: Serpula (Lagena) sulcata Walker and Jacob, 1798, = *Serpula (Lagena) striata sulcata rotunda* Walker and Boys, 1784. Subsequent designation, Parker and Jones, 1859 [cited as *Lagena sulcata* Walker and Jacob]. *Gender:* feminine.

LAGENA HISPIDA Reuss

Pl. IV, figs. 17, 18

Lagena hispida REUSS, 1858, Zeitschr. deutsch.

geol. Gesell., vol. 10, p. 434. [*nomen*].
Lagena hispida Reuss. Reuss, 1863, Akad. Wiss. Wien, Math.-naturw. Kl., Sitzb., vol. 46 (Jahrgang 1862), p. 335, pl. 6, figs. 77-79.
Lagena hispida Reuss. Brady, 1884, Challenger, Rept., Zoology, vol. 9, pp. 444, 459, pl. 57, figs. 1-4.
Lagena hispida Reuss. Frizzell, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 102, pl. 14, fig. 8. (synonymy).
Lagena hispida Reuss. Barker, 1960, Soc. Econ. Paleo. Mineral, Spec. Pub. 9, p. 116, pl. 57, figs. 1-4.

Diagnosis: Test small, varied, surface finely spinose; wall calcareous, perforate; apertural end produced, forming an elongate, slender neck, with a delicate spine at the base of the single chamber in some specimens; aperture terminal, radiate.

Figured specimens: USNM 639461 (fig. 17), length 0.25 mm, diameter 0.175 mm; USNM 639462 (fig. 18); collected 8 feet below the top. Compared with numerous plesiotypes in USNM: compare favorably.

Discussion: This form is rare in the Arkadelphia. It has been reported from the Austin, Taylor, Navarro, and Midway groups of Texas, Arkansas, Mississippi, and Tennessee.

Lagena sulcata (Walker and Jacob)

Serpula (Lagena) striata sulcata rotunda Walker and Boys, 1784, Testacea minuta rariora, p. 2, pl. 1, fig. 6.
Serpula (Lagena) sulcata Walker and Jacob, 1798, *in* Kanmacher's ed. of Adams's Essays Micros., p. 634, pl. 14, fig. 5.
Lagena sulcata (Walker and Jacob). Carsey, 1926, Texas Bur. Econ. Geol., Univ. Texas, Bull. 2612, p. 31, pl. 7, fig. 4.
Lagena sulcata (Walker and Jacob). Frizzell, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 103, pl. 14, fig. 14. (synonymy).

Lagena sulcata semiinterrupta Berry

Pl. IV, fig. 19

Lagena sulcata (Walker and Jacob) var. *semiinterupta* W. Berry, 1929, *in* Berry and Kelley, U. S. Nat. Mus. Proc., vol. 76, art. 19, p. 5, pl. 3, fig. 19.
Lagena sulcata (Walker and Jacob), var. *semiinterrupta* W. Berry. Cushman, 1931, Tennessee Div. Geol., Bull. 41, p. 37, pl. 5, figs. 9-11.
Lagena sulcata (Walker and Jacob) Parker and Jones var. *semiinterrupta* W. Berry. Cushman, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 94, pl. 39, figs. 18-21. (synonymy).

Diagnosis: Test small, flask-shaped, surface ornamented with 16 or 18 plate-like costae arranged in pairs which join near the apical end and appear looped; wall calcareous, perforate; apertural end produced into a slender neck; aperture rounded, terminal.

Figured specimen: USNM 639463, length 0.20 mm, maximum diameter 0.125 mm, collected 9 feet below the top. Compared with the holotype in USNM: agrees favorably.

Discussion: This subspecies differs from the typical form in the character of the paired costae which appear to form loops near the apical end. It is reported from the uppermost Cretaceous of Tennessee and New Jersey.

Subfamily Nodosariinae Ehrenberg, 1839

Genus Lenticulina Lamarck, 1804

Lenticulina Lamarck, 1804, Mus. Natl. d'Hist. Nat., Ann., vol. 5, p. 186.

Type species: Lenticulites rotulata Lamarck, 1804. Subsequent designation, Cushman, 1927. *Gender:* feminine.

Discussion: Lenticulina Lamarck cannot be separated satisfactorily from *Robulus* Montfort, *Astacolus* Montfort, *Cristellaria* Lamarck, and related forms designated as genera by various authors. Some species of *Lenticulina* Lamarck appear to grade into *Saracenaria* Defrance, *Marginulina* d'Orbigny, and other related genera.

Subgenus Lenticulina Lamarck, 1804

Lenticulina (Lenticulina) rotulata (Lamarck)

Pl. II, fig. 16

Lenticulites rotulata Lamarck, 1804, Mus. Natl. d'Hist. Nat., Ann., vol. 5, p. 188; vol. 8 (1806), pl. 62 (14), fig. 11.
Cristellaria rotulata Lamarck. Carsey, 1926, Texas Bur. Econ. Geol., Univ. Texas, Bull. 2612, p. 39, pl. 6, fig. 2.
Lenticulina rotulata (Lamarck). Plummer, 1931, Texas Bur. Econ. Geol., Univ. Texas, Bull. 3101, p. 142, pl. 11, fig. 20.
"*Lenticulina rotulata* (Lamarck)". Frizzell, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 82, pl. 8, fig. 14. (synonymy).

Diagnosis: Test involute, biconvex; peripheral margin sharply angular with a distinct keel; 8 to 9 chambers in the adult volution; sutures distinct, slightly raised, tangential at the umbo from which they radiate as slightly curved lines; umbo distinct; apertures of earlier chambers visible at the periphery; radiate aperture slightly raised at the extremity of the last-formed chamber.

Figured specimen: USNM 639464, maximum diameter 0.80 mm, collected 8 feet below the top. Compared with numerous plesiotypes in USNM: agrees favorably with forms from the Western Hemisphere identified as *L. rotulata* Lamarck.

Discussion: Many forms referred to Lamarck's species are not conspecific. "*Lenticulina rotulata* (Lamarck)" is quite variable even within the Gulf Coast Cretaceous. The practice of assigning specimens with a distinct umbo, a distinct keel, and slightly curved tangential sutures to this species is followed here.

Lenticulina (Lenticulina) jonesi Sandidge

Lenticulina jonesi Sandidge, 1932, Jour. Paleontology, vol. 6, p. 273, pl. 42, figs. 1, 2.
Lenticulina jonesi Sandidge. Cushman, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 55, pl. 18, fig. 14. (synonymy).
Lenticulina jonesi Sandidge. Cushman, 1949, U. S. Geol. Surv., Prof. Paper 221-A, p. 4, pl. 2, fig. 4.

Discussion: This species, reported by Cushman (1949) from the Arkadelphia, was not identified from the samples studied by the writer.

Subgenus Robulus Montfort, 1808

Robulus Montfort, 1808, Conch. Syst., vol. 1, p. 215, 54th genre.

Type species: Robulus cultratus Denys de Montfort, 1808. Original designation.
Gender: masculine.

Discussion: This subgenus differs from the typical subgenus principally in the character of the radiate aperture, which has an enlarged slit extending into the apertural face along the median line.

Lenticulina (Robulus) navarroensis (Plummer)

Pl. II, fig. 11

Cristellaria cultrata Montfort. Carsey (*not* Montfort), 1926, Texas Bur. Econ. Geol., Univ. Texas, Bull. 2612, p. 38, pl. 6, fig. 3.
Cristellaria navarroensis Plummer, 1927, Texas Bur. Econ. Geol., Univ. Texas, Bull. 2644, p. 39, text figs. 4a, b.
Cristellaria midwayensis Plummer. Berry and Kelley (*not* Plummer), 1929, U. S. Natl. Mus., Proc., vol. 76, art. 19, p. 7, pl. 1, fig. 3.
Lenticulina navarroensis (Plummer). Plummer, 1931, Texas Bur. Econ. Geol., Univ. Texas, Bull. 3101, p. 141.
Robulus navarroensis (Plummer). Jennings, 1936, Bull. Amer. Paleontology, vol. 23, no. 78, p. 15, pl. 1, figs. 14a, b.
Robulus navarroensis (Plummer) Cushman [sic]. Cushman, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 51, pl. 16, figs. 6-8. (synonymy).
Robulus navarroensis (Plummer) var. *navarroensis* (Plummer). Frizzell, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 81, pl. 8, fig. 6.

Diagnosis: Test closely coiled; umbonate, the sutures distinctly limbate and fused with the umbo which is slightly raised; periphery bears a prominent, thin keel; chambers 10 to 12 in the adult volution, quite distinct, gradually increasing in size; sutures quite distinct, limbate, curved; wall smooth and flush except near the umbo; aperture radiate with an enlarged ventral slit in the median line.

Figured specimen: USNM 639465, maximum diameter 0.913 mm, collected 16 feet above the base. Compared with plesiotypes in USNM: agrees, though smaller than some plesiotypes.

Discussion: This species, as the name implies, is characteristic of the Navarro. It is abundant in the Arkadelphia and equivalent strata. The species displays considerable individual variation, a common feature of this subgenus. It is reported from Texas, Arkansas, Mississippi, Alabama, New Jersey, Kansas, Nebraska, and South Dakota.

Lenticulina (Robulus) navarroensis extruatus (Cushman)

Pl. II, fig. 12

Robulus navarroensis (Plummer) var. *extruatus* Cushman, 1941, Cushman Lab. Foram. Res., Contr., vol. 14, pt. 2, p. 31, pl. 5, fig. 1.
Robulus navarroensis (Plummer) Cushman var. *extruatus* Cushman. Cushman, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 52, pl. 16, figs. 9, 10; pl. 17, fig. 2. (synonymy).
Robulus navarroensis (Plummer) var. *extruatus* Cushman. Frizzell, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 81, pl. 8, figs. 5a, b.

Diagnosis: Test exhibits a tendency to uncoil; sutures decidedly raised into thickened ridges instead of fusing into the smooth umbo as in the typical subspecies.

Figured specimen: USNM 639466, maximum diameter 1.25 mm, collected 8 feet below the top. Compared with the holotype and paratypes in USNM: agrees, but this specimen is smaller.

Discussion: Cushman states (1946): "This seems to be a varietal form of *R. navarroensis* and has a distinct keel. It also tends

toward *R. spisso-costatus* in its ornamentation and may be a stage between the two." This subspecies is abundant in the Arkadelphia. It is reported from the Corsicana marl and Kemp clay of Texas and the Prairie Bluff chalk of Mississippi.

LENTICULINA (ROBULUS) PONDI (Cushman)

Pl. II, fig. 13

Robulus pondi CUSHMAN, 1931, Tennessee Div. Geol., Bull. 41, p. 25, pl. 2, figs. 9a, b.
Robulus pondi Cushman. CUSHMAN, 1946, U. S. Geol., Surv., Prof. Paper 206, p. 52, pl. 16, figs. 1-5. (synonymy).
Robulus pondi Cushman. CUSHMAN, 1949, U. S. Geol. Surv., Prof. Paper 221-A, p. 4, pl. 2, figs. 2, 3.
Robulus pondi Cushman. FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 81, pl. 8, figs. 7a, b.

Diagnosis: Test closely coiled, tending to uncoil in some specimens; umbos flattened; periphery angled, the apertures of earlier chambers forming prominent nodes between the straight to slightly concave chamber margins; chambers 10 to 12 in the adult volution, distinct, slightly enlarging as added; sutures distinct, subtangential, slightly curved; wall smooth; aperture radiate with an additional circular opening at the summit of the apertural face.

Figured specimen: USNM 639467, maximum diameter 0.975 mm, collected 8 feet below the top. Compared with the holotype and paratypes in USNM: smaller than holotype, nodes more prominent; agrees exactly with several paratypes from the Selma chalk.

Discussion: This species is common in beds of upper Taylor and Navarro age in Texas, Arkansas, Mississippi, Alabama, and Tennessee.

LENTICULINA (ROBULUS) SPISSOCOSTATUS (Cushman)

Pl. II, fig. 14

Cristellaria pseudomamilligerus H. J. Plummer. ALBRITTON and PHLEGER (*not* Plummer), 1937, Jour. Paleontology, vol. 11, no. 4, p. 351.
Robulus spisso-costatus CUSHMAN, 1938, Cushman Lab. Foram. Res., Contr., vol. 14, pt. 2, p. 32, pl. 5, fig. 2.
Robulus spisso-costatus Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 52, pl. 16, figs. 11-14; pl. 17, figs. 1a, b. (synonymy).
Robulus spisso-costatus Cushman. FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 81, pl. 9, figs. 9a, b.

Diagnosis: Test compressed, the juvenarium closely coiled, the adult chambers slightly evolute exposing the inner portion of the penultimate coil; periphery subacute with a slight, rounded keel; chambers 9 to 12 in the adult volution, increasing gradually in size as added, uniformly shaped; sutures distinct, curved, limbate, raised, thickened near the umbo and fused with the umbo; wall smooth, except for the raised sutures; aperture radiate, placed at the outer angle, with a ventral supplementary slit in the median line.

Figured specimen: USNM 639468, maximum diameter 1.16 mm, collected 8 feet below the top. Compared with the holotype and paratypes in USNM: smaller than holotype; agrees exactly with several paratypes from the Corsicana marl.

Discussion: This species is characteristic of upper Navarro strata. It is reported from the Corsicana marl, the Kemp clay, the Prairie Bluff chalk, and the Selma chalk. It differs from *L.* (*R.*) *navarroensis* (Plummer) in the absence of a thin, flange-like keel and in the greatly thickened sutures near and at the umbo.

LENTICULINA (ROBULUS) MUENSTERI (Roemer)

Pl. II, fig. 15

Robulina münsteri ROEMER, 1839, Versteiner. norddeutschen Oolithen-Gebirges, Nachtrag. (Hannover), p. 48, pl. 20, figs. 29a, b.
Cristellaria münsteri (Roemer). REUSS, 1863, Akad. Wiss. Wien, Math.-naturw. Kl., Sitzb., vol. 46, pt. 1, p. 77, pl. 9, figs. 3, 4.
Robulus münsteri (Reuss) (?). CUSHMAN, 1932, Jour. Paleontology, vol. 6, no. 4, p. 334, pl. 50, figs. 2a, b.
Robulus münsteri (Roemer) Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 53, pl. 17, figs. 3-9. (synonymy).
Robulus münsteri (Roemer) Cushman. CUSHMAN, 1949, U. S. Geol. Surv., Prof. Paper 221-A, p. 4.
Robulus münsteri (Roemer). FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 81, pl. 8, figs. 1a, 1b, 2-4.

Diagnosis: Test compressed, involute, except for the last few adult chambers of some specimens which are slightly evolute, exposing the penultimate coil; periphery with a sharp keel; strongly umbonate; chambers 9 to 12 in the adult volution, distinct, uniform, increasing gradually in size as added, not inflated; sutures distinct, tangential, slightly curved, slightly limbate; wall smooth; aperture radiate, positioned at the peripheral angle.

Figured specimen: USNM 639469, maximum diameter 1.00 mm, collected 8 feet below the top. Compared with plesiotypes in USNM: well within the range of forms from the Western Hemisphere identified as *R. münsteri* (Roemer); identical to some plesio-

types from the upper Taylor marl of Texas.

Discussion: There is wide variation among forms identified with Roemer's species. It is doubtful if all are conspecific. Similar forms are reported from the Austin, Taylor, and Navarro strata of Texas, Arkansas, Mississippi, and Tennessee.

Genus Darbyella Howe and Wallace, 1933

Darbyella Howe and Wallace, 1933, Louisiana Geol. Surv., Geol. Bull. 2, p. 23.

Type species: Darbyella danvillensis Howe and Wallace, 1933. Original designation. *Gender:* feminine.

Diagnosis: Test closely coiled throughout, juvenarium planispiral, adult chambers formed to one side of the earlier plane of coiling; wall calcareous, finely perforate; surface generally smooth; aperture radiate or with an elongate slit at the peripheral angle.

Discussion: Numerous species of *Darbyella* Howe and Wallace have a radiate or robuline aperture. The generic description is here emended to include such forms.

Darbyella sp.

Pl. III, figs. 1, 2

Diagnosis: Test involute, biconvex, closely coiled, planispiral in juvenarium, adult volution displaced to one side; periphery sharply angled; eight chambers in the last volution; sutures distinct, slightly curved, tangential, radiating from the quite prominent umbo; chambers distinct, glassy; aperture radiate with an elongate slit 0.05 mm below the apex of the apertural face.

Figured specimen: USNM 639470, maximum diameter 0.65 mm, collected 8 feet below the top of the Arkadelphia.

Discussion: Only a single specimen of this form was recovered. In view of the belief of some workers that *Darbyella* is not morphologically sound, the species is best left unnamed.

Genus Planularia Defrance, 1826

Planularia Defrance, 1826, Dict. Sci. Nat., vol. 41 (pin-plo), p. 244.

Type species: Peneroplis auris Defrance, 1824. Monotypic. *Gender:* feminine.

Discussion: Strongly flattened species are assigned to this genus readily, but less flattened forms appear to grade into other genera.

Planularia dissona (Plummer)

Pl. III, fig. 3

Cristellaria reniformis d'Orbigny. Carsey (*not* d'Orbigny), 1926, Texas Bur. Econ. Geol., Univ. Texas, Bull. 2612, p. 37, pl. 3, fig. 2.

Astacolus dissonus Plummer, 1931, Texas Bur. Econ. Geol., Univ. Texas, Bull. 3101, p. 145, pl. 11, figs. 17, 18; pl. 15, figs. 2-7.

Planularia dissona (Plummer). Cushman, 1941, Cushman Lab. Foram. Res., Contr., vol. 17, pt. 3, p. 68, pl. 16, figs. 15-19.

Planularia dissona (Plummer) Cushman. Cushman, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 57, pl. 19, figs. 11-18. (synonymy).

Planularia planotrochiformis Hussey and McNulty, 1950, Jour. Paleontology, vol. 24, no. 4, p. 472, text figs. 1-9.

Planularia dissona (Plummer). Frizzell, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 82, pl. 8, figs. 17a, 17b, 18, 19.

Diagnosis: Test strongly compressed, thickest at the umbo; juvenarium closely coiled, adult portion of the megalospheric test uncoiling; periphery with a thin keel in the earlier portion, subacute in the uncoiled portion; chambers distinct, increasing rapidly in size as added, becoming elongate in the adult, somewhat inflated in the uncoiled portion of the test; sutures distinct, slightly limbate and curved in the earlier portion, slightly depressed and less strongly curved in the later uncoiled portion; wall smooth or with a few weak costae which are parallel to the periphery; aperture radiate, slightly raised, positioned at the peripheral angle.

Figured specimen: USNM 639471, length 0.79 mm, breadth 0.50 mm, collected 22 feet above the base. Compared with plesiotypes in USNM: well within the range of variation.

Discussion: This species is quite varied, but is an excellent marker for the upper Navarro. It has been reported from the Kemp clay, the Corsicana marl, and the Nacatoch sand.

Planularia deadericki Cushman

Pl. III, fig. 4

Planularia deadericki Cushman, 1947, Cushman Lab. Foram Res., Contr., vol. 23, pt. 3, p. 56, pl. 13, figs. 11-13.

Planularia deadericki Cushman. Cushman, 1949, U. S. Geol. Surv., Prof. Paper 221-A, p. 4, pl. 2, figs. 6, 7.

Diagnosis: Test strongly compressed, juvenarium closely coiled, later portion tending to uncoil; periphery carinate with a narrow, transparent keel; chambers distinct, only slightly inflated; sutures distinct, slightly depressed; wall ornamented with longitudinal costae, curved, similar to the periphery; aperture terminal, radiate, positioned at the peripheral angle.

Figured specimen: USNM 639472, length 0.60 mm, breadth 0.34 mm, collected 8 feet below the top. Compared with the holotype and paratypes in USNM: agrees.

Discussion: This species is more compressed and more ornate than *Planularia dissona* (Plummer). It is common in the Arkadelphia, but has not been reported from other strata.

Genus MARGINULINA d'Orbigny, 1826

Marginulina d'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 258.

Type species: Nautilus raphanus Linné, 1758. Subsequent designation, Deshayes, 1832 [cited as *Marginulina raphanus* (Linné)]. *Gender:* feminine.

MARGINULINA sp.

Pl. III, fig. 5

Diagnosis: Test compressed; juvenarium coiled, later portion uncoiled; periphery strongly convex; venter of adult concave; chambers distinct, increasing gradually in size as added; sutures distinct, slightly curved; wall smooth; aperture radiate, positioned at the peripheral angle.

Figured specimen: USNM 639473, length 0.55 mm, breadth 0.30 mm, collected 9 feet above the base.

Discussion: This form resembles *Marginulina cretacea* Cushman, but the holotype and numerous paratypes of that species were examined and the Arkadelphia form is different in possessing a clearly defined reentrant between the juvenarium and the adult chambers. It differs from *M. curvatura* Cushman in being compressed.

MARGINULINA NAVARROANA Cushman

Marginulina navarroana CUSHMAN, 1937, Cushman Lab. Foram. Res., Contr., vol. 13, pt. 4, p. 98, pl. 14, figs. 17, 18.
Marginulina navarroana Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 62, pl. 22, figs. 1-5.
Marginulina navarroana Cushman. CUSHMAN, 1949, U. S. Geol. Surv., Prof. Paper 221-A, p. 5, pl. 2, fig. 10.
Marginulina navarroana Cushman. FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 84, pl. 9, figs. 6-8.

Discussion: This species, reported by Cushman (1949) from the Arkadelphia, was not identified from the samples studied by the writer.

MARGINULINA SILICULA (Plummer)

Vaginulina (?) *trilobata* (d'Orbigny) (?). CUSHMAN, 1930, Cushman Lab. Foram. Res., Contr., vol. 6, pt. 2, p. 30, pl. 4, fig. 11.
Hemicristellaria silicula PLUMMER, 1931, Texas Bur. Econ. Geol., Univ. Texas, Bull. 3101, p. 148, pl. 10, figs. 8, 9.
Marginulina silicula (Plummer). CUSHMAN, 1937, Cushman Lab. Foram Res., Contr., vol. 13, pt. 4, p. 97, pl. 14, figs. 19-22.
Marginulina silicula (Plummer) Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 62, pl. 21, figs. 42-45. (synonymy).
Marginulina silicula (Plummer) Cushman. CUSHMAN, 1949, U. S. Geol. Surv., Prof. Paper 221-A, p. 5, pl. 2, fig. 11.
Marginulina silicula (Plummer). FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 85, pl. 9, figs. 14, 15.

Discussion: This species, reported by Cushman (1949) from the Arkadelphia, was not identified from the samples studied by the writer.

MARGINULINA PLUMMERAE Cushman

Pl. III, fig. 6

Cristellaria lineara CARSEY (not *C. linearis* d'Orbigny), 1926, Texas Bur. Econ. Geol., Univ. Texas, Bull, 2612, p. 36, pl. 2, fig. 3.
Hemicristellaria ensis (Reuss). PLUMMER (*not* Reuss), 1931, Texas Bur. Econ. Geol., Univ. Texas, Bull. 3101, p. 146, pl. 10, figs. 1-4.
Marginulina plummerae CUSHMAN, 1937, Cushman Lab. Foram. Res., Contr., vol. 13, pt. 4, p. 97, pl. 13, figs. 21-23.
Marginulina plummerae Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 62, pl. 22, figs. 6-10. (synonymy).

Diagnosis: Test elongate, compressed, especially in the coiled juvenarium; adult portion of test uncoiled, less compressed, subcircular in transverse section; venter nearly straight, periphery slightly convex, becoming slightly concave in elongate specimens; chambers distinct, increasing rapidly in size in coiled portion, gradually in uncoiled portion and distinctly inflated; sutures distinct, limbate, gently curved, slightly raised, thickened at the middle; wall smooth except for the raised sutures; aperture radiate, positioned at the peripheral angle.

Figured specimen: USNM 639474, length 0.52 mm, breadth of adult portion 0.175 mm, collected 8 feet below the top. Compared with the holotype and paratypes in USNM: does not agree exactly with holotype, but is within the range of paratypes.

Discussion: This species is restricted to the upper Navarro strata. It is reported from the Kemp clay, the Corsicana marl, and the Prairie Bluff chalk.

MARGINULINA CURVATURA Cushman

Pl. III, fig. 7

Marginulina curvatura CUSHMAN, 1938, Cushman Lab. Foram. Res., Contr., vol. 14, pt. 2, p. 34, pl. 5, figs. 13, 14.
Marginulina curvatura Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 63, pl. 22, figs. 11-14. (synonymy).
Marginulina curvatura Cushman. FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 84, pl. 8, figs. 40, 41.

Diagnosis: Test elongate, slightly compressed; juvenarium coiled, later chambers uncoiled in a curved to rectilinear series; chambers distinct, gradually more inflated and less overlapped in later portion, subcircular in transverse section; early sutures slightly depressed, gradually becoming distinctly depressed; wall smooth; aperture radiate, positioned at the peripheral angle.

Figured specimen: USNM 639475, length 0.46 mm, breadth 0.25 mm, collected 21 feet above the base. Compared with the holotype and paratypes in USNM: not quite as straight as the holotype; agrees exactly with one paratype.

Discussion: This species is restricted to upper Navarro strata. It is reported also from the Corsicana marl of Texas.

MARGINULINA SILIQUA Cushman

Pl. III, fig. 8

Marginulina siliqua CUSHMAN, 1938, Cushman Lab. Foram. Res., Contr., vol. 14, pt. 2, p. 34, pl. 5, figs. 15, 16.
Marginulina siliqua Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 63, pl. 22, figs. 15, 16.
Marginulina siliqua Cushman. CUSHMAN, 1949, U. S. Geol. Surv., Prof. Paper 221-A, p. 5, pl. 2, fig. 14.
Marginulina siliqua Cushman. FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 85, pl. 9, figs. 16, 17.

Diagnosis: Test small, strongly compressed, peripheral margin subacute; juvenarium coiled, adult chambers uncoiled; chambers distinct, short but increasing in breadth as added; the first four or five chambers extend back to the proloculus, later chambers form a gently curved linear series, latest chambers slightly inflated; sutures distinct, slightly limbate, faintly depressed between the last 2 or 3 adult chambers; wall smooth; aperture radiate, slightly projecting, positioned on the dorsal periphery.

Figured specimen: USNM 639476, length 0.32 mm, breadth 0.16 mm, collected 8 feet below the top. Compared with the holotype and paratype in USNM: agrees, though immature.

Discussion: This form is very rare in the Arkadelphia. It has been reported from the Kemp clay and the Corsicana marl of Texas.

Genus DENTALINA d'Orbigny, 1826

Dentalina D'ORBIGNY, *in* RISSO, 1826, Hist. Nat. l'Europe Méridionale, tome 4, p. 16.

Type species: Nodosaria (Dentaline) cuvieri d'Orbigny, 1826. Monotypic *in* Risso, 1826 [cited as *Dentalina cuvieri* (d'Orbigny)]. *Gender:* feminine.

DENTALINA LEGUMEN (Reuss)

Pl. III, fig. 9

Nodosaria (Dentalina) legumen REUSS, 1845, Versteiner. böhm. Kreidefm., pt. 1, p. 28, pl. 13, figs. 23, 24.
Dentalina legumen (Reuss). REUSS, 1851, Haidinger's naturw. Abh., vol. 4, p. 10, pl. 1, fig. 14.
Dentalina nana (Reuss). CUSHMAN (not *Nodosaria (D.) nana* Reuss, 1863; not *Nodosaria nana* Reuss, 1860), 1931, Tennessee Div. Geol., Bull. 41, p. 29, pl. 3, fig. 21.
Dentalina legumen Reuss. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 65, pl. 23, figs. 1, 2. (synonymy).
Dentalina legumen (Reuss). FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 88, pl. 9, figs. 56, 57.

Diagnosis: Test elongate, tapering, base pointed; chambers increase rapidly in size as added; sutures distinct, oblique, depressed; wall smooth; aperture radiate, terminal, peripherally positioned.

Figured specimen: USNM 639477, length 0.675 mm, collected 21 feet above the base. Compared with numerous plesiotypes in USNM: identical to the plesiotype from the Arkadelphia, agrees with others.

Discussion: This form is widely distributed through the upper Cretaceous strata of the Gulf Coast. It is of little value for correlation due to the variation in size, length, and shape of individuals.

DENTALINA GRACILIS (d'Orbigny)

Pl. III, figs. 10, 11

Nodosaria (Dentalina) gracilis D'ORBIGNY, 1840, Soc. Géol. France, Mém., sér. 1, vol. 4, pt. 1, p. 14, pl. 1, fig. 5.
Dentalina gracilis (d'Orbigny). FRANKE, 1928, K. Preuss. Geol. Landesanstalt, Abh., new ser., vol. 111, p. 29, pl. 2, fig. 22.
Dentalina gracilis D'Orbigny. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 65, pl. 23, figs. 3-6. (synonymy).

Dentalina gracilis (d'Orbigny). FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 88, pl. 9, figs. 49, 50.

Diagnosis: Test elongate, slender, slightly curved, tapering; initial portion blunt; chambers fairly uniform, increasing gradually in length and diameter as added; sutures distinct, strongly depressed; wall smooth; aperture radiate, terminal.

Figured specimens: USNM 639478 (fig. 10), length 1.00 mm, maximum diameter 0.175 mm, collected 8 feet below the top; USNM 639479 (fig. 11). Compared with plesiotypes in USNM: agree with plesiotypes from the Arkadelphia and other formations.

Discussion: This varied form is widely distributed in the upper Cretaceous of the Gulf Coastal Plain.

DENTALINA LORNEIANA d'Orbigny

Pl. III, figs. 12, 13

Dentalina lorneiana D'ORBIGNY, 1840, Soc. Géol. France, Mém., sér. 1, vol. 4, p. 14, pl. 1, figs. 8, 9.
Nodosaria lorneiana (d'Orbigny). REUSS, 1845, Versteiner. böhm. Kreidefm., pt. 1, p. 27, pl. 8, fig. 5.
Dentalina lorneiana D'Orbigny. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 66, pl. 23, figs. 7-11. (synonymy).
Dentalina lorneiana d'Orbigny. CUSHMAN, 1949, U. S. Geol. Surv., Prof. Paper 221-A, p. 5, pl. 2, fig. 16.
Dentalina lorneiana d'Orbigny. FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 89, pl. 9, figs. 58, 59.

Diagnosis: Test elongate, slender, very slightly curved; initial portion broadly rounded; chambers increasing rapidly in length, but only gradually in diameter as added, slightly inflated; sutures distinct, slightly depressed; wall smooth; aperture radiate, terminal.

Figured specimens: USNM 639480 (fig. 13), length 0.80 mm, diameter 0.125 mm, collected 8 feet below the top; USNM 639481 (fig. 12). Compared with identified specimens in USNM: within the range of specimens, identical to some.

Discussion: This form is widely distributed in the Gulf Coast. It has been reported from the Austin, Taylor, and Navarro strata of Texas, Arkansas, Mississippi, and Tennessee and from the Niobrara chalk of Nebraska.

DENTALINA ACULEATA (d'Orbigny)

Pl. III, fig. 14

[?] *Nodosaria (Dentalina) aculeata* D'ORBIGNY, 1840, Soc. Géol. France, Mém., sér. 1, vol. 4, p. 13, pl. 1, figs. 2, 3 [possibly = *Ramulina*].
Lagena incidenta CARSEY, 1926, Texas Bur. Econ. Geol., Univ. Texas, Bull. 2612, p. 30, pl. 4, fig. 12.
Ramulina globulifera H. B. Brady. PLUMMER (*partim;* not *R. globulifera* Brady), 1931, Texas Bur. Econ. Geol., Univ. Texas, Bull. 3101, p. 174, pl. 11, fig. 15a (*not* 15b).
Dentalina aculeata d'Orbigny. CUSHMAN, 1944, Cushman Lab. Foram. Res., Contr., vol. 20, pt. 1, p. 6, pl. 2, fig. 11.
Dentalina aculeata (d'Orbigny). CUSHMAN *(partim),* 1946, U. S. Geol. Surv., Prof. Paper 206, p. 67, pl. 26, fig. 17 (*not* 18). (synonymy).
Dentalina aculeata (d'Orbigny) ?. FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 86, pl. 9, fig. 27.

Diagnosis: Test free; chambers inflated, subpyriform, separated by strongly constricted, tubular necks; entire surface ornamented with numerous and irregular spines; aperture terminal, rarely preserved.

Figured specimen: USNM 639482, length of single chamber 0.75 mm, diameter 0.35 mm, collected 8 feet below the top. Compared with numerous identified specimens in USNM: agrees.

Discussion: This species was described by d'Orbigny from the Senonian of the Paris basin. His specimens may represent free terminal chambers of a *Ramulina* R. Jones. Forms identified with d'Orbigny's species are known only as separated, single chambers in the Cretaceous of North America.

DENTALINA CATENULA Reuss

Pl. III, figs. 15, 16

Dentalina catenula REUSS, 1860, Akad. Wiss. Wien, Math.-naturw. Kl., Sitzb., vol. 40, p. 185, pl. 3, fig. 6.
Nodosaria farcimen Soldani. CARSEY (not *Orthoceras farcimen* Soldani), 1926, Texas Bur. Econ. Geol., Univ. Texas, Bull. 2612, p. 34, pl. 4, fig. 11.
Dentalina soluta Reuss. PLUMMER (*not* Reuss), 1931, Texas Bur. Econ. Geol., Univ. Texas, Bull. 3101, p. 150, pl. 11, fig. 14.
Dentalina catenula Reuss. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 67, pl. 23, figs. 27-32. (synonymy).
Dentalina catenula Reuss. FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 87, pl. 9, figs. 35-37.

Diagnosis: Test elongate, slightly curved, tapering; initial portion with a distinct spine; chambers pyriform, overlapping, increasing gradually in size as added, uniformly shaped, with the maximum diameter below the middle of the test and tapering toward the aperture; sutures distinct, strongly depressed; wall smooth; aperture radiate, terminal.

Figured specimens: USNM 639483 (fig. 16), length 2.20 mm, diameter 0.34 mm, collected 10 feet below the top; USNM 639484 (fig. 15). Compared with numerous identified specimens in USNM: agree.

Discussion: This species is widely distributed in the Taylor group of the Gulf Coast, but occurs only sparsely in the Navarro beds of Texas and Arkansas.

Dentalina basiplanata Cushman

Pl. III, fig. 17

Dentalina annulata (Reuss). Cushman (*not* Reuss), 1931, Tennessee Div. Geol., Bull. 41, p. 28, pl. 3, fig. 3.
Dentalina megalopolitana Reuss. Cushman (*partim; not* Reuss), 1931, Jour. Paleontology, vol. 5, no. 4, p. 304, pl. 34, fig. 17.
Dentalina reussi Neugeboren. Plummer (*not* Neugeboren), 1931, Texas Bur. Econ. Geol., Univ. Texas, Bull. 3101, p. 151, pl. 11, fig. 5.
Dentalina gracilis d'Orbigny. Albritton and Phleger (not *Nodosaria (D.) gracilis* d'Orbigny), 1937, Jour. Paleontology, vol. 11, no. 4, p. 350.
Dentalina basiplanata Cushman, 1938, Cushman Lab. Foram. Res., Contr., vol. 14, pt. 2, p. 38, pl. 6, figs. 6-8.
Dentalina basiplanata Cushman. Cushman, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 68, pl. 24, figs. 1-6. (synonymy).
Dentalina basiplanata Cushman. Frizzell, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 86, pl. 9, figs. 32, 33.

Diagnosis: Test elongate, slightly tapering, slightly curved; microspheric juvenarium bears oblique costae indicating coiling, commonly slightly compressed; chambers distinct, adult chambers inflated, increasing in size and inflation as added; earlier chambers more strongly overlapping; sutures distinct, somewhat limbate; earlier sutures flush, oblique; later sutures depressed, horizontal; wall calcareous; surface smooth, except for earliest portion of the test; aperture radiate, terminal.

Figured specimen: USNM 639485, length 1.15 mm, diameter 0.20 mm, collected 16 feet above the base. Compared with the holotype and paratypes in USNM: agrees.

Discussion: This species is common and widely distributed in the Taylor and Navarro of Texas, Arkansas, Mississippi, Alabama, and Tennessee.

Dentalina crinita Plummer

Pl. III, fig. 18

Nodosaria consobrina d'Orbigny. Carsey (not *Dentalina consobrina* d'Orbigny), 1926, Texas Bur. Econ. Geol., Univ. Texas, Bull. 2612, p. 32, pl. 2, fig. 5.
Dentalina crinita Plummer, 1931, Texas Bur. Econ. Geol., Univ. Texas, Bull. 3101, p. 154, pl. 11, figs. 12, 13.
Dentalina crinita Plummer. Cushman, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 69, pl. 24, figs. 29, 30. (synonymy).
Dentalina crinita Plummer. Frizzell, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 87, pl. 9, fig. 42.

Diagnosis: Test quite elongate, slender, diameter nearly uniform throughout; chambers distinct; earlier chambers not inflated, overlapping; later chambers become gradually more inflated and less strongly overlapping; sutures distinct, slightly limbate, later ones depressed; wall calcareous; surface of juvenarium smooth, of adult test ornamented with irregular spinose projections arranged in a longitudinal linear pattern, appearing hirsute; aperture radiate, terminal, raised, eccentric.

Figured specimen: USNM 639486, length 1.79 mm, diameter 0.20 mm, collected 16 feet above the base. Compared with identified specimens in USNM: agrees.

Discussion: This species is reported from the Taylor and Navarro of Texas, Arkansas, Mississippi, and Tennessee.

Dentalina delicatula Cushman

Pl. III, fig. 19

Nodosaria obliqua Linnaeus. Carsey (not *Nautilus obliquus* L.), 1926, Texas Bur. Econ. Geol., Univ. Texas, Bull. 2612, p. 35, pl. 2, fig. 6.
Dentalina obliqua (Linné). Plummer (not *Nautilus obliquus* L.), 1931, Texas Bur. Econ. Geol., Univ. Texas, Bull. 3101, p. 153, pl. 11, fig. 6.
Dentalina delicatula Cushman, 1938, Cushman Lab. Foram. Res., Contr., vol. 14, pt. 2, p. 40, pl. 6, figs. 19, 20.
Dentalina delicatula Cushman. Cushman, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 70, pl. 25, figs. 1-6. (synonymy).
Dentalina delicatula Cushman. Frizzell, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 88, pl. 9, figs. 46, 47.

Diagnosis: Test elongate, slender, gently curved, slightly tapering with a distinct spine at the base; chambers distinct; earlier chambers not inflated, overlapping, increasing slightly in height as added; adult chambers inflated, with a lobulate periphery, somewhat pyriform; sutures distinct, limbate, later ones depressed; wall calcareous, surface ornamented with numerous (15 to 20) strong longitudinal costae, somewhat lower and more delicate on the final chambers, unreduced at the sutures; aperture radiate, terminal, elevated on a tapered neck.

Figured specimen: USNM 639487, length 1.55 mm, diameter 0.275 mm, collected 22 feet above the base. Compared with the holotype and paratypes in USNM: agrees

with the holotype, within the range of the varied paratypes.

Discussion: This species differs from *Dentalina alternata* (Jones) in having more delicate and thinner walls and in the greater number of costae. *Dentalina delicatula* Cushman is reported only from the Navarro strata of Texas and Arkansas.

Genus Nodosaria Lamarck, 1816

Nodosaria Lamarck, 1816, Tableau Encyclopédique et Méthodique (Paris), pt. 23, pp. 13, 14.

Type species: Nautilus radicula Linné, 1758. Subsequent designation, Children, 1823 [cited as *Nodosaria radicula* (Linné)]. *Gender:* feminine.

Nodosaria vertebralis (Batsch)

Pl. III, fig. 20

Nautilus (Orthoceras) vertebralis Batsch, 1791, Conch. des Seesandes, pp. 2, 5, pl. 2, figs. 6a, b.
Dentalina vertebralis (Batsch). Sherborn and Chapman, 1886, Royal Micros. Soc., Jour., ser. 2, vol. 6, p. 752, pl. 14, figs. 39a, b.
Nodosaria vertebralis Batsch. H. B. Brady, 1884, Challenger, Rept., Zoology, vol. 9, p. 514, pl. 63, fig. 35; pl. 64, figs. 11-14.
Nodosaria vertebralis (Batsch). Plummer, 1927, Texas Bur. Econ. Geol., Univ. Texas, Bull. 2644, p. 88, pl. 5, fig. 10. (synonymy).
Nodosaria vertebralis (Batsch). Nuttall, 1930, Jour. Paleontology, vol. 4, no. 3, p. 283.
Nodosaria vertebralis (Batsch). Harris and Jobe, 1951, Microfauna of Basal Midway (Norman, Oklahoma), p. 23, pl. 4, fig. 9.

Diagnosis: Test elongate, slender, straight to slightly arcuate; chambers short, compact, subcylindrical; sutures marked by darker bands, constricted only between the last few chambers; wall calcareous; surface ornamented by a few (about 8) coarse, longitudinal costae; aperture radiate, somewhat eccentric, elevated on a neck.

Figured specimen: USNM 639488, length 2.75 mm, maximum diameter 0.41 mm, collected 22 feet above the base. Compared with numerous identified specimens in USNM: agrees.

Discussion: Individuals referred to *Nodosaria vertebralis* (Batsch) pass through intermediate forms with almost imperceptible gradation into *Nodosaria affinis* d'Orbigny and may be separated only with difficulty. This species is known from the Midway formation (Paleocene) of Arkansas and Texas. This is the first record from the uppermost Cretaceous of the Gulf Coast.

Nodosaria affinis Reuss

Pl. III, figs. 21, 22

Nodosaria (Dentalina) affinis Reuss, 1845, Versteiner. böhm. Kreidefm., pt. 1, p. 26, pl. 13, fig. 16.
Nodosaria vertebralis Batsch var. *austinensis* Carsey, 1926, Texas Bur. Econ. Geol., Univ. Texas, Bull. 2612, p. 31, pl. 7, fig. 12.
Nodosaria marla Carsey, 1926, Texas Bur. Econ. Geol., Univ. Texas, Bull. 2612, p. 34, pl. 4, fig. 6.
Nodosaria proxima Silvestri. Berry and Kelley (*not* Silvestri), 1929, U. S. Natl. Mus., Proc., vol. 76, art. 19, p. 7, pl. 1, fig. 13.
Nodosaria zippei Reuss. Plummer (*not* Reuss), 1931, Texas Bur. Econ. Geol., Univ. Texas, Bull. 3101, p. 157.
Nodosaria affinis Reuss. Cushman, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 70, pl. 25, figs. 8-23. (synonymy).
Nodosaria affinis Reuss. Frizzell, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 89, pl. 10, figs. 3-7.

Diagnosis: Test elongate, normally bearing a stout spine at the base; the microspheric form with many chambers, tapering, somewhat curved in some specimens, maximum width near the apertural end; the megalospheric form with a quite large proloculus, the few later chambers reducing rapidly in diameter; chambers distinct, inflated; sutures distinct, strongly compressed, somewhat limbate; wall calcareous; surface ornamented by numerous (about 13 to 15) longitudinal costae, sharp and platelike; aperture radiate, terminal, elevated on a neck.

Figured specimens: USNM 639489 (fig. 21), length 3.80 mm, maximum diameter 0.65 mm; USNM 639490 (fig. 22), length 1.00 mm; collected 22 feet above the base. Compared with numerous identified specimens in USNM: agree.

Discussion: This species is markedly dimorphic and somewhat variable, especially in the microspheric form. It is reported from numerous localities throughout the Austin, Taylor, and Navarro strata of Texas, Arkansas, Mississippi, Alabama, and Tennessee.

Nodosaria obscura Reuss

Pl. III, fig. 23

Nodosaria (Nodosaria) obscura Reuss, 1845, Versteiner. böhm. Kreidefm., pt. 1, p. 26, pl. 13, figs. 7-9.
Nodosaria obscura Reuss. Cushman, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 73, pl. 26, figs. 15, 16. (synonymy).
Nodosaria obscura Reuss. Frizzell, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 91, pl. 10, figs. 26, 27.

Diagnosis: Test fusiform, of varied lengths, broadest near the apertural end, pointed at the base; chambers obscured by the strong ornamentation of the test, not inflated; sutures indistinct, not depressed; wall calcareous; surface ornamented by 10 to 15 distinct, longitudinal costae extending the entire length of the test and coalescing and thickening at the apertural end to form a distinct, collar-like structure about the aperture; aperture obscurely radiate, terminal.

Figured specimen: USNM 639491, length 0.62 mm, diameter 0.14 mm, collected 8 feet below the top. Compared with numerous identified specimens in USNM: agrees.

Discussion: This species is more common in the upper Taylor and the Navarro strata of the Gulf Coast but also has been reported from the lower Selma (Austin age) of Mississippi.

Genus CHRYSALOGONIUM Schubert, 1907

Chrysalogonium SCHUBERT, 1907, Neues Jahr. für Min. Geol. Pal., vol. 25, p. 243.

Type species: Nodosaria polystoma Schwager, 1866. Original designation. *Gender:* neuter.

CHRYSALOGONIUM TEXANUM Cushman

Pl. III, fig. 24

Chrysalogonium texanum CUSHMAN, 1936, Cushman Lab. Foram. Res., Contr., vol. 12, pt. 3, p. 55, pl. 9, figs. 24, 25.

Chrysalogonium texanum Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 75, pl. 27, figs. 14, 15.

Chrysalogonium texanum Cushman. FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 92, pl. 10, figs. 40, 41.

Diagnosis: Test quite elongate, slender, tapering, gently arcuate, a distinct spine at the base; chambers distinct, slightly inflated, increasing in length as added; length of adult chambers at least three times breadth; sutures distinct, slightly limbate, slightly depressed; wall calcareous; surface smooth; adult aperture sieve-like, slightly raised, terminal.

Figured specimen: USNM 639492, length 2.75 mm, maximum diameter 0.225 mm, collected 10 feet below the top. Compared with the holotype and paratypes in USNM: agrees, but larger.

Discussion: This species is reported from the Austin, Taylor, and Navarro of Texas and Arkansas.

CHRYSALOGONIUM GRANTI (Plummer)

Nodosaria filiformis d'Orbigny. CARSEY (*not* d'Orbigny), 1926, Texas Bur. Econ. Geol., Univ. Texas, Bull. 2612, p. 33, pl. 7, fig. 8.

Nodosaria granti PLUMMER, 1927, Texas Bur. Econ. Geol., Univ. Texas, Bull. 2644, p. 83, pl. 5, figs. 9a-d.

Dentalina granti (Plummer). PLUMMER, 1931, Texas Bur. Econ. Geol., Univ. Texas, Bull. 3101, p. 149, pl. 11, figs. 8, 9.

Ellipsonodosaria (?) *granti* (Plummer). CUSHMAN, 1936, Cushman Lab. Foram. Res., Contr., vol. 12, pt. 3, p. 51, pl. 9, figs. 3-5.

Ellipsonodosaria? granti (Plummer) Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 136, pl. 56, figs. 24-26. (synonymy).

Chrysalogonium granti (Plummer). FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 92, pl. 10, fig. 21.

Discussion: This species, reported by Cushman (1949) from the Arkadelphia, was not identified from the samples studied by the writer.

Genus PSEUDONODOSARIA Boomgaart, 1949

Pseudonodosaria BOOMGAART, 1949, Smaller Foraminifera from Bodjonegoro (Java), Utrecht Univ., Thesis, p. 81.

Type species: Glandulina discreta Reuss, 1850. Original designation. *Gender:* feminine.

PSEUDONODOSARIA LARVA (Carsey)

Pl. IV, fig. 2

Nodosaria (Glandulina) manifesta (Reuss). CUSHMAN, 1926, Amer. Assoc. Petrol. Geol., Bull., vol. 10, no. 6, p. 594, pl. 18, fig. 8.

Nodosaria larva CARSEY, 1926, Texas Bur. Econ. Geol., Univ. Texas, Bull. 2612, p. 31, pl. 2, fig. 2.

Nodosaria radicula (Linnaeus). PLUMMER (not *Nautilus radicula* Linné, 1758), 1927, Texas Bur. Econ. Geol., Univ. Texas, Bull. 2644, p. 77, pl. 4, fig. 9a (*not* fig. 9b).

Nodosaria radicula (Linné). PLUMMER (not *Nautilus radicula* Linné), 1931, Texas Bur. Econ. Geol., Univ. Texas, Bull. 3101, p. 155, pl. 11 (fig. 1 ?), fig. 2.

Nodosaria humilis Roemer. CUSHMAN (*not* Roemer), 1931, Tennessee Div. Geol., Bull. 41, p. 32, pl. 4, fig. 5.

Pseudoglandulina manifesta (Reuss). CUSHMAN and TODD (not *Glandulina manifesta* Reuss, 1851), 1943, Cushman Lab. Foram. Res., Contr., vol. 19, pt. 3, p. 58, pl. 10, fig. 15.

Pseudoglandulina manifesta (Reuss). CUSHMAN (not *Glandulina manifesta* Reuss), 1946, U. S. Geol. Surv., Prof. Paper 206, p. 76, pl. 27, figs. 21-26 (*not* fig. 20).

Pseudoglandulina manifesta (Reuss). FRIZZELL (not *Glandulina manifesta* Reuss), 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 92, pl. 10, figs. 29, 31 (*not* fig. 30).

Diagnosis: "Test free, elongate, base smooth and rounded, consisting of a rectilinear series of

chambers, early ones closely appressed, strongly overlapping and subcylindrical, later chambers slightly inflated with a a lesser amount of overlap and separated by slight constrictions, final chamber turbinate in form, somewhat produced to the aperture; sutures distinct, straight, horizontal, flush with the surface in the early portion, slightly constricted in the later portion where the chambers are more inflated; wall calcareous, hyaline, surface smooth; aperture terminal, radiate. Specimens range from 0.39 to 0.88 mm in length and 0.18 to 0.26 mm in width." (Loeblich and Tappan, 1955).

Figured specimen: USNM 639493, length 0.475 mm, maximum diameter 0.20 mm, collected 8 feet below the top. Compared with numerous plesiotypes in USNM: agrees.

Genus Rectoglandulina Loeblich and Tappan, 1955

Rectoglandulina Loeblich and Tappan, 1955, Smithsonian Misc. Colln., vol. 126, no. 3, p. 3.

Type species: Rectoglandulina appressa Loeblich and Tappan, 1955. Original designation. *Gender:* feminine.

Rectoglandulina appressa Loeblich and Tappan

Pl. IV, fig. 1

Pseudoglandulina lagenoides (Olszewski). Cushman and Deaderick (not *Glandulina lagenoides* Olszewski, 1875), 1944, Jour. Paleontology, vol. 18, no. 4, p. 334, pl. 51, figs. 14, 15. [not *Pseudoglandulina lagenoides* (Olszewski). of Authors, *partim.*]

Pseudoglandulina sp. Plummer, 1931, Texas Bur. Econ. Geol., Univ. Texas, Bull. 3101, p. 158, pl. 10, figs. 16, 17.

Rectoglandulina appressa Loeblich and Tappan, 1955, Smithsonian Misc. Colln., vol. 126, no. 3, p. 4, pl. 1, figs. 1-4.

Diagnosis: "Test free, subfusiform, widest centrally, chambers uniserial, closely appressed, increasing rapidly in diameter from the pointed base, last chamber occupying one-half to three-fifths the length of the test, elongate turbinate in form; sutures distinct, horizontal, flush with the surface; wall calcareous, surface smooth; aperture terminal, radiate.

Length of holotype 0.44 mm, greatest breadth 0.23 mm. Other specimens range from 0.26 to 0.57 mm in length." (Loeblich and Tappan, 1955).

Figured specimen: USNM 639494, length 0.50 mm, maximum diameter 0.275 mm, collected 8 feet below the top.

Discussion: This species has been reported from the Ozan sand and the Annona chalk of Arkansas and from the Corsicana and Taylor marls of Texas.

Rectoglandulina lagenoides (Olszewski)

Pl. IV, fig. 3

Glandulina lagenoides Olszewski, 1875, Sprawozdonie Komisyi Fizyograficznéj, Akad. Umiejetnosci, Krakowie, vol. 9, p. 107, pl. 1, fig. 6.

[?] *Nodosaria laevigata* Nilsson. Carsey (*not* Nilsson), 1926, Texas Bur. Econ. Geol., Univ. Texas, Bull. 2612, p. 32, pl. 4, fig. 13.

Pseudoglandulina lagenoides (Olszewski). Cushman and Hedberg, 1941, Cushman Lab. Foram. Res., Contr., vol. 17, pt. 4, p. 89, pl. 21, fig. 34.

Pseudoglandulina lagenoides (Olszewski) Cushman and Hedberg. Cushman, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 76, pl. 27, fig. 29. (synonymy, *partim*).

Pseudoglandulina lagenoides (Olszewski). Frizzell, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 92, pl. 10, fig. 28.

Diagnosis: Test free, strongly fusiform, widest centrally, chambers uniserial, closely appressed; increasing rapidly in diameter from the pointed base to the midpoint of the test, then reducing in the last-formed chamber which forms about one-third the length of the test; sutures distinct, horizontal, flush with the surface; wall calcareous; surface smooth; aperture radiate, terminal.

Figured specimen: USNM 639495, length 0.60 mm, maximum breadth 0.21 mm, collected 10 feet below the top. Compared with numerous plesiotypes of *"Pseudoglandulina lagenoides* (Olszewski)" in USNM: agrees.

Discussion: This species differs from *Rectoglandulina appressa* Loeblich and Tappan in its more fusiform shape and in the ratio of the last-formed chamber to the length of the test. *R. lagenoides* (Olszewski) is known only from the upper Taylor and Navarro strata in the Gulf Coast.

Rectoglandulina pygmaea (Reuss)

Pl. IV, fig. 4

Glandulina pygmaea Reuss, 1851, Haidinger's naturw. Abh., vol. 4, pt. 1, p. 6, pl. 1, fig. 3.

Pseudoglandulina pygmaea (Reuss) Cushman. Cushman, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 76, pl. 27, figs. 27, 28.

Pseudoglandulina pygmaea (Reuss). Frizzell, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 92, pl. 10, fig. 37.

Diagnosis: Test free, small, fusiform; chambers strongly appressed, the last-formed chamber appearing to envelop the test; apertural end produced into a slight neck; sutures indistinct; wall calcareous; surface costate; aperture radiate, terminal.

Figured specimen: USNM 639496, length

0.35 mm, diameter 0.213 mm, collected 8 feet below the top. Compared with numerous plesiotypes in USNM: agrees.

Discussion: This form is reported from the Taylor and Navarro of Texas, Arkansas, Mississippi, and Alabama.

Genus Saracenaria Defrance, 1824

Saracenaria Defrance, 1824, Dict. Sci. Nat., vol. 32, p. 176.

Type species: Saracenaria italica Defrance, 1824. Monotypic. *Gender:* feminine.

Saracenaria triangularis (d'Orbigny)

Pl. IV, fig. 5

Cristellaria triangularis d'Orbigny, 1840, Soc. Géol. France, Mém., sér. 1, vol. 4, pt. 1, p. 27, pl. 2, figs. 21, 22.
Saracenaria triangularis (D'Orbigny). Cushman and Church, 1929, California Acad. Sci., Proc., ser. 4, vol. 18, p. 505, pl. 37, figs. 13, 14.
Saracenaria triangularis (D'Orbigny) Cushman and Church. Cushman, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 58, pl. 28, figs. 1-3. (synonymy).
Saracenaria triangularis (d'Orbigny). Frizzell, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 83, pl. 8, figs. 28a, b.

Diagnosis: Test free, large; juvenarium coiled, the later chambers somewhat uncoiled, becoming triangular in transverse section; chambers distinct, few in number; sutures distinct, curved, not depressed; wall calcareous; surface smooth except for the thickened sides of the apertural face; aperture radiate, positioned at the peripheral angle.

Figured specimen: USNM 639497, length 0.425 mm, breadth 0.325 mm, collected 9 feet above the base. Compared with numerous plesiotypes in USNM: agrees favorably.

Discussion: This form is reported from the Austin, Taylor, and Navarro of Texas, Arkansas, Mississippi, Alabama, and Tennessee.

Saracenaria saratogana Howe and Wallace

Pl. IV, fig. 6

Saracenaria italica Defrance. Cushman (*not* Defrance), 1931, Jour. Paleontology, vol. 5, no. 4, p. 305, pl. 34, figs. 15, 16.
Saracenaria cf. *italica* Defrance. Cushman and Todd, 1943, Cushman Lab. Foram. Res., Contr., vol. 19, pt. 3, p. 58, pl. 10, fig. 17.
Saracenaria saratogana Howe and Wallace, 1932, Louisiana Dept. Conserv., Geol. Bull. 2, p. 41.
Saracenaria saratogana Howe and Wallace. Cushman, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 58, pl. 28, figs. 4-6.
Saracenaria saratogana Howe and Wallace. Frizzell, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 83, pl. 8, figs. 20, 21.

Diagnosis: Test free; juvenarium coiled, adult chambers uncoiled, triangular in transverse section; adult chambers distinct, the angles bluntly rounded; sutures distinct, slightly curved, flush; wall calcareous, surface smooth except for the slightly projecting inner corners of the apertural faces of the uncoiled chambers; aperture radiate, slightly raised, positioned at the peripheral angle.

Figured specimen: USNM 639498, length 0.825 mm, breadth 0.35 mm, collected 9 feet above the base. Compared with numerous plesiotypes in USNM: within the range of specimens.

Discussion: This species is reported from the Navarro of Texas, Arkansas, Mississippi, and Alabama. It differs from *S. triangularis* (d'Orbigny) in the blunter angles and distinct uncoiling.

Genus Vaginulina d'Orbigny, 1826

Vaginulina d'Orbigny, 1826, Ann. Sci. Nat., vol. 7, p. 257.

Type species: Nautilus legumen Linné, 1758. Subsequent designation, Cushman, 1913 [cited as *Vaginulina legumen* Linnaeus]. *Gender:* feminine.

Vaginulina cretacea Plummer

Pl. IV, figs. 9, 10

Vaginulina gracilis var. *cretacea* Plummer, 1927, Texas Bur. Econ. Geol., Univ. Texas, Bull. 2644, p. 172, pl. 2, fig. 8.
Vaginulina cretacea Plummer. Cushman, 1936, Geol. Soc. Amer., Bull., vol. 47, p. 417, pl. 1, fig. 5.
Vaginulina cretacea Plummer. Cushman, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 80, pl. 30, figs. 11-14. (synonymy).
Vaginulina cretacea Plummer. Frizzell, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 93, pl. 10, figs. 54, 55.

Diagnosis: Test quite elongate, somewhat compressed, slender, tapering, slightly arcuate, peripheral edge concave, inner edge convex, periphery rounded; chambers numerous, distinct, inflated only slightly; juvenarium with slight traces of coiling; early chambers low, increasing gradually in height as added to the high and broad adult chambers; sutures quite distinct, slightly oblique in juvenarium, nearly horizontal in the adult, limbate with a raised, elongate beadlike protuberance at the midpoint of each suture; wall calcareous; surface smooth except for the raised sutures; aperture radiate, slightly produced, positioned at the peripheral angle.

Figured specimens: USNM 639499 (fig. 9), length 2.40 mm, width 0.50 mm; USNM 639500 (fig. 10), length 2.00 mm, collected 32 feet above the base. Compared with numerous plesiotypes in USNM: agree.

Discussion: This species is restricted to the Navarro of Texas, Arkansas, and Mississippi where it is common.

Genus Citharina d'Orbigny, 1839

Citharina d'Orbigny, *in* de la Sagra, 1839, Hist. Phys. Pol. Nat. Cuba, Foraminifères, p. 37.

Type species: Vaginulina (Citharina) strigillata Reuss, 1846. Subsequent designation, Loeblich and Tappan, 1949 [cited as *Citharina strigillata* Reuss, 1846]. *Gender: feminine.*

Citharina multicostata (Cushman)

Vaginulina multicostata Cushman, 1930, Cushman Lab. Foram. Res., Contr., vol. 6, pt. 2, p. 28, pl. 4, fig. 4.
Vaginulina simondsi Carsey. Cushman (*partim; not* Carsey), 1931, Tennessee Div. Geol., Bull. 41, p. 33, pl. 4, figs. 7a, b (*not* 8a, b).
Vaginulina simondsi Carsey. Cushman (*not* Carsey), 1931, Jour. Paleontology, vol. 5, no. 4, p. 306, pl. 35, fig. 7.
Vaginulina multicostata Cushman. Cushman, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 79, pl. 29, figs. 9-16. (synonymy).
Citharina multicostata (Cushman). Frizzell, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 95, pl. 11, figs. 27, 28.

Diagnosis: Test elongate, strongly compressed peripheral edge straight or gently curved, inner edge strongly convex, base pointed; chambers few, elongate, curved, low and broad, the last-formed extending halfway to the base along the inner margin; sutures distinct, somewhat limbate, not depressed, strongly oblique, gently curved; wall calcareous; surface ornamented with numerous fine costae subparallel to the peripheral edge; aperture radiate, elevated at the peripheral angle.

Identified specimen: USNM 639501 (not figured), length of broken specimen 1.25 mm, maximum breadth 0.25 mm, collected 15 feet below the top. Compared with the holotype (of which only the upper half remains) in USNM: agrees.

Discussion: This species is relatively rare in the Arkadelphia and only broken specimens were recovered from the samples studied. *C. multicostata* (Cushman) is reported from numerous localities in the Taylor and Navarro throughout the Gulf Coast province.

Citharina barcoensis (Cushman and Hedberg)

Pl. IV, fig. 7

Vaginulina barcoensis Cushman and Hedberg, 1941, Cushman Lab. Foram. Res., Contr., vol. 17, pt. 4, p. 90, pl. 22, fig. 2.

Diagnosis: Test strongly compressed, initial end acute, with a blunt spine, dorsal margin with a distinct keel and gently curved, ventral margin truncate, greatest breadth near the base; chambers distinct, not inflated, increasing gradually in height and rapidly in breadth as added, each reaching back toward the basal line; sutures distinct, curved, slightly limbate; wall calcareous; surface ornamented with fine, longitudinal costae subparallel to the dorsal margin; aperture terminal, slightly elevated, radiate.

Figured specimen: USNM 639502, length 1.05 mm, breadth 0.30 mm, collected 22 feet above the base.

Discussion: This species was described from the upper Cretaceous Colon formation, northeastern Colombia. It is distinguished by the carinate dorsal margin or keel and by the backward extension of the chambers to the basal line. It is rare in the Arkadelphia marl. The final chamber of the figured specimen extends backward about seven-eighths of the length of the test. It differs in this respect from *C. multicostata* (Cushman) in which the final chambers extend backward about halfway, and in greater breadth compared to the length of the test.

Vaginulina subplumoides Parr from the upper Eocene of Western Australia is similar but appears to lack the carinate dorsal margin. However, if examination of the actual specimen should reveal such a keel, Parr's name is prior and must be used for the American form.

Citharina simondsi (Carsey)

Pl. IV, fig. 8

Vaginulina simondsi Carsey, 1926, Texas Bur. Econ. Geol., Univ. Texas, Bull. 2612, p. 40, pl. 2, fig. 4.
Vaginulina simondsi Carsey. Cushman, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 80, pl. 29, figs. 23-25. (synonymy).
Citharina simondsi (Carsey). Frizzell, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 95, pl. 11, figs. 14, 15.

Diagnosis: Test free, of medium size, strongly compressed, broadest near the apertural end, peripheral and inner edges straight, thickened, strongly carinate, a distinct initial spine at the base; chambers numerous, distinct, low and

broad, increasing uniformly in breadth as added; sutures distinct, somewhat limbate, straight or only slightly curved, flush; wall calcareous; surface ornamented with longitudinal costae subparallel to the peripheral edge, generally stronger in the early stages; aperture radiate, elevated slightly at the peripheral angle.

Figured specimen: USNM 639503, length 1.54 mm, maximum breadth 0.375 mm, collected 10 feet below the top. Compared with numerous plesiotypes in USNM: compares favorably.

Discussion: This form is limited to the upper Navarro strata. It is rare in the Arkadelphia. It differs from the larger species *Citharina webbervillensis* (Carsey) in the more extensive costae present and in the nearly straight sutures.

Citharina navarroana (Cushman)

Vaginulina navarroana Cushman, 1936, Geol. Soc. Amer., Bull., vol. 47, p. 416, pl. 1, fig. 3.
Vaginulina navarroana Cushman. Cushman, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 80, pl. 29, figs. 17-22. (synonymy).
Citharina navarroana (Cushman). Frizzell, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 95, pl. 11, figs. 16-18.

Discussion: This species, reported by Cushman (1949) from the Arkadelphia, was not identified from the samples studied by the writer. The holotype of this small form (in the USNM) was examined.

Citharina webbervillensis (Carsey)

Pl. IV, fig. 11

Vaginulina webbervillensis Carsey, 1926, Texas Bur. Econ. Geol., Univ. Texas, Bull. 2612, p. 39, pl. 2, fig. 7.
Vaginulina webbervillensis Carsey. Cushman, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 81, pl. 30, figs. 5-10. (synonymy).
Citharina webbervillensis (Carsey). Frizzell, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 96, pl. 11, figs. 38, 39.

Diagnosis: Test quite large, strongly compressed, broadest near the apertural end, a distinct spine at the base, periphery of juvenarium bicarinate or tricarinate, periphery rounded and smooth in the adult, peripheral edge thickened and nearly straight, inner edge convex; chambers numerous, distinct, curved, low and broad, increasing rapidly in breadth as added; sutures distinct, limbate along the peripheral edge, flush, recurved toward the proloculus; wall calcareous; surface ornamented with a few costae, especially in the juvenarium; aperture radiate, produced, positioned at the peripheral angle.

Figured specimen: USNM 639504, length 3.075 mm, breadth 0.95 mm, collected 9 feet above the base. Compared with numerous plesiotypes in USNM: agrees.

Discussion: This is a large, easily recognized species characteristic of upper Navarro strata of the Gulf Coast province where it occurs in abundance.

Genus Neoflabellina Bartenstein, 1948

Neoflabellina Bartenstein, 1948, Senckenbergiana, vol. 28, no. 4-6, p. 122.

Type species: Flabellina rugosa d'Orbigny, 1840. Original designation. *Gender:* feminine.

Neoflabellina rugosa (d'Orbigny)

Pl. IV, fig. 12

Flabellina rugosa d'Orbigny, 1840, Soc. Géol. France, Mém., sér. 1, vol. 4, p. 23, pl. 2, figs. 4, 5, 7.
Flabellina interpunctata von der Marck, 1858, Naturh. Ver. Preuss. Rheinlande, Westfalens, Verh., vol. 15, p. 53, pl. 1, fig. 5.
Frondicularia baudouiniana (d'Orbigny). Cushman (*not* d'Orbigny), 1926, Cushman Lab. Foram. Res., Contr., vol. 2, pt. 1, p. 21, pl. 3, fig. 5.
not *Frondicularia projecta* Carsey, 1926, Texas Bur. Econ. Geol., Univ. Texas, Bull. 2612, p. 41, pl. 6, fig. 5.
not *Flabellina projecta* (Carsey). Plummer, 1931, Texas Bur. Econ. Geol., Univ. Texas, Bull. 3101, p. 165, pl. 12, figs. 5-8.
Palmula rugosa (d'Orbigny). Cushman, 1940, Foraminifera, Ed. 3, illus. key, p. 465, pl. 20, fig. 8.
Palmula rugosa (D'Orbigny) Cushman. Cushman, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 83, pl. 31, figs. 9-17. (synonymy).
Neoflabellina rugosa (d'Orbigny). Bartenstein, 1948, Senckenbergiana, vol. 28, no. 4-6, p. 124.
Neoflabellina rugosa (d'Orbigny). Frizzell, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 97, pl. 12, figs. 15, 16.

Diagnosis: Test free, sagittate to rhomboid or broadly elliptical in lateral view, strongly compressed, periphery truncated, sides nearly flat; microspheric juvenarium planispirally coiled; adult chambers chevron-shaped, narrow and embracing, extending back on either side and almost enclosing the juvenarium; sutures distinct, raised, sharp, and forming a loop near the apertural end of the last-formed chambers; wall calcareous; surface with small, raised papillae between the raised sutures; aperture indistinctly radiate, elevated on a short projecting neck.

Figured specimen: USNM 639505 (immature individual), length 0.475 mm, maximum breadth 0.325 mm, collected 32 feet above the base. Compared with numerous

plesiotypes in USNM: compares favorably.

Discussion: A single immature specimen was recovered from the samples and is the first record of this species in the Arkadelphia marl. It has been reported previously from a single locality in the Austin chalk of Texas and from numerous localities in the Taylor, Navarro, and Midway of the Gulf Coast.

NEOFLABELLINA RETICULATA (Reuss)

Pl. IV, figs. 13, 14

Flabellina reticulata REUSS, 1851, Haidinger's naturw. Abh., vol. 4, pt. 1, p. 30, pl. 1, fig. 22.
Flabellina favosa BEISSEL, 1891, K. Preuss. Geol. Landesanstalt, Abh., new ser., vol. 3, p. 49, pl. 19, figs. 25-28; pl. 26, fig. 28.
Frondicularia reticulata (Reuss). BAGG, 1898, U. S. Geol. Surv., Bull. 88, p. 50, pl. 3, fig. 6.
Frondicularia cf. *interpunctata* (Von der Marck). CUSHMAN (*not* von der Marck), 1926, Amer. Assoc. Petrol. Geol., Bull., vol. 10, no. 6, p. 598, pl. 20, fig. 6.
Palmula reticulata (Reuss). CUSHMAN, 1940, Foraminifera, Ed. 3, illus. key, p. 465, pl. 20, fig. 9.
Palmula reticulata (Reuss). CUSHMAN and TODD, 1943, Cushman Lab. Foram. Res., Contr., vol. 19, pt. 3, p. 60, pl. 10, fig. 23. (synonymy).
Palmula reticulata (Reuss) Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 84, pl. 31, figs. 1-6. (synonymy).
Neoflabellina reticulata (Reuss). BARTENSTEIN, 1948, Senckenbergiana, vol. 28, no. 4-6, p. 124.
Neoflabellina reticulata (Reuss). FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 97, pl. 12, figs. 13, 14.

Diagnosis: Test free, rhomboid in lateral view or with the base rounded, strongly compressed, periphery truncated, sides quite flat; microspheric juvenarium planispirally coiled; adult chambers chevron-shaped, narrow, extending back on both sides; chambers distinct; sutures distinct, somewhat raised; wall calcareous; surface covered by a raised meshwork with the long axis perpendicular to the sutures; aperture radiate, slightly produced.

Figured specimens: USNM 639506 (fig. 14), length 1.375 mm, breadth 0.90 mm; USNM 639507 (fig. 13), length 0.825 mm, collected 9 feet above the base. Compared with numerous plesiotypes in USNM: agree.

Discussion: This species is characteristic of the Navarro in the Gulf Coast and is confined to Navarro strata with one reported exception, the Taylor marl (upper part), Leon County, Texas.

Genus FRONDICULARIA Defrance, 1824

Frondicularia DEFRANCE, 1824, Dict. Sci. Nat., vol. 32, p. 178.

Type species: Renulina complanata Defrance, 1824. Subsequent designation, Cushman, 1913 [cited as *Frondicularia complanata* Defrance]. *Gender:* feminine.

FRONDICULARIA INVERSA Reuss

Pl. IV, fig. 15

Frondicularia inversa REUSS, 1844, Geogn. Skizzen Böhmen, II: Die Kreidegebilde. . . , Prague: C. W. Medau, vol. 2, pt. 1, p. 211.
Frondicularia inversa Reuss. CUSHMAN *(partim)*, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 86, pl. 33, figs. 16-18 (*not* figs. 11-15). (synonymy).
Frondicularia inversa Reuss. FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 98, pl. 12, figs. 31, 32.

Diagnosis: Test elongate, elliptical, quite strongly compressed, periphery rounded, with a short stout spine at the base; chambers distinct, proloculus narrow, elongate; adult chambers are progressively less embracing, giving a narrow tapered shape to the adult test; sutures distinct, flush, gently curved; wall calcareous; surface smooth or with a few fine vertical costae near the midline; aperture radiate, terminal.

Figured specimen: USNM 639508, length of broken specimen 1.325 mm (fig. 15), length of entire specimen 2.175 mm, maximum breadth 0.818 mm, collected 8 feet below the top. Compared with identified specimens in USNM: agrees with specimen identified by Reuss, except for the globular proloculus; agrees with specimens from the Selma chalk.

Discussion: This species is reported from the Austin, Taylor, and Navarro of Texas, Arkansas, and Tennessee.

Genus PSEUDOFRONDICULARIA Thalmann, 1938

Pseudofrondicularia WEDEKIND, 1937, Einführung Grundl. Hist. Geol., vol. 2, p. 94. [Type species not explicitly designated.]
Pseudofrondicularia THALMANN, 1938, Paläont. Zentralblatt, Leipzig, vol. 11, no. 4, p. 210.

Type species: Frondicularia carinata Burbach, 1886. Original designation, Thalmann, 1938. *Gender:* feminine.

PSEUDOFRONDICULARIA ARKADELPHIANA (Cushman)

Pl. IV, fig. 16

Frondicularia arkadelphiana CUSHMAN, 1936, Cushman Lab. Foram. Res., Contr., vol. 12, pt. 1, p. 12, pl. 3, figs. 2, 3.

Frondicularia arkadelphiana Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 91, pl. 37, figs. 21, 22.
Frondicularia arkadelphiana Cushman. CUSHMAN, 1949, U. S. Geol. Surv., Prof. Paper 221-A, p. 6.

Diagnosis: Test elongate, narrow, slightly tapering, periphery truncated, slightly concave, sides quite flat; proloculus spherical, somewhat thicker than the remainder of the test; adult chambers distinct, chevron-shaped, increasing gradually and regularly in size as added, not inflated; sutures distinct, strongly oblique, slightly curved, somewhat raised; wall calcareous, perforate; surface ornamented with fine, longitudinal, raised costae, somewhat finer and more numerous on the later chambers, the costae fusing into the raised sutural ridge at the base of each chamber; aperture small, radiate, terminal, elevated on a slight neck.

Figured specimen: USNM 639509, length of broken specimen 1.66 mm, breadth 0.575 mm, collected 10 feet below the top. Compared with the holotype and paratype in USNM: agrees favorably but more robust than the holotype and paratype.

Discussion: This species is restricted to strata of Navarro age and constitutes an excellent index fossil for the Arkadelphia and equivalents.

PSEUDOFRONDICULARIA LANCEOLA (Reuss)

Frondicularia lanceola REUSS, 1860, Akad. Wiss. Wien, Math.-naturw. Kl., Sitzb., vol. 40, p. 198, pl. 5, figs. 1a, b.
Frondicularia lanceola Reuss. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 85, pl. 33, figs. 1-4. (synonymy).
Frondicularia lanceola Reuss. CUSHMAN, 1949, U. S. Geol. Surv., Prof. Paper 221-A, p. 6, pl. 3, fig. 6.
Pseudofrondicularia lanceola (Reuss) var. *lanceola* (Reuss). FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 100, pl. 13, figs. 16, 17.

Discussion: This species, reported by Cushman (1949) from the Arkadelphia, was not identified from the samples studied by the writer.

Family POLYMORPHINIDAE d'Orbigny, 1839

Subfamily POLYMORPHININAE d'Orbigny, 1839

Genus GUTTULINA d'Orbigny, 1839

Guttulina D'ORBIGNY, *in* DE LA SAGRA, 1839, Hist. Phys. Pol. Nat. Cuba, Foraminifères, p. 132.

Type species: Polymorphina (Guttulina) communis d'Orbigny, 1826. Subsequent designation, Galloway and Wissler, 1927. *Gender:* feminine.

GUTTULINA ADHAERENS (Olszewski)

Pl. IV, fig. 20

Polymorphina adhaerens OLSZEWSKI, 1875, Sprawozdonie Komisyi Fizyograficnéj, Akad. Umiejetnosci, Krakowie, vol. 9, p. 119, pl. 1, fig. 11.
Polymorphina communis d'Orbigny. CARSEY (*not* d'Orbigny), 1926, Texas Bur. Econ. Geol., Univ. Texas, Bull. 2612, p. 42, pl. 1, fig. 5.
Guttulina adhaerens (Olszewski). CUSHMAN and OZAWA, 1930, U. S. Natl. Mus., Proc., vol. 77, art. 6, p. 36, pl. 1, fig. 9; pl. 6, fig. 7.
Guttulina problema d'Orbigny. PLUMMER (*not* d'Orbigny), 1931, Texas Bur. Econ. Geol., Univ. Texas, Bull. 3101, p. 173, pl. 13, fig. 1.
Guttulina adhaerens (Olszewski) Cushman and Ozawa. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 96, pl. 40, figs. 8-10. (synonymy).
Guttulina adhaerens (Olszewski). FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 103, pl. 14, figs. 16, 17.

Diagnosis: Test ovate to subovate, broadest below the middle, rounded at the base, acute at the apertural end; chambers clavate, arranged in a subquinqueloculine series, each succeeding chamber removed slightly farther from the base; sutures only slightly depressed, distinct; wall calcareous; surface smooth; aperture radiate, terminal.

Figured specimen: USNM 639510, length 0.465 mm, breadth 0.375 mm, collected 22 feet above the base. Compared with plesiotypes in USNM: agrees favorably.

Discussion: This species is reported from the upper Taylor and Navarro of the Gulf Coast.

Genus GLOBULINA d'Orbigny, 1839

Globulina D'ORBIGNY, *in* DE LA SAGRA, 1839, Hist. Phys. Pol. Nat. Cuba, Foraminifères, p. 134.

Type species: Polymorphina (Globuline) gibba d'Orbigny, 1826. Subsequent designation, Cushman, 1927 [cited as *Globulina gibba,* 1826]. *Gender:* feminine.

GLOBULINA LACRIMA LACRIMA Reuss

Pl. IV, fig. 21

Polymorphina (Globulina) lacrima REUSS, 1845, Versteiner. böhm. Kreidefm., pt. 1, p. 40, pl. 12, fig. 6; pl. 13, fig. 83.
Globulina lacrima Reuss. REUSS, 1851, Haidinger's naturw. Abh., vol. 4, pt. 1, p. 27, pl. 4, fig. 9.

Polymorphina gibba d'Orbigny. CUSHMAN (*not* d'Orbigny), 1926, Amer. Assoc. Petrol. Geol., Bull., vol. 10, no. 6, p. 604, pl. 20, figs. 8, 15.
Globulina lacrima Reuss. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 96, pl. 40, figs. 11, 12. (synonymy).
Globulina lacrima Reuss. CUSHMAN, 1949, U. S. Geol. Surv., Prof. Paper 221-A, p. 6, pl. 3, fig. 10.
Globulina lacrima (Reuss) var. *lacrima* (Reuss). FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 104, pl. 14, figs. 21a-c.

Diagnosis: Test subglobular, base broadly rounded, apertural end produced, acuminate, rounded in transverse section; chambers few, enveloping earlier chambers almost to the base; sutures flush; wall calcareous; surface smooth; aperture radiate, produced into a slight neck.

Figured specimen: USNM 639511, length 0.40 mm, breadth 0.225 mm, collected 22 feet above the base. Compared with plesiotypes in USNM: compares favorably but is less globular.

Discussion: The typical subspecies is reported from numerous localities in the Austin, Taylor, and Navarro of the Gulf Coast.

GLOBULINA LACRIMA SUBSPHAERICA (Berthelin)

Pl. IV, fig. 22

Polymorphina subsphaerica BERTHELIN, 1880, Soc. Géol. France, Mém., sér. 3, vol. 1, pt. 5, p. 58, pl. 4, figs. 18a, b.
Globulina lacrima Reuss var. *subsphaerica* (Berthelin). CUSHMAN and OZAWA, 1930, U. S. Nat. Mus., Proc., vol. 77, art. 6, p. 78, pl. 19, figs. 5-7.
?Globulina inaequalis Reuss. SANDIDGE (*not* Reuss), 1932, Amer. Midland Nat., vol. 13, p. 359, pl. 31, figs. 25, 26.
Globulina lacrima Reuss var. *subsphaerica* (Berthelin) Cushman and Ozawa. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 96, pl. 40, fig. 13. (synonymy).
Globulina lacrima (Reuss) var. *subsphaerica* (Berthelin). FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 104, pl. 14, figs. 22, 23.

Diagnosis: This form differs from the typical subspecies in the slightly compressed test which is more rounded at the base. The aperture is fistulose in some specimens.

Figured specimen: USNM 639512, length 0.45 mm, breadth 0.387 mm, collected 22 feet above the base. Compared with plesiotypes in USNM: compares favorably with the plesiotypes including one from the Arkadelphia which is fistulose.

Discussion: This subspecies is reported from the Taylor and Navarro of Texas, Arkansas, Mississippi, and Tennessee, and from the upper Cretaceous of Europe, Mexico, Nebraska, California, and New Jersey.

GLOBULINA LACRIMA HORRIDA Reuss

Pl. IV, fig. 23

Globulina horrida REUSS, 1846, Versteiner. böhm Kreidefm., pt. 2, p. 110, pl. 43, fig. 14.
Globulina lacrima Reuss var. *horrida* Reuss. CUSHMAN and OZAWA, 1930, U. S. Natl. Mus., Proc., vol. 77, art. 6, p. 79, pl. 19, fig. 3.
Globulina lacrima Reuss var. *horrida* Reuss. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 97, pl. 40, fig. 14. (synonymy).
Globulina lacrima (Reuss) var. *horrida* Reuss. FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 104, pl. 14, fig. 20.

Diagnosis: This subspecies commonly has a fistulose aperture and differs from the typical form principally in the finely spinose surface.

Figured specimen: USNM 639513, length 0.30 mm, breadth 0.40 mm, collected 8 feet below the top. Compared with plesiotypes in USNM: compares favorably except some plesiotypes are not fistulose, including one from the Arkadelphia.

Discussion: This subspecies is reported from numerous localities in the Austin, Taylor, and Navarro of the Gulf Coast.

GLOBULINA PRISCA Reuss

Pl. IV, fig. 24

Globulina prisca REUSS, 1862, Akad. Wiss. Wien, Math.-naturw. Kl., Sitzb., vol. 46, pt. 1, p. 79, pl. 9, fig. 8.
Globulina prisca Reuss. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 97, pl. 40, figs. 15-17. (synonymy).
Globulina prisca Reuss. FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 104, pl. 14, fig. 24.

Diagnosis: Test elongate, fusiform, somewhat compressed, apertural end acuminate, base rounded or acuminate; chambers elongate, tapering to the base, triloculine; sutures only slightly depressed; wall calcareous; surface smooth; aperture radiate.

Figured specimen: USNM 639514, length 0.525 mm, breadth 0.262 mm, collected 16 feet above the base. Compared with plesiotypes in USNM: compares favorably.

Discussion: This species is reported also from the Prairie Bluff chalk of Alabama, the Selma chalk of Mississippi, and the Annona chalk of Texas.

Genus Pyrulina d'Orbigny, 1839

Pyrulina d'Orbigny, *in* de la Sagra, 1839, Hist. Phys. Pol. Nat. Cuba, Foraminifères, p. 107.

Type species: Polymorphina (Pyruline) gutta d'Orbigny, 1826. Monotypic. *Gender:* feminine.

Pyrulina cylindroides (Roemer)

Pl. IV, fig. 25

Polymorphina cylindroides Roemer, 1838, Neues Jahrb., p. 385, pl. 3, fig. 26.
Polymorphina fusiformis Roemer. Cushman (*not* Roemer), 1926, Amer. Assoc. Petrol. Geol., Bull., vol. 10, no. 6, p. 604, pl. 20, fig. 14.
Polymorphina gutta d'Orbigny. W. Berry (*not* d'Orbigny), *in* Berry and Kelley, 1929, U. S. Natl. Mus., Proc., vol. 76, art. 19, p. 10, pl. 1, fig. 11.
Pyrulina cylindroides (Roemer). Cushman and Ozawa, 1930, U. S. Natl. Mus., Proc., vol. 77, art. 6, p. 56, pl. 14, figs. 1-5.
Pyrulina cylindroides (Roemer) Cushman and Ozawa. Cushman, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 97, pl. 40, figs. 18, 19. (synonymy).
Pyrulina cylindroides (Roemer). Frizzell, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 104, pl. 14, figs. 25-27.

Diagnosis: Test elongate, fusiform to subcylindrical, both ends acuminate, nearly circular in transverse section; chambers elongate, only partially embracing; juvenarium triloculine, adult chambers tending to appear biserial, progressively less embracing; sutures only slightly depressed; wall calcareous; surface smooth; aperture radiate.

Figured specimen: USNM 639515, length 0.538 mm, breadth 0.25 mm, collected 9 feet above the base. Compared with numerous plesiotypes in USNM: compares favorably.

Discussion: This species is widely distributed in the Taylor and Navarro of the Gulf Coast. It is rare in the Arkadelphia.

Genus Pseudopolymorphina Cushman and Ozawa, 1928

Pseudopolymorphina Cushman and Ozawa, 1928, Cushman Lab. Foram. Res., Contr., vol. 4, pt. 1, p. 15.

Type species: Pseudopolymorphina hanzawai Cushman and Ozawa, 1928. Original designation. *Gender:* feminine.

Pseudopolymorphina cuyleri Plummer

Pl. V, fig. 1

Pseudopolymorphina mendezensis (White). Cushman and Ozawa (*partim;* not *Polymorphina mendezensis* White), 1930, U. S. Natl. Mus., Proc., vol. 77, art. 6, p. 109, pl. 28, figs. 7-9.
Pseudopolymorphina cuyleri Plummer, 1931, Texas Bur. Econ. Geol., Univ. Texas, Bull. 3101, p. 173, pl. 9, figs. 18-21.
Pseudopolymorphina cuyleri Plummer. Cushman, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 98, pl. 41, figs. 2-10. (synonymy).
Pseudopolymorphina cuyleri Plummer. Frizzell, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 105, pl. 14, figs. 29-32.

Diagnosis: Test large, strongly compressed, tapering gradually from the rounded base to the maximum width at the base of the last-formed pair of chambers, periphery rounded, apertural end produced; chambers distinct, increasing gradually in breadth as added, height rather uniform throughout; sutures distinct, somewhat limbate, slightly depressed near the periphery in some adult specimens; wall calcareous, thickened, with additional thickening along the median axis of some specimens; surface generally smooth; aperture radiate, terminal.

Figured specimen: USNM 639516, length 1.85 mm, breadth 1.20 mm, collected 30 feet above the base. Compared with topotypes and plesiotypes in USNM: agrees.

Discussion: This species is reported only from the Arkadelphia marl of Arkansas, the Corsicana marl of Texas, and the Prairie Bluff chalk of Mississippi and Alabama. Thus, it is confined to Navarro strata.

Subfamily Webbinellinae Rhumbler, 1904

Genus Vitriwebbina Chapman, 1892

Vitriwebbina Chapman, 1892, Geol. Mag., new ser., decade 3, vol. 9, p. 52.

Type species: Vitriwebbina sollasi Chapman, 1892. Subsequent designation, Cushman, 1927. *Gender:* feminine.

Vitriwebbina biosculata Frizzell

Pl. V, fig. 4

Bullopora laevis (Sollas). Cushman and Todd (not *Webbina laevis* Sollas), 1943, Cushman Lab. Foram. Res., Contr., vol. 19, pt. 3, p. 63, pl. 11, fig. 8.
Bullopora laevis (Sollas) Wickenden. Cushman (*partim;* not *Webbina laevis* Sollas), 1946, U. S. Geol. Surv., Prof. Paper 206, p. 98, pl. 42, figs. 1-4. (synonymy, *partim*).
Vitriwebbina biosculata Frizzell, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, pp. 107, 158, pl. 15, fig. 7.

Diagnosis: Test large, composed of a free globuline juvenarium, followed by a series of encrusting chambers, commonly branching; adult test attached to shell fragments, echinoid re-

mains, other foraminifers, or rarely inorganic detritus; juvenarium tiny, pear-shaped, with two to six chambers, lying parallel to and completely surrounded by the collar-like first encrusting chamber but with the upper half rising above it; encrusting chambers numerous (5 to 10 or more), extremely variable in shape and size, outline typically subcircular to trigonal, ranging to elongate or irregular, commonly "U-shaped" or "Y-shaped", slowly increasing in size as added, separated by the posterior neck-like projection of each chamber; wall calcareous, perforate; surface smooth; aperture multiple, one to four tiny produced openings on each chamber (typically two), situated at base of chamber, extra apertures open or connecting with chambers of branches of test.

Figured specimen: USNM 639517, length 1.16 mm, approximate diameter 0.35 mm, collected 16 feet above the base. Compared with plesiotypes of "*Bullopora laevis* (Sollas)" in USNM (one is now the holotype of this species): agrees.

Discussion: Vitriwebbina biosculata Frizzell is distinguished by its smooth surface from *V. tuberculata* (Sollas); and, by its multiple aperture from *V. laevis* (Sollas) and *V. chapmani* Plummer. It is reported from the Austin, Taylor, and Navarro strata of the Gulf Coast province (Frizzell, 1954).

Subfamily Ramulininae Brady, 1884

Genus Ramulina R. Jones, 1875

Ramulina Rupert Jones, *in* J. Wright, 1875, Belfast Nat. Field Club, Proc., new ser., vol. 1, appendix 3, p. 88.

Type species: Ramulina laevis R. Jones, 1875. Monotypic. *Gender:* feminine.

Ramulina arkadelphina Cushman

Pl. V, fig. 2

Ramulina arkadelphiana Cushman, 1938, Cushman Lab. Foram. Res., Contr., vol. 14, pt. 2, p. 43, pl. 7, figs. 12-14.
Ramulina arkadelphiana Cushman. Cushman, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 99, pl. 43, figs. 3-8.
Ramulina arkadelphiana Cushman. Frizzell, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 105, pl. 14, figs. 40-43.

Diagnosis: Test free, consisting of irregularly elongate or fusiform chambers with somewhat tapering tubular projections extending in various directions; wall calcareous, thin; surface finely hispid; apertures simple, the open ends of the tubes.

Figured specimen: USNM 639518, length 0.65 mm, maximum diameter 0.175 mm, collected 8 feet below the top. Compared with the holotype and paratypes in USNM: agrees.

Discussion: This species is distinguished by its irregular form and the finely hispid surface. It is restricted to Navarro strata.

Ramulina globotubulosa Cushman

Pl. V, fig. 3

Ramulina sp. (?). Cushman, 1931, Tennessee Div. Geol., Bull. 41, p. 42, pl. 7, fig. 1.
Ramulina globo-tubulosa Cushman, 1938, Cushman Lab. Foram. Res., Contr., vol. 14, pt. 2, p. 44, pl. 7, fig. 16.
Ramulina globo-tubulosa Cushman. Cushman, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 100, pl. 43, fig. 10.
Ramulina globo-tubulosa Cushman. Frizzell, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 106, pl. 14, fig. 49.

Diagnosis: Test small, subspherical with fine tubular projections radiating from the inflated central chamber; wall calcareous; surface finely hispid; apertures simple, the open ends of the tubular projections.

Figured specimen: USNM 639519, length 0.55 mm, diameter of central chamber 0.225 mm, collected 8 feet below the top. Compared with the holotype in USNM: agrees perfectly.

Discussion: This is the first record of this species in the Arkadelphia. It is reported from the Austin, Taylor, and Navarro strata of the Gulf Coast.

Superfamily Buliminacea Jones, 1875

Family Turrilinidae Cushman, 1927

Subfamily Turrilininae Cushman, 1927

Genus Buliminella Cushman, 1911

Buliminella Cushman, 1911, U. S. Natl. Mus., Bull. 71, pt. 2, p. 88.

Type species: Bulimina elegantissima d'Orbigny, 1839. Original designation [cited as *Buliminella elegantissima* (d'Orbigny)]. *Gender:* feminine.

Buliminella cushmani Sandidge

Pl. V, fig. 21

Buliminella cushmani Sandidge, 1932, Jour. Paleontology, vol. 6, no. 3, p. 280, pl. 42, figs. 18, 19.
Buliminella cushmani Sandidge. Cushman, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 119, pl. 50, fig. 15. (synonymy).
Buliminella cushmani Sandidge. Cushman, 1949,

U. S. Geol., Surv., Prof. Paper 221-A, p. 8, pl. 4, fig. 2.
Buliminella cushmani Sandidge. FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 114, pl. 16, figs. 40a, b.

Diagnosis: Test small, compact, fusiform, spirally coiled, involute, circular in transverse section, base pointed, apertural end gradually tapering and rounded; chambers numerous, four in the last-formed volution, slightly inflated; sutures distinct, depressed; wall calcareous, thin, finely perforate; surface smooth; aperture loop-shaped, comma-like, extending from near the apex to the basal margin of the last-formed chamber. Length of holotype 0.4 mm.

Figured specimen: USNM 639520, length 0.225 mm, maximum diameter 0.15 mm, collected 8 feet below the top. Compared with plesiotypes in USNM: agrees.

Discussion: This form is smaller and more compact than *Buliminella carseyae* Plummer and the sutures curve more gracefully than in the latter. *B. cushmani* Sandidge is reported from the Austin, Taylor, and Navarro strata.

Family BOLIVINITIDAE Cushman, 1927

Subfamily BOLIVINITINAE Cushman, 1927

Genus BOLIVINITA Cushman, 1927

Bolivinita CUSHMAN, 1927, Cushman Lab. Foram. Res., Contr., vol. 2, pt. 4, p. 90.

Type species: Textularia quadrilatera Schwager, 1866. Original designation [cited as *Bolivinita quadrilatera* (Schwager)]. *Gender:* feminine.

BOLIVINITA COSTIFERA Cushman

Bolivinita costifera CUSHMAN, 1937, Cushman Lab. Foram. Res., Contr., vol. 13, pt. 4, p. 105, pl. 15, figs. 15a, b.
Bolivinita costifera Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 115, pl. 49, fig. 3.
Bolivinita costifera Cushman. CUSHMAN, 1949, U. S. Geol. Surv., Prof. Paper 221-A, p. 8.

Discussion: This species, reported (questionably) by Cushman (1949) from the Arkadelphia, was not identified from the samples studied by the writer. The holotype and numerous paratypes in the USNM were examined.

Subfamily BOLIVININAE Glaessner, 1937

Genus BOLIVINA d'Orbigny, 1839

Bolivina D'ORBIGNY, 1839, Voyage Amer. Merid., vol. 5, pt. 5, p. 61.

Type species: Bolivina plicata d'Orbigny, 1839. Subsequent designation, Cushman, 1911. *Gender:* feminine.

BOLIVINA INCRASSATA Reuss

Bolivina incrassata REUSS, 1851, Haidinger's Naturw. Abh., vol. 4, p. 29, pl. 4, fig. 13.
Bolivina incrassata Reuss var. *lata* EGGER, 1899, K. Bayer. Akad. Wiss., Math.-naturh., Abt., Abh., Kl. 2, vol. 21, pt. 1, p. 46, pl. 16, figs. 8, 9.
Bolivina primatumida WHITE, 1929, Jour. Paleontology, vol. 3, no. 1, p. 44, pl. 4, figs. 20a, b.
Bolivina incrassata Reuss. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 127, pl. 53, figs. 8-11. (synonymy).
Bolivina incrassata Reuss. CUSHMAN, 1949, U. S. Geol. Surv., Prof. Paper 221-A, p. 8, pl. 4, fig. 6.
"*Bolivina incrassata* Reuss". FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 117, pl. 17, fig. 25.

Discussion: This species, reported by Cushman (1949) from the Arkadelphia, was not identified from the samples studied by the writer.

BOLIVINA DECURRENS (Ehrenberg)

Grammostomum? decurrens EHRENBERG, 1854, Mikrogeologie, p. 22, pl. 30, fig. 17.
Bolivina decurrens (Ehrenberg). MARSSON, 1878, Naturw. Ver., Neu-Vorpommern u. Rügen, Greifswald, Mitt., Berlin, Jahrg. 10, p. 156, pl. 3, fig. 24.
Bolivina decurrens (Ehrenberg) Marsson. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 127, pl. 53, figs. 12, 13. (synonymy).
Bolivina decurrens (Ehrenberg) Marsson. CUSHMAN, 1949, U. S. Geol. Surv., Prof. Paper 221-A, p. 9, pl. 4, fig. 7.
Bolivina decurrens (Ehrenberg). FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 117, pl. 17, fig. 24.

Discussion: This species, reported by Cushman (1949) from the Arkadelphia, was not identified from the samples studied by the writer.

Genus LOXOSTOMUM Ehrenberg, 1854

Loxostomum EHRENBERG, 1854, Mikrogeologie, p. 22.

Type species: Loxostomum subrostratum Ehrenberg, 1854. Subsequent designation, Cushman, 1928. *Gender:* neuter.

LOXOSTOMUM CUSHMANI Wickenden

Pl. V, fig. 26

Loxostomum clavatum (Cushman). CUSHMAN (*partim;* not *Bolivina clavata* Cushman), 1932, Jour. Paleontology, vol. 6, no. 4, p. 340, pl. 51, figs. 8a, b.
Loxostomum cushmani WICKENDEN, 1932, Royal Soc. Canada, Trans., third ser., vol. 26, sec. 4, p. 91, pl. 1, figs. 6a, b.
Loxostoma cushmani Wickenden. CUSHMAN and DEADERICK, 1942, Cushman Lab. Foram. Res., Contr., vol. 18, pt. 3, p. 63, pl. 15, figs. 11-13.
Loxostoma cushmani Wickenden. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 129, pl. 53, figs. 24-31. (synonymy).
Loxostomum cushmani Wickenden. FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 118, pl. 17, figs. 32-34.

Diagnosis: Test elongate, narrow, slightly tapering, only slightly compressed, periphery rounded, juvenarium distinctly biserial, tending to become uniserial in the adult; chambers distinct, particularly in the later portion, adult chambers inflated, slightly overlapping; sutures distinct, early ones horizontal and not depressed, gradually becoming deeply depressed and oblique in the adult with distinct re-entrants or lobed sutural processes; wall calcareous; surface smooth or with faint longitudinal costae in juvenarium, adult smooth except for the crenulations at the base of the chambers; aperture of adult rounded, terminal.

Figured specimen: USNM 639521, length 0.90 mm, breadth 0.175 mm, collected 8 feet below the top. Compared with two paratypes in USNM: agrees, but immature. The paratypes have globular final chambers which the Arkadelphia specimen lacks.

Discussion: This form is extremely rare in the Arkadelphia. It occurs widely in the Austin, Taylor, and Navarro of the Gulf Coast province.

LOXOSTOMUM GEMMA (Cushman)

Pl. V, figs. 27, 28

Bolivina gemma CUSHMAN, 1927, Cushman Lab. Foram. Res., Contr., vol. 2, pt. 4, p. 87, pl. 12, figs. 3a, b. [The species-group name is a noun in apposition.]
Loxostoma gemmum (Cushman). CUSHMAN, 1937, Cushman Lab. Foram. Res., Spec. Pub. 9, p. 172, pl. 20, figs. 14-16.
Loxostoma gemmum (Cushman) Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 129, pl. 54, figs. 1-3.
Loxostomum gemma (Cushman). FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 118, pl. 17, figs. 35a, b.

Diagnosis: Test elongate, somewhat tapering, compressed, periphery rounded, biserial throughout, slightly twisted in the earlier portion; chambers distinct, numerous, increasing regularly in size and breadth as added, slightly inflated in the adult stage; sutures distinct, somewhat limbate, slightly depressed toward the periphery, axial margin raised, forming a "zigzag" row of beads of clear shell material, particularly in the earlier portion of the test; wall calcareous, thick, finely perforate; surface smooth except for the beaded ornamentation and fine striations near the base of some specimens; aperture elongate, elliptical, slightly curved, becoming terminal in the adult.

Figured specimens: USNM 639522 (fig. 27), length 0.76 mm, breadth 0.24 mm; USNM 639523 (fig. 28), collected 8 feet below the top. Compared with the holotype and paratypes in USNM: agree exactly.

Discussion: This species is restricted to Navarro strata. It is distinguished by the distinct beaded ornamentation.

LOXOSTOMUM PLAITUM (Carsey)

Pl. V, fig. 29

Bolivina plaita CARSEY, 1926, Texas Bur. Econ. Geol., Univ. Texas, Bull. 2612, p. 26, pl. 4, fig. 2.
Proroporus plaita (Carsey). CUSHMAN, 1927, Cushman Lab. Foram. Res., Contr., vol. 2, pt. 4, p. 89, pl. 12, figs. 7a, b.
Loxostomum plaitum (Carsey). CUSHMAN, 1928, Cushman Lab. Foram. Res., Spec. Pub. 1, p. 254, pl. 37, fig. 9.
Loxostoma plaitum (Carsey) Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 130, pl. 54, figs. 10-14. (synonymy).
Loxostomum plaitum (Carsey) var. *plaitum* (Carsey). FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 118, pl. 17, fig. 38.

Diagnosis: Test quite elongate, slender, slightly tapering, slightly twisted, compressed, periphery rounded, maximum breadth toward the apertural end; chambers numerous, distinct, increasing rapidly in height as added; juvenarium biserial, chambers slightly inflated; adult chambers strongly inflated, tending to become uniserial; sutures distinct, slightly depressed, commonly somewhat limbate, earlier sutures strongly oblique and slightly curved, later sutures strongly curved; wall calcareous, finely perforate; surface smooth; aperture tending to become terminal in the adult, narrowly ovate.

Figured specimen: USNM 639524, length 0.60 mm, breadth 0.14 mm, collected 8 feet below the top. Compared with identified specimens in USNM: compares favorably.

Discussion: This species is abundant and widely distributed in strata of Navarro age, but is less common in the Taylor and Austin.

Family EOUVIGERINIDAE Cushman, 1927

Genus PSEUDOUVIGERINA Cushman, 1927

Pseudouvigerina CUSHMAN, 1927, Cushman Lab. Foram. Res., Contr., vol. 2, pt. 4, p. 81.

Type species: Uvigerina cristata Marsson, 1878. Original designation. *Gender:* feminine.

PSEUDOUVIGERINA SELIGI (Cushman)

Pl. V, fig. 19

Uvigerina seligi CUSHMAN, 1925, Cushman Lab. Foram. Res., Contr., vol. 1, pt. 1, p. 1, pl. 4, figs. 1a-c.
Uvigerina tenuistriata Reuss. CARSEY (*not* Reuss), 1926, Texas Bur. Econ. Geol., Univ. Texas, Bull. 2612, p. 42, pl. 1, fig. 1.
Eouvigerina americana Cushman. ALBRITTON and PHLEGER (*not* Cushman), 1937, Jour. Paleontology, vol. 11, no. 4, p. 351.
Pseudouvigerina seligi (Cushman). CUSHMAN and TODD, 1943, Cushman Lab. Foram. Res., Contr., vol. 19, pt. 3, p. 65, pl. 11, figs. 19a, b.
Pseudouvigerina seligi (Cushman) Cushman and Todd. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 117, pl. 49, figs. 21-24. (synonymy).
Pseudouvigerina seligi (Cushman). FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 113, pl. 16, figs. 34, 35a, b.

Diagnosis: Test minute, elongate; chambers few, the final three comprising the major portion of the test, angled, the basal portion of each chamber sharply undercut forming an overhanging shoulder; sutures distinct, depressed; wall calcareous; surface of chambers roughened, with a few prominent longitudinal costae independent of adjacent chambers; aperture circular, elevated on a short, broad, cylindrical neck with a phialine lip.

Figured specimen: USNM 639525, length 0.30 mm, breadth 0.138 mm, collected 16 feet above the base. Compared with plesiotypes in USNM: agrees. The cotypes were obscured by a moldy coating and were inaccessible for comparison.

Discussion: This species is restricted to strata of Navarro age, but is widely distributed in the Gulf Coast localities. The types are from the Arkadelphia marl in the subsurface of Bossier Parish, Louisiana.

Genus SIPHOGENERINOIDES Cushman, 1927

Siphogenerinoides CUSHMAN, 1927, Cushman Lab. Foram. Res., Contr., vol. 3, pt. 1, p. 63.
Siphogenerinoides Cushman, emend. STONE, 1946, Jour. Paleontology, vol. 20, no. 5, pp. 465-469.

Type species: Siphogenerina plummeri Cushman, 1926. Original designation [cited as *Siphogenerinoides plummeri* Cushman]. *Gender:* masculine.

SIPHOGENERINOIDES PLUMMERI (Cushman)

Pl. V, fig. 20

Siphogenerina plummeri CUSHMAN, 1926, U. S. Natl. Mus., Proc., vol. 67, art. 25, p. 18.
Siphogenerinoides plummeri Cushman. CUSHMAN, 1927, Cushman Lab. Foram. Res., Contr., vol. 3, pt. 1, p. 63, pl. 13, fig. 16.
Siphogenerinoides plummeri (Cushman) Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 117, pl. 50, figs. 1a, b. (synonymy).
Siphogenerinoides plummeri (Cushman). STONE, 1946, Jour. Paleontology, vol. 20, no. 5, p. 469, pl. 71, figs. 2a, b, 3, 26.
Siphogenerinoides plummeri (Cushman). FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 113, pl. 16, figs. 36a, b.

Diagnosis: Test elongate, slightly tapering, broadest at the last-formed chamber, 4 to 5 times as long as broad; apertural end broadly rounded; base of megalospheric form bluntly rounded, slightly spinose in some specimens; base of microspheric form attenuate, biserial stage flattened and twisted in most specimens; microspheric juvenarium triserial, then biserial, later symmetrically uniserial; megalospheric proloculus followed by several biserial chambers, then symmetrically uniserial; wall calcareous, hyaline, conspicuously perforate; surface ornamented by 8 to 13 sharp longitudinal costae continuous over the sutures or broken into small downward-projecting spines at the base of the chambers, also ornamented by less distinct minor costae; sutures retroflexed along the major costae, depressed slightly in the earlier test and more clearly depressed in the adult; internal siphon reaching from the initial chambers to the last-formed, twisting about 90° per chamber as it passes through the test, the uppermost end forming a small separate opening outside of and tangent to the aperture on the concave side, the unattached upper edge of the siphon formed by the concave apertural lip which may be broken or incompletely fused, the other edge of the siphon continuous with the septal face of the last-formed chamber which is slightly upwarped near the edge of the siphon; aperture central, terminal, sharply arcuate, on a short neck with a flaring phialine lip, commonly broken along the concave side.

Figured specimen: USNM 639526, length 0.80 mm, diameter 0.20 mm, collected 8 feet below the top. Compared with the holotype in USNM: agrees.

Discussion: This species is restricted to strata of Navarro age. It is distinctive and serves as an excellent index fossil.

SIPHOGENERINOIDES BREVISPINOSA Cushman

Siphogenerinoides brevispinosa CUSHMAN, 1939,

Cushman Lab. Foram. Res., Contr., vol. 15, pt. 4, p. 92, pl. 16, figs. 7a, b.
Siphogenerinoides brevispinosa Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 119, pl. 50, fig. 12.
Siphogenerinoides brevispinosa Cushman. STONE, 1946, Jour. Paleontology, vol. 20, no. 5, p. 472, pl. 71, figs. 5-7, 27.
Siphogenerinoides brevispinosa Cushman. CUSHMAN, 1949, U. S. Geol. Surv., Prof. Paper 221-A, p. 8.

Discussion: This species reported (questionably) by Cushman (1946, 1949) from the Arkadelphia, was not identified from the samples studied by the writer. The holotype and paratypes in the USNM were examined.

Family BULIMINIDAE Jones, 1875

Subfamily BULIMININAE Jones, 1875

Genus BULIMINA d'Orbigny, 1826

Bulimina D'ORBIGNY, 1826, Ann. Sci. Nat., sér. 1, vol. 7, p. 269.

Type species: Bulimina marginata d'Orbigny, 1826. Subsequent designation, Cushman, 1911. *Gender:* feminine.

BULIMINA ASPERA Cushman and Parker

Pl. V, fig. 22

Bulimina pupoides d'Orbigny. CARSEY (*not* d'Orbigny), 1926, Texas Bur. Econ. Geol., Univ. Texas, Bull. 2612, p. 29, pl. 4, fig. 3.
Bulimina obtusa d'Orbigny. CUSHMAN and CHURCH (*not* d'Orbigny), 1929, California Acad. Sci., Proc., ser. 4, vol. 18, p. 513, pl. 39, figs. 17-19.
Bulimina subornata Brady. SANDIDGE (*not* Brady), 1932, Jour. Paleontology, vol. 6, no. 3, p. 280, pl. 43, fig. 2.
[?] *Bulimina elongata* d'Orbigny. SANDIDGE (*not* d'Orbigny), 1932, Jour. Paleontology, vol. 6, no. 3, p. 281, pl. 43, fig. 3.
Bulimina quadrata Plummer. CUSHMAN and PARKER (*partim; not* Plummer), 1935, Cushman Lab. Foram. Res., Contr., vol. 11, pt. 4, p. 100, pl. 15, figs. 12, 15, 16 (*not* 13, 14).
Bulimina kickapooensis COLE *(partim),* 1938, Florida Dept. Conserv., Geol. Bull. 16, p. 45.
Bulimina aspera CUSHMAN and PARKER, 1940, Cushman Lab. Foram. Res., Contr., vol. 16, pt. 2, p. 44, pl. 8, figs. 18, 19.
Bulimina aspera Cushman and Parker. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 121, pl. 51, figs. 7, 10, 13, 15, 16. (synonymy).
Bulimina aspera Cushman and Parker. FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 114, pl. 16, figs. 43-46.

Diagnosis: Test medium size, slightly tapering consisting of 4 to 5 volutions, base bluntly pointed, commonly bearing one or two short basal spines; chambers joined at an angle of 90 degrees or less, slightly inflated; sutures distinct, slightly depressed; wall calcareous; surface of initial part of test roughened, perforated, with the perforations commonly arranged in regular lines; aperture elongate, at apex of test, with a small plate-like tooth.

Figured specimen: USNM 639527, length 0.40 mm, diameter 0.20 mm, collected 8 feet below the top. Compared with the holotype and paratypes in USNM: agrees perfectly.

Discussion: This species is reported from numerous localities in the Taylor and Navarro of the Gulf Coast.

BULIMINA PROLIXA Cushman and Parker

Bulimina puschi Reuss. CUSHMAN (*not* Reuss), 1931, Tennessee Div. Geol., Bull. 41, p. 47, pl. 7, figs. 19a, b.
Bulimina prolixa CUSHMAN and PARKER, 1935, Cushman Lab. Foram. Res., Contr., vol. 11, pt. 4, p. 98, pl. 15, figs. 5a, b.
Bulimina prolixa Cushman and Parker. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 122, pl. 51, figs. 19-22. (synonymy).
Bulimina prolixa Cushman and Parker. CUSHMAN, 1949, U. S. Geol. Surv., Prof. Paper 221-A, p. 8, pl. 4, fig. 4.
Bulimina prolixa Cushman and Parker. FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 115, pl. 17, figs. 4, 5.

Discussion: This species, reported by Cushman (1949) from the Arkadelphia, was not identified from the samples studied by the writer. The holotype and paratypes in the USNM were examined.

BULIMINA ARKADELPHIANA Cushman and Parker

Pl. V, figs. 23, 24

Bulimina arkadelphiana CUSHMAN and PARKER, 1935, Cushman Lab. Foram. Res., Contr., vol. 11, pt. 4, p. 96, pl. 15, figs. 1, 2.
Bulimina arkadelphiana Cushman and Parker. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 124, pl. 52, figs. 3, 4.

Diagnosis: Test small to medium size, tapering, the megalospheric form consisting of about 5 volutions and considerably smaller than the microspheric form with about 8 volutions; chambers numerous, adult ones inflated; sutures distinct, deeply depressed; wall calcareous, finely perforate; surface of lower portion of chambers covered with sharp spines, especially prominent at the lower margins; aperture elongate with a small lip.

Figured specimens: USNM 639528 (fig. 23), length 0.50 mm, maximum diameter 0.25 mm; USNM 639529 (fig. 24), collected 16 feet above the base. Compared with the

holotype and paratypes in USNM: agree perfectly.

Discussion: This form is restricted to the Arkadelphia marl. It is easily recognized by its striking ornamentation.

Superfamily ASTERIGERINACEA d'Orbigny, 1839

Family DISCORBIDAE Cushman, 1927

Subfamily DISCORBINAE Cushman, 1927

Genus GYROIDINA d'Orbigny, 1826

Gyroïdina D'ORBIGNY, 1826, Ann, Sci. Nat., sér. 1, vol. 7, p. 278.

Type species: Gyroidina orbicularis d'Orbigny, 1826. Subsequent designation, Cushman, 1927 [cited as *Gyroidina orbiculus* d'Orbigny]. *Gender:* feminine.

GYROIDINA DEPRESSA (Alth)

Pl. VI, figs. 1, 2, 3, 4

Rotalina depressa ALTH, 1850, Haidinger's naturw. Abh., vol. 3, p. 266, pl. 13, fig. 21.
Rotalia cretacea CARSEY, 1926, Texas Bur. Econ. Geol., Univ. Texas, Bull. 2612, p. 48, pl. 5, figs. 1a, b.
Rotalia beccarii Linnaeus, var. *ripleyensis* W. BERRY, *in* BERRY and KELLEY, 1929, U. S. Natl. Mus., Proc., vol. 76, art. 19, p. 15, pl. 3, figs. 10-12.
Gyroidina depressa (Alth). CUSHMAN and CHURCH, 1929, California Acad. Sci., Proc., ser. 4, vol. 18, p. 515, pl. 41, figs. 4-6.
Valvulineria cretacea (Carsey). CUSHMAN and TODD, 1943, Cushman Lab. Foram. Res., Contr., vol.19, pt. 3, p. 67, pl. 12, figs. 1a-c.
Valvulineria cretacea (Carsey) Cushman and Todd. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 138, pl. 57, figs. 8a-c.
Gyroidina depressa (Alth) Cushman and Church. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 139, pl. 58, figs. 1-4. (synonymy).
Valvulineria cretacea (Carsey) Cushman and Todd. CUSHMAN, 1949, U. S. Geol. Surv., Prof. Paper 221-A, p. 9.
Gyroidina depressa (Alth) Cushman and Church. CUSHMAN, 1949, U. S. Geol. Surv., Prof. Paper 221-A, p. 9, pl. 4, figs. 12, 13.
Gyroidina depressa (Alth). FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 123, pl. 18, figs. 36a-c.

Diagnosis: Test trochoid, biconvex, compressed, the dorsal side somewhat flattened, periphery rounded; chambers distinct, numerous, 10 to 12 in the last-formed volution; sutures distinct, gently curved, slightly limbate and nearly flush on the dorsal surface, radial and slightly depressed on the ventral surface; wall calcareous; surface smooth; aperture low, eccentric on the ventral side near the umbilicus.

Figured specimens: USNM 639530 (fig. 1, 2), maximum diameter 0.30 mm; USNM 639531 (fig. 3); USNM 639532 (fig. 4), collected 8 feet below the top. Compared with identified specimens in USNM: compares favorably.

Discussion: This species is common in the Austin, Taylor, and Navarro strata of Texas, Arkansas, Mississippi, Alabama, and Tennessee.

GYROIDINA ARKADELPHIANA Cushman

pl. VI, figs. 5, 6

Gyroidina arkadelphiana CUSHMAN, 1938, Cushman Lab. Foram. Res., Contr., vol. 14, pt. 2, p. 49, pl. 8, figs. 7a-c.
Gyroidina arkadelphiana Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 141, pl. 58, figs. 10a-c.

Diagnosis: Test planoconvex, dorsal surface flattened or slightly concave, ventral surface strongly convex with a large, deep umbilicus, periphery rounded, somewhat angled and raised at the edge of the dorsal surface; chambers numerous, about 10 in the adult volution, increasing rapidly in size and width on the ventral side; sutures distinct, radial, slightly depressed; wall calcareous; surface smooth except for raised ridges on the dorsal surface representing the angled margins of the preceding chambers; aperture elongate, at the inner margin of the last-formed chamber on the ventral side.

Figured specimen: USNM 639533, height 0.30 mm, maximum diameter 0.45 mm, collected 16 feet above the base. Compared with the holotype and paratype in USNM: agrees perfectly.

Discussion: This species is known only from the Arkadelphia marl, Hempstead County, Arkansas.

Genus STENSIOINA Brotzen, 1936

Stensiöina BROTZEN, 1936, Sveriges Geol. Undersökning, Afh., ser. C, no. 396, vol. 30, pt. 3, p. 315.

Type species: Rotalia exsculpta Reuss, 1860. Original designation [cited as *Stensiöina exsculpta* (Reuss)]. *Gender:* feminine.

STENSIOINA AMERICANA Cushman and Dorsey

Pl. VI, figs. 7, 8

Cibicides excolata (Cushman). CUSHMAN (not *Truncatulina excolata* Cushman, 1926), 1931, Jour. Paleontology, vol. 5, no. 4, p. 315, pl. 36, figs. 8a-c.

Stensiöina americana (Cushman). Cole (*not* Cushman), 1938, Florida Dept. Conserv., Geol. Bull. 16, p. 35, pl. 3, figs. 2, 3.
Stensiöina americana Cushman and Dorsey, 1940, Cushman Lab. Foram. Res., Contr., vol. 16, pt. 1, p. 5, pl. 1, figs. 7a-c.
Stensiöina americana Cushman and Dorsey. Cushman, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 141, pl. 65, figs. 14a-c. (synonymy).
Stensiöina americana Cushman and Dorsey. Frizzell, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 124, pl. 19, figs. 5a-c.

Diagnosis: Test small, trochoid, dorsal side flattened and slightly concave in central portion, peripheral margin acutely keeled, ventral side broadly convex, forming an angle of less than 90° with the dorsal side, umbonate, umbilical area flat to depressed; chambers distinct, uniform, increasing regularly in size as added, about 8 in the last-formed volution; sutures on the dorsal side distinct, raised, marked by irregular, broken, gently curved costae, spiral suture indistinct, irregular, and broken, sutures on the ventral side slightly depressed, gently curved, marked by narrow bands of clear shell material; wall calcareous, coarsely perforate; ventral surface smooth, dorsal surface roughened; aperture eccentric, an elongate, low, arched slit midway between the umbo and the keeled periphery.

Figured specimen: USNM 639534, diameter 0.275 mm, collected 8 feet below the top. Compared with the holotype and paratypes in USNM: agrees perfectly.

Discussion: This species is distinguished from *S. excolata* (Cushman) by its smaller size and concave dorsal surface. It is reported from the Taylor and Navarro of Texas, Arkansas, and Alabama. This is the first record from the Arkadelphia marl.

Family Siphoninidae Cushman, 1927

Genus Siphonina Reuss, 1850

Siphonina Reuss, 1850, Akad. Wiss. Wien, Math.-naturw. Kl., Denkschr., vol. 1, p. 372.

Type species: Siphonina fimbriata Reuss, 1850. Monotypic. *Gender:* feminine.

Siphonina prima Plummer

Pl. VI, figs. 9, 10

Siphonina prima Plummer, 1927, Texas Bur. Econ. Geol., Univ. Texas, Bull. 2644, p. 148, pl. 12, figs. 4a-c.
Siphonina prima Plummer. Cushman, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 143, pl. 59, figs. 3-5. (synonymy).
Siphonina prima Plummer. Frizzell, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 125, pl. 19, figs. 8a-c.

Diagnosis: Test minute, subcircular, biconvex, strongly convex, periphery sharply acute and delicately serrate, slightly lobate; typically 5 chambers in the last-formed volution, slightly inflated on the ventral side; sutures curved, not depressed, marked by the serrate edges of the chambers on the dorsal side, nearly radial on the ventral side, slightly curved, somewhat depressed; wall calcareous, distinctly and coarsely perforate; surface smooth; aperture small, narrowly elliptical, parallel to and just ventral to the periphery, without a distinct neck.

Figured specimen: USNM 639535, maximum diameter 0.21 mm, collected 8 feet below the top. Compared with identified specimens and plesiotypes in USNM: agrees.

Discussion: This species is reported from the Midway (Paleocene) of Texas and from the Navarro of Texas, Arkansas, Mississippi, Alabama, and Tennessee.

Superfamily Globigerinacea Carpenter, Parker and Jones, 1862

Family Heterohelicidae Cushman, 1927

Subfamily Guembelitriinae Montanaro Gallitelli, 1957

Genus Guembelitria Cushman, 1933

Gümbelitria Cushman, 1933, Cushman Lab. Foram. Res., Contr., vol. 9, pt. 2, p. 37.

Type species: Gümbelitria cretacea Cushman, 1933. Original designation. *Gender:* feminine.

Guembelitria cretacea Cushman

Pl. V, fig. 13

Gümbelitria cretacea Cushman, 1933, Cushman Lab. Foram. Res., Contr., vol. 9, pt. 2, p. 37, pl. 4, figs. 12a, b.
Gümbelitria cretacea Cushman. Cushman, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 103, pl. 44, figs. 14a, b. (synonymy).
Gümbelitria cretacea Cushman. Frizzell, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 110, pl. 15, figs. 45a, b.

Diagnosis: Test quite small, triserial; chambers globular, nearly spherical; sutures strongly depressed; wall calcareous, finely perforate; surface smooth; aperture large, semicircular, at the inner margin of the last-formed chamber.

Figured specimen: USNM 639536, length 0.19 mm, breadth 0.125 mm, collected 8 feet below the top. Compared with several plesiotypes in USNM: compares favorably.

Discussion: This is the first record for the form from the Arkadelphia. It is restricted to the Navarro strata of Texas, Arkansas, Mississippi, and Alabama.

Subfamily HETEROHELICINAE Cushman, 1927

Genus HETEROHELIX Ehrenberg, 1843

Heterohelix EHRENBERG, 1843, K. Akad. Wiss. Berlin, Physik. Abh., (Jahrg. 1841), p. 429.
Heterohelix Ehrenberg, emend. LOEBLICH, 1951, Cushman Foundation Foram. Res., Contr., vol. 2, pt. 3, p. 107.

Type species: Spiroplecta americana Ehrenberg, 1844 = *Heterohelix* sp. Ehrenberg, 1843. First and only species assigned to the genus by Ehrenberg (Loeblich, 1951). *Gender:* feminine.

HETEROHELIX PLUMMERAE (Loetterle)

Pl. V, fig. 9

Gümbelina plummerae LOETTERLE, 1937, Nebraska Geol. Surv., ser. 2, Bull. 12, p. 33, pl. 5, figs. 1, 2. [not *Ventilabrella plummerae* Sandidge, 1932 = *Guembelina carseyae* (Plummer).]
Gümbelina plummerae Loetterle. CUSHMAN *(partim)*, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 104, pl. 45, figs. 1-3. (synonymy, *partim*).
Gümbelina plummerae Loetterle. FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 109, pl. 15, figs. 36a, b.

Diagnosis: Test comparatively large, stout, juvenarium rapidly tapering, adult test gradually tapering or even contracted, thickness commonly greater than breadth, early periphery slightly keeled, later deeply indented; adult chambers strongly inflated, some specimens with one or more irregularly placed terminal chambers resembling *Planoglobulina* Cushman; sutures depressed, somewhat curved in the adult portion; wall calcareous; surface distinctly costate, less markedly in the later chambers; aperture a low, broad arch with a slight lip.

Figured specimen: USNM 639537, length 0.45 mm, breadth 0.31 mm, collected 8 feet below the top. Compared with plesiotypes in USNM: the plesiotypes are more strongly inflated and tapered.

Discussion: This species is reported from numerous localities in the Austin, Taylor, and Navarro of the Gulf Coast.

HETEROHELIX STRIATA (Ehrenberg)

Pl. V, fig. 10

Textularia striata EHRENBERG, 1840, K. Akad. Wiss. Berlin, Physik. Abh., (Jahrg. 1838), p. 135, pl. 4, figs. 1α, 1α', 2α, 3α, 9α.
Gümbelina striata (Ehrenberg). EGGER *(partim)*, 1899, K. Bayer. Akad. Wiss., Math.-naturh., Abt., Abh., Kl. 2, vol. 21, pt. 1, p. 33, pl. 14, figs. 37-39 (*not* figs. 5-7, 10, 11).
Gümbelina striata (Ehrenberg) Egger. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 104, pl. 45, figs. 4, 5. (synonymy).
Gümbelina striata (Ehrenberg) Egger. CUSHMAN, 1949, U. S. Geol. Surv., Prof. Paper 221-A, p. 7, pl. 3, fig. 24.
Gümbelina striata (Ehrenberg). FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 110, pl. 15, figs. 39, 40.

Diagnosis: Test elongate, tapering, greatest breadth near apertural end, periphery lobate; chambers distinctly inflated, subspherical; sutures distinct, strongly depressed; wall calcareous; surface ornamented with distinct and fine longitudinal costae, becoming less distinct in later chambers which bear fine pits in longitudinal alignment, final chambers smooth; aperture large, open, at the inner margin of the apertural face.

Figured specimen: USNM 639538, length 0.425 mm, breadth 0.26 mm, collected 8 feet below the top. Compared with plesiotypes in USNM: agrees favorably.

Discussion: This species is widely distributed in the Austin, Taylor, and Navarro strata of the Gulf Coast.

HETEROHELIX GLOBULOSA (Ehrenberg)

Pl. V, fig. 11

Textularia globulosa EHRENBERG, 1840, K. Akad. Wiss. Berlin, Physik. Abh., (Jahrg. 1838), p. 135, pl. 4, figs. 2β, 4β, 5β, 7β, 8β.
Textilaria globifera REUSS *(partim)*, 1860, Akad. Wiss. Wien, Math.-naturw. Kl., Sitzb., vol. 40, p. 232, pl. 13, figs. 7, 8. (*not* synonymy).
Gümbelina globulosa (Ehrenberg). EGGER, 1899, K. Bayer. Akad. Wiss., Math.-naturw., Abt., Abh., Kl. 2, vol. 21, pt. 1, p. 32, pl. 14, fig. 43.
Gümbelina globifera (Reuss). EGGER, 1899, K. Bayer. Akad. Wiss., Math.-naturw., Abt., Abh., Kl. 2, vol. 21, pt. 1, p. 33, pl. 14, figs. 35, 36, 53-55.
Gümbelina pupa (Reuss). WHITE (not *Textilaria pupa* Reuss), 1929, Jour. Paleontology, p. 38, pl. 4, figs. 11a, b.
Gümbelina globulosa (Ehrenberg) Egger. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 105, pl. 45, figs. 9-15. (synonymy).
Gümbelina globulosa (Ehrenberg). FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 109, pl. 15, figs. 24-27.
Heterohelix globulosa (Ehrenberg). MONTANARO GALLITELLI, 1957, U. S. Natl. Mus., Bull. 215, p. 137, pl. 31, figs. 12-15.

Diagnosis: Test tapering, greatest breadth near the apertural end, base subacute, periphery distinctly lobate; chambers inflated, nearly spherical, increasing rapidly and regularly in size as added; sutures distinct, depressed; wall calcareous, finely perforate; surface smooth; aperture broad, low, with a slightly thickened rim above.

Figured specimen: USNM 639539, length 0.30 mm, breadth 0.225 mm, collected 8 feet

below the top. Compared with plesiotypes in USNM: agrees favorably.

Discussion: This species is common in the Gulf Coast Taylor and Navarro strata. It is distinguished by its small size and regular form.

Genus Pseudoguembelina Bronnimann and Brown, 1953

Pseudoguembelina Bronnimann and Brown, 1953, Cushman Foundation Foram. Res., Contr., vol. 4, pt. 4, p. 150.

Type species: Gümbelina excolata Cushman, 1926. Original designation. *Gender:* feminine.

Pseudoguembelina costulata (Cushman)

Pl. V, fig. 12

Gümbelina costulata Cushman, 1938, Cushman Lab. Foram. Res., Contr., vol. 14, pt. 1, p. 16, pl. 3, figs. 7-9.
Gümbelina costulata Cushman. Cushman, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 108, pl. 46, figs. 10-12. (synonymy).
Gümbelina costulata Cushman. Cushman, 1949, U. S. Geol. Surv., Prof. Paper 221-A, p. 7, pl. 3, fig. 25.
Gümbelina costulata Cushman. Frizzell, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 108, pl. 15, figs. 17-19.
Pseudoguembelina costulata (Cushman). Montanaro Gallitelli, 1957, U. S. Natl. Mus., Bull. 215, p. 139, pl. 31, figs. 21, 22.

Diagnosis: Test biserial, tapering, compressed, greatest breadth near the apertural end, base acute or pointed, earlier periphery slightly keeled, later slightly indented; chambers slightly inflated, reniform, generally broader than high, final chambers higher peripherally and laterally compressed near the aperture; earlier sutures slightly limbate, later depressed and slightly curved; wall calcareous; surface ornamented with fine, longitudinal costae, becoming curved and subparallel to the periphery in the adult; aperture arched, sinuous, extending downward into tubuliform lateral lobes in each mature chamber producing accessory apertures which may be covered by tiny flaps.

Figured specimen: USNM 639540, length 0.40 mm, breadth 0.26 mm, collected 8 feet below the top. Compared with the holotype and paratypes in USNM: agrees, but larger than the holotype.

Discussion: This species is reported from the Taylor and Navarro of Texas, Arkansas, Mississippi, Alabama, and Tennessee.

Genus Tubitextularia Sulc, 1929

Tubitextularia Sulc, 1929, Vestnìk. Stàt. Geol. Československ. Rep., vol. 5, p. 148.

Type species: Pseudotextularia bohemica Sulc, 1929. *Gender*: feminine.

Discussion: Rectogümbelina Cushman, 1932, is a junior synonym of *Tubitextularia* Sulc (Glaessner, 1936; Montanaro Gallitelli, 1957).

Tubitextularia cretacea (Cushman)

Rectogümbelina cretacea Cushman, 1932, Cushman Lab. Foram. Res., Contr., vol. 8, pt. 1, p. 6, pl. 1, figs. 11, 12.
Rectogümbelina cretacea Cushman. Cushman, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 110, pl. 47, figs. 2, 3. (synonymy).
Tubitextularia cretacea (Cushman). Montanaro Gallitelli, 1957, U. S. Natl. Mus., Bull. 215, p. 143.

Discussion: This species, described from the Arkadelphia (questionably) by Cushman (1932, 1946), was not identified from the samples studied by the writer. The holotype and paratypes in the USNM were examined.

Genus Pseudotextularia Rzehak, 1891

Pseudotextularia Rzehak *(partim),* 1891, Naturh. Hofmuseums, Wien, Ann., vol. 6, no. 1, p. 2.

Type species: Cuneolina elegans Rzehak, 1891. Subsequent monotypy, Rzehak, 1891. *Gender:* feminine.

Pseudotextularia elegans (Rzehak)

Pl. V, fig. 17

Cuneolina elegans Rzehak *(partim),* 1891, Naturh. Hofmuseums, Wien, Ann., vol. 6, no. 1, p. 2.
Pseudotextularia varians Rzehak *(partim),* 1895, Naturh. Hofmuseums, Wien, Ann., vol. 10, pt. 2, p. 217, pl. 7, fig. 1 (*not* figs. 2, 3).
not *Gümbelina fructicosa* Egger, 1900, K. Bayer. Akad. Wiss., Math-naturh., Abt., Abh., Kl. 2, vol. 21, p. 35, pl. 14, figs. 8, 9.
Textularia taylorensis Dumble and Applin, 1924, Pan-American Geol., vol. 41, p. 342 [*nomen nudum*].
Pseudotextularia elegans Rzehak var. *varians* Rzehak. Glaessner *(partim),* 1936, Prob. Paleontology, Univ. Moscow Paleont. Lab., vol. 1, p. 101.
not *Pseudotextularia varians* Rzehak. Cushman, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 110, pl. 47, figs. 4-7.
not *Pseudotextularia varians* Rzehak. Cushman, 1949, U. S. Geol. Surv., Prof. Paper 221-A, p. 8, pl. 3, fig. 26.
not *Pseudotextularia elegans* (Rzehak). Frizzell, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 111, pl. 16, figs. 5-7.

Pseudotextularia elegans (Rzehak). MONTANARO GALLITELLI, 1957, U. S. Natl. Mus., Bull. 215, p. 138, pl. 33, figs. 6a-c.

Diagnosis: Test free, biserial, cuneiform; chambers increase rapidly in size as added, later chambers increase rapidly in thickness and become compressed laterally so that the original ratio of breadth to thickness is inverted, reaching an extreme of 1:4; sutures distinct; wall calcareous; surface ornamented by longitudinal costae; aperture an elongate slit at the base of the apertural face of the last-formed chamber.

Figured specimen: USNM 539541, length 0.44 mm, breadth 0.25 mm, thickness 0.30 mm, collected 8 feet below the top of the Arkadelphia.

Discussion: Pseudotextularia Rzehak properly includes only forms which are exclusively biserial. Many specimens with proliferation of chambers in the adult stage have been referred to this genus and to the species *Pseudotextularia elegans* (Rzehak), but should be placed in *Racemiguembelina* Montanaro Gallitelli, 1957. This is the first record of the exclusively biserial form from the Arkadelphia marl.

Genus RACEMIGUEMBELINA Montanaro Gallitelli, 1957

Racemiguembelina MONTANARO GALLITELLI, 1957, U. S. Natl. Mus., Bull. 215, p. 142.

Type species: Gümbelina fructicosa Egger, 1900. Original designation. *Gender:* feminine.

RACEMIGUEMBELINA FRUCTICOSA (Egger)

Pl. V, fig. 14

Cuneolina elegans RZEHAK *(partim),* 1891, Naturh. Hofmuseums, Wien, Ann., vol. 6, no. 1, p. 2.

Pseudotextularia varians RZEHAK *(partim),* 1895, Naturh. Hofmuseums, Wien, Ann., vol. 10, pt. 2, p. 217, pl. 7, figs. 2, 3 (*not* fig. 1).

Gümbelina fructicosa EGGER, 1900, K. Bayer. Akad. Wiss., Math.-naturh., Abt., Abh., Kl. 2, vol. 21, p. 35, pl. 14, figs. 8, 9.

Pseudotextularia elegans Rzehak var. *varians* Rzehak. GLAESSNER *(partim),* 1936, Prob. Paleontology, Univ. Moscow Paleont. Lab., vol. 1, p. 101.

Pseudotextularia varians Rzehak. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 110, pl. 47, figs. 4-7. (synonymy).

Planoglobulina acervulinoides (Egger) Cushman. CUSHMAN *(partim),* 1946, U. S. Geol. Surv., Prof. Paper 206, p. 111, pl. 47, figs. 15a, b (*not* 12-14).

Pseudotextularia varians Rzehak. CUSHMAN, 1949, U. S. Geol. Surv., Prof. Paper 221-A, p. 8, pl. 3, fig. 26.

Pseudotextularia elegans (Rzehak). FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 111, pl. 16, figs. 5-7.

Racemiguembelina fructicosa (Egger). MONTANARO GALLITELLI, 1957, U. S. Natl. Mus., Bull. 215, p. 142, pl. 32, figs. 14, 15.

Diagnosis: Test free, biserial, somewhat compressed, increasing regularly and equally in thickness and breadth, finally proliferated with additional globular chambers, the last of which form a crown at the top of the test; sutures distinct, depressed; wall calcareous; surface longitudinally costate; aperture a series of arcuate, basal openings.

Figured specimen: USNM 639542, length 0.57 mm, breadth 0.35 mm, collected 10 feet below the top. Numerous plesiotypes of "*Pseudotextularia varians* Rzehak" in the USNM are conspecific.

Discussion: Cushman reported (1949) "*Pseudotextularia varians* Rzehak" from the Arkadelphia and illustrated a specimen with proliferation of the final chambers. Cushman's specimen must be placed in *Racemiguembelina* Montanaro Gallitelli, 1957.

Genus PLANOGLOBULINA Cushman, 1927

Planoglobulina CUSHMAN, 1927, Cushman Lab. Foram. Res., Contr., vol. 2, pt. 4, p. 77.

Type species: Gümbelina acervulinoides Egger, 1900. Original designation. *Gender:* feminine.

PLANOGLOBULINA ACERVULINOIDES (Egger)

Gümbelina acervulinoides EGGER, 1900, K. Bayer. Akad. Wiss., Math.-naturh., Abt., Abh., Kl. 2, vol. 21, p. 36, pl. 14, figs. 17, 18, 20-22.

Pseudotextularia acervulinoides Cushman. CUSHMAN, 1926, Wash. Acad. Sci., Jour., vol. 15, p. 134.

Planoglobulina acervulinoides (Egger) Cushman. CUSHMAN, 1927, Cushman Lab. Foram. Res., Contr., vol. 3, pt. 1, pl. 13, fig. 5.

Planoglobulina acervulinoides (Egger) Cushman. CUSHMAN *(partim),* 1946, U. S. Geol. Surv., Prof. Paper 206, p. 111, pl. 47, figs. 12-14 (*not* fig. 15). (synonymy, *partim*).

[*?*]*Planoglobulina acervulinoides* (Egger) Cushman. CUSHMAN, 1949, U. S. Geol. Surv., Prof. Paper 221-A, p. 8, pl. 3, fig. 27.

Planoglobulina acervulinoides (Egger). MONTANARO GALLITELLI, 1957, U. S. Natl. Mus., Bull. 215, p. 141.

Discussion: This species, reported by Cushman (1949) from the Arkadelphia, was not recovered from the samples studied by the writer. Forms included in this species by Cushman are now placed in *Racemi-*

guembelina fructicosa (Egger). Thus, it is doubtful if *Planoglobulina acervulinoides* (Egger) has been found in the Arkadelphia.

PLANOGLOBULINA CARSEYAE (Plummer)

Pl. V, fig. 18

Textularia globulosa Ehrenberg. CARSEY (*not* Ehrenberg), 1926, Texas Bur. Econ. Geol., Univ. Texas, Bull. 2612, p. 25, pl. 5, figs. 2a, b.
Pseudotextularia a, d PLUMMER, 1927, Texas Bur. Econ. Geol., Univ. Texas, Bull. 2644, p. 172, pl. 2, figs. 1, 4.
Ventilabrella carseyae PLUMMER, 1931, Texas Bur. Econ. Geol., Univ. Texas, Bull. 3101, p. 178, pl. 9, figs. 7-10.
Ventilabrella plummerae SANDIDGE, 1932, Amer. Midland Nat., vol. 13, p. 195, pl. 19, figs. 5, 6.
Ventilabrella carseyae Plummer. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 112, pl. 48, figs. 1-5. (synonymy).
not *Ventilabrella carseyae* Plummer. CUSHMAN, 1949, U. S. Geol. Surv., Prof. Paper 221-A, p. 8, pl. 3, fig. 28.
Gümbelina carseyae (Plummer). FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 108, pl. 15, figs. 14-16.
Planoglobulina carseyae (Plummer). MONTANARO GALLITELLI, 1957, U. S. Natl. Mus., Bull. 215, p. 269, pl. 32, fig. 13.

Diagnosis: Test tapering, biserial, not compressed; chambers inflated, rapidly increasing in size as added; some specimens with three or more chambers in horizontal series in adult stage; sutures distinct, strongly depressed; wall calcareous, thin; surface longitudinally costate; aperture large, low, broad, at the inner margin of the apertural face, with a slight lip, and with a supplementary opening at the outer basal margin in the penultimate chamber.

Figured specimen: USNM 639543, length 0.375 mm, breadth 0.275 mm, collected 8 feet below the top. Compared with numerous identified specimens in USNM: compares favorably, but immature.

Discussion: This species is reported only from the Navarro strata and equivalents. The immature biserial stage differs clearly from *Pseudotextularia elegans* (Rzehak) which is laterally compressed.

PLANOGLOBULINA GLABRATA (Cushman)

Pl. V, fig. 15

Ventilabrella eggeri Cushman var. *glabrata* CUSHMAN, 1938, Cushman Lab. Foram. Res., Contr., vol. 14, pt. 1, p. 26, pl. 4, figs. 15-17.
Ventilabrella eggeri Cushman var. *glabrata* Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 111, pl. 47, figs. 20-22.
Ventilabrella eggeri Cushman var *glabrata* Cushman. FRIZZELL 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 111, pl. 16, figs. 11, 12.
Planoglobulina glabrata (Cushman). MONTANARO GALLITELLI, 1957, U. S. Natl. Mus., Bull. 215, p. 141, pl. 32, figs. 10-12.

Diagnosis: Test free, strongly compressed, flabelliform; juvenarium resembles *Heterohelix globulosa* (Ehrenberg), adult chambers proliferated in the plane of biseriality; chambers numerous, globular; sutures distinct, depressed; wall calcareous, finely perforate; surface finely costate; aperture multiple, basal, in the final series of chambers.

Figured specimen: USNM 539544, length 0.44 mm, breadth 0.50 mm, collected 21 feet above the base of the Arkadelphia marl.

Discussion: The juvenarium of the form has been shown (Montanaro Gallitelli, 1957) to indicate the derivation of the genus from a *globulosa*-like *Heterohelix*. *Planoglobulina glabrata* (Cushman) is rare in the Arkadelphia. It is reported from the Austin, Taylor, and Navarro of the Gulf Coast.

PLANOGLOBULINA AUSTINANA (Cushman)

Pl. V, fig. 16

Ventilabrella eggeri Cushman. CARMAN (*not* Cushman), 1929, Jour. Paleontology, vol. 3, no. 3, p. 314, pl. 34, fig. 7.
Ventilabrella austinana CUSHMAN, 1938, Cushman Lab. Foram. Res., Contr., vol. 14, pt. 1, p. 26, pl. 4, figs. 19a, b.
Ventilabrella austinana Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 111, pl. 47, fig. 16. (synonymy).
Ventilabrella austiniana Cushman. FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 111, pl. 16, figs. 9a, b.

Diagnosis: Test free, strongly compressed, tapering; juvenarium biserial, chambers numerous; adult chambers globular, typically consisting of only two rows of chambers proliferated in the plane of biseriality; sutures distinct, depressed; wall calcareous, finely perforate; surface smooth; aperture multiple, basal.

Figured specimen: USNM 639545, length 0.50 mm, breadth 0.41 mm, collected 8 feet below the top. Compared with the holotype and paratypes in USNM: agrees.

Discussion: This species is distinguished by the evenly tapered test and smooth surface from *P. glabrata* (Cushman) which is flared laterally. This is the first record from the Navarro. It has been reported from the Eagle Ford, Austin, and Taylor of Texas and the lower Selma chalk (Austin) of Mississippi.

Family GLOBOTRUNCANIDAE Brotzen, 1942

Genus GLOBOTRUNCANA Cushman, 1927

Globotruncana CUSHMAN, 1927, Cushman Lab. Foram. Res., Contr., vol. 3, pt. 1, p. 91.

Type species: Pulvinulina arca Cushman, 1926. Original designation and monotypy. *Gender:* feminine.

GLOBOTRUNCANA ARCA (Cushman)

?Pulvinulina rosetta DUMBLE and APPLIN, 1924, Pan-American Geol., vol. 41, p. 342 [*nomen nudum*].
Pulvinulina arca CUSHMAN, 1926, Cushman Lab. Foram. Res., Contr., vol. 2, pt. 1, p. 23, pl. 3, figs. 1a-c.
Globigerina rosetta CARSEY, 1926, Texas Bur. Econ. Geol., Univ. Texas, Bull. 2612, p. 44, pl. 5, figs. 3a-c.
Globotruncana arca (Cushman). CUSHMAN, 1927, Cushman Lab. Foram. Res., Contr., vol. 3, pt. 1, p. 91, pl. 19, figs. 11a-c.
Globotruncana arca (Cushman). PLUMMER *(partim),* 1931, Texas Bur. Econ. Geol., Univ. Texas, Bull. 3101, p. 195, pl. 13, figs. 9, 11 [holotype of *Globigerina rosetta* Carsey], (*not* figs. 7, 8).
Globotruncana arca (Cushman) Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 150, pl. 62, figs. 4, 5. (synonymy).
Globotruncana arca (Cushman) Cushman. CUSHMAN, 1949, U. S. Geol. Surv., Prof. Paper 221-A, p. 10, pl. 4, figs. 22, 23.
Globotruncana arca (Cushman). FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 128, pl. 20, figs. 22a-c.
Globotruncana arca (Cushman). BOLLI, LOEBLICH, and TAPPAN, 1957, U. S. Natl. Mus., Bull. 215, p. 44, pl. 11, figs. 6-11c.
Globotruncana arca (Cushman). BARR, 1962, Paleontology, vol. 4, pt. 4, p. 567, pl. 69, figs. 8a-c.

Discussion: This species, reported by Cushman (1949) from the Arkadelphia, was not identified in the samples studied by the writer. Several hundred Arkadelphia specimens of *Globotruncana* were examined but none could be placed in *Globotruncana arca* (Cushman). The holotype in the USNM was examined. Cushman's figures (1949) do not appear typical for the species. It is doubtful that it is present in the Arkadelphia marl.

GLOBOTRUNCANA CANALICULATA (Reuss)

Rosalina canaliculata REUSS, 1854, Akad. Wiss. Wien, Math.-naturw. Kl., Denkschr., vol. 7, p. 70, pl. 26, figs. 4a, b.
Globigerina canaliculata (Reuss). EGGER, 1900, K. Bayer. Akad. Wiss., Math.-naturh., Abt., Abh., Kl. 2, vol. 21, pt. 1, p. 172, pl. 21, figs. 15-17, 24-26.
Globotruncana canaliculata (Reuss). CUSHMAN, 1927, Cushman Lab. Foram. Res., Contr., vol. 3, pt. 2, p. 116, pl. 23, figs. 11a-c.
Globotruncana canaliculata (Reuss) Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 149, pl. 61, figs. 17, 18. (synonymy).
[?] *Globotruncana canaliculata* (Reuss) Cushman. CUSHMAN, 1949, U. S. Geol. Surv., Prof. Paper 221-A, p. 10, pl. 4, figs. 20, 21.
Globotruncana canaliculata (Reuss). FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 128, pl. 20, figs. 21a-c.

Discussion: This species, reported by Cushman (1949) from the Arkadelphia, was not identified in the samples studied by the writer. Several hundred Arkadelphia specimens of *Globotruncana* were examined but none could be placed in *Globotruncana canaliculata* (Reuss). Cushman's figures (1949) do not appear to have the characteristic canaliculate periphery.

GLOBOTRUNCANA CRETACEA Cushman

Pl. VI, figs. 19, 20

Globotruncana arca (Cushman). CUSHMAN (not *Pulvinulina arca* Cushman), 1931, Tennessee Div. Geol., Bull. 41, p. 59, pl. 11, figs. 6a, b.
Globotruncana arca (Cushman). PLUMMER (*partim;* not *Pulvinulina arca* Cushman), 1931, Texas Bur. Econ. Geol., Univ. Texas, Bull. 3101, p. 230, pl. 13, figs. 7, 8, (*not* 9, 11).
Globotruncana cretacea CUSHMAN, 1938, Cushman Lab. Foram. Res., Contr., vol. 14, pt. 3, p. 67, pl. 11, figs. 6a-c.
Globotruncana cretacea CUSHMAN, 1939, Cushman Lab. Foram. Res., Contr., vol. 15, pt. 4, p. 92, pl. 16, figs. 8a-c [erroneously republished as new].
Globotruncana cretacea Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 151, pl. 62, figs. 7a-c. (synonymy).
Globotruncana cretacea Cushman. CUSHMAN, 1949, U. S. Geol. Surv., Prof. Paper 221-A, p. 10, pl. 4, figs. 24, 25.
Globotruncana cretacea Cushman. FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 128, pl. 20, figs. 25a-c.

Diagnosis: Test free, biconvex, dorsal surface somewhat flattened, or even slightly concave in some specimens, umbilical surface strongly convex, periphery with a single keel, somewhat lobulate; chambers distinct, the last-formed nearly semi-circular in dorsal view, slightly overlapping, ventrally inflated; dorsal sutures quite distinct, strongly curved, raised, conspicuously beaded, ventral sutures depressed; wall calcareous, finely perforate; surface smooth except for the beaded peripheral ridge and dorsal sutures; aperture ventral, opening into the umbilical cavity which is covered by a thin, plate-like tegilla in well-preserved specimens.

Figured specimen: USNM 639546, maximum diameter 0.52 mm, collected 8 feet below the top. Compared with the holotype in USNM: agrees perfectly.

Discussion: This species is common to abundant in numerous localities in the Austin, Taylor, and Navarro of the Gulf Coast. It is abundant in the Arkadelphia marl. The species is somewhat varied and it is probable that the specimens identified as *Globotruncana arca* (Cushman) and *G. canaliculata* (Reuss) by Cushman are conspecific with *G. cretacea* Cushman.

GLOBOTRUNCANA GANSSERI Bolli

Pl. VI, figs. 21, 22

Globotruncana gansseri BOLLI, 1950, Cushman Foundation Foram. Res., Contr., vol. 1, pts. 3-4, p. 87. [*nomen nudum*].

Globotruncana gansseri BOLLI, 1951, Jour. Paleontology, vol. 25, no. 2, p. 196, pl. 35, figs. 1-3.

Globotruncana gansseri Bolli. BOLLI, LOEBLICH, and TAPPAN, 1957, U. S. Natl. Mus., Bull. 215, p. 54 (synonymy), p. 56.

Diagnosis: Test free, trochoid, planoconvex, dorsal surface flattened, ventral surface strongly convex, a distinct lobulate marginal keel separates the two surfaces, test quadrangular in transverse section with a prominent, deep umbilicus; chambers distinct, overlapping, ventrally inflated, typically 5 to a volution, the last-formed and largest chamber subcircular in dorsal view; dorsal sutures quite distinct, curved, raised, and finely beaded, ventral sutures depressed; wall calcareous, finely perforate; surface smooth to finely hispid or rugulose, particularly on the ventral surface; aperture ventral, quite large, opening into the prominent umbilical cavity which is covered by a thin tegilla in well preserved specimens.

Figured specimen: USNM 639547, maximum diameter 0.46 mm, thickness 0.275 mm, collected 16 feet above the base. Compared with a topotype (Cushman Collection 59687) in the USNM: agrees exactly.

Discussion: This form is common in the Arkadelphia and constitutes an excellent marker fossil for the Navarro and equivalents (Maestrichtian).

Family GLOBOROTALIIDAE Cushman, 1927

Subfamily GLOBOROTALIINAE Cushman, 1927

Genus GLOBOROTALIA Cushman, 1927

Globorotalia CUSHMAN, 1927, Cushman Lab. Foram. Res., Contr., vol. 3, pt. 1, p. 91.

Type species: Pulvinulina menardii var. *tumida* H. B. Brady, 1877. Original designation and monotypy [cited as *Pulvinulina tumida* H. B. Brady, 1884]. *Gender:* feminine.

"GLOBOROTALIA MEMBRANACEA (Ehrenberg)"

Globorotalia membranacea (Ehrenberg) White. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 152, pl. 63, figs. 5a, b.

Globorotalia membranacea (Ehrenberg) White. CUSHMAN, 1949, U. S. Geol. Surv., Prof. Paper 221-A, p. 10.

Globorotalia membranacea (Ehrenberg). FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 130, pl. 20, figs. 30a, b.

Discussion: "*Globorotalia membranacea* (Ehrenberg)" was reported by Cushman from the Corsicana marl of Texas (1946) and the Arkadelphia marl (1949). His figures are globorotaliform but the apertural view is not shown and the presence of an apertural lip is not noted in his descriptions. Cushman recorded a single specimen from the Arkadelphia marl in 1949.

Globorotalia was not recovered from the zonal samples studied by the writer, but a single specimen was found in a bulk surface sample from the upper Arkadelphia. This form has a rounded periphery and compares quite favorably with Cushman's illustrations. As recent studies (Bolli, Loeblich, and Tappan, 1957) have shown *Globorotalia* to be confined to the post-Cretaceous, it is likely that both this specimen and Cushman's single specimen are contamination due to surface wash from the overlying Midway formation where unkeeled *Globorotalia* is known to occur.

Ehrenberg illustrated but did not describe *Globorotalia membranacea* and the depository of the types is not given. The only available evidence, Ehrenberg's figures, could place the form in almost any coiled genus, and *G. membranacea* is therefore unrecognizable (Loeblich and Tappan, 1957).

Family GLOBIGERINIDAE Carpenter, Parker and Jones, 1862

Subfamily GLOBIGERININAE Carpenter, Parker and Jones, 1862

Genus RUGOGLOBIGERINA Bronnimann, 1952

Rugoglobigerina BRONNIMANN, 1952, Bull. Amer. Paleontology, vol. 34, no. 140, p. 16.

Type species: Globigerina rugosa Plummer, 1927. Original designation. *Gender:* feminine.

RUGOGLOBIGERINA RUGOSA (Plummer)

Pl. VI, fig. 18

Globigerina cretacea d'Orbigny. CARSEY (*not* d'Orbigny), 1926, Texas Bur. Econ. Geol., Univ. Texas, Bull. 2612, p. 43, pl. 5, figs. 5a, b.
Globigerina rugosa PLUMMER, 1927, Texas Bur. Econ. Geol., Univ. Texas, Bull. 2644, p. 38, pl. 2, figs. 10a-d.
Globigerina rugosa Plummer. PLUMMER, 1931, Texas Bur. Econ. Geol., Univ. Texas, Bull, 3101, p. 194.
Rugoglobigerina rugosa (Plummer). BRONNIMANN, 1952, Bull. Amer. Paleontology, vol. 34, no. 140, p. 16.
Globigerina rugosa Plummer. FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 127, pl. 20, figs. 3-6.
Rugoglobigerina rugosa (Plummer). BOLLI, LOEBLICH, and TAPPAN, 1957, U. S. Natl. Mus., Bull. 215, p. 43, pl. 11, figs. 2a-c.

Diagnosis: Test free, minute, trochospiral, biconvex, umbilicate, periphery rounded; chambers nearly spherical, five in the last volution, enlarging rapidly as added; sutures depressed, radial; wall calcareous, perforate; surface ornamented with numerous large pustules which may coalesce into distinct ridges radiating from the midpoint of each chamber on the periphery; primary apertures interiomarginal, umbilical, in well preserved specimens covered by tegilla perforated by the accessory infralaminal and intralaminal apertures which are the only openings to the exterior.

Figured specimen: USNM 639548, maximum diameter 0.39 mm, collected 8 feet below the top. Compared with the autotypes in USNM: agrees.

Discussion: This small distinctly ornamented form is an index fossil for the Navarro strata of the Gulf Coast.

Superfamily ORBITOIDACEA Schwager, 1876

Family ANOMALINIDAE Cushman, 1927

Genus ANOMALINA d'Orbigny, 1826

Anomalina D'ORBIGNY, 1826, Ann. Sci. Nat., sér. 1, vol. 7, p. 282.
Anomalina d'Orbigny, emend. MARIE, 1941, Paris, Mus. Natl. Hist. Nat., Mém., new ser., vol. 12, fasc. 1, pp. 243, 257.

Type species: Anomalina punctulata d'Orbigny, 1826. First species, designated by Cushman, 1915. *Gender:* feminine.

ANOMALINA NELSONI W. Berry

Anomalina nelsoni W. BERRY, *in* BERRY and KELLEY, 1929, U. S. Natl. Mus., Proc., vol. 76, art. 19, p. 14, pl. 2, figs. 19-21.
Anomalina involuta (Reuss). CUSHMAN (not *Rotalina involuta* Reuss, 1851; not *Rotalina involuta* Terquem, 1882), 1931, Tennessee Div. Geol., Bull. 41, p. 60, pl. 12, figs. 1a-c.
Cibicides nelsoni PLUMMER, 1936, Texas Bur. Econ. Geol., Univ. Texas, Bull. 3501, p. 288, pl. 5, figs. 1-6.
Valvulineria nelsoni (Plummer). JENNINGS, 1936, Bull. Amer. Paleontology, vol. 23, no. 78, p. 32, pl. 4, figs. 1a, b.
Anomalina nelsoni W. Berry. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 154, pl. 63, figs. 8, 9. (synonymy).

Discussion: This species, reported by Cushman (1946) from the Arkadelphia, was not identified from the samples studied by the writer. The holotype in the USNM was examined.

ANOMALINA PSEUDOPAPILLOSA Carsey

Pl. VI, fig. 23

Anomalina pseudopapillosa CARSEY, 1926, Texas Bur. Econ. Geol., Univ. Texas, Bull. 2612, p. 47, pl. 1, figs. 6a, b.
Anomalina navarroensis PLUMMER, 1927, Texas Bur. Econ. Geol., Univ. Texas, Bull. 2644, p. 38, pl. 2, figs. 6a-c.
Anomalina pseudopapillosa Carsey. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 154, pl. 64, figs. 1a-c. (synonymy).
Anomalina pseudopapillosa Carsey. FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 131, pl. 21, figs. 6a-c.

Diagnosis: Test free, trochospiral, subequally biconvex, both sides nearly involute, periphery rounded but somewhat contracted; chambers simple, numerous, 12 or more in the adult volution, slightly inflated, uniform, increasing gradually in size as added; sutures distinct, strongly limbate, somewhat raised, terminating inwardly in distinctive bead-like prominences; wall calcareous, coarsely perforate; surface appears granular; aperture nearly equatorial, basal in the apertural face, with a slight lip.

Figured specimen: USNM 639549, maximum diameter 0.288 mm, collected 8 feet below the top. Compared with numerous identified specimens in USNM: agrees.

Discussion: This small, distinctive species is an excellent marker for the Navarro strata. It has been reported from numerous localities in Texas, Arkansas, Mississippi, and Alabama.

Genus ANOMALINOIDES Brotzen, 1942

Anomalinoides BROTZEN, 1942, Sveriges Geol. Undersökning, Afh., ser. C, no. 451, vol. 36, pt. 8, p. 23.

Type species: Anomalinoides plummerae Brotzen, 1942, = *Anomalina pinguis* Jennings, 1936. Original designation. *Gender:* masculine.

ANOMALINOIDES PINGUIS (Jennings)

Pl. VI, fig. 24

Anomalina grosserugosa Gümbel. CARSEY (not *Truncatulina grosserugosa* Gümbel), 1926, Texas Bur. Econ. Geol., Univ. Texas, Bull. 2612, p. 46, pl. 3, figs. 3a, b.
Anomalina pinguis JENNINGS, 1936, Bull. Amer. Paleontology, vol. 23, no. 78, p. 37, pl. 5, fig. 1.
Anomalinoides plummerae BROTZEN, 1942, Sveriges Geol. Undersökning, Afh., ser. C, no. 451, vol. 36, pt. 8, p. 23.
Anomalina pinguis Jennings. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 156. (synonymy).
Anomalina pinguis Jennings. CUSHMAN, 1949, U. S. Geol. Surv., Prof. Paper 221-A, p. 10, pl. 4, figs. 29, 30.
Anomalinoides pinquis (Jennings). FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 131, pl. 21, figs. 8a-c. (synonymy).

Diagnosis: Test free, trochospiral, subequally biconvex, ventral side involute and slightly more convex, periphery broadly rounded; chambers simple, 8 to 9 in the adult volution, distinctly inflated; sutures distinct, limbate in juvenarium, depressed in the adult volution, slightly curved; aperture basal, nearly equatorial, extending to the dorsal side along the inner margin of the last-formed chamber.

Figured specimen: USNM 639550, maximum diameter 0.288 mm, collected 8 feet below the top. Compared with plesiotypes in USNM: compares favorably with those from the Arkadelphia, but those from the Pecan Gap chalk are much more inflated.

Discussion: This species is reported from the Corsicana marl and Taylor marl of Texas and from the Navesink marl and Mt. Laurel sand of New Jersey.

Genus PLANULINA d'Orbigny, 1826

Planulina D'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 280.

Type species: Planulina ariminensis d'Orbigny, 1826. First species, designated by Galloway and Wissler, 1927. *Gender:* feminine.

PLANULINA CORRECTA (Carsey)

Pl. VI, figs. 25, 26

Discorbis correcta CARSEY, 1926, Texas Bur. Econ. Geol., Univ. Texas, Bull. 2612, p. 45, pl. 3, figs. 5a, b.
Planulina correcta (Carsey). CUSHMAN, 1940, Cushman Lab. Foram. Res., Contr., vol. 16, pt. 2, p. 36, pl. 6, figs. 11a-c.
Planulina correcta (Carsey) Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 158, pl. 65, figs. 1a-c. (synonymy).
Planulina correcta (Carsey). FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 132, pl. 21, figs. 10a-c.

Diagnosis: Test free, trochospiral, strongly compressed, periphery somewhat rounded, lobulate, dorsal side gently convex and evolute, ventral side strongly flattened to concave and nearly involute; chambers distinct, slightly inflated, 5 to 9 in the adult volution, earlier chambers low and broad, becoming abruptly higher and increasingly larger in the adult volution; sutures distinct, earlier ones limbate and slightly raised, later ones simple, slightly depressed and curved; wall calcareous, distinctly perforate; surface smooth; aperture a low elongate slit with a slight lip.

Figured specimen: USNM 639551, maximum diameter 0.60 mm, collected 8 feet below the top. Compared with identified specimens in USNM: agrees.

Discussion: This characteristic species is restricted to the Navarro strata of Texas, Arkansas, Mississippi, and Alabama.

Superfamily CASSIDULINACEA d'Orbigny, 1839

Family CAUCASINIDAE Bykova, 1959

Subfamily FURSENKOININAE Loeblich and Tappan, 1961

Genus FURSENKOINA Loeblich and Tappan, 1961

Virgulina D'ORBIGNY (not *Virgulina* Bory de St. Vincent, 1823), 1826, Ann. Sci. Nat., vol. 7, p. 267.
Fursenkoina LOEBLICH and TAPPAN, 1961, Jour. Paleontology, vol. 35, no. 2, p. 314.

Type species: Virgulina squammosa d'Orbigny, 1826. Original designation. *Gender:* feminine.

FURSENKOINA NAVARROANA (Cushman)

Pl. V, fig. 25

Virgulina navarroana CUSHMAN, 1933, Cushman Lab. Foram. Res., Contr., vol. 9, pt. 3, p. 63, pl. 7, figs. 9, 10.
Virgulina navarroana Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 126, pl. 53, figs. 5-7. (synonymy).
Virgulina navarroana Cushman. FRIZZELL, 1954,

Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 117, pl. 17, figs. 17, 18.

Diagnosis: Test elongate, tapering, maximum breadth near the apertural end, periphery rounded, initial end pointed; chambers biserial, distinct, slightly inflated, twisted in a gentle spiral about the elongate axis, the last-formed somewhat more elongate than the earlier ones; sutures distinct, slightly depressed; wall calcareous, perforate; surface smooth; aperture elliptical, loop-shaped, with a slight rim.

Figured specimen: USNM 639552, length 0.34 mm, breadth 0.125 mm, collected 8 feet below the top. Compared with the holotype and paratypes in USNM: compares favorably with the holotype and well within the range of the paratypes.

Discussion: This species was described from the Corsicana marl. It occurs also in the Kemp clay and rarely in the Arkadelphia marl.

Family Pleurostomellidae Reuss, 1860

Subfamily Pleurostomellinae Reuss, 1860

Genus Stilostomella Guppy, 1894

Stilostomella Guppy, 1894, Zool. Soc. London, Proc., p. 649.
Ellipsonodosaria A. Silvestri, 1900, Accad. Sci. Lett. Arti Zelanti Acireale, Atti Rend., vol. 10, p. 4.
Siphonodosaria A. Silvestri, 1924, Soc. Geol. Ital., Boll., vol. 42, p. 18.

Type species: Stilostomella rugosa Guppy, 1894. Monotypic. *Gender:* feminine.

Stilostomella stephensoni (Cushman)

Pl. V. fig. 30

Ellipsonodosaria stephensoni Cushman, 1936, Cushman Lab. Foram. Res., Contr., vol. 12, pt. 3, p. 52, pl. 9, figs. 10-15.
Ellipsonodosaria stephensoni Cushman. Cushman, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 134, pl. 56, figs. 2-7. (synonymy).
Ellipsonodosaria stephensoni Cushman. Frizzell, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 121.
Stilostomella stephensoni (Cushman). Frizzell, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 151, pl. 18, figs. 22, 23.

Diagnosis: Test elongate, tapering, slightly arcuate; chambers distinct, increasing in length and rather rapidly in diameter as added, adult chambers pyriform, somewhat inflated, broadest near the base; sutures distinct, depressed, somewhat limbate; wall calcareous, perforate; surface of early chambers smooth, later with a circlet of short, backwardly projecting spines near the base and a few, additional scattered spines on the upper part of the adult chamber; aperture crescentic with a distinct tooth and a slight lip, and surrounded by a distinct ring of shell material.

Figured specimen: USNM 639553, length of broken specimen 0.66 mm, maximum diameter 0.10 mm, collected 30 feet above the base. Compared with the holotype and paratypes in USNM: compares favorably.

Discussion: This species is reported from numerous upper Taylor and Navarro localities in Texas and Arkansas and from the lower Selma chalk (Austin) of Lee County, Mississippi.

Stilostomella stephensoni speciosa (Cushman)

Pl. V, fig. 31

Ellipsonodosaria stephensoni Cushman var. *speciosa* Cushman, 1938, Cushman Lab. Foram. Res., Contr., vol. 14, pt. 2, p. 47, pl. 8, fig. 3.
Ellipsonodosaria stephensoni Cushman var. *speciosa* Cushman. Cushman, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 135, pl. 56, fig. 8. (synonymy).

Diagnosis: This form differs from the typical subspecies in the strongly pyriform adult chambers with spines distributed over the entire surface instead of confined to the basal margin.

Figured specimen: USNM 639554, length of broken specimen 0.75 mm, maximum diameter 0.125 mm, collected 30 feet above the base. Compared with the holotype and paratypes in USNM: agrees.

Discussion: This subspecies was described from Arkadelphia exposures 6 miles northwest of Hope, Arkansas. It has been reported only from the Arkadelphia and the Colon shale of Colombia.

Stilostomella alexanderi (Cushman)

Ellipsonodosaria alexanderi Cushman, 1936, Cushman Lab. Foram. Res., Contr., vol. 12, pt. 3, p. 52, pl. 9, figs. 6-9.
Ellipsonodosaria alexanderi Cushman. Cushman, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 135, pl. 56, figs. 12-15.
Ellipsonodosaria alexanderi Cushman var. *alexanderi* Cushman. Frizzell, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 121.
Stilostomella alexanderi (Cushman) var. *alexanderi* (Cushman). Frizzell, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 151, pl. 18, figs. 13-14.

Diagnosis: Test elongate, straight or gently curved; microspheric test increasing rapidly in

diameter from the small proloculus, megalospheric test not tapering; chambers distinct, inflated, increasing gradually in length, adult chambers about twice as long as broad, pyriform; sutures distinct, strongly depressed; wall calcareous, perforate; surface ornamented with short, backwardly projecting spines, forming a single ring in the early microspheric chambers, numerous and irregularly distributed over the surface of the adult chambers; aperture a semi-circular opening with a single tooth, a distinct neck, and a slightly raised lip.

Discussion: The types of the species are from the Taylor marl in Delta County, Texas. This form is characteristic for the upper part of the Taylor marl.

STILOSTOMELLA ALEXANDERI IMPENSIA (Cushman)

Pl. V, fig. 32

Ellipsonodosaria alexanderi Cushman var. *impensia* CUSHMAN, 1938, Cushman Lab. Foram. Res., Contr., vol. 14, pt. 2, p. 48, pl. 8, figs. 4, 5.
Ellipsonodosaria alexanderi Cushman var. *impensia* Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 136, pl. 56, figs. 16-18. (synonymy).
Ellipsonodosaria alexanderi Cushman var. *impensia* Cushman. FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 121.
Stilostomella alexanderi (Cushman) var. *impensia* (Cushman). FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 151, pl. 18, figs. 15, 16.

Diagnosis: This subspecies differs from the typical form in the more fusiform adult chambers which are also more spinose, in the early microspheric chambers which bear numerous spines, in the greater number of spines which project backward less prominently, and in the larger size of the test.

Figured specimen: USNM 639555, length of incomplete specimen 1.59 mm, maximum diameter 0.25 mm, collected 30 feet above the base. Compared with the holotype and paratypes in USNM: agrees.

Discussion: The types of this subspecies are from the Corsicana marl, Limestone County, Texas. This form is characteristic of the upper Navarro strata of Texas, Arkansas, Mississippi, and Alabama. It is recorded also from the Mal Paso shale of Peru.

Family NONIONIDAE Schultze, 1854

Subfamily CHILOSTOMELLINAE Brady, 1881

Genus ALLOMORPHINA Reuss, 1850

Allomorphina REUSS, 1850, Akad. Wiss. Wien, Math.-naturw. Kl., Denkschr., vol. 1, p. 380.

Type species: Allomorphina trigona Reuss, 1850. Monotypic. *Gender:* feminine.

ALLOMORPHINA NAVARROANA Cushman

Pl. VI, fig. 15

Allomorphina navarroana CUSHMAN, 1936, Cushman Lab. Foram. Res., Contr., vol. 12, pt. 4, p. 73, pl. 13, figs. 1a-c.
Allomorphina navarroana Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 145, pl. 60, figs. 5a-c. (synonymy).
Allomorphina navarroana Cushman. CUSHMAN, 1949, U. S. Geol. Surv., Prof. Paper 221-A, p. 9, pl. 4, fig. 18.
Allomorphina navarroana Cushman. FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 126, pl. 19, figs. 18a-c.

Diagnosis: Test small, a low trochospiral, slightly longer than broad, periphery rounded, three chambers to a volution in the juvenarium, tending to reduce to two in the adult test; chambers distinct, slightly inflated, the last two adult chambers form a large proportion of the test; sutures distinct, slightly depressed; wall calcareous, perforate; surface smooth; aperture low, elongate, interiomarginal, with a distinct overhanging lip.

Figured specimen: USNM 639556, length 0.26 mm, collected 8 feet below the top. Compared with the holotype and paratypes in USNM: compares favorably.

Discussion: This form is restricted to the Navarro strata of Arkansas and Texas. The types of the species are from the Corsicana marl, Navarro County, Texas.

Subfamily NONIONINAE Schultze, 1854

Genus NONIONELLA Cushman, 1926

Nonionella CUSHMAN, 1926, Cushman Lab. Foram. Res., Contr., vol. 2, pt. 3, p. 64.

Type species: Nonionella miocenica Cushman, 1926. Original designation. *Gender:* feminine.

NONIONELLA ROBUSTA Plummer

Pl. V, figs. 5, 6

Nonionina scapha Fichtel and Moll. CARSEY (not *Nautilus scapha* Fichtel and Moll), 1926, Texas Bur. Econ. Geol., Univ. Texas, Bull. 2612, p. 49, pl. 1, figs. 2a-c.
Nonionella robusta Plummer, 1931, Texas Bur. Econ. Geol., Univ. Texas, Bull. 3101, p. 175, pl. 14, figs. 12a-c.
Nonionella robusta Plummer. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 100, pl. 43, figs. 21-23. (synonymy).

Nonionella robusta Plummer. FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 107, pl. 15, figs. 10a-c.

Diagnosis: Test small, moderately compressed, nearly equally biconvex, asymmetrically developed; umbilicate, dorsal umbilicus small, narrow, and shallowly depressed, exposing the inner volutions, ventral umbilicus irregularly filled by the lobate extensions of the chambers; periphery narrowly rounded and bluntly angular in the adult stage, only slightly lobate in the later portion of some tests, but generally an even curve; chambers distinct, about 8 in the final volution, lengthening rapidly, gently inflated in most specimens; sutures distinct, slightly depressed or flush, somewhat curved; wall calcareous, distinctly perforate; surface smooth; aperture a low slit, interiomarginal on the ventral side.

Figured specimen: USNM 639557, length 0.288 mm, breadth 0.25 mm, collected 8 feet below the top. Compared with plesiotypes in USNM: agrees.

Discussion: This species is reported from numerous localities in the Navarro of Texas, Arkansas, Mississippi, and Alabama.

NONIONELLA ANSATA Cushman

Pl. V, fig. 7

Nonionella ansata CUSHMAN, 1938, Cushman Lab. Foram. Res., Contr., vol. 14, pt. 2, p. 44, pl. 7, figs. 17a-c.

Nonionella ansata Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 101, pl. 44, figs. 1a-c.

Nonionella ansata Cushman. CUSHMAN, 1949, U. S. Geol. Surv., Prof. Paper 221-A, p. 7, pl. 3, fig. 18.

Diagnosis: Test small, strongly compressed, sides nearly flat, periphery rounded, adult test nearly as broad as long; chambers distinct, about 10 in the adult volution, increasing rapidly in length and gradually in height as added, with prominent lobate ventral expansions of the adult chambers into the umbilicus; sutures distinct, only slightly depressed, strongly curved; wall calcareous, finely perforate; surface smooth; aperture a low, elongate slit, interiomarginal on the ventral side.

Figured specimen: USNM 639558, length 0.30 mm, maximum breadth 0.225 mm, collected 8 feet below the top. Compared with the holotype and paratypes in USNM: agrees.

Discussion: This form is restricted to the Navarro strata. It is known only from the Arkadelphia marl and the Prairie Bluff chalk of Alabama.

Genus PULLENIA Parker and Jones, 1862

Pullenia PARKER and JONES, *in* CARPENTER, 1862, Introd. Foram., Ray Soc., London, p. 184.

Type species: Nonionina bulloides d'Orbigny, 1846, [? = *Nonionina sphaeroides* d'Orbigny, 1826 (indeterminate)]. Monotypic. *Gender:* feminine.

PULLENIA AMERICANA Cushman

Pl. VI, figs. 16, 17

Pullenia quinqueloba (Reuss). CUSHMAN and CHURCH (not *Nonionina quinqueloba* Reuss), 1929, California Acad. Sci., Proc., ser. 4, vol. 18, p. 517, pl. 41, figs. 10, 11.

Pullenia americana CUSHMAN, 1936, Cushman Lab. Foram. Res., Contr., vol. 12, pt. 4, p. 76, pl. 13, figs. 4, 5. (synonymy).

Pullenia americana Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 146, pl. 60, figs. 13, 14. (synonymy).

Pullenia americana Cushman. FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 126, pl. 19, figs. 21a, b.

Diagnosis: Test planispiral, completely involute, laterally compressed, slightly umbilicate, periphery rounded; chambers distinct, somewhat inflated, 5 to 6 in the adult volution, increasing gradually in size as added; sutures distinct, somewhat depressed, slightly curved; wall calcareous, finely perforate; surface smooth; aperture elongate, arched, interiomarginal and equatorial.

Figured specimen: USNM 639559, height 0.64 mm, breadth 0.54 mm, thickness 0.34 mm, collected 8 feet below the top. The Arkadelphia specimen is much larger than the holotype of the species.

Discussion: This species is reported from numerous localities in the Taylor and Navarro of Texas, Arkansas, Mississippi, and Tennessee.

PULLENIA MINUTA Cushman

Pullenia minuta CUSHMAN, 1936, Cushman Lab. Foram. Res., Contr., vol. 12, pt. 4, p. 77, pl. 13, figs. 7a, b.

Pullenia minuta Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 147, pl. 60, fig. 12. (synonymy).

Pullenia minuta Cushman. CUSHMAN, 1949, U. S. Geol. Surv., Prof. Paper 221-A, p. 9, pl. 4, fig. 19.

Pullenia minuta Cushman. FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 126, pl. 19, figs. 20a, b.

Discussion: This species, reported by Cushman (1949) from the Arkadelphia, was not identified from the samples studied by the writer. The holotype and paratypes in the USNM were examined.

Family ALABAMINIDAE Hofker, 1951

Genus PSEUDOPARRELLA Cushman and ten Dam, 1948

Pulvinulinella CUSHMAN (not *Pulvinulinella* Eimer and Fickert, 1899), 1926, Cushman Lab. Foram. Res., Contr., vol. 2, pt. 3, p. 62.
Pseudoparrella CUSHMAN and TEN DAM, 1948, Cushman Lab. Foram. Res., Contr., vol. 24, pt. 3, p. 49.

Type species: Pulvinulinella subperuviana Cushman, 1926. Original designation. *Gender:* feminine.

PSEUDOPARRELLA GLABRATA (Cushman)

Pl. VI, figs. 13, 14

Pulvinulinella glabrata CUSHMAN, 1938, Cushman Lab. Foram. Res., Contr., vol. 14, pt. 3, p. 66, pl. 11, figs. 4a-c.
Pulvinulinella glabrata Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 144, pl. 59, figs. 10a-c. (synonymy).
Pseudoparrella glabrata (Cushman). FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 126, pl. 19, figs. 16a-c.

Diagnosis: Test small, trochospiral, biconvex, ventral side umbilicate, periphery subacute; chambers distinct, 5 or 6 in the adult volution, uniform, increasing gradually in size as added, not inflated; sutures distinct, on the dorsal side limbate, strongly oblique, slightly curved, on the ventral side subradiate, slightly depressed; wall calcareous, perforate; surface smooth, appearing polished; aperture elongate, elliptical, extending into the apertural face, subparallel to the plane of coiling, just ventral to the periphery.

Figured specimen: USNM 639560, maximum diameter 0.275 mm, collected 8 feet below the top. Compared with the holotype in USNM: agrees, though larger than the holotype.

Discussion: This species is common in the Navarro and occurs less commonly in the Taylor marl.

PSEUDOPARRELLA NAVARROANA (Cushman)

Pl. VI, figs. 11, 12

Pulvinulinella navarroana CUSHMAN, 1938, Cushman Lab. Foram. Res., Contr., vol. 14, pt. 3, p. 66, pl. 11, figs. 5a-c.
Pulvinulinella navarroana Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 144, pl. 60, figs. 1a-c.
Pseudoparrella navarroana (Cushman). FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 126, pl. 19, figs. 9a-c.

Diagnosis: Test trochospiral, biconvex, periphery acute with a distinct keel; chambers distinct, about 10 in the adult volution, uniform, increasing gradually in size as added, not inflated; sutures distinct, limbate, on the dorsal side strongly oblique, on the ventral side radial, somewhat sigmoid, fusing into a clear umbo at the center; wall calcareous, distinctly perforate; surface slightly granular; aperture narrow, an elongate slit, immediately below and parallel to the periphery.

Figured specimen: USNM 639561, maximum diameter 0.35 mm, collected 8 feet below the top. Compared with the holotype and paratypes in USNM: agrees perfectly.

Discussion: This species is reported only from Navarro strata. It is distinguished by the distinctly limbate sutures.

Family CIBICIDIDAE Cushman, 1927

Subfamily CIBICIDINAE Cushman, 1927

Genus CIBICIDES Montfort, 1808

Cibicides MONTFORT, 1808, Conch. Syst., vol. 1, p. 123.

Type species: Cibicides refulgens Montfort, 1808. Original designation. *Gender:* masculine.

CIBICIDES HARPERI (Sandidge)

Pl. VI, figs. 27, 28

[?] *Cibicides ripleyensis* SANDIDGE (not *Truncatulina ripleyensis* W. BERRY), 1932, Amer. Midland Nat., vol. 13, no. 4, p. 199, pl. 19, figs. 17-19.
Anomalina harperi SANDIDGE, 1932, Amer. Midland Nat., vol. 13, no. 5, p. 316, pl. 29, figs. 5, 6 (*not* figs. 1, 2).
Cibicides harperi (Sandidge). CUSHMAN, 1940, Cushman Lab. Foram. Res., Contr., vol. 16, pt. 2, p. 38, pl. 7, figs. 3-5.
Cibicides harperi (Sandidge) Cushman. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 159, pl. 65, figs. 5-7.
Cibicides harperi (Sandidge) Cushman. CUSHMAN, 1949, U. S. Geol. Surv., Prof. Paper 221-A, p. 10, pl. 4, figs. 33, 34.
Cibicides harperi (Sandidge). FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 133, pl. 21, figs. 22a, b.

Diagnosis: Test trochospiral, subequally biconvex, ventral side somewhat conical, dorsal side umbilically flattened; periphery subacute, smooth in earlier portion, later lobulate; chambers numerous, about 9 in the last-formed volution, increasing gradually in size as added, the early chambers concealed on the dorsal side by a spiral of clear shell material in the umbilicus, ventral side involute with a small umbo; sutures distinct, limbate, gently curved dorsally; wall calcareous, coarsely perforate; aperture arched, basal, pe-

ripheral, extending a short distance onto the dorsal side.

Figured specimen: USNM 639562, maximum diameter 0.325 mm, collected 10 feet below the top. Compared with plesiotypes from the Arkadelphia in USNM: compares favorably.

Discussion: This species is reported from the Navarro of Texas, Arkansas, and Alabama.

CIBICIDES BEAUMONTIANUS (d'Orbigny)

Pl. VI, figs. 29, 30

Truncatulina beaumontiana D'ORBIGNY, 1840, Soc. Géol. France, Mém., sér. 1, vol. 4, p. 35, pl. 3, figs. 17-19.
Cibicides involuta (Reuss). CUSHMAN (not *Rotalina involuta* Reuss), 1931, Jour. Paleontology, vol. 5, no. 4, p. 315, pl. 36, figs. 10a-c.
Cibicides beaumontiana (d'Orbigny). BROTZEN, 1936, Sveriges Geol. Undersökning, Afh., ser. C, no. 396, vol. 30, pt. 3, p. 188.
Cibicides beaumontianus (d'Orbigny). CUSHMAN, 1940, Cushman Lab. Foram. Res., Contr., vol. 16, pt. 2, p. 39, pl. 7, figs. 9a-c.
Cibicides beaumontianus (D'Orbigny). Brotzen. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 160, pl. 65, figs. 12a-c. (synonymy).
Cibicides beaumontianus (d'Orbigny) Brotzen. CUSHMAN, 1949, U. S. Geol. Surv., Prof. Paper 221-A, p. 10, pl. 4, figs. 37, 38.
Cibicides beaumontianus (d'Orbigny). FRIZZELL, 1954, Texas Bur. Econ. Geol., Univ. Texas, Rept. Invest. 22, p. 132, pl. 21, figs. 19a-c.

Diagnosis: Test trochospiral, planoconvex, dorsal surface flattened or slightly concave, evolute, ventral side strongly convex, involute, periphery acute, slightly lobulate; chambers distinct, about 7 or 8 in the adult volution, slightly inflated ventrally, increasing rapidly in size as added; sutures distinct, earlier ones slightly limbate, strongly curved, later ones slightly depressed on the ventral side; wall calcareous, perforate; surface smooth, or somewhat thickened at the sutures in the dorsal umbilicus; aperture a low opening at the periphery extending onto the dorsal side at the base of the last-formed chamber.

Figured specimen: USNM 639563, maximum diameter 0.54 mm, collected 8 feet below the top. Compared with plesiotypes in USNM: atypical but within the range of the plesiotypes though most are larger and more strongly inflated.

Discussion: This species is fairly common in the Taylor and Navarro strata of Texas, Arkansas, Alabama, and Mississippi.

CIBICIDES SUBCARINATUS Cushman and Deaderick

Cibicides subcarinatus CUSHMAN and DEADERICK, 1944, Jour. Paleontology, vol. 18, no. 4, p. 341.
Cibicides subcarinatus Cushman and Deaderick. CUSHMAN, 1946, U. S. Geol. Surv., Prof. Paper 206, p. 159, pl. 65, figs. 8-11. (synonymy).
Cibicides subcarinatus Cushman and Deaderick. CUSHMAN, 1949, U. S. Geol. Surv., Prof. Paper 221-A, p. 10, pl. 4, figs. 35, 36.

Discussion: This species, reported by Cushman (1949) from the Arkadelphia, was not identified from the samples studied by the writer.

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