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VIRGINIA CONSERVATION COMMISSION  
**VIRGINIA GEOLOGICAL SURVEY**  
ARTHUR BEVAN, *State Geologist*

**Bulletin 67**

**An Upper Eocene Foraminiferal Fauna from  
Deep Wells in York County, Virginia**

By

**JOSEPH A. CUSHMAN and D. J. CEDERSTROM**



PREPARED IN COOPERATION WITH THE GEOLOGICAL SURVEY OF THE  
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## FOREWORD

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This report embraces the results of studies and identification of foraminifera from the Upper Eocene, including some new species and varieties, by the senior author, from cuttings from deep water wells drilled at the Navy Mine Depot, Yorktown, Virginia, by the Navy Department during the early part of World War II. The cuttings were collected by the junior author. The report is one of the results of cooperative investigations of the geology and ground-water resources of the Coastal Plain region of Virginia by the United States and the Virginia Geological Surveys.

The manuscript and illustrations were submitted to the printer on December 11, 1945, during the administration of Dr. Arthur Bevan as State Geologist. Because of unprecedented difficulties and delays, beyond the control of the Virginia Geological Survey, this Bulletin was not printed and delivered to us until the date stamped below.

On September 1, 1947, the undersigned was appointed State Geologist of Virginia to succeed Dr. Arthur Bevan who resigned on that date.

WILLIAM M. MCGILL,

*State Geologist.*

Virginia Geological Survey,  
Box 1428, University Station,  
Charlottesville, Virginia,  
December 15, 1948.

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COMMONWEALTH OF VIRGINIA  
VIRGINIA GEOLOGICAL SURVEY  
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CHARLOTTESVILLE, VA., December 10, 1945.

*To the Virginia Conservation Commission:*

GENTLEMEN:

I have the honor to transmit for publication as Bulletin 67 of the Virginia Geological Survey, the text and illustrations of a report on *An Upper Eocene Foraminiferous Fauna from Deep Wells in York County, Virginia*, by Joseph A. Cushman and D. J. Cederstrom.

This report is a contribution to the understanding of the sub-surface and surface geology of the Coastal Plain not only in Virginia, but in the northern Atlantic Coastal Plain. It should, therefore, be useful to all who are interested in developing the ground-water and other economic resources in the Coastal Plain of Virginia and adjacent areas. The data were obtained from deep wells drilled during the war by the Navy Department.

The report is based on cooperative investigations of the Coastal Plain of Virginia by the Federal and State geological surveys. The field work was done by Mr. Cederstrom of the Federal Survey.

Respectfully submitted,

ARTHUR BEVAN,  
*State Geologist.*

Approved for publication:

Virginia Conservation Commission,  
Richmond, Virginia, December 12, 1945.

R. A. GILLIAM, *Executive Secretary and Treasurer.*

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# An Upper Eocene Foraminiferal Fauna from Deep Wells in York County, Virginia\*

By JOSEPH A. CUSHMAN and D. J. CEDERSTROM

## INTRODUCTION

This publication deals chiefly with an assemblage of foraminifera not hitherto reported from the northern Atlantic Coastal Plain. The described fauna was obtained from cable-tool cuttings from three wells at the Navy Mine Depot, Yorktown, Virginia. As the strata containing the fauna have not been recognized in outcrop, it has seemed desirable to give a new name to the subsurface stratigraphic unit containing the fossils and to describe briefly the character of the unit and its relations to the enclosing beds.

In the past two years the senior author has had occasion to examine and classify several hundred assemblages of foraminifera obtained by the junior author from well cuttings in eastern Virginia and submitted in connection with studies of the geology and groundwater resources of the Coastal Plain of Virginia, a cooperative investigation by the State and Federal Geological surveys. During the course of the examination it became apparent that strata other than those recognized in the surface exposures as the Pamunkey group, of early and middle Eocene age, were represented. These strata are upper Eocene. Their fauna shows many similarities to previously described faunas of the Jackson group,<sup>1</sup> but contains many forms not previously recorded in this group, including a number of new species and varieties.

The specimens recorded here were selected by the junior author from floated samples<sup>2</sup> containing hundreds of foraminifera and mounted for subsequent study by the senior author. All identifications and descriptions of fossils are the work of the senior author. The types and figured specimens are deposited in the Cushman Laboratory for Foraminiferal Research.

The faunal assemblage described occurs at a depth of 330 to 390 feet (303 to 363 feet below sea level) in Yorktown Navy Mine Depot

<sup>1</sup>Cushman, J. A., Upper Eocene foraminifera of the southeastern United States: U. S. Geol. Survey Prof. Paper 181, 1935.

<sup>2</sup>The samples of well cuttings were washed and foraminifera floated in large part by Miss N. Morris.

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well 2; at 380 to 500 feet (300 to 420 feet below sea level) in Yorktown Navy Mine Depot wells 3<sup>3</sup> and 4 (samples combined). The samples studied are as follows: well 2, at depths of 330, 360, and 380 feet; wells 3 and 4, at 380-390, 390-400, 400-410, 410-420, 420-430, 450-460, 460-470, 470-480, and 490-500 feet.

Well 2 was drilled in 1941 at the Navy Mine Depot to a depth of 470 feet. It is located in a ravine south of headquarters at an elevation of 27 feet above sea level. Water from this well is combined with flow from near-by springs and pumped into the distribution system. Wells 3 and 4 were drilled in 1942 on the high terrace about 80 feet above sea level near a circular cement tank a short distance west of headquarters. The deepest of these wells (3) was drilled to a depth of 620 feet. Both wells were abandoned because water-bearing sands were not encountered.

The fauna occurring in Navy Mine Depot wells 3 and 4 is composed of unusually large, varied, perfectly preserved specimens. Some residues obtained from washing a handful of mud contain thousands of foraminifera. The higher samples are almost pure and are regarded as being truly representative of the enclosing formation; the samples from 460 to 500 feet contain a very few older Eocene forms at 460 feet, which suggests that samples from 460 to 500 feet in wells 3 and 4 at the Navy Mine Depot, predominantly Jackson in foraminiferal content, are largely derived from material washed down from above. This could occur if the driller did not follow the drill closely with casing.

### CHICKAHOMINY FORMATION

The name Chickahominy formation is here proposed for the beds approximately 80 feet thick that consist of blue, gray, and dull-brown clays containing a fauna of Jackson age, that are overlain by the Miocene Chesapeake group and are underlain by the lower and middle Eocene Pamunkey group. The type locality is in wells 3 and 4 at the Navy Mine Depot, Yorktown, Va.

The Chickahominy strata are not appreciably different in appearance from the Miocene strata which immediately overlie them or from the older Eocene deposits below. Washed residues, however, have distinctive characteristics that readily distinguish the formation from the deposits above and below it. The washed residue of the Chickahominy formation generally contains a high proportion of glauconite

<sup>3</sup> Cederstrom, D. J., Selected well logs in the Virginia Coastal Plain north of James River: Virginia Geol. Survey Circular 3, pp. 61-62, 1945.



to quartz (up to 80 per cent glauconite) and is further characterized by the presence of rather abundant pyrite (up to about 20 per cent). The abundance of foraminifera and paucity of megascopic fossils also appear to be constant features of these beds, not only at Yorktown but elsewhere. The cuttings from the Miocene deposits contain little glauconite.

The washed residue from the samples at depths of 410-420 and 430-440 feet in wells 3 and 4, excluding abundant gypsum which to date has not been found elsewhere in these beds, contains less than one-third pyrite, less than one-third glauconite, and more than one-third foraminifera. Other samples contain somewhat smaller proportions of these constituents and more quartz (and gypsum).

In wells 3 and 4 a distinct lithologic break occurs at 460 feet below the surface. From this level to 620 feet, washed residues without exception contain less than 5 per cent glauconite and rarely contain pyrite. Thus the lithologic and fossil evidence points to the conclusion that the foraminifera of Jackson age present from 460 to 500 feet were carried down from above and that the lower boundary of the Chickahominy formation should be placed at 460 feet. The total number of specimens present becomes progressively smaller with depth and a very few older Eocene forms are present below 460 feet. The Chickahominy formation in wells 3 and 4 is therefore considered to extend from 380 to 460 feet below the surface or 300 to 380 feet below sea level.

In well 2 abundant foraminifera of Jackson age are present from 330 to 380 feet and a few are present at 400 feet (373 feet below sea level). At this lower depth older Eocene fossils appear in abundance. Thus it seems certain that the Jackson fauna is limited to about 80 feet of section at Yorktown.

Preliminary studies indicate that the Chickahominy formation is present in the subsurface strata at Camp Peary in York County, Fort Eustis in Warwick County, Byrdton in Northumberland County, Windsor Shades in New Kent County, Drivers in Suffolk County, and at Norfolk and Newport News.

## DESCRIPTION OF FOSSILS

## Family TEXTULARIIDAE

## Genus SPIROPLECTAMMINA Cushman, 1927

**Spiroplectammina mississippiensis** (Cushman)

(For figures, see U. S. Geol. Survey Prof. Paper 181, pl. 1, figs. 3 and 4, 1935.)

*Textularia mississippiensis* Cushman, U. S. Geol. Survey Prof. Paper 129, pp. 90, 125, pl. 14, fig. 4, 1922; Prof. Paper 133, p. 17, 1923.

Cushman and Applin, Am. Assoc. Petroleum Geologists Bull., vol. 10, p. 166, pl. 6, figs. 10, 11, 1926.

Cushman and Thomas, Jour. Paleontology, vol. 3, p. 177, pl. 23, fig. 1, 1929.

Cushman, Cushman Lab. Foram. Research Contr., vol. 5, p. 79, pl. 12, fig. 5, 1929.

Howe and Wallace, Louisiana Dept. Cons. Geol. Bull. 2, p. 19, pl. 1, fig. 7, 1932.

Cushman, U. S. Geol. Survey Prof. Paper 181, p. 7, pl. 1, figs. 3, 4, 1935.

Davis, Jour. Paleontology, vol. 15, p. 150, pl. 24, figs. 15, 17; pl. 25, figs. 5 and 6, 1941.

Cushman and Siegfus, San Diego Soc. Nat. History Trans., vol. 9, no. 34, p. 401, pl. 15, fig. 6, 1942.

Goudkoff and Porter, Am. Assoc. Petroleum Geologists Bull., vol. 26, p. 1653 (list), 1942.

Kelly, idem, vol. 27, pp. 8, 11 (lists), 1943.

*Spiroplectammina* cf. *mississippiensis* Cushman and Applin, Cushman Lab. Foram. Research Contr., vol. 19, p. 30, pl. 7, fig. 5, 1943.

This species is widely distributed in the Eocene and Oligocene of America. It has not been recorded north of Mississippi in the Atlantic area. Specimens occur in wells 3 and 4 at depths of 380-390, 390-400, 410-430, 430-440, 450-460, and 470-480 feet.

**Spiroplectammina mississippiensis** (Cushman), var. *alabamensis* (Cushman)

(For figures, see U. S. Geol. Survey Prof. Paper 181, pl. 1, figs. 5, 6, 1935.)

- Textularia mississippiensis* Cushman, var. *alabamensis* Cushman, U. S. Geol. Survey Prof. Paper 133, p. 17, pl. 1, fig. 4, 1923:  
 Howe, Jour. Paleontology, vol. 2, p. 175 (list), 1928.  
 Ellis, Am. Assoc. Petroleum Geologists Bull., vol. 17, no. 11, pl. 1, fig. 6, 1933.  
 Cushman, U. S. Geol. Survey Prof. Paper 181, p. 7, pl. 1, figs. 5, 6, 1935.  
 Davis, Jour. Paleontology, vol. 15, p. 150, pl. 25, figs. 2, 3, 1941.  
 Cushman and McGlamery, U. S. Geol. Survey Prof. Paper 197-B, p. 66, 1942.  
 Howe, Jour. Paleontology, vol. 16, p. 268 (list), 1942.

*Spiroplectammina mississippiensis* (Cushman), var. *alabamensis* Cushman and Herrick, Cushman Lab. Foram. Research Contr., vol. 21, p. 56, pl. 9, figs. 1-3, 1945.

This variety is found in the lower Oligocene and upper Eocene of South Carolina, Georgia, Alabama, Mississippi, and Texas. It occurs in well 2 at 330 feet and in wells 3 and 4 at 390-400, 400-410, 470-480, and 490-500 feet.

#### Genus TEXTULARIA Defrance, 1824

##### *Textularia subhauerii* Cushman

(For figures, see U. S. Geol. Survey Prof. Paper 181, pl. 1, fig. 10, 1935.)

- Textularia subhauerii* Cushman, U. S. Geol. Survey Prof. Paper 129, pp. 89, 126, pl. 14, fig. 2, 1922; Prof. Paper 133, p. 16, 1923.  
 Applin, Am. Assoc. Petroleum Geologists Bull., vol. 9, p. 24, 1925.  
 Cushman, Jour. Paleontology, vol. 1, p. 148, pl. 23, fig. 2, 1927.  
 Cole and Gillespie, Bull. Am. Paleontology, vol. 15, no. 57b, p. 6, 1930.  
 Cushman, U. S. Geol. Survey Prof. Paper 181, p. 8, pl. 1, fig. 10, 1935.  
 Cushman and McGlamery, Prof. Paper 189-D, p. 103, 1938.  
 Davis, Jour. Paleontology, vol. 15, p. 152, pl. 25, fig. 15, 1941.  
 Howe, idem, vol. 16, p. 268 (list), 1942.

This species is recorded from the Oligocene of Alabama, Texas, and Mexico, and from beds of Jackson (Eocene) age of South Carolina, Georgia, Florida, Alabama, and Mississippi. It occurs in wells 3 and 4 at depths of 380-390, 390-400, 400-410, 410-420, 430-440, and 490-500 feet.

## Family VERNEUILINIDAE

Genus GAUDRYINA d'Orbigny, 1839

**Gaudryina** cf. **G. (Pseudogaudryina) alazanensis** Cushman

(Plate 1, figure 1)

The single specimen figured from 460-470 feet in wells 3 and 4 resembles this species, known only from the lower Oligocene of Mexico. More specimens are needed to make certain of its specific identity.

## Family VALVULINIDAE

Genus PLECTINA Marsson, 1878

**Plectina virginiana** Cushman and Cederstrom, n. sp.

(Plate 1, figure 2)

Test small, elongate, gradually tapering, the greatest breadth near the apertural end, periphery slightly lobulated in the later, biserial portion; chambers of the earliest portion rather indistinct, not inflated, in the later biserial portion somewhat inflated and distinct, about three pairs of biserial chambers; sutures of the earlier portion indistinct; wall finely arenaceous, smoothly finished; aperture in the adult, terminal, rounded, without a distinct neck.

Length 0.62-0.75 mm.; breadth 0.30 mm.

Holotype (Cushman Coll. No. 45066) from the Chickahominy formation (Eocene), at a depth of 380-390 feet in Yorktown Navy Mine Depot wells 3 and 4, York County, Virginia. It also occurs at depths of 400-410 and 410-420 feet in the same well.

This species somewhat resembles *P. watersi* Cushman but differs in the smaller, slenderer test and more inflated adult chambers.

## Family MILIOLIDAE

Genus MASSILINA Schlumberger, 1893

**Massilina decorata** Cushman

(For figures, see U. S. Geol. Survey Prof. Paper 181, pl. 3, figs. 14-16, 1935.)

- Massilina decorata* Cushman, U. S. Geol. Survey Prof. Paper 129, p. 143, pl. 34, fig. 7, 1922; Prof. Paper 133, p. 55, 1923.  
 Cushman and G. D. Hanna, California Acad. Sci. Proc., 4th ser., vol. 16, p. 224, 1927.  
 Howe, Jour. Paleontology, vol. 2, p. 175 (list), 1928.  
 Cushman, Cushman Lab. Foram. Research Contr., vol. 5, p. 40, pl. 7, fig. 1, 1929.  
 Cole and Ponton, Florida Geol. Survey Bull. 5, p. 29, pl. 10, fig. 5, 1930.  
 Howe and Wallace, Louisiana Dépt. Cons. Geol. Bull. 2, p. 20, pl. 2, fig. 6, 1932.  
 Cushman and McMasters, Jour. Paleontology, vol. 10, p. 510, pl. 74, fig. 8, 1936.  
 Cushman, U. S. Geol. Survey Prof. Paper 181, p. 13, pl. 3, figs. 14-16, 1935; Cushman Lab. Foram. Research Contr., vol. 15, p. 52, pl. 9, fig. 13, 1939.  
 Galloway and Heminway, New York Acad. Sci., Scientific Survey of Porto Rico and the Virgin Islands, vol. 3, pt. 4, p. 314, pl. 5, fig. 1, 1941.  
 Cushman and McGlamery, U. S. Geol. Survey Prof. Paper 197-B, p. 66, pl. 4, fig. 3, 1942.  
 Franklin, Jour. Paleontology, vol. 18, p. 308, pl. 45, fig. 7, 1944.

This species apparently has a wide distribution in the American Tertiary. It is recorded from the upper Eocene of Mississippi, Louisiana, and California; from the Eocene in cores taken off the eastern coast of the United States; from the Oligocene of Florida, Alabama, Mississippi, and Venezuela; and from the lower Miocene of Puerto Rico.

It occurs in the Yorktown wells at the following depths: well 2, 330, 360, and 380 feet; wells 3 and 4, 380-390, 410-420, 430-440, 450-460, and 470-480 feet.

#### Family LAGENIDAE

Genus ROBULUS Montfort, 1808

**Robulus alato-limbatus** (Gümbel)

(For figures, see U. S. Geol. Survey Prof. Paper 181, pl. 6, fig. 2, 1935.)

*Robulina alato-limbata* Gümbel, K. bayer, Akad. Wiss., Math.-naturh. Abt., Abh., Kl. 2, vol. 10, p. 641, pl. 1, fig. 70, 1868 (1870).

- Cristellaria alato-limbata* Cushman and Applin, Am. Assoc. Petroleum Geologists Bull., vol. 10, p. 171, pl. 8, fig. 8, 1926.
- Robulus alato-limbatus* Cole, Bull. Am. Paleontology, vol. 14, no. 51, p. 18, pl. 4, fig. 1, 1927.
- Howe and Wallace, Louisiana Dept. Cons. Geol. Bull. 2, p. 37, pl. 3, fig. 2, 1932.
- Cushman, U. S. Geol. Survey Prof. Paper 181, p. 15, pl. 6, fig. 2, 1935.
- Coryell and Embich, Jour. Paleontology, vol. 11, p. 299, pl. 41, fig. 16, 1937.
- Howe, Louisiana Dept. Cons. Geol. Bull. 14, p. 40, pl. 4, fig. 18, 1939.
- Cushman and Siegfus, San Diego Soc. Nat. History Trans., vol. 9, no. 34, p. 404, pl. 15, figs. 19-21, 1942.
- Cushman and Applin, Cushman Lab. Foram. Research Contr., vol. 19, p. 33, pl. 7, fig. 11, 1943.
- Cushman and Simonson, Jour. Paleontology, vol. 18, p. 194, pl. 30, fig. 8, 1944.
- Cushman and Todd, Cushman Lab. Foram. Research Contr., vol. 21, p. 13, pl. 3, fig. 11, 1945.

This species, described from the Eocene of southern Europe, is recorded from the Eocene of America in South Carolina, Alabama, Mississippi, Louisiana, Texas, and California, and also in Mexico and Panama.

This species is common in the material from Yorktown, occurring at the following depths: well 2, 330 and 360 feet; wells 3 and 4, 380-390, 390-400, 400-410, 410-420, 420-430, 430-440, 470-480, and 490-500 feet.

***Robulus limbosus* (Reuss), var. *hockleyensis* (Cushman and Applin)**

(For figures, see U. S. Geol. Survey Prof. Paper 181, pl. 4, fig. 15; pl. 6, fig. 3, 1935.)

*Cristellaria limbosa* (Reuss), var. *hockleyensis* Cushman and Applin, Am. Assoc. Petroleum Geologists Bull., vol. 10, p. 171, pl. 8, figs. 3, 4, 1926.

- Robulus limbosus* (Reuss), var. *hockleyensis* Ellisor, Am. Assoc. Petroleum Geologists Bull., vol. 17, no. 11, pl. 1, fig. 11, 1933.  
Cushman and Dusenbury, Cushman Lab. Foram. Research Contr., vol. 10, p. 52, pl. 7, fig. 1, 1934.  
Cushman, U. S. Geol. Survey Prof. Paper 181, p. 16, pl. 4, fig. 15; pl. 6, fig. 3, 1935; Cushman Lab. Foram. Research Contr., vol. 15, p. 53, pl. 9, fig. 21, 1939.  
Cushman and Simonson, Jour. Paleontology, vol. 18, p. 194, pl. 30, fig. 9, 1944.

The records for this variety are from the upper Eocene of North and South Carolina, Alabama, Texas, and California. It also occurs in the Eocene of a submarine core off the eastern coast of the United States, as well as in the Oligocene of California.

In the Yorktown wells it occurs fairly commonly in well 2 at 330 and 380 feet and in wells 3 and 4, at 380-390, 390-400, 400-410, 410-420, 430-440, 450-460, and 470-480 feet.

- Robulus articulatus*** (Reuss), var. ***texanus*** (Cushman and Applin)  
(For figures, see U. S. Geol. Survey Prof. Paper 181, pl. 4, figs. 16, 17, 1935.)

*Cristellaria articulata* Reuss, var. *texana* Cushman and Applin, Am. Assoc. Petroleum Geologists Bull., vol. 10, p. 170, pl. 8, figs. 1, 2, 1926.

*Lenticulina articulata* (Reuss), var. *texana* Howe and Wallace, Louisiana Dept. Cons. Geol. Bull. 2, p. 31, pl. 5, figs. 1, 2, 1932.

- Robulus articulatus* (Reuss), var. *texanus* Ellisor, Am. Assoc. Petroleum Geologists Bull., vol. 17, no. 11, pl. 2, fig. 3, 1933.  
Cushman and Dusenbury, Cushman Lab. Foram. Research Contr., vol. 10, p. 53, pl. 7, figs. 2, 3, 1934.  
Cushman, U. S. Geol. Survey Prof. Paper 181, p. 16, pl. 4, figs. 16, 17, 1935.  
Cushman and Frizzell, Cushman Lab. Foram. Research Contr., vol. 19, p. 83, pl. 14, fig. 10, 1943.  
Cushman and Simonson, Jour. Paleontology, vol. 18, p. 194, pl. 30, fig. 7, 1944.

The records for this variety include the upper Eocene of South Carolina, Louisiana, Texas, and California, and the Oligocene of California and Washington.

In the Yorktown wells it occurs in wells 3 and 4 at depths of 390-400, 400-410, 410-420, and 420-430 feet. This variety is much less common than the two preceding forms.

**Robulus guttucostatus** (Gümbel) (Pl. 1, figs. 4, 5)

*Robulina guttucostata* Gümbel, K. bayer. Akad. Wiss., Math.-naturh. Abt., Abh., Kl. 2, vol. 10, p. 643, pl. 1, fig. 74, 1868 (1870).

Hantken, Magyar kir. földt. int. Evkönyve, vol. 4, p. 48, pl. 6, fig. 10, 1875 (1876); K. ungar. geol. Anstalt Mitt. Jahrb., vol. 4, p. 57, pl. 6, fig. 10, 1875 (1881).

*Robulus guttucostatus* Cushman, U. S. Geol. Survey Prof. Paper 181, p. 15, pl. 5, figs. 1, 2, 1935.

In the American upper Eocene this species is recorded from Florida, Alabama, and Mississippi. It is not common in the well samples but occurs in wells 3 and 4 at depths of 380-390, 390-400, 400-410, 410-420, 420-430, 450-460, and 460-470 feet.

**Robulus virginianus** Cushman and Cederstrom, n. sp. (Pl. 1, fig. 3)

Test somewhat compressed, close coiled, periphery spinose; chambers distinct, slightly inflated in the middle, the final chamber with a definite raised peripheral ridge, about ten in the adult coil, each with a short spine in the middle of the periphery; sutures slightly curved, very little depressed; wall with a raised area along the middle of each chamber, in the earlier ones broken into a few spinose knobs; aperture radiate, at the peripheral angle, with a few coarse teeth.

Length of holotype 0.90 mm.; breadth 0.75 mm.

Holotype (Cushman Coll. No. 45108) from the Chickahominy formation (Eocene), at a depth of 380-390 feet in Yorktown Navy Mine Depot wells 3 and 4, York County, Virginia.

This species differs from *R. guttucostatus* (Gümbel), var. *yazooensis* Cushman in the spinose periphery, the raised areas of the chambers broken into several spinose projections, and the thicker test.

Genus PLANULARIA Defrance, 1824

**Planularia crassilimbata** (Nuttall) (Pl. 1, figs. 6, 7)

*Cristellaria crassilimbata* Nuttall, Quart. Jour. Geol. Soc., vol. 84, p. 87, pl. 5, figs. 16, 17, text fig. 3, 1928.



This species was described from the Tertiary of Trinidad and has not been recorded elsewhere. Very typical specimens occur in Yorktown wells 3 and 4 at depths of 380-390 and 390-400 feet.

**Planularia** sp. (Pl. 2, figs. 1, 2)

The compressed specimens figured are interesting ones from wells 3 and 4 at depths of 450-460 feet. No other specimens are available at present to give the full characters, but it seems worth while to figure and record these.

Genus **MARGINULINA** d'Orbigny, 1826

**Marginulina subrecta** Franke

(For figures, see U. S. Geol. Survey Prof. Paper 181, pl. 7, fig. 3, 1935.)

*Marginulina subrecta* Franke, Danmarks geol. Undersogelse, vol. 2, Raekke, no. 46, p. 19, pl. 1, fig. 28, 1927.

Cushman, U. S. Geol. Survey Prof. Paper 181, p. 18, pl. 7, fig. 3, 1935.

The only other American Eocene record is from South Carolina. It is fairly common in the Yorktown wells, occurring in well 2 at a depth of 330 feet and in wells 3 and 4 at depths of 380-390, 390-400, 400-410, 410-430, 430-440, 450-460 feet.

**Marginulina splendens** Hantken (Pl. 2, fig. 3)

*Marginulina splendens* Hantken, K. ungar. geol. Anstalt Mitt. Jahrb., vol. 4, p. 87, pl. 4, fig. 11, 1875 (1881).

Liebus, Neues Jahrb. für Min., 1901, p. 124; Jahrb. Geol. Reichsanst., vol. 56, p. 354, 1906.

This species was described and recorded from the upper Eocene of Europe. Specimens from Yorktown wells 3 and 4, at depths of 380-390, 400-410, and 410-430 feet, seem identical.

**Marginulina triangularis** d'Orbigny, var. **panamensis** Coryell  
and Embich (Pl. 2, fig. 4)

*Marginulina triangularis* d'Orbigny, var. *panamensis* Coryell and Embich, Jour. Paleontology, vol. 11, p. 297, pl. 42, fig. 1, 1937.

Cushman, Cushman Lab. Foram. Research Contr., vol. 15, p. 56, pl. 9, fig. 26, 1939.

This variety was described from the upper Eocene of Panama. It also occurs in the Eocene of *Atlantis* core 21-38 from the ocean bottom off the eastern coast of the United States. At Yorktown it occurs in wells 3 and 4 at depths of 380-390, 390-400, and 420-430 feet.

***Marginulina subbullata* Hantken (Pl. 2, fig. 5)**

- Marginulina subbullata* Hantken, Magyar kir. földt. int. Evkönyve, vol. 4, p. 39, pl. 4, figs. 9, 10; pl. 5, fig. 9, 1875 (1876); K. ungar. geol. Anstalt Mitt. Jahrb., vol. 4, p. 46, pl. 4, figs. 9, 10; pl. 5, fig. 9, 1875 (1881).
- Cushman, Cushman Lab. Foram. Research Contr., vol. 1, pt. 3, p. 62, pl. 10, fig. 3, 1925.
- Cushman and G. D. Hanna, California Acad. Sci. Proc., 4th ser., vol. 16, p. 216, pl. 13, fig. 11, 1927.
- Cole, Bull. Am. Paleontology, vol. 14, no. 51, p. 14, pl. 5, fig. 10, 1927.
- Cushman, Cushman Lab. Foram. Research Contr., vol. 5, p. 85, pl. 12, fig. 20, 1929.
- Nuttall, Jour. Paleontology, vol. 9, p. 125, pl. 14, fig. 16, 1935.
- Coryell and Embich, idem, vol. 11, p. 297, pl. 42, fig. 2, 1937.
- Cushman, Cushman Lab. Foram. Research Contr., vol. 15, p. 55, pl. 9, figs. 30, 31, 1939.
- LeRoy, Nat. Tijdschr. Nederl.-Indie, vol. 99, pt. 6, p. 234, pl. 1, figs. 11-13, 1939.
- Cushman and Siegfus, San Diego Soc. Nat. History Trans., vol. 9, no. 34, p. 408, pl. 16, fig. 21, 1942.
- Beck, Jour. Paleontology, vol. 17, p. 597, pl. 104, fig. 7, 1943.

The references given are only those accompanied by figures which seem to belong to this widely distributed species described from the upper Eocene of Europe. The only specimens from the Yorktown wells are from wells 3 and 4 at depths of 430-440 feet. These are very similar to ones found in the Eocene of a submarine core from off the eastern United States.

Genus *DENTALINA* d'Orbigny, 1826

***Dentalina cooperensis* Cushman**

(For figures, see U. S. Geol. Survey Prof. Paper 181, pl. 8, figs. 3, 4, 1935.)

*Dentalina cooperensis* Cushman, Cushman Lab. Foram. Research Contr., vol. 9, p. 8, pl. 1, fig. 17, 1933; U. S. Geol. Survey Prof. Paper 181, p. 20, pl. 8, figs. 3, 4, 1935.

Palmer and Bermudez, Soc. cubana hist. nat. Mem., vol. 10, p. 263, pl. 15, fig. 17, 1936.

Coryell and Embich, Jour. Paleontology, vol. 11, p. 298, pl. 42, fig. 7, 1937.

Cushman and Simonson, idem, vol. 18, p. 196, pl. 31, figs. 5-7, 1944.

Cooper, idem, vol. 18, p. 347, pl. 54, fig. 21, 1944.

This species evidently has a wide distribution, occurring in the Eocene of South Carolina, Georgia, Florida, Alabama, Mississippi, Illinois, and Panama, and in the Oligocene of Cuba and California. Typical specimens occur at the following depths: well 2, 330 feet; wells 3 and 4, 380-390, 390-400, 420-430, and 450-460 feet.

***Dentalina* cf. *vertebralis* (Batsch)**

(For figures, see reference below.)

*Dentalina* cf. *D. vertebralis* Cushman, U. S. Geol. Survey Prof. Paper 181, p. 21, pl. 8, figs. 13, 14, 1935.

The reference above is from the upper Eocene of South Carolina, where this form occurred at three different localities. Similar specimens occur at the following depths: well 2, 330 and 360 feet; wells 3 and 4, 380-390, 390-400, 410-420, 430-440, 450-460, and 490-500 feet.

***Dentalina* cf. *jacksonensis* (Cushman and Applin)**

(For figures, see U. S. Geol. Survey Prof. Paper 181, pl. 8, figs. 7-9, 1935.)

Specimens possibly belonging to this upper Eocene species occur in wells 3 and 4 at depths of 380-390 feet.

***Dentalina capitata* (Boll) (Pl. 2, figs. 6-10)**

*Nodosaria capitata* Boll, Geogn. deutsch. Ostseelander, p. 177, pl. 2, fig. 13, 1846.

*Dentalina capitata* Reuss, Akad. Wiss. Wien, Math.-naturwiss. Kl., Sitzungsber., vol. 18, p. 223, pl. 1, fig. 4, 1855 (1856); vol. 50, p. 454, pl. 1, figs. 8-10, 1864 (1865).

Hantken, K. ungar. geol. Anstalt Mitt. Jahrb., vol. 4, p. 35, pl. 3, fig. 16, 1875 (1881).

Cushman and Dusenbury, Cushman Lab. Foram. Research Contr., vol. 10, p. 56, pl. 7, fig. 20, 1934.

This species, known mostly from the upper Eocene of Europe, has also been recorded from the Eocene of California. Specimens which seem typical are common, occurring at the following depths: well 2, 330 and 360 feet; wells 3 and 4, 380-390, 390-400, 400-410, 410-420, 420-430, 450-460, and 460-470 feet.

***Dentalina intermedia* Hantken (Pl. 2, figs. 11, 12)**

*Dentalina intermedia* Hantken, K. ungar. geol. Anstalt Mitt. Jahrb., vol. 4, p. 30, pl. 3, figs. 4, 8, 1875 (1881).

This species was described from the upper Eocene of central Europe. Specimens from the Yorktown wells are rare but are similar to topotypes, with which they have been compared. They are from wells 3 and 4 at depths of 380-390, 390-400, 430-440, and 460-470 feet.

***Dentalina soluta* Reuss (Pl. 2, figs. 13, 14)**

*Dentalina soluta* Reuss, Deutsch. geol. Gesell. Zeitschr., vol. 3, p. 60, pl. 3, fig. 4, 1851.

Bornemann, idem, vol. 7, p. 322, 1855.

Stache, *Novara*-Exped., Geol. Theil, vol. 1, pt. 2, p. 203, pl. 22, fig. 29, 1864.

Hantken, K. ungar. geol. Anstalt Mitt. Jahrb., vol. 4, p. 29, pl. 3, figs. 2, 14, 1875 (1881).

Franke, Mus. Natur.-Heimatkunde Naturw. Ver. Abhandl. Ber., vol. 4, pt. 2, p. 167, pl. 5, fig. 28, 1925; Danmarks geol. Undersogelse, vol. 2, Raekke, no. 46, p. 13, pl. 1, fig. 12, 1927.

Plummer, Texas Univ. Bull. 3101, p. 150, pl. 11, fig. 14, 1931.

Cushman, Cushman Lab. Foram. Research Contr., vol. 15, p. 56, pl. 10, fig. 1, 1939.

Toulmin, Jour. Paleontology, vol. 15, p. 587, pl. 79, figs. 23, 24, 1941.

Franklin, idem, vol. 18, p. 310, pl. 46, fig. 12, 1944.

Cushman and Stainforth, Cushman Lab. Foram. Research Special Publ. 14, p. 24, pl. 3, fig. 18, 1945.

This species was described from the lower Oligocene of Europe but also occurs in the Eocene. In America it has been recorded from

the Upper Cretaceous to the Oligocene. It occurs in the Eocene of a submarine core off the eastern coast of the United States. Specimens occur in wells 3 and 4 at depths of 410-430 feet.

***Dentalina bevani*** Cushman and Cederstrom, n. sp. (Pl. 2,  
figs. 15-18)

Test elongate, slender, gently curved, slightly tapering, initial end with a short spine; chambers numerous, distinct, inflated toward the apertural end, very gradually increasing in size as added; sutures distinct, slightly limbate, becoming progressively depressed toward the apertural end, nearly at right angles to the elongate axis; wall ornamented with eight to ten, fairly high, longitudinal costae, continuous over the sutures; aperture at the outer angle of the last-formed chamber, radiate, with a short but distinct neck.

Length up to 2.00 mm.; diameter up to 0.35 mm.

Holotype (Cushman Coll. No. 45163) from the Chickahominy formation (Eocene), at a depth of 390-400 feet in Yorktown Navy Mine Depot wells 3 and 4, York County, Virginia.

This species differs from *Marginalina cocoaensis* Cushman, which it somewhat resembles, in the more rounded and inflated chambers, straighter and more depressed sutures, and slenderer, more curved test. It is named for Arthur Bevan, State Geologist of Virginia.

This is one of the most distinctive and abundant species of the Chickahominy formation, occurring at the following depths: well 2, 330, 360, and 380 feet; wells 3 and 4, 380-390, 390-400, 400-410, 410-430, 430-440, 450-460, 460-470, 470-480, and 490-500 feet. This should make an excellent index fossil for the Chickahominy formation.

***Dentalina*** sp. (Pl. 2, figs. 19, 20)

A very few, mostly incomplete, specimens of a species which is here figured, occur in wells 3 and 4 at depths of 380-390, 420-430, 430-440, and 490-500 feet. There are not enough specimens to warrant specific determination.

In addition, other species of *Dentalina* are represented by too few or too poorly preserved specimens to give data for identification.

Genus PSEUDOGLANDULINA Cushman, 1929

***Pseudoglandulina laevigata*** (d'Orbigny) (Pl. 3, fig. 1)

*Nodosaria (Glandulina) laevigata* d'Orbigny, Annales sci. nat., vol. 7, p. 252, pl. 10, figs. 1-3, 1826.

*Pseudoglandulina laevigata* Cushman, Cushman Lab. Foram. Research Contr., vol. 15, p. 58, pl. 10, figs. 15, 16, 1939.

Specimens similar to those recorded from the Eocene of the *Atlantis* submarine core from off the eastern coast of the United States occur rarely in wells 3 and 4 at 400-410 feet.

***Pseudoglandulina conica* (Neugeboren) (Pl. 3, fig. 2)**

*Glandulina conica* Neugeboren, Siebenburg. Ver. Naturwiss. Verh. u. Mitt., vol. 1, p. 51, pl. 1, fig. 5, 1850.

*Pseudoglandulina conica* Cushman and Barksdale, Stanford Univ., Dept. Geology Contr., vol. 1, no. 2, p. 65, pl. 12, figs. 1-3, 1930.

Cushman, Cushman Lab. Foram. Research Special Pub. 5, pl. 21, fig. 16, 1933.

Palmer and Bermúdez, Soc. cubana hist. nat. Mem., vol. 10, p. 276, pl. 13, figs. 9-11, 1936.

*Glandulina radícula* Cole (not Linné), Bull. Am. Paleontology, vol. 14, no. 51, p. 17, pl. 3, figs. 6, 7, 1927.

This species has been recorded from the Eocene of Cuba and California and the Oligocene of Cuba and Mexico. Specimens apparently identical occur in wells 3 and 4 at 390-400, 450-460, and 460-470 feet.

***Pseudoglandulina virginiana* Cushman and Cederstrom, n. sp. (Pl. 3, figs. 3, 4.)**

Test circular in section, slightly longer than broad, initial end with a short, stout spine, apertural end broadly rounded; chambers few, usually three to five in the adult, increasing rapidly in size as added; sutures rather indistinct, not depressed; wall smooth, polished; aperture central, terminal, with a distinct, short neck and a slightly toothed lip.

Length 0.80-1.00 mm.; diameter 0.60-0.65 mm.

Holotype (Cushman Coll. No. 45196) from the Chickahominy formation (Eocene), at a depth of 430-440 feet in Yorktown Navy Mine Depot wells 3 and 4, York County, Virginia.

This species closely resembles "*Glandulina napaeformis* Stache" from the Tertiary of the Australian region, but differs in the larger size and broader and less tapering early stages. The apertural characters are similar to those of Stache's species.

This species is common and should make a good index fossil for the Chickahominy formation. It occurs in wells 3 and 4 at 380-390, 390-400, 400-410, 410-420, 420-430, and 430-440 feet.

***Pseudoglandulina* sp. (Pl. 3, fig. 5)**

The specimen figured from the sample in wells 3 and 4, at depths of 430-440 feet, has a very prominent ornamentation consisting of longitudinal costae, but, as it was the only specimen found, no specific identification has been attempted.

Genus **SARACENARIA** Defrance, 1824

***Saracenaria arcuata* (d'Orbigny), var. *hantkeni* Cushman**

(For figures, see U. S. Geol. Survey Prof. Paper 181, pl. 5, figs. 6, 7, 1935.)

*Cristellaria arcuata* Hantken (not d'Orbigny), Magyar kir. földt. int. Evkönyve, vol. 4, p. 45, pl. 5, figs. 5, 6, 1875 (1876); K. ungar. geol. Anstalt Mitt. Jahrb., vol. 4, p. 53, pl. 5, figs. 5, 6, 1875 (1881).

*Saracenaria arcuata* (d'Orbigny), var. *hantkeni* Cushman, Cushman Lab. Foram. Research Contr., vol. 9, p. 4, pl. 1, figs. 11, 12, 1933; U. S. Geol. Survey Prof. Paper 181, p. 17, pl. 5, figs. 6, 7, 1935.

This species occurs in the American upper Eocene of South Carolina, Alabama, and Mississippi. Specimens occur in samples from wells at Yorktown at the following depths: well 2, 330 feet; wells 3 and 4, 380-390, 390-400, 400-410, 410-420, and 430-440 feet.

Genus **FRONDICULARIA** Defrance, 1826

***Frondicularia virginiana* Cushman and Cederstrom, n. sp.**  
(Pl. 3, figs. 6-9)

Test comparatively large, nearly as broad as long, strongly compressed, the central portion slightly concave, periphery concave with slight keel at each side, initial end with occasional, irregular, short, spinose projections; chambers comparatively few, usually up to seven or occasionally nine in the adult, increasing only slightly in height, slightly convex in the middle; sutures distinct, slightly limbate, depressed somewhat, especially toward the middle of the test; wall

mostly smooth but the earlier portion with a few varied costae on the proloculum and the following one to three chambers often with slight elevations in irregular longitudinal lines; aperture terminal, slightly extended, radiate.

Length of holotype 2.60 mm.; breadth 2.15 mm.; thickness 0.30 mm.

Holotype (Cushman Coll. No. 45211) from the Chickahominy formation (Eocene), at a depth of 420-430 feet in Yorktown Navy Mine Depot wells 3 and 4, York County, Virginia.

This species slightly resembles *Fronicularia bradyana* Karrer but differs in the broader test, more even chambers, and the ornamentation of the early portion.

This is a rather striking species and, although not common, should make a good index fossil. It occurs in well 2 at depths of 330 and 360 feet; in wells 3 and 4 at 400-410, 410-430, 430-440, and 460-470 feet.

#### Genus LAGENA Walker and Jacob, 1798

##### **Lagena cf. acuticosta** Reuss

(For figures, see U. S. Geol. Survey Prof. Paper 181, pl. 9, figs. 5, 6, 1935.)

A few specimens from wells 3 and 4, at depths of 380-390, 410-420, and 430-440 feet, are referred to this species. They are very rare.

##### **Lagena costata** (Williamson)

(For figures, see U. S. Geol. Survey Prof. Paper 181, pl. 9, figs. 7, 8, 1935.)

*Entosolemia costata* Williamson, Recent Foraminifera of Great Britain, p. 9, pl. 1, fig. 18, 1858.

*Lagena costata* Reuss, Akad. Wiss. Wien, Math.-naturwiss. Kl., Sitzungsber, vol. 46, p. 329, pl. 4, fig. 54, 1862 (1863).

Cushman, U. S. Geol. Survey Prof. Paper 181, p. 23, pl. 9, figs. 7, 8, 1935.

This species is recorded from the upper Eocene, Ocala limestone of Georgia, and Cooper marl of South Carolina. Rare specimens occur in wells 3 and 4 at depths of 380-390, 390-400, 430-440, and 460-470 feet.



**Lagena laevis** (Montagu) ?

(For figures, see U. S. Geol. Survey Prof. Paper 181, pl. 9, figs. 3, 4, 1935.)

"Serpula (*Lagena*) *laevis ovalis*" Walker and Boys, *Testacea minuta*, p. 3, pl. 1, fig. 9, 1784.

*Vermiculium laeve* Montagu, *Testacea Brittanica*, p. 524, 1803.

*Lagena laevis* Williamson, *Annals and Mag. Nat. History*, 2d ser., vol. 1, p. 12, pl. 1, figs. 1, 2, 1848.

Cushman, U. S. Geol. Survey Prof. Paper 181, p. 22, pl. 9, figs. 3, 4, 1935.

The only specimen referable to this species is from wells 3 and 4 at depths of 390-400 feet.

## Family POLYMORPHINIDAE

Genus *GUTTULINA* d'Orbigny, 1826

***Guttulina problema*** d'Orbigny

(For figures and references, see U. S. Geol. Survey Prof. Paper 181, p. 23, pl. 9, fig. 12, 1935.)

This is a widely distributed species. It occurs at the following depths: well 2, 330, 360, and 380 feet; wells 3 and 4, 380-390, 390-400, 400-410, 410-420, 430-440, 450-460, 460-470, and 490-500 feet.

***Guttulina irregularis*** (d'Orbigny)

(For figures and references, see U. S. Geol. Survey Prof. Paper 181, p. 24, pl. 9, figs. 13-16, 1935.)

Specimens referable to this species occur at the following depths: well 2, 330 and 360 feet; wells 3 and 4, 380-390, 390-400, 400-410, 410-420, 430-440, 450-460, and 460-470 feet.

***Guttulina hantkeni*** Cushman and Ozawa (Pl. 3, figs. 10, 11)

*Polymorphina acuta* Hantken (not d'Orbigny), *K. ungar. geol. Anstalt Mitt. Jahrb.*, vol. 4, p. 60, pl. 8, fig. 4, 1875 (1881) (*acuminata* on explanation of plate).

- Guttulina hantkeni* Cushman and Ozawa, U. S. Nat. Mus. Proc., vol. 77, art. 6, p. 33, pl. 5, figs. 4-6, 1930.  
 Cushman and Dusenbury, Cushman Lab. Forum. Research Contr., vol. 10, p. 60, pl. 8, fig. 5, 1934.  
 Cushman and Todd, idem, vol. 18, p. 34, pl. 6, figs. 11, 12, 1942.  
 Curran, Am. Assoc. Petroleum Geologists Bull., vol. 27, p. 1381 (list), 1943.

The types of this species are from the upper Eocene of Hungary. It has been recorded from the Naheola formation of the Midway group (Paleocene) of Alabama, the Claiborne or equivalent beds of New Jersey and Louisiana, and the Poway conglomerate and Tejon formation of California.

The species is common in the material from Yorktown, occurring at the following depths: well 2, 330, 360, and 380 feet; wells 3 and 4, 380-390, 390-400, 400-410, 410-420, 420-430, 430-440, and 450-460 feet.

Genus GLOBULINA d'Orbigny, 1839

**Globulina gibba** d'Orbigny

(For figures and references, see U. S. Geol. Survey Prof. Paper 181, p. 25, pl. 9, fig. 18, 1935.)

This very common and widely ranging species occurs commonly in the well material at the following depths: well 2, 360 feet; wells 3 and 4, 380-390, 390-400, 400-410, 410-430, 430-440, 450-460, 470-480, and 490-500 feet.

**Globulina gibba** d'Orbigny, var. *punctata* d'Orbigny (Pl. 3, fig. 12)

*Globulina punctata* d'Orbigny, Foraminifères fossiles du bassin tertiaire de Vienne, p. 229, pl. 13, figs. 17, 18, 1846.

*Globulina gibba* d'Orbigny, var. *punctata* Cushman and Ozawa, U. S. Nat. Mus. Proc., vol. 77, art. 6, p. 69, pl. 17, figs. 4, 5, 1930.

*Polymorphina hirsuta* H. B. Brady, Parker, and Jones, Linnean Soc. London Trans., vol. 27, p. 243, pl. 42, fig. 37, 1870.

Reuss, Akad. Wiss. Wien, Math.-naturwiss. Kl., Sitzungsber, vol. 62, pt. 1, p. 486, 1870; von Schlicht, Die Foraminiferen des Septarienthones von Pietzpuhl, pl. 34, figs. 1-3, 1870.

Jones and Chapman, Linnean Soc. Jour. Zoology, vol. 25, p. 511, text fig. 21, 1896.

Jones, Foraminifera of the Crag, pt. 3, p. 273, pl. 6, fig. 14, 1896.  
Heron-Allen and Earland, Royal Micr. Soc. Jour., 1909, p. 435,  
pl. 17, fig. 7.

Franke, Greifswald Univ., Geol.-paleont. Inst., Abh., vol. 6, p. 79,  
pl. 6, fig. 22, 1925.

*Globulina rugosa* d'Orbigny, Foraminifères fossiles du bassin tertiaire  
de Vienne, p. 229, pl. 13, figs. 19, 20, 1846.

Terquem, Essai sur le classement des animaux qui vivent sur la  
plage et dans les environs de Dunkerque, pt. 2, p. 77, pl. 10,  
fig. 1, 1876.

*Polymorphina rugosa* Cushman, U. S. Nat. Mus. Bull. 104, pt. 4, p.  
157, pl. 41, fig. 6, 1923.

*Polymorphina globosa* Karrer (not von Münster), Akad. Wiss. Wien,  
Math.-naturwiss. Kl., Sitzungsber, vol. 52, pt. 1, p. 497, pl.,  
fig. 12, 1865.

This variety is widely distributed in Europe and ranges from  
upper Eocene to Recent. It has not been recorded from America.  
Specimens that seem to belong to this variety occur at the following  
depths: well 2, 360 feet; wells 3 and 4, 390-400, 410-430, and  
490-500 feet.

#### ***Globulina inaequalis* Reuss**

(For references and figures, see U. S. Geol. Survey Prof. Paper 181,  
p. 26, pl. 9, fig. 22, 1935.)

This species is widely distributed and occurs in the Eocene, Oli-  
gocene, and Miocene in America. It is not common in this material,  
but occurs at the following depths: wells 3 and 4, 390-400, 400-410,  
410-420, and 460-470 feet.

#### ***Globulina münsteri* (Reuss)**

(For references and figures, see U. S. Geol. Survey Prof. Paper 181,  
p. 27, pl. 9, fig. 25, 1935.)

The only specimen referable to this species was from wells 3 and  
4 at depths of 420-430 feet.

## Genus POLYMORPHINA d'Orbigny, 1826

**Polymorphina advena** Cushman

(For figures, see U. S. Geol. Survey Prof. Paper 181, pl. 10, fig. 8, 1935.)

*Polymorphina advena* Cushman, U. S. Geol. Survey Prof. Paper 129, p. 132, pl. 31, fig. 4, 1922; Cushman Lab. Foram. Research Contr., vol. 5, p. 41, pl. 7, fig. 5, 1929.

Cushman and Ozawa, U. S. Nat. Mus. Proc., vol. 77, art. 6, p. 118, pl. 30, fig. 10, 1930.

Cushman and Ponton, Florida Geol. Survey Bull. 9, p. 67, pl. 10, fig. 4, 1932.

Cushman, U. S. Geol. Survey Prof. Paper 181, p. 29, pl. 10, fig. 8, 1935.

Cushman and McGlamery, idem, Prof. Paper 189-D, p. 106, pl. 24, fig. 21, 1938.

Howe, Jour. Paleontology, vol. 16, p. 268 (list), 1942.

Cushman and Herrick, Cushman Lab. Foram. Research Contr., vol. 21, p. 61, pl. 10, fig. 5, 1945.

This species is known from the Miocene of Florida, the Oligocene of Alabama and Mississippi, and the upper Eocene of Georgia, South Carolina, Alabama, and Mississippi.

It is rare in the material from Yorktown, occurring only in wells 3 and 4 at depths of 400-410 feet.

## Genus SIGMOMORPHINA Cushman and Ozawa

**Sigmomorphina semitecta** (Reuss), var. **terquemiana** (Fornasini)  
(Pl. 3, figs. 13, 14)

(For references, see U. S. Geol. Survey Prof. Paper 181, p. 28, 1935.)

The only occurrence of this variety is from wells 3 and 4 at depths of 490-500 feet.

## Genus SIGMOIDELLA Cushman and Ozawa, 1928

**Sigmoidella plummerae** Cushman and Ozawa (Pl. 4, figs. 1, 2)

*Sigmoidella plummerae* Cushman and Ozawa, U. S. Nat. Mus. Proc., vol. 77, art. 6, p. 142, pl. 39, fig. 3, 1930.

Cushman, Cushman Lab. Foram. Research Contr., vol. 6, p. 101, 1930; U. S. Geol. Survey Prof. Paper 181, p. 29, pl. 10, fig. 13, 1935.

Howe, Louisiana Dept. Cons. Geol. Bull. 14, p. 56, pl. 7, fig. 14, 1939.

This species occurs in the Cook Mountain formation of the Claiborne group (Eocene) in Texas and Louisiana and is common in the Cooper marl of Jackson age (Eocene) in South Carolina. It is common in the samples from Yorktown at the following depths: well 2, 330 feet; wells 3 and 4, 380-390, 390-400, 400-410, 410-420, 420-430, 430-440, 450-460, and 490-500 feet.

Genus *POLYMORPHINELLA* Cushman and Hanzawa, 1936

*Polymorphinella gracilis* Cushman and Cederstrom, n. sp.  
(Pl. 4, fig. 3)

Test elongate, slender, early portion tapering to an acute point, later portion with the sides nearly parallel, dorsal margin slightly concave, ventral margin convex, apertural end bluntly pointed; chambers distinct, the early biserial portion with four or five, slightly enlarging chambers, three in the adult uniserial portion; sutures distinct, slightly depressed in the later portion; wall smooth; aperture terminal, radiate.

Length 0.76-0.90 mm.; breadth 0.12-0.15 mm.

Holotype (Cushman Coll. No. 45286), from the Chickahominy formation (Eocene), at a depth of 390-400 feet in Yorktown Navy Mine Depot wells 3 and 4, York County, Virginia. Specimens occur also at 400-410 feet and in well 2 at 330 feet.

This species differs from *P. elongata* Toulmin in the smaller, slenderer test, more pointed base, and less oblique sutures.

#### Family NONIONIDAE

Genus *NONION* Montfort, 1808

*Nonion planatum* Cushman and Thomas (Pl. 4, fig. 4)

*Nonion planatum* Cushman and Thomas, Jour. Paleontology, vol. 4, p. 37, pl. 3, fig. 5, 1930.

Cushman and Dusenbury, Cushman Lab. Foram. Research Contr., vol. 10, p. 60, pl. 8, fig. 6, 1934.

Cushman and Garrett, idem, vol. 15, p. 81, pl. 14, figs. 12, 13, 1939.

- Howe, Louisiana Dept. Cons. Geol. Bull. 14, p. 58, pl. 7, figs. 24, 25, 1939.
- Cushman, U. S. Geol. Survey Prof. Paper 191, p. 4, pl. 1, fig. 15, 1939.
- Beck, Jour. Paleontology, vol. 17, p. 603, pl. 107, figs. 12, 13, 1943.
- Cushman and Applin, Cushman Lab. Foram. Research Contr., vol. 19, p. 37, pl. 7, fig. 24, 1943.
- Kelley, Am. Assoc. Petroleum Geologists Bull., vol. 27, pp. 8, 11 (lists), 1943.
- Martin, Stanford Univ. Publ., Univ. Ser., Geol. Sci., vol. 3, no. 3, p. 11 (list), 1943.
- Bandy, Jour. Paleontology, vol. 18, p. 370, pl. 60, fig. 15, 1944.
- Cushman and Todd, Cushman Lab. Foram. Research Contr., vol. 21, p. 15, pl. 3, fig. 29, 1945.
- Cushman and Herrick, *idem*, vol. 21, p. 61, pl. 10, fig. 8, 1945.

This species is found especially in the Eocene in beds of Claiborne age, but also in beds of Wilcox and Jackson age. It is recorded from Georgia, Alabama, Mississippi, Louisiana, Texas, California, Oregon, and Washington. It occurs in wells 3 and 4 at depths of 380-390, 390-400, 400-410, 410-420, and 430-440 feet.

***Nonion danvillensis*** Howe and Wallace (Pl. 4, fig. 5)

- Nonion danvillensis* Howe and Wallace, Louisiana Dept. Cons. Geol. Bull. 2, p. 51, pl. 9, fig. 3, 1932.
- Cushman, U. S. Geol. Survey Prof. Paper 191, p. 5, pl. 1, fig. 19, 1939.
- Howe, Jour. Paleontology, vol. 16, p. 267 (list), 1942.

The records for this species are from the Jackson formation (Eocene) of Louisiana and the Glendon formation (lower Oligocene) of Alabama. A single specimen from wells 3 and 4, at 430-440 feet, seems typical.

Genus *NONIONELLA* Cushman, 1926

- Nonionella hantkeni*** (Cushman and Applin), var. *spissa* Cushman (Pl. 4, fig. 6)
- Nonionella hantkeni* (Cushman and Applin), var. *spissa* Cushman, Cushman Lab. Foram. Research Contr., vol. 7, p. 58, pl. 7, fig. 13, 1931.

Ellisor, Am. Assoc. Petroleum Geologists Bull., vol. 17, no. 11, pl. 2, figs. 10, 12, 1933.

Cushman, U. S. Geol. Survey Prof. Paper 181, p. 31, pl. 12, fig. 6, 1935.

Cushman and McGlamery, Prof. Paper 189-D, p. 106, pl. 25, fig. 2, 1938.

Cushman, Prof. Paper 191, p. 30, pl. 8, fig. 5, 1939.

Cushman and Herrick, Cushman Lab. Foram. Research Contr., vol. 21, p. 63, pl. 10, fig. 12, 1945.

This variety occurs in the upper Eocene of South Carolina, Georgia, Florida, Alabama, Mississippi, and Texas, and in the Oligocene of Alabama. It occurs in wells 3 and 4 at depths of 380-390, 390-400, and 410-420 feet.

#### Family HETEROHELICIDAE

#### Genus GÜMBELINA Egger, 1899

**Gümbelina cubensis** Palmer, var. *heterostoma* Bermudez  
(Pl. 4, fig. 7)

*Gümbelina cubensis* Palmer, var. *heterostoma* Bermudez, Soc. cubana hist. nat. Mem., vol. 11, p. 143, pl. 17, figs. 5-7, 1937.

The only previous record for this variety is from the Eocene of Cuba. Specimens from wells 3 and 4, at depths of 390-400, 410-430, and 430-440 feet, seem to be identical with this variety.

#### Genus PLECTOFRONDICULARIA Liebus, 1903

#### **Plectofrondicularia cookei** Cushman

(For figures, see U. S. Geol. Survey Prof. Paper 181, pl. 13, figs. 11, 12, 1935.)

*Plectofrondicularia cookei* Cushman, Cushman Lab. Foram. Research Contr., vol. 9, p. 11, pl. 1, fig. 26, 1933; U. S. Geol. Survey Prof. Paper 181, p. 34, pl. 12, figs. 11, 12, 1935.

Coryell and Embich, Jour. Paleontology, vol. 11, p. 303, pl. 42, fig. 14, 1937.

Bermudez, Soc. cubana hist. nat. Mem., vol. 12, p. 19, 1938.

Martin, Stanford Univ. Publ., Univ. Ser., Geol. Sci., vol. 3, no. 3, p. 12 (list), 1943.

Weaver, Washington Univ. (Seattle) Pub. in Geology, vol. 6, no. 1, p. 25 (list), 1944.

Cushman and Stainforth, Cushman Lab. Foram. Research Special Pub. 14, p. 36, pl. 5, fig. 12, 1945.

This is a species of the upper Eocene, recorded from South Carolina, Cuba, Panama, Trinidad, and California.

Rather typical specimens occur in wells 3 and 4, at depths of 450-460 and 470-480 feet.

***Plectofrondicularia virginiana*** Cushman and Cederstrom, n. sp.  
(Pl. 4, fig. 8)

Test very strongly compressed, rhomboid, longer than broad, initial end somewhat rounded, periphery acute but not keeled; chambers numerous, earlier ones biserial, soon becoming uniserial, low, extending backward at the periphery, at least to the middle even in the final chamber, not inflated; sutures distinct, strongly limbate; wall smooth except for the very earliest portion which is raised somewhat in the middle; aperture terminal, without a neck.

Length 1.00-1.25 mm.; breadth 0.40-0.60 mm.; thickness 0.05 mm.

Holotype (Cushman Coll. No. 45306) from the Chickahominy formation (Eocene), at a depth of 390-400 feet in Yorktown Navy Mine Depot wells 3 and 4, York County, Virginia.

This species is rather common and should make a good index fossil. It occurs at the following depths: well 2, 330 and 360 feet; wells 3 and 4, 380-390, 390-400, 400-410, 410-430, 430-440, 450-460, 470-480, and 490-500 feet. It differs from *P. packardi* Cushman and Schenck in the smaller size, more rhomboid form, much more strongly compressed test, and the basal portion with a single raised area.

Family BULIMINIDAE

Genus BULIMINA d'Orbigny, 1826

***Bulimina ovata*** d'Orbigny

(For figures and references, see U. S. Geol. Survey Prof. Paper 181, p. 35, pl. 13, figs. 15, 16, 1935.)

This occurs commonly at the following depths: well 2, 330 and 360 feet; wells 3 and 4, 380-390, 390-400, 400-410, 410-420, 420-430, 430-440, 460-470, and 490-500 feet.



**Bulimina jacksonensis** Cushman, var. *cuneata* Cushman

(For figures, see U. S. Geol. Survey Prof. Paper 181, pl. 13, figs. 10, 11, 1935.)

*Bulimina jacksonensis* Cushman, var. *cuneata* Cushman, Cushman Lab. Foram. Research Contr., vol. 2, pt. 2, p. 35, 1926; U. S. Geol. Survey Prof. Paper 181, p. 35, pl. 13, figs. 10, 11, 1935.

The only records for this variety are from the upper Eocene of South Carolina and Alabama. It is a common species in the material from Yorktown occurring at the following depths: well 2, 380 feet; wells 3 and 4, 380-390, 390-400, 430-440, 450-460, 460-470, 470-480, and 490-500 feet.

**Bulimina cooperensis** Cushman

(For figures, see U. S. Geol. Survey Prof. Paper 181, pl. 13, figs. 12-14, 1935.)

*Bulimina cooperensis* Cushman, Cushman Lab. Foram. Research Contr., vol. 9, p. 12, pl. 1, fig. 32, 1933; U. S. Geol. Survey Prof. Paper 181, p. 35, pl. 13, figs. 12-14, 1935; Cushman Lab. Foram. Research Contr., vol. 21, p. 8, 1945.

The records for this species are from the upper Eocene, Cooper marl of South Carolina and Twiggs clay member of the Barnwell formation of Georgia. The only occurrence in the material from Yorktown is in well 2, at a depth of 360 feet.

Genus *VIRGULINA* d'Orbigny, 1826**Virgulina minutissima** Cushman (Pl. 4, fig. 9)

*Virgulina minutissima* Cushman, Cushman Lab. Foram. Research Contr., vol. 21, p. 8, pl. 2, fig. 7, 1945.

This species, described from the Twiggs clay member of the Barnwell formation (upper Eocene) of Georgia, occurs in wells 3 and 4 at depths of 380-390, 390-400, 400-410, 410-420, and 430-440 feet.

**Virgulina recta** Cushman, var. *howei* Cushman (Pl. 4, fig. 10)

*Virgulina recta* Cushman, var. *howei* Cushman, Cushman Lab. Foram. Research Special Pub. 6, p. 47, pl. 7, fig. 4, 1936; Special Pub. 9, p. 8, pl. 1, figs. 24, 25, 1937.

This variety from the Jackson formation (upper Eocene) in Louisiana, is present in wells 3 and 4 at 390-400, 400-410, and 430-440 feet.

Genus BOLIVINA d'Orbigny, 1839

**Bolivina gardnerae** Cushman, var. **lineata** Cushman and Cederstrom, n. var. (Pl. 4, fig. 11)

Variety differs from the typical in the more rounded periphery and the arrangement of the coarse perforations in distinct, longitudinal lines.

Holotype of variety (Cushman Coll. No. 45347) from the Chickahominy formation (Eocene), at a depth of 430-440 feet in Yorktown Navy Mine Depot wells 3 and 4, York County, Virginia. Specimens also occur in well 2, at 360 feet, and wells 3 and 4, at 410-420, 420-430, 450-460, 470-480, and 490-500 feet.

**Bolivina virginiana** Cushman and Cederstrom, n. sp. (Pl. 4, fig. 12)

Test small, about twice as long as broad, initial end broadly rounded, very gradually tapering, periphery acute, sometimes slightly keeled near the initial end; chambers rather indistinct, increasing very gradually in size and height as added, not inflated; sutures in the later portion limbate and slightly raised, gently curved; wall ornamented with irregular, longitudinal costae on the earlier half, gradually becoming obsolete toward the apertural end; aperture a fairly narrow opening at the inner end of the terminal face of the last-formed chamber, often with a slight lip.

Length 0.28-0.35 mm.; breadth 0.12-0.18 mm.

Holotype (Cushman Coll. No. 45354) from the Chickahominy formation (Eocene), at a depth of 380-390 feet in Yorktown Navy Mine Depot wells 3 and 4, York County, Virginia. The species also occurs at depths of 390-400 and 400-410 feet in the same wells.

It differs from *B. tectiformis* Cushman which it resembles, in the thinner periphery, more irregular ornamentation, and lack of a distinct median elevation.

Genus LOXOSTOMUM Ehrenberg, 1854

**Loxostomum longiforme** Cushman and Cederstrom, n. sp. (Pl. 4, fig. 13)

Test elongate, slender, about three times as long as broad, periphery rounded, base bluntly rounded, early portion slightly tapering, adult portion with the sides nearly parallel or even contracting slightly toward the apertural end; chambers numerous, distinct, later ones inflated, increasing gradually in height as added; sutures distinct, strongly oblique but not curved, depressed except in the early portion; wall coarsely perforate, with a tendency to a longitudinal arrangement, in some specimens very finely spinose; aperture terminal, elliptical.

Length 0.32-0.40 mm.; breadth 0.10-0.12 mm.

Holotype (Cushman Coll. No. 45358) from the Chickahominy formation (Eocene), at a depth of 380-390 feet in Yorktown Navy Mine Depot wells 3 and 4, York County, Virginia. It also occurs at depths of 390-400, 400-410, 410-430, and 430-440 feet in the same wells.

This species differs from *L. claibornense* Cushman in the straighter sutures and more nearly parallel sides.

#### Genus UVIGERINA d'Orbigny, 1826

##### *Uvigerina cookei* Cushman

(For figures, see U. S. Geol. Survey Prof. Paper 181, pl. 15, figs. 14-16, 1935.)

*Uvigerina cookei* Cushman, U. S. Geol. Survey Prof. Paper 181, p. 39, pl. 15, figs. 14-16, 1935.

Cushman and Edwards, Cushman Lab. Foram. Research Contr., vol. 13, p. 76, pl. 11, figs. 10, 11, 1937.

This species occurs in beds of Jackson age (Eocene) in North Carolina, South Carolina, Georgia, and Alabama. It is common in the material from Yorktown at the following depths: well 2, 330 and 360 feet; wells 3 and 4, 380-390, 390-400, 400-410, 410-420, 420-430, 430-440, 450-460, and 470-480 feet.

##### *Uvigerina dumblei* Cushman and Applin

(For figures, see U. S. Geol. Survey Prof. Paper 181, pl. 15, fig. 17, 1935.)

*Uvigerina dumblei* Cushman and Applin, Am. Assoc. Petroleum Geologists Bull., vol. 10, p. 177, pl. 8, fig. 19, 1926.

Cushman, U. S. Geol. Survey Prof. Paper 181, p. 39, pl. 15, fig. 17, 1935.

Cushman and Edwards, Cushman Lab. Foram. Research Contr.,  
vol. 13, p. 78, pl. 11, fig. 17, 1937.

This species has been recorded only from the upper Eocene of Texas. It occurs in wells 3 and 4, at depths of 410-430 feet, in typical form.

#### *Uvigerina gardnerae* Cushman

(For figures, see U. S. Geol. Survey Prof. Paper 181, pl. 15, figs. 18,  
19, 1935.)

*Uvigerina gardnerae* Cushman, in Cushman and Applin, Am. Assoc.  
Petroleum Geologists Bull., vol. 10, p. 175, pl. 8, figs. 16, 17,  
1926.

Howe and Wallace, Louisiana Dept. Cons. Geol. Bull. 2, p. 63,  
pl. 12, fig. 6, 1932.

Cushman, U. S. Geol. Survey Prof. Paper 181, p. 40, pl. 15, figs.  
18, 19, 1935.

Cushman and Edwards, Cushman Lab. Foram. Research Contr.,  
vol. 13, p. 79, pl. 11, figs. 19, 20, 1937.

This species is known from the upper Eocene of South Carolina, Florida, Alabama, Mississippi, Louisiana, and Texas. Although recorded elsewhere, the figures do not seem to be the same or no figures are given. It occurs in wells 3 and 4, at depths of 380-390, 390-400, 400-410, 470-480, and 490-500 feet.

#### *Uvigerina yazooensis* Cushman

(For figures, see U. S. Geol. Survey Prof. Paper 181, pl. 16, figs. 5,  
6, 1935.)

*Uvigerina yazooensis* Cushman, Cushman Lab. Foram. Research Contr.,  
vol. 9, p. 13, pl. 1, fig. 29, 1933; U. S. Geol. Survey Prof.  
Paper 181, p. 41, pl. 16, figs. 5, 6, 1935.

Cushman and Edwards, Cushman Lab. Foram. Research Contr.,  
vol. 13, p. 85, pl. 12, figs. 16, 17, 1937.

This species is known from the upper Eocene of South Carolina, Alabama, Mississippi, and probably from Mexico. It occurs at the following depths: well 2, 330 and 360 feet; wells 3 and 4, 390-400, 410-420, and 470-480 feet.

**Uvigerina elongata** Cole (Pl. 4, fig. 15)

- Uvigerina elongata* Cole, Bull. Am. Paleontology, vol. 14, no. 51, p. 26, pl. 4, figs. 2, 3, 1927.
- Palmer and Bermudez, Soc. cubana hist. nat. Mem., vol. 10, p. 292, 1936.
- Cushman and Edwards, Cushman Lab. Foram. Research Contr., vol. 13, p. 78, pl. 11, figs. 15, 16, 1937.
- Cushman, idem, vol. 15, p. 65, pl. 11, fig. 11, 1939.
- Howe, Louisiana Dept. Cons. Geol. Bull. 14, p. 71, pl. 8, fig. 20, 1939.
- Galloway and Heminway, New York Acad. Sci., Scientific Survey of Puerto Rico and the Virgin Islands, vol. 3, pt. 4, p. 428, pl. 33, fig. 5, 1941.

A few specimens appear to belong to this species described from the Guayabal formation of Mexico, and recorded from the Cook Mountain formation of Louisiana, the Eocene of cores taken off the east coast of the United States, the Oligocene of Cuba, and the upper Oligocene to lower Miocene of Puerto Rico. The species occurs at the following depths: well 2, 330 feet; wells 3 and 4, 390-400, 400-410, 410-420, and 460-470 feet.

Genus **ANGULOGERINA** Cushman, 1927**Angulogerina cooperensis** Cushman

(For figures, see U. S. Geol. Survey Prof. Paper 181, pl. 16, fig. 9, 1935.)

- Angulogerina cooperensis* Cushman, U. S. Geol. Survey Prof. Paper 181, p. 42, pl. 16, fig. 9, 1935.
- Bermudez, Soc. cubana hist. nat. Mem, vol. 11, p. 338, 1937.
- Galloway and Heminway, New York Acad. Sci., Scientific Survey of Puerto Rico and the Virgin Islands, vol. 3, pt. 4, p. 436, pl. 34, fig. 13, 1941.
- Cushman and Herrick, Cushman Lab. Foram. Research Contr., vol. 21, p. 66, pl. 10, fig. 28, 1945.

A few specimens referable to this species, described from the Eocene of South Carolina, occur in wells 3 and 4, at depths of 390-400, 400-410, and 470-480 feet.

**Angulogerina danvillensis** Howe and Wallace (Pl. 4, fig. 16)

*Angulogerina danvillensis* Howe and Wallace, Louisiana Dept. Cons. Geol. Bull. 2, p. 56, pl. 12, fig. 2, 1932.

The only record for this species is from the Jackson formation (upper Eocene) of Louisiana.

Specimens very similar to topotypes of this species occur at the following depths: well 2, 330, 360, and 380 feet; wells 3 and 4, 380-390, 390-400, 400-410, 410-420, 420-430, 430-440, 450-460, 460-470, 470-480, and 490-500 feet.

Genus ENTOSOLENIA Ehrenberg, 1848

**Entosolenia cf. apiculata** (Reuss) (Pl. 4, fig. 14)

A single specimen from wells 3 and 4, 410-420 feet, seems to belong to this species.

Family ELLIPSOIDINIDAE

Genus ELLIPSONODOSARIA A. Silvestri, 1900

**Ellipsonodosaria atlantisae** Cushman, var. **hispidula** Cushman  
(Pl. 4, figs. 17, 18)

*Ellipsonodosaria atlantisae* Cushman, var. *hispidula* Cushman, Cushman Lab. For. Research Contr., vol. 15, p. 70, pl. 12, fig. 5, 1939.

The types of this variety are from the Eocene of a submarine core off the eastern coast of the United States. The form is common in the Eocene of the Yorktown wells at the following depths: well 2, 330 and 360 feet; wells 3 and 4, 380-390, 390-400, 400-410, 410-420, 420-430, 430-440, 450-460, and 470-480 feet.

**Ellipsonodosaria cf. longiscata** (d'Orbigny) (Pl. 4, figs. 19-21)

Specimens which may be referred to this species occur at the following depths: well 2, 330 feet; wells 3 and 4, 380-390, 390-400, 400-410, 410-430, 450-460, and 490-500 feet.

Family ROTALIIDAE

Genus DISCORBIS Lamarck, 1804

**Discorbis alveata** Cushman

(For figures, see U.S. Geol. Survey Prof. Paper 181, pl. 17, fig. 4, 1935.)

*Discorbis alveata* Cushman, Cushman Lab. Foram. Research Contr., vol. 9, p. 16, pl. 2, fig. 4, 1933; U. S. Geol. Survey Prof. Paper 181, p. 44, pl. 17, fig. 4, 1935.

The only record for this species is from the Jackson group (upper Eocene) of Mississippi. A single typical specimen occurred in wells 3 and 4 at depths of 410-420 feet.

#### GENUS EPONIDES Montfort, 1808

##### **Eponides jacksonensis** (Cushman and Applin)

(For figures, see U. S. Geol. Survey Prof. Paper 181, pl. 19, figs. 4-8, 1935.)

*Pulvinulina jacksonensis* Cushman and Applin, Am. Assoc. Petroleum Geologists Bull., vol. 10, p. 181, pl. 9, figs. 24, 25, 1926.

*Eponides jacksonensis* Cushman, U. S. Geol. Survey Prof. Paper 181, p. 46, pl. 19, figs. 4-8, 1935.

Coryell and Embich, Jour. Paleontology, vol. 11, p. 301, pl. 43, fig. 5, 1937.

Cole, Florida Geol. Survey Bull. 19, p. 37, pl. 1, figs. 3, 4, 1941.

Applin and Applin, Am. Assoc. Petroleum Geologists Bull., vol. 28, no. 12, pl. 1, fig. 6, 1944.

Applin and Jordan, Jour. Paleontology, vol. 19, p. 130 (list), 1945.

Cushman, Cushman Lab. Foram. Research Contr., vol. 21, p. 10, 1945.

This species is characteristic of the upper Eocene, occurring in South Carolina, Georgia, Florida, Alabama, Mississippi, and Panama. A single specimen occurred in wells 3 and 4 at depths of 470-480 feet.

##### **Eponides umbonatus** (Reuss)

(For figures and earlier references, see U. S. Geol. Survey Prof. Paper 181, p. 48, pl. 19, fig. 10, 1935.)

This species is very widely distributed in the Tertiary. It occurs at the following depths: well 2, 330 and 360 feet; wells 3 and 4, 380-390, 390-400, 400-410, 410-430, 430-440, 450-460, and 470-480 feet.

## Genus VALVULINERIA Cushman, 1926

**Valvulineria texana** Cushman and Ellisor (Pl. 5, figs. 1, 2)

*Valvulineria texana* Cushman and Ellisor, Cushman Lab. Foram. Research Contr., vol. 7, p. 56, pl. 7, fig. 9, 1931.

Howe and Wallace, Louisiana Dept. Cons. Geol. Bull. 2, p. 70, pl. 13, fig. 6, 1932.

Ellisor, Am. Assoc. Petroleum Geologists Bull., vol. 17, no. 11, pl. 4, fig. 1, 1933.

Cushman and Herrick, Cushman Lab. Foram. Research Contr., vol. 21, p. 68, pl. 11, fig. 6, 1945.

This species is known from the Jackson formation (upper Eocene) of Texas and Louisiana. Rare specimens occur in wells 3 and 4 at depths of 380-390, 400-410, 410-420, and 430-440 feet.

## Genus GYROIDINA d'Orbigny, 1826

**Gyroidina orbicularis** d'Orbigny, var. **planata** Cushman

(For figures, see U. S. Geol. Survey Prof. Paper 181, pl. 18, fig. 3, 1935.)

*Gyroidina orbicularis* d'Orbigny, var. *planata* Cushman, U. S. Geol. Survey Prof. Paper 181, p. 45, pl. 18, fig. 3, 1935.

Cushman and Siegfus, San Diego Soc. Nat. History Trans., vol. 9, no. 34, p. 419, pl. 17, fig. 32, 1942.

Cushman and Frizzell, Cushman Lab. Foram. Research Contr., vol. 19, p. 87, pl. 15, figs. 2-4, 1943.

The types of this variety are from the Cooper marl (upper Eocene) of South Carolina. It is also recorded from the Kreyenhagen shale (Eocene and Oligocene) of California and the Lincoln formation (Oligocene) of Washington.

This variety is common in the Yorktown material at the following depths: well 2, 330, 360 and 380 feet; wells 3 and 4, 380-390, 390-400, 400-410, 410-420, 420-430, 430-440, 450-460, 460-470, 470-480, and 490-500 feet.

**Gyroidina danvillensis** Howe and Wallace (Pl. 5, fig. 3)

*Gyroidina danvillensis* Howe and Wallace, Louisiana Dept. Cons. Geol. Bull. 2, p. 69, pl. 13, fig. 3, 1932.

Nuttall, Jour. Paleontology, vol. 9, p. 128, pl. 15, figs. 10, 11, 1935.



Martin, Stanford Univ. Publ., Univ. Ser., Geol. Sci., vol. 3, no. 3, p. 11 (list), 1943.

The types of this species are from the Jackson formation (upper Eocene) of Louisiana. It is also recorded from the upper Eocene of Venezuela and California. The only specimens are from well 2 at a depth of 380 feet, and from wells 3 and 4 at depths of 410-420 feet.

Genus SIPHONINA Reuss, 1849

**Siphonina tenuicarinata** Cushman (Pl. 5, fig. 4)

*Siphonina tenuicarinata* Cushman, Jour. Paleontology, vol. 1, p. 166, pl. 26, figs. 11, 12, 1927; U. S. Nat. Mus. Proc., vol. 72, art. 20, p. 6, pl. 4, fig. 1, 1927.

Cole, Bull. Am. Paleontology, vol. 14, no. 51, p. 30, pl. 5, figs. 1, 2, 1927.

Weinzierl and Applin, Jour. Paleontology, vol. 3, p. 407, 1929.

Cushman, Cushman Lab. Foram. Research Contr., vol. 5, p. 100, pl. 14, fig. 9, 1929.

Nuttall, Jour. Paleontology, vol. 6, p. 26, 1932.

Hadley, Bull. Am. Paleontology, vol. 20, no. 70A, p. 23, 1934.

Palmer and Bermudez, Soc. cubana hist. nat. Mem., vol. 10, p. 304, 1936.

Coryell and Embich, Jour. Paleontology, vol. 11, p. 301, pl. 43, fig. 7, 1937.

Hedberg, idem, vol. 11, p. 679, pl. 92, fig. 4, 1937.

LeRoy, Nat. Tijdschr. Nederl.-Indie, vol. 99, pt. 6, p. 258, pl. 3, figs. 7-9, 1939.

Coryell and Rivero, Jour. Paleontology, vol. 14, p. 337, pl. 43, figs. 22, 29, 1940.

Galloway and Heminway, New York Acad. Sci., Scientific Survey of Puerto Rico and the Virgin Islands, vol. 3, pt. 4, p. 402, pl. 26, fig. 2, 1941.

Franklin, Jour. Paleontology, vol. 18, p. 316, pl. 47, fig. 7, 1944.

Weaver, Washington Univ. (Seattle) Pub. in Geology, vol. 6, no. 1, p. 25 (list), 1944.

This species, from the records, seems to be widely distributed in formations of upper Eocene to Miocene. It is rather common in the Yorktown material, occurring at the following depths: well 2, 330 feet; wells 3 and 4, 380-390, 390-400, 400-410, 410-420, 420-430, 430-440, 450-460, and 490-500 feet.

## Genus EPISTOMINA Terquem, 1883

**Epistomina eocenica** Cushman and M. A. Hanna (Pl. 5, figs. 5, 6)

*Epistomina eocenica* Cushman and M. A. Hanna, San Diego Soc. Nat. History Trans., vol. 5, no. 4, p. 53, pl. 5, figs. 4, 5, 1927.

Cushman and Schenck, California Univ., Dept. Geol. Sci., Bull., vol. 17, p. 313, pl. 44, fig. 9, 1928.

Weinzierl and Applin, Jour. Paleontology, vol. 3, p. 407, 1929.

Cushman and McMasters, idem, vol. 10, p. 515, pl. 76, fig. 5, 1936.

Cushman and Frizzell, Cushman Lab. Foram. Research Contr., vol. 19, p. 87, pl. 15, figs. 9, 10, 1943.

Martin, Stanford Univ. Publ., Univ. Ser., Geol. Sci., vol. 3, no. 3, p. 10 (list), 1943.

Cushman and Simonson, Jour. Paleontology, vol. 18, p. 202, pl. 34, fig. 6, 1944.

The range of this species seems to be from the middle Eocene (Claiborne) to the lower Oligocene, and it has been recorded from Texas, California, Oregon, and Washington. Our specimens from Yorktown seem to be identical with the types with which they have been compared. They occur at the following depths: well 2, 380 feet; wells 3 and 4, 380-390, 390-400, 400-410, 410-430, 430-440, and 460-470 feet.

## Family CASSIDULINIDAE

## Genus CERATOBULIMINA Toula, 1915

**Ceratobulimina rotundata** Cushman and Cederstrom, n. sp.  
(Pl. 5, fig. 7)

Test only slightly longer than broad, thick, periphery broadly rounded, the final whorl forming nearly the whole surface of the test; chambers distinct, very slightly if at all inflated, usually seven in the adult whorl; sutures distinct, the spiral suture on the dorsal side slightly depressed, sutures sharply depressed on the ventral side, especially toward the umbilicus; wall smooth, polished; aperture narrow, extending into the apertural face which is distinctly flattened.

Length 0.45-0.55 mm.; breadth 0.35-0.45 mm.; thickness 0.30-0.35 mm.

Holotype (Cushman Coll. No. 45477) from the Chickahominy formation (Eocene), at a depth of 400-410 feet in Yorktown Navy Mine Depot wells 3 and 4, York County, Virginia.

This species differs from *C. alazanensis* Cushman and Harris in the more rounded form and the much narrower aperture. This should make a good index fossil for the Chickahominy formation. It occurs in well 2 at 330, 360 and 380 feet; wells 3 and 4, 380-390, 390-400, 400-410, 410-420, 420-430, 430-440, and 470-480 feet.

Genus PULVINULINELLA Cushman, 1926

**Pulvinulinella atlantisae** Cushman (Pl. 5, fig. 8)

*Pulvinulinella atlantisae* Cushman, Cushman Lab. Foram. Research Contr., vol. 15, p. 72, pl. 12, fig. 16, 1939.

Cushman and Herrick, *idem*, vol. 21, p. 70, pl. 11, fig. 8, 1945.

A few specimens seem to be identical with this species described from the Eocene of a submarine core taken off the eastern coast of the United States. They are from wells 3 and 4, at depths of 450-460, 460-470, 470-480, and 490-500 feet.

**Pulvinulinella danvillensis** Howe and Wallace (Pl. 5, fig. 9)

*Pulvinulinella danvillensis* Howe and Wallace, Louisiana Dept. Cons. Geol. Bull. 2, p. 71, pl. 13, fig. 7, 1932.

Cushman and Herrick, Cushman Lab. Foram. Research Contr., vol. 21, p. 70, pl. 11, fig. 9, 1945.

This species was described from the Jackson formation (Eocene) of Louisiana and recorded from the McBean formation of Georgia. A number of typical specimens occur in wells 3 and 4 at depths of 410-420 feet.

Genus CASSIDULINA d'Orbigny, 1826

**Cassidulina globosa** Hantken

(For figures and references, see U. S. Geol. Survey Prof. Paper 181, p. 49, pl. 20, fig. 12, 1935.)

This species is particularly common in the Cooper marl (upper Eocene) of South Carolina. A few specimens occur in wells 3 and 4 at depths of 390-400, 400-410, and 410-420 feet.

Family CHILOSTOMELLIDAE

Genus PULLENIA Parker and Jones, 1862

**Pullenia quinqueloba** (Reuss), var. **angusta** Cushman and Todd  
(Pl. 5, fig. 10)

*Pullenia quinqueloba* (Reuss), var. *angusta* Cushman and Todd, Cushman Lab. Foram. Research Contr., vol. 19, p. 10, pl. 2, figs. 3, 4, 1943.

The records for this variety are mostly from the lower Eocene, including Alabama, Texas, Mexico, and western Europe. Specimens, evidently to be included in this variety, occur at the following depths: well 2, 360 feet; and wells 3 and 4, 400-410, 410-420, and 420-430 feet.

#### Family HANTKENINIDAE

Genus HANTKENINA Cushman, 1924

**Hantkenina alabamensis** Cushman, var. **primitiva** Cushman and Jarvis (Pl. 5, fig. 11)

*Hantkenina alabamensis* Cushman, var. *primitiva* Cushman and Jarvis, Cushman Lab. Foram. Research Contr., vol. 5, p. 16, pl. 3, figs. 2, 3, 1929.

Renz, 8th Am. Sci. Congress Proc., p. 541 (list), 1942.

The only previous records for this variety are from the upper Eocene of Trinidad. Rare specimens from well 2, at a depth of 330 feet; and wells 3 and 4, at depths of 400-410 feet, seem identical.

#### Family GLOBOROTALIIDAE

Genus GLOBOROTALIA Cushman, 1927

**Globorotalia cocoaensis** Cushman

(For figures, see U. S. Geol. Survey Prof. Paper 181, pl. 21, figs. 1-3, 1935.)

*Globorotalia cocoaensis* Cushman, Cushman Lab. Foram. Research Contr., vol. 4, p. 75, pl. 10, fig. 3, 1928.

Howe and Wallace, Louisiana Dept. Cons. Geol. Bull. 2, p. 75, pl. 14, fig. 4, 1932.

Ellisor, Am. Assoc. Petroleum Geologists Bull., vol. 17, no. 11, pl. 4, fig. 6, 1933.

Cushman, U. S. Geol. Survey Prof. Paper 181, p. 50, pl. 21, figs. 1-3, 1935.

Coryell and Embich, Jour. Paleontology, vol. 11, p. 301, pl. 43, fig. 11, 1937.

Thalmann, Stanford Univ. Publ., Univ. Ser., Geol. Sci., vol. 3, no. 1, p. 9 (list), 1942.

Cushman and Herrick, Cushman Lab. Foram. Research Contr., vol. 21, p. 71, pl. 11, fig. 13, 1945.

The records for this species are from the upper Eocene, including South Carolina, Georgia, Florida, Alabama, Mississippi, and Panama. It is also recorded from the Eocene of Borneo. It is rare in the material from Yorktown, occurring in wells 3 and 4 at depths of 390-400 and 490-500 feet.

**Globorotalia centralis** Cushman and Bermudez (Pl. 5, fig. 12)

*Globorotalia centralis* Cushman and Bermudez, Cushman Lab. Foram. Research Contr., vol. 13, p. 26, pl. 2, figs. 62-65, 1937.

Howe, Louisiana Dept. Cons. Geol. Bull. 14, p. 84, pl. 12, figs. 4-6, 1939.

Cushman and Herrick, Cushman Lab. Foram. Research Contr., vol. 21, p. 71, 1945.

The records for this species are from the upper Eocene of Cuba, the Cook Mountain formation (middle Eocene) of Louisiana, and the McBean formation of Georgia. Typical specimens occur rarely in well 2 at a depth of 330 feet, and in wells 3 and 4 at depths of 380-390, 390-400, 400-410, and 410-420 feet.

**Globorotalia crassata** (Cushman), var. **densa** (Cushman)  
(Pl. 5, fig. 13)

*Pulvinulina crassata* Cushman, var. *densa* Cushman, Am. Assoc. Petroleum Geologists Bull., vol. 9, p. 301, 1925.

*Globorotalia crassata* (Cushman), var. *densa* Cushman and Barksdale, Stanford Univ., Dept. Geology, Contr., vol. 1, no. 2, p. 68, pl. 12, fig. 8, 1930.

Glaessner, Moscow Univ. Studies in Micropaleontology, vol. 1, p. 32, pl. 1, fig. 8, 1937.

Cushman, Cushman Lab. Foram. Research Contr., vol. 15, p. 74, pl. 12, fig. 20, 1939.

Martin, Stanford Univ. Publ., Univ. Ser., Geol. Sci., vol. 3, no. 3, p. 11 (list), 1943.

The types of this species are from the Eocene of Mexico. It is also recorded from the Eocene of California, the Caucasus region, and from a submarine core taken off the eastern coast of the United States. The only occurrence in our material is in wells 3 and 4, at depths of 470-480 feet.

## Family ANOMALINIDAE

## Genus CIBICIDES Montfort, 1808

**Cibicides ouachitaensis** Howe and Wallace (Pl. 6, fig. 1)

*Cibicides ouachitaensis* Howe and Wallace, Louisiana Dept. Cons. Geol. Bull. 2, p. 78, pl. 14, fig. 6, 1932.

The only record for this species is from the Jackson formation (upper Eocene) of Louisiana. It is fairly common in the Yorktown wells at the following depths: well 2, 360 and 380 feet; wells 3 and 4, 380-390, 400-410, 450-460, 470-480, and 490-500 feet.

**Cibicides ocalanus** Cushman (Pl. 6, fig. 2)

*Cibicides mississippiensis* (Cushman), var. *ocalanus* Cushman, U. S. Geol. Survey Prof. Paper 181, p. 54, 1935.

Applin and Jordan, Jour. Paleontology, vol. 19, p. 130 (list); p. 148, 1945.

This form seems to be enough different from typical *C. mississippiensis* to warrant making it a distinct species. It is recorded from beds of Jackson age (upper Eocene) from South Carolina, Georgia, Florida, and Alabama. It is common in the well material, occurring at the following depths: well 2, 330, 360 and 380 feet; wells 3 and 4, 380-390, 390-400, 400-410, 410-420, 420-430, 430-440, 450-460, 460-470, 470-480, and 490-500 feet.

**Cibicides cf. pseudoungerianus** (Cushman)

(For references and figures, see U. S. Geol. Survey Prof. Paper 181, p. 52, pl. 23, fig. 1, 1935.)

Rare specimens from wells 3 and 4, at depths of 400-410 feet and 410-420 feet are close to this species but not entirely typical. More specimens are needed to confirm the specific identity.

**Cibicides cf. cooperensis** Cushman

(For figures, see U. S. Geol. Survey Prof. Paper 181, pl. 23, fig. 3, 1935.)

*Cibicides cooperensis* Cushman, Cushman Lab. Foram. Research Contr., vol. 9, p. 20, pl. 2, fig. 11, 1933; U. S. Geol. Survey Prof. Paper 181, p. 53, pl. 23, fig. 3, 1935.

The only previous record for this species is from the Cooper marl (upper Eocene) of South Carolina. Specimens that seem to belong here are from well 2 at a depth of 330 feet, and wells 3 and 4 at depths of 390-400, 400-410, 410-430, and 430-440 feet.

***Cibicides speciosus*** Cushman and Cederstrom, n. sp.

(Pl. 6, figs. 3, 4)

Test nearly plano-convex, ventral side strongly convex, dorsal side flattened or slightly convex in the middle, periphery acute but not keeled; chambers distinct, not inflated, ten to twelve in the adult whorl, of nearly uniform shape, very gradually increasing in size as added; sutures distinct, on the ventral side, limbate and raised above the general surface, dorsally curved, limbate and very slightly raised; wall coarsely perforate, dorsal side with all but the final whorl ornamented with a complicated pattern of raised areas and depressions; aperture extending onto the dorsal side with a distinct lip on the inner margin of the last-formed chamber.

Diameter 0.65-0.80 mm.; thickness 0.25-0.35 mm.

Holotype (Cushman Coll. No. 45540) from the Chickahominy formation (Eocene), at a depth of 390-400 feet in Yorktown Navy Mine Depot wells 3 and 4, York County, Virginia.

This species differs from *C. pseudoungerianus* (Cushman) in the raised sutures and highly ornamented central area of the dorsal side. It occurs in well 2, at depths of 330, 360 and 380 feet; and wells 3 and 4, at depths of 380-390, 390-400, 400-410, 410-430, 430-440, 450-460, 460-470, 470-480, and 490-500 feet.

***Cibicides sculpturatus*** Cushman and Cederstrom, n. sp.

(Pl. 6, figs. 5, 6)

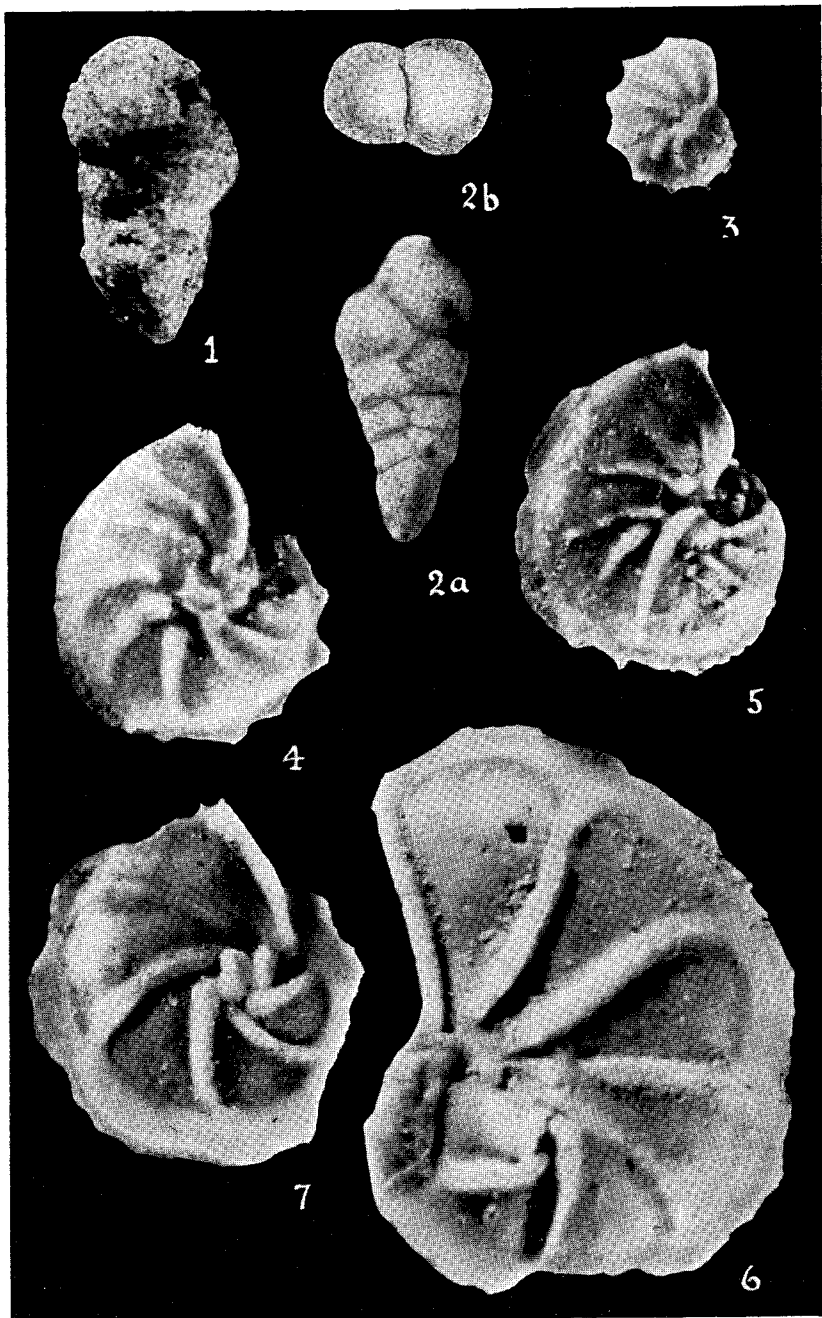
Test plano-convex, ventral side strongly convex, dorsal side flattened or distinctly concave in some specimens, periphery in the early stages subacute, rounded in the adult and slightly lobulate; chambers of the early portion indistinct, as many as nine in the final whorl where they are slightly inflated; sutures of the later portion distinct, slightly curved and gradually more depressed as growth proceeds; wall very coarsely perforate, the edges of the pores raised to form a complex pitted surface; aperture peripheral and extending into the dorsal side with a thin, curved lip on the inner margin of the last-formed chamber.

Diameter 0.85-1.25 mm.; thickness 0.40-0.50 mm.

Holotype (Cushman Coll. No. 45555) from the Chickahominy formation (Eocene), at a depth of 410-430 feet in Yorktown Navy Mine Depot wells 3 and 4, York County, Virginia.

This species differs from *C. lobatulus* (Walker and Jacob) in the very highly ornate test. It occurs commonly at the following depths and should make a good index fossil: well 2, 330 feet; wells 3 and 4, 390-400, 400-410, 410-430, 430-440, and 450-460 feet.





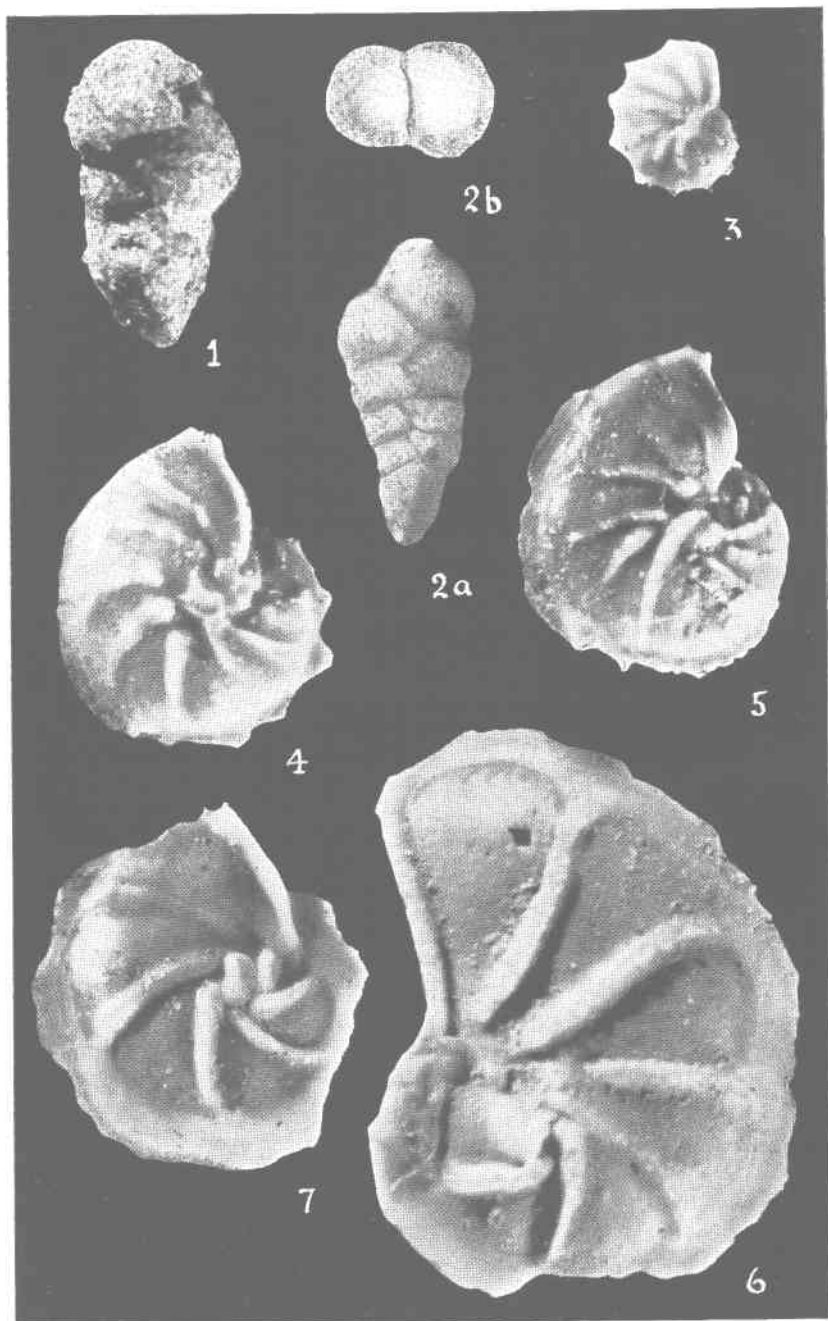
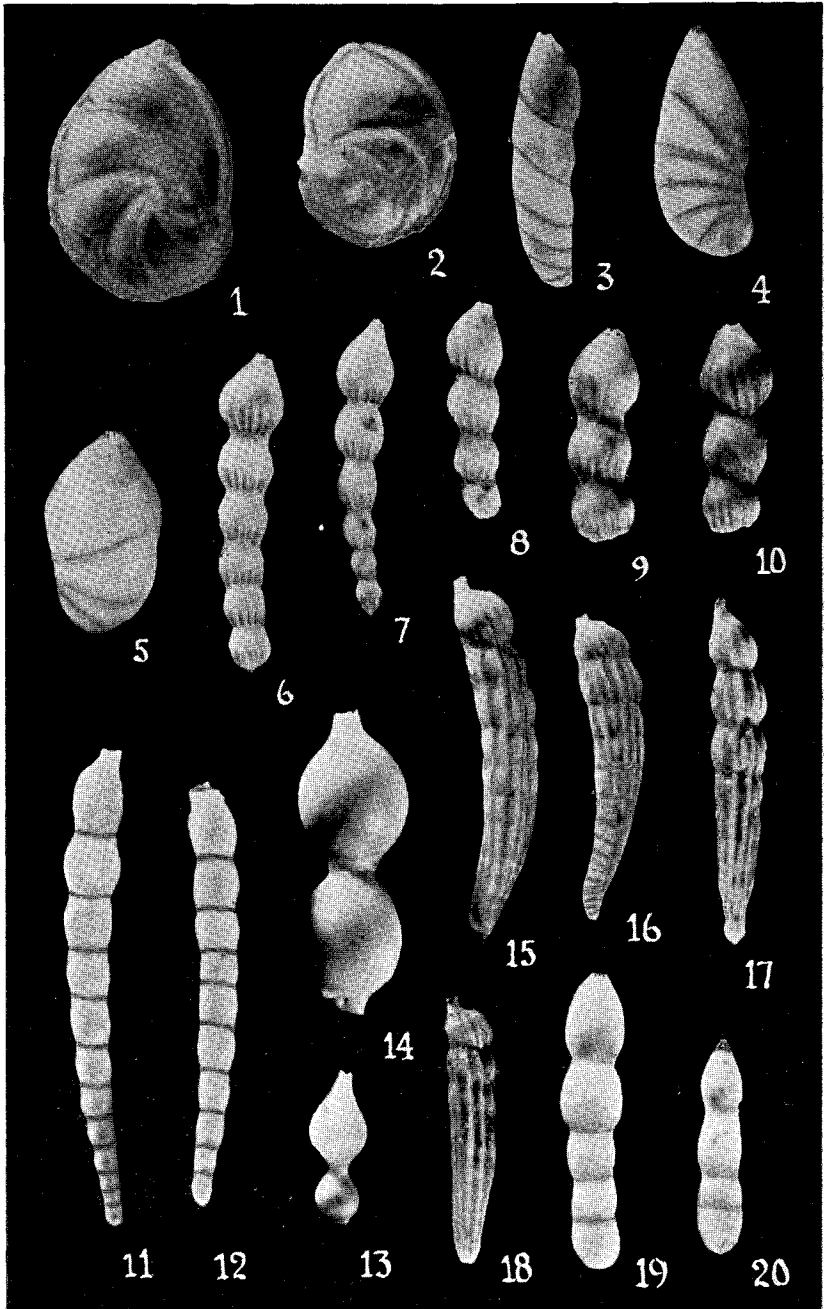


PLATE 1

FIGURE

1. *Gaudryina* cf. *G. (Pseudogaudryina) alazanensis*. Cushman. ×27.
2. *Plectina virginiana* Cushman and Cederstrom, n. sp. ×62.  
*a*, Front view; *b*, apertural view.
3. *Robulus virginianus* Cushman and Cederstrom, n. sp. ×27.
- 4, 5. *Robulus gutticostatus* (Gümbel). ×27.
- 6, 7. *Planularia crassilimbata* (Nuttall). ×27.



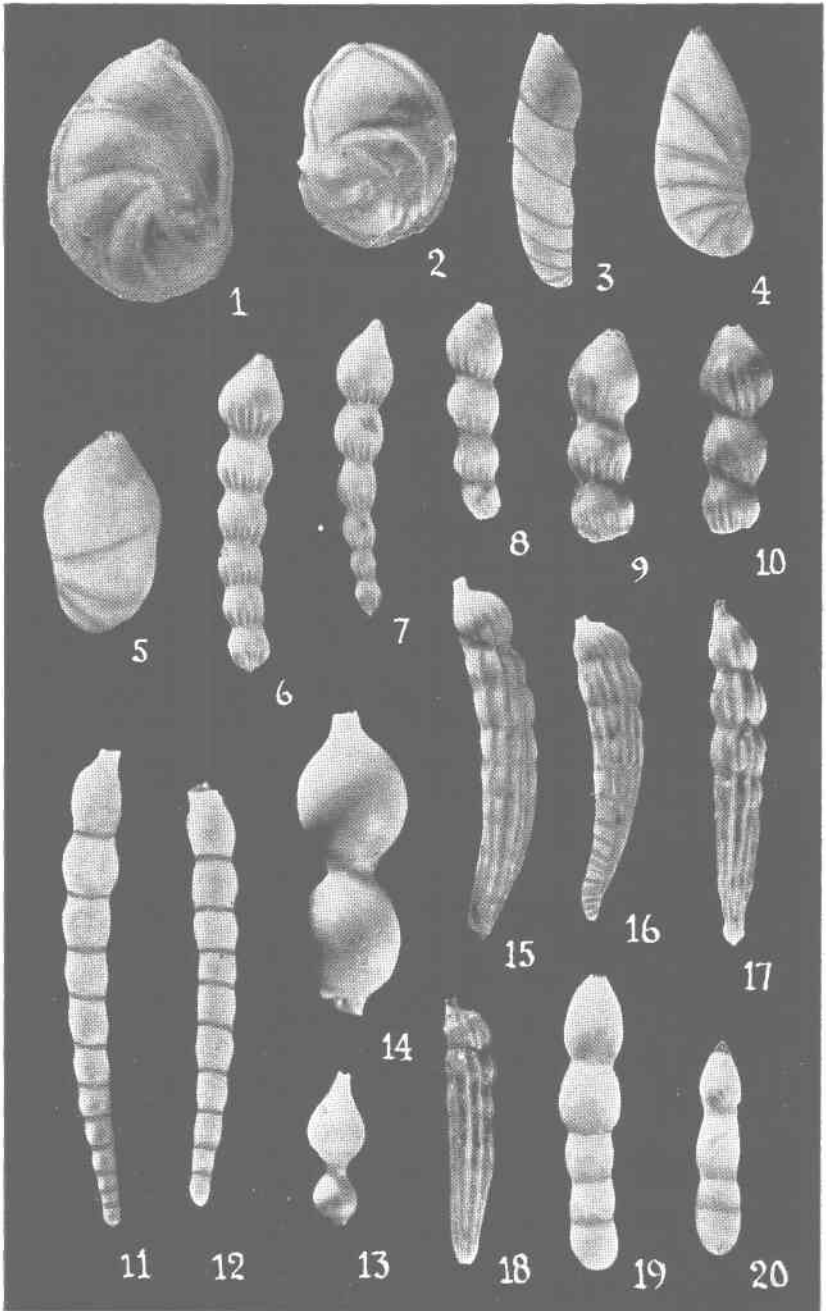
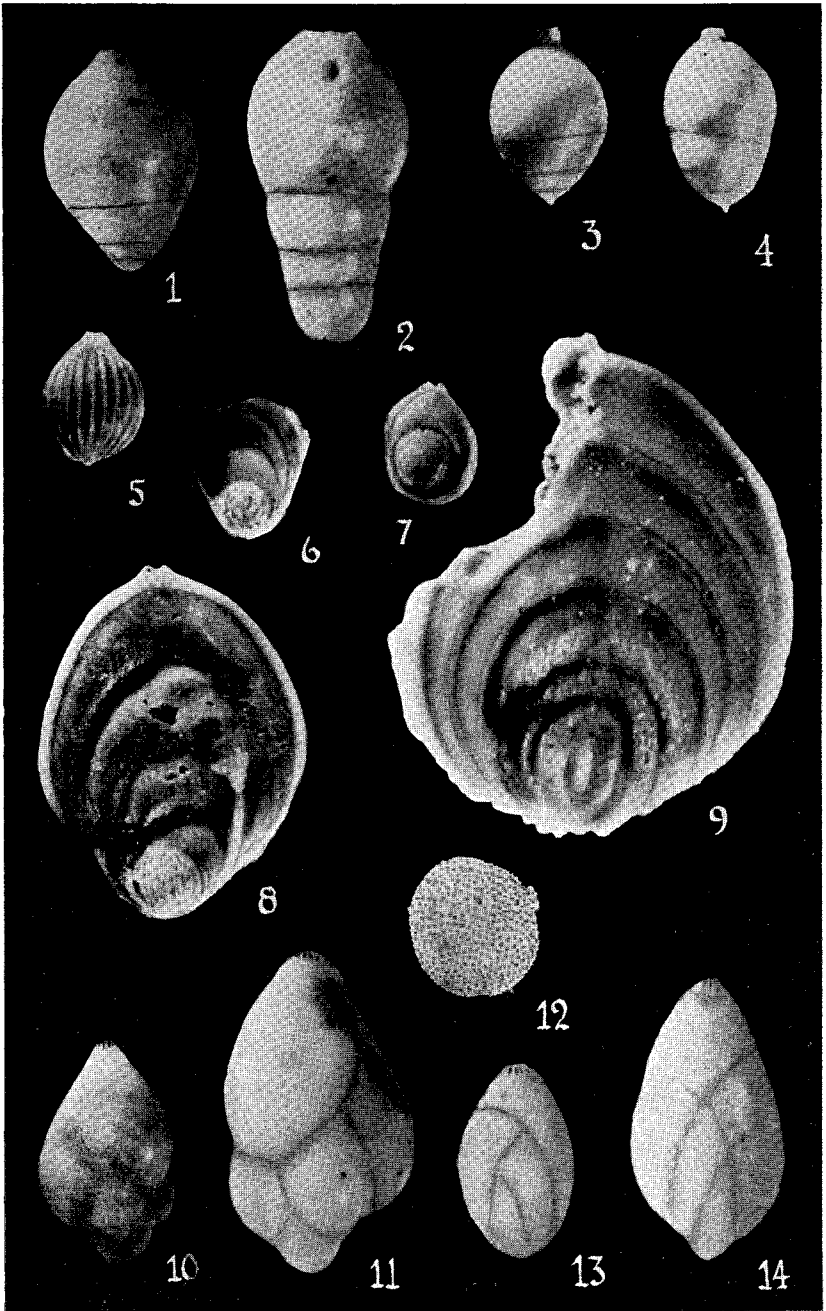


PLATE 2

FIGURE

- 1, 2. *Planularia* sp.  $\times 27$ .
3. *Marginulina splendens* Hantken.  $\times 42$ .
4. *Marginulina triangularis* d'Orbigny, var. *panamensis* Coryell and Embich.  $\times 62$ .
5. *Marginulina subbullata* Hantken.  $\times 62$ .
- 6-10. *Dentalina capitata* (Boll).  $\times 27$ .
- 11, 12. *Dentalina intermedia* Hantken. 11,  $\times 27$ . 12,  $\times 42$ .
- 13, 14. *Dentalina soluta* Reuss.  $\times 27$ .
- 15-18. *Dentalina bezzani* Cushman and Cederstrom, n. sp.  $\times 27$ . 15, Holotype. 16-18, Paratypes.
- 19, 20. *Dentalina* sp.  $\times 42$ .



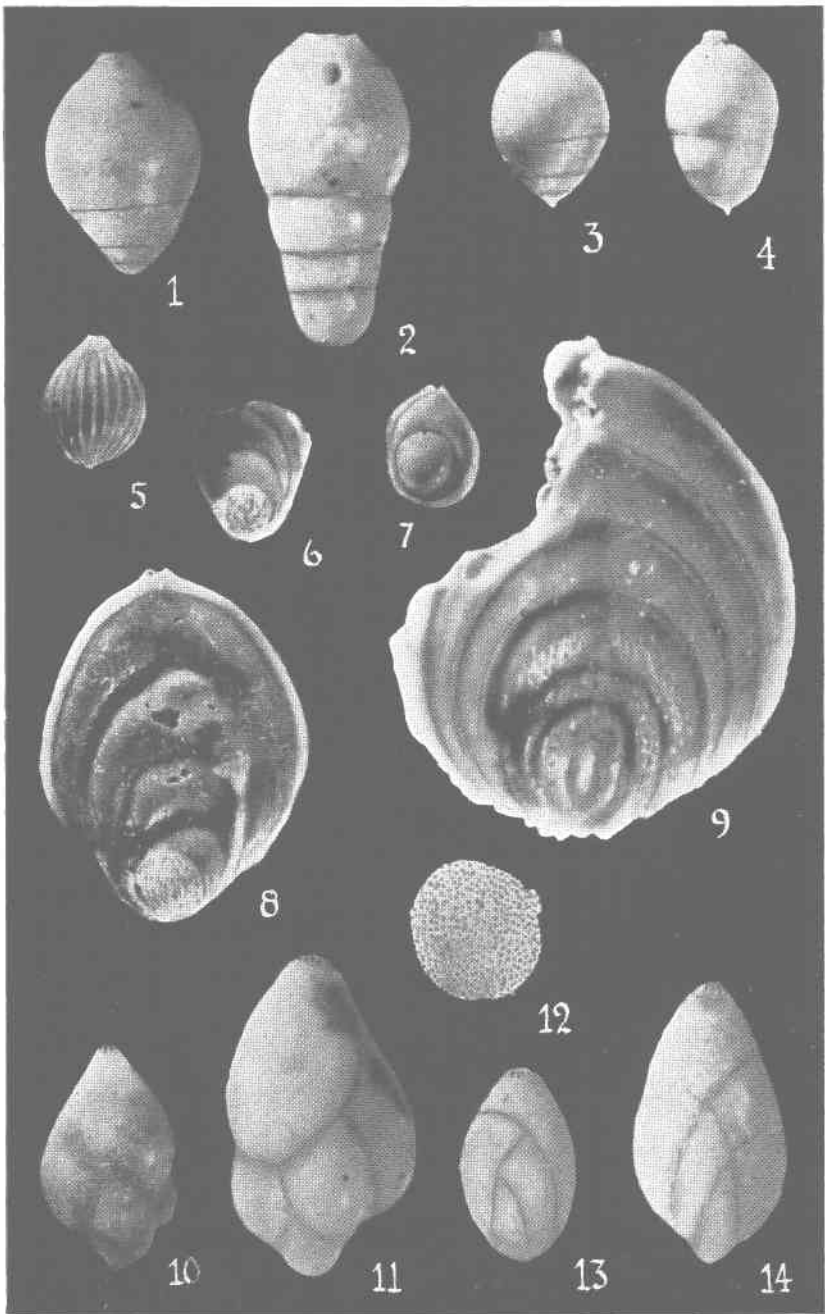
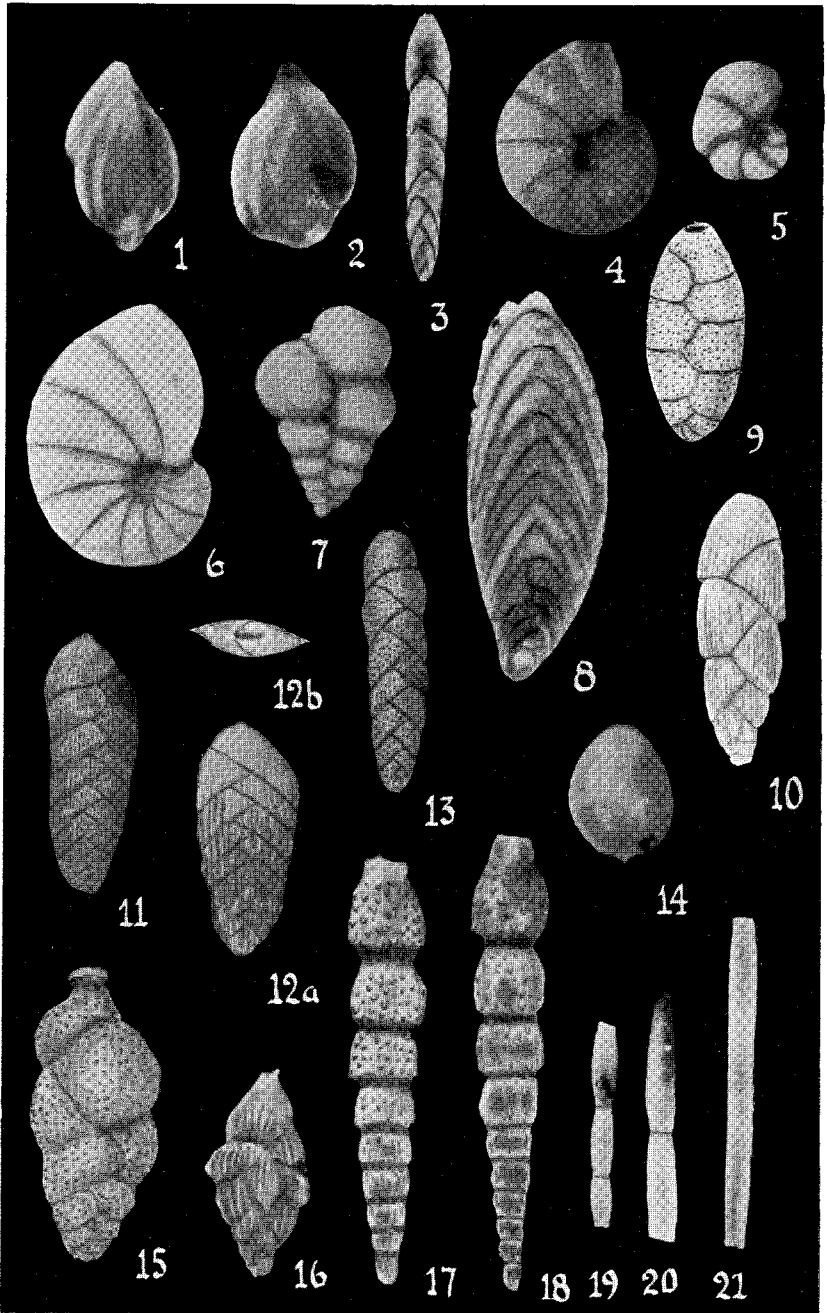




PLATE 3

FIGURE

1. *Pseudoglandulina laevigata* (d'Orbigny). ×62.
2. *Pseudoglandulina conica* (Neugeboren). ×62.
- 3, 4. *Pseudoglandulina virginiana* Cushman and Cederstrom, n. sp.  
×27. 3, Paratype. 4, Holotype.
5. *Pseudoglandulina* sp. ×27.
- 6-9. *Fronicularia virginiana* Cushman and Cederstrom, n. sp.  
×27. 6-8, Paratypes; 6, 7, Young. 9, Holotype.
- 10, 11. *Guttulina hantkeni* Cushman and Ozawa. ×62.
12. *Globulina gibba* d'Orbigny, var. *punctata* d'Orbigny. ×27.
- 13, 14. *Sigmomorphina semitecta* (Reuss), var. *terquemiana* (Fornasini). ×62.



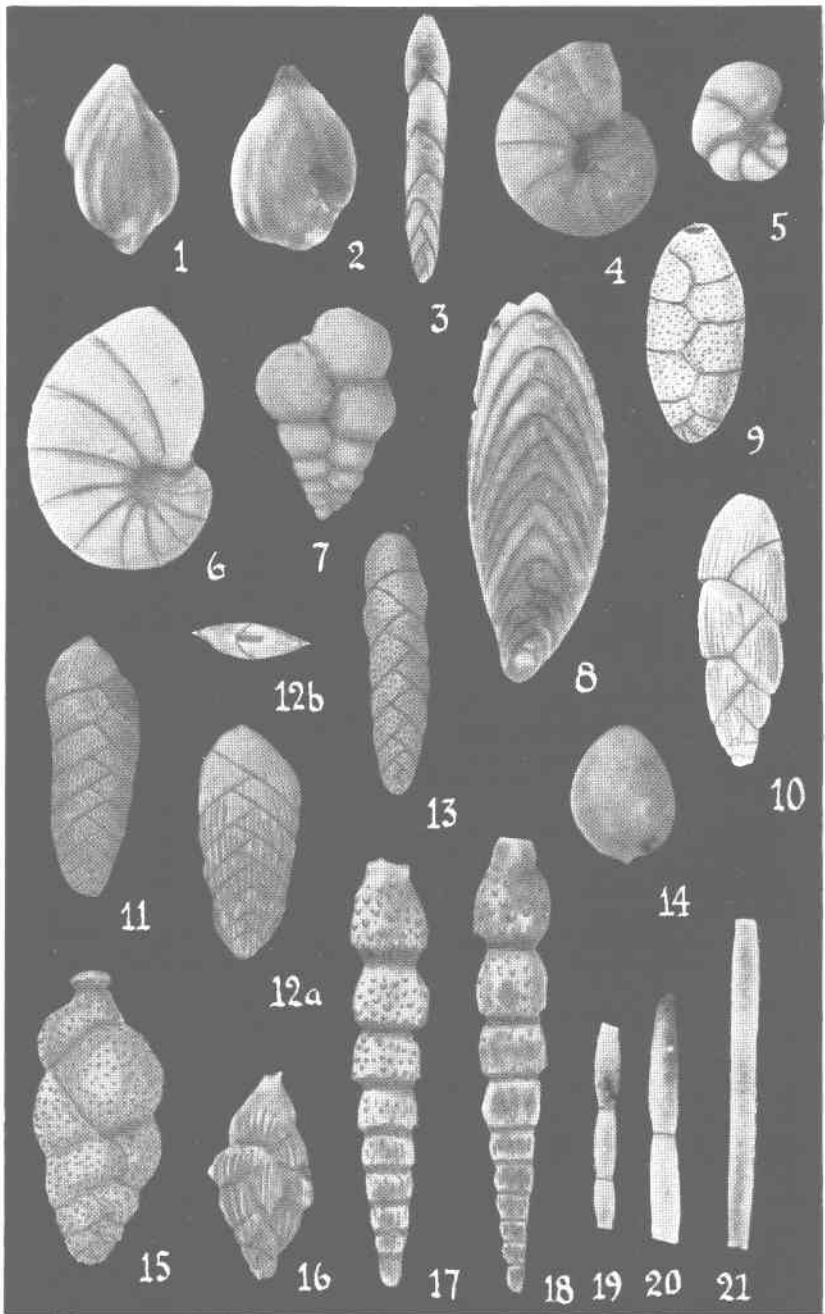
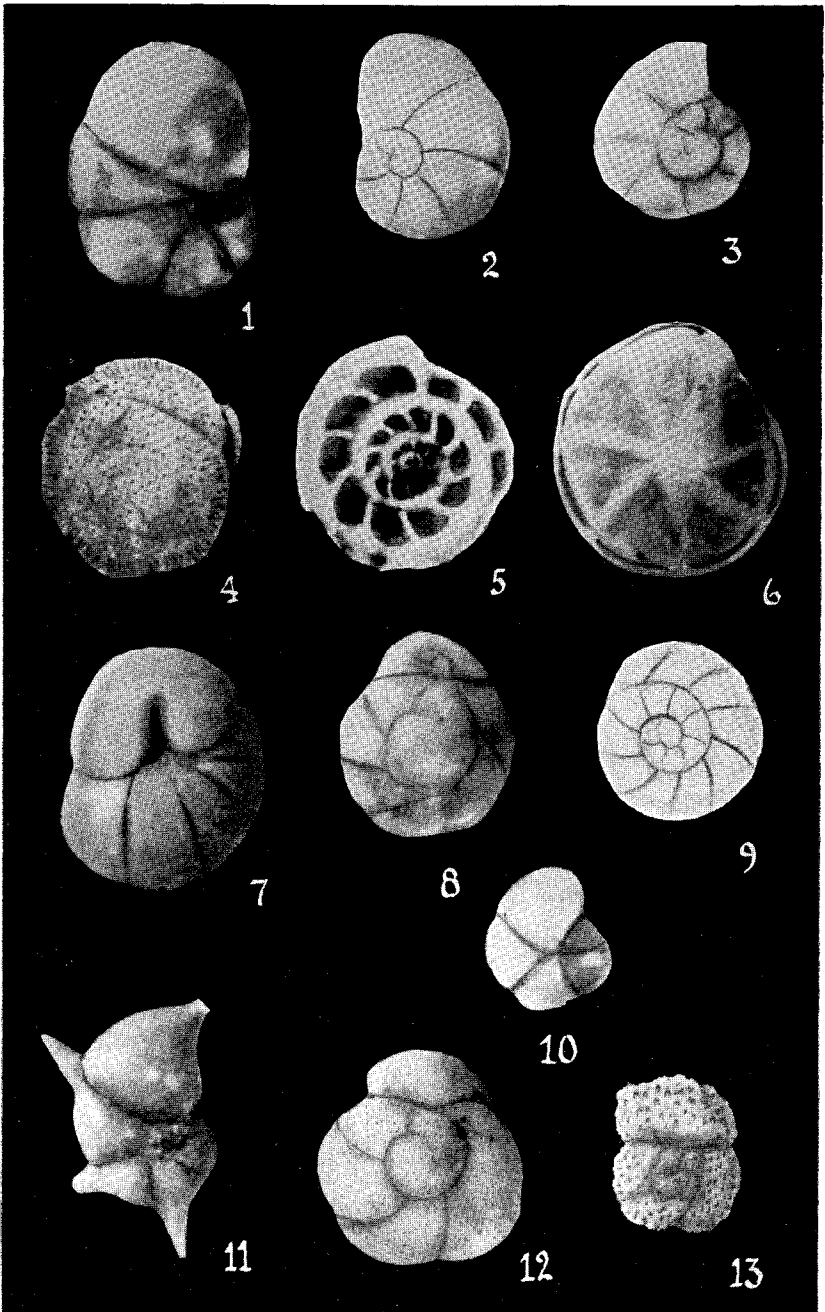


PLATE 4

FIGURE

- 1, 2. *Sigmoidella plummerae* Cushman and Ozawa.  $\times 27$ .
3. *Polymorphinella gracilis* Cushman and Cederstrom, n. sp.  $\times 42$ .
4. *Nonion planatum* Cushman and Thomas.  $\times 62$ .
5. *Nonion danvillensis* Howe and Wallace.  $\times 62$ .
6. *Nonionella hantkeni* (Cushman and Applin), var. *spissa* Cushman.  $\times 62$ .
7. *Gümbelina cubensis* Palmer, var. *heterostoma* Bermudez.  $\times 100$ .
8. *Plectofrondicularia virginiana* Cushman and Cederstrom, n. sp.  $\times 42$ .
9. *Virgulina minutissima* Cushman.  $\times 120$ .
10. *Virgulina recta* Cushman, var. *howei* Cushman.  $\times 120$ .
11. *Bolivina gardnerae* Cushman, var. *lineata* Cushman and Cederstrom, n. var.  $\times 100$ .
12. *Bolivina virginiana* Cushman and Cederstrom, n. sp.  $\times 100$ .  
a, Front view; b, apertural view.
13. *Loxostomum longiforme* Cushman and Cederstrom, n. sp.  $\times 100$ .
14. *Entosolenia* cf. *apiculata* (Reuss).  $\times 100$ .
15. *Uvigerina elongata* Cole.  $\times 100$ .
16. *Angulogerina danvillensis* Howe and Wallace.  $\times 62$ .
- 17, 18. *Ellipsonodosaria atlantisae* Cushman, var. *hispidula* Cushman.  $\times 100$ .
- 19-21. *Ellipsonodosaria* cf. *longiscata* (d'Orbigny).  $\times 42$ .



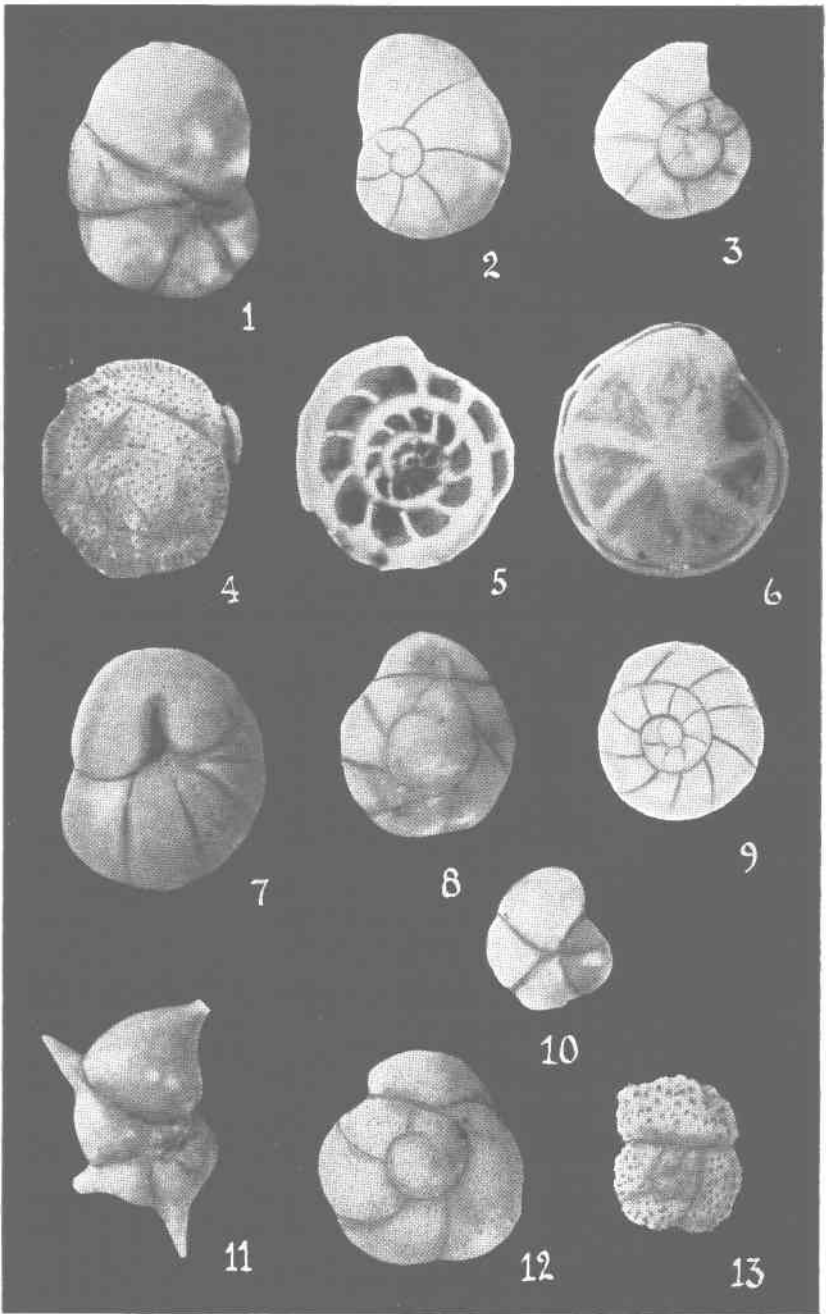
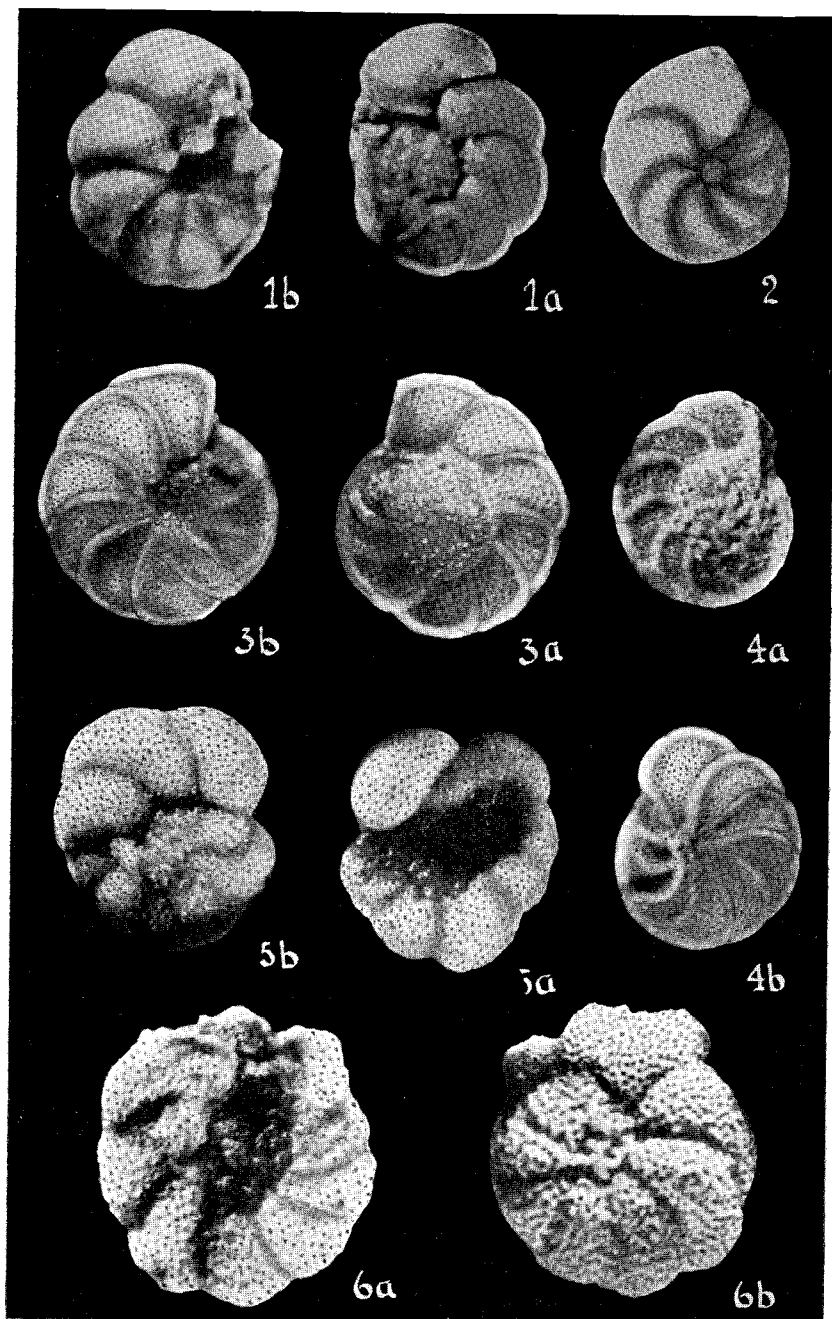


PLATE 5

FIGURE

- 1, 2. *Valvulineria texana* Cushman and Ellisor. ×100.
3. *Gyroidina danvillensis* Howe and Wallace. ×100.
4. *Siphonina tenuicarinata* Cushman. ×62.
- 5, 6. *Epistomina eocenica* Cushman and M. A. Hanna. 5, Section. ×42. 6, Ventral view. ×62.
7. *Ceratobulimina rotundata* Cushman and Cederstrom, n. sp. ×62.
8. *Pulvinulinella atlantisae* Cushman. ×62.
9. *Pulvinulinella danvillensis* Howe and Wallace. ×160.
10. *Pullenia quinqueloba* (Reuss), var. *angusta* Cushman and Todd. ×62.
11. *Hantkenina alabamensis* Cushman, var. *primitiva* Cushman and Jarvis. ×62.
12. *Globorotalia centralis* Cushman and Bermudez. ×62.
13. *Globorotalia crassata* (Cushman), var. *densa* (Cushman). ×62.





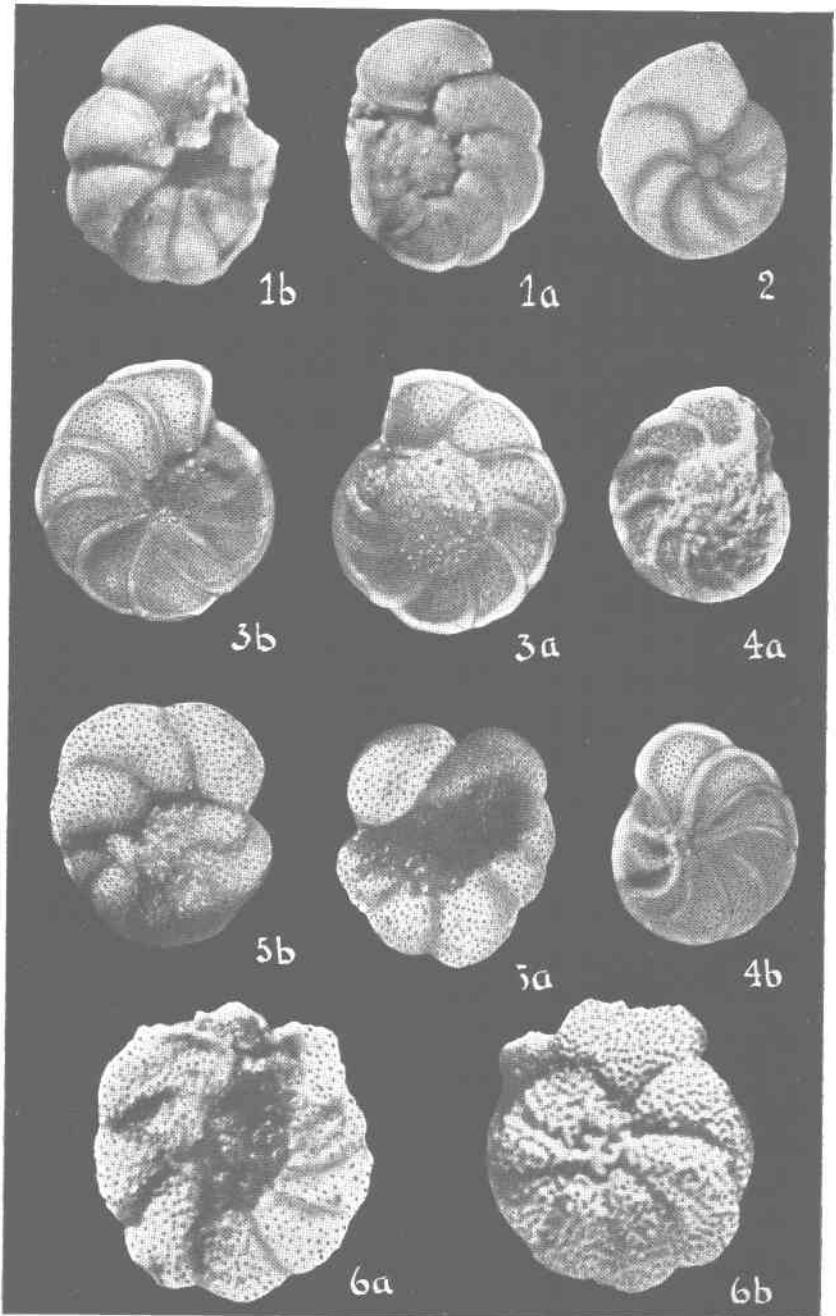


PLATE 6

FIGURE

1. *Cibicides ouachitaensis* Howe and Wallace.  $\times 42$ . *a*, Dorsal view; *b*, ventral view.
2. *Cibicides ocalanus* Cushman.  $\times 62$ .
- 3, 4. *Cibicides speciosus* Cushman and Cederstrom, n. sp.  $\times 42$ .  
3, Paratype. *a*, Dorsal view; *b*, ventral view. 4, Holotype.  
*a*, Dorsal view; *b*, ventral view.
- 5, 6. *Cibicides sculpturatus* Cushman and Cederstrom, n. sp.  $\times 42$ .  
5, Holotype. *a*, Dorsal view; *b*, ventral view. 6, Paratype.  
*a*, Dorsal view; *b*, ventral view.

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