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VOL. XXXII

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*1948-49*

PALEONTOLOGICAL RESEARCH INSTITUTION  
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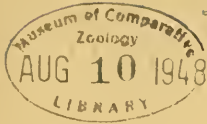


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**BULLETINS**  
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**Vol. 32**

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**No. 129**

**BREVICONES FROM THE NEW YORK SILURIAN**

By

ROUSSEAU H. FLOWER

New York State Museum

*July 22, 1948*

Paleontological Research Institution

ITHACA, NEW YORK





## BREVICONES FROM THE NEW YORK SILURIAN

By

ROUSSEAU H. FLOWER

New York State Museum

Except for the remarkable cephalopod association of the Shelby beds (Clarke and Ruedemann, 1903), cephalopods in the Silurian of New York are rare and often not well enough preserved for description. The Medinan contains orthoceracones of uncertain structure and taxonomic position and *Oncoceras gibbosum* Hall (1851), a species which Foerste (1928, p. 229) referred with doubt to *Gomphoceras*. There still remains much uncertainty as to the affinities of this species which in form lies between the compressed Ordovician *Oncoceratidae* and the depressed brevicones of the Silurian typified by *Amphicyrtoceras*.

The previously described Clinton cephalopods were listed by the writer and new ones were described (Flower, 1942). To these are added the new species *Mandaloceras chaceæ* and *Gomphoceras jewetti*. In the overlying Lockport and Guelph occur the two Shelby horizons with a rich cephalopod assemblage. The overlying shales of the Salina have yielded few good specimens. A crushed brevicone from the Pittsford shale was referred by Ruedemann (1916) to *Septameroceras* Hyatt, a genus which Foerste (1930, p. 381) discovered to be synonymous with *Hexameroceras*, the median seventh lobe of the aperture being adventitious. The Bertie has yielded among the orthoceracones *Orthoceras vicinus* Ruedemann and *Daxosonoceras oconellæ* Ruedemann and several additional orthoceracones which are as yet unnamed. The Bertie is rich in brevicones, having supplied *Priesteroceras timidum* Ruedemann, *Phragmocrina oscula* (Ruedemann), *Gomphoceras ruedemanni* Foerste, and *Phragmoceras accola* Ruedemann.

A considerable assemblage occurs in the Cobleskill, but preservation is generally\* poor, and the cephalopod fauna has not been adequately described. Orthoceracones are present, among them representatives of *Ormoceras* and *Armenoceras*. Best known of the Cobleskill forms are the striking trochoceroids, *Mitroceras gebhardi* (Hall) and *Foersteoceras turbinatum*

(Hall). Among the brevicones *Phragmoceras corallophilum* Clarke, redescribed in the present paper, proves to be a *Tetrameroceras*, the second species of the genus to be encountered in the American Silurian. Other brevicones are *Cayuoceras mami* Flower (1947) and the form described below as *Hexameroceras bollmanae*.

The Manlius fauna is virtually undescribed. Here are representatives of *Ormoceras*, fragmentary and poorly preserved, none of which are described as yet. *Oncoceras ovoides* Hall, a species of uncertain generic position but possibly allied to *Cayuoceras*, and *Herkimerceras subrectum* belong here. To these are added the new species *Phragmocerina litchfieldensis*.

Three of the species described here are based upon material from the collections of Cornell University. For opportunities to study and describe this material I am indebted to Prof. W. S. Cole. Other material is from the New York State Museum. Acknowledgment should also be made to the New York State Museum for defraying the cost of the plates.

*Mandaloceras chaseae* Flower, n. sp.

Plate 1, figs. 5, 6

The holotype is slightly flattened by pressure, a straight breviconic shell 57 mm. long, expanding from 11 mm. and 9 mm. at the base, to 31 mm. and 22 mm. in the 33 mm. of the phragmone, and contracting to a height of 17 mm. at the aperture which is so crushed that the width is negligible. In profile the dorsum and venter are essentially straight and diverging basally, the dorsum more strongly curved than the venter over the gibbous portion, the dorsal margin slightly convex to aperture, ventral profile becoming straight and then faintly concave. The aperture, though distorted, shows clearly the long hyponomic sinus and the presence of a single pair of lateral sinuses. The margin of the aperture is faintly produced. Surface markings consist of fine transverse rugose markings which reflect the course of a hyponomic sinus from the earliest growth stage. The siphuncle lies close to the venter; its structure has not been observed.

*Discussion.*—Three specimens in the Jewett Collection of Cornell University, No. 7075, bear the label "*Oncoceras subrectum*, Clinton group, Lockport. Very rare, type of Hall. E. J." These specimens consist of one small unidentifiable fragment of a small very obese brevicone, and two slightly flattened but rela-

tively complete shells. Removal of the chert which surrounded the apertures disclosed that one represents the genus *Mandaloceras* while the other is a true *Gomphoceras*. In spite of Jewett's label, these specimens are obviously not the original of *Oncoceras subrectum* Hall, for the illustration accompanying the description shows a conch represented only by a septate phragmocone which is considerably larger than that of any of the three specimens available for study. At the present time I have been unable to locate the type of *Oncoceras subrectum*. It is not in the obvious repositories, the New York State Museum, the American Museum of Natural History, the University of Chicago, or the University of California. I am indebted to the late Dr. Bruce L. Clark and to Dr. J. M. Weller for assistance in the search for the type of *Oncoceras subrectum*. This species is of uncertain generic affinities, representing a phragmocone which could belong to several of the various breviconic genera known in the Silurian.

The two most nearly complete of the Cornell University specimens include the type of *Mandaloceras chasea* and that of *Gomphoceras jewetti*. *M. chasea* is distinctive among its congeners in the subconical rather than dome-shaped living chamber, the unusual length of the hyponomic sinus, and the small size of the shell.

*Type*.—Holotype, Cornell University Collection. No. 7025.

*Occurrence*.—Limestone of the Clinton (Irondequoit limestone, *vide* C. A. Hartnagle), Lockport, N. Y.

*Gomphoceras jewetti* Flower, n. sp.

Plate 1, figs. 1-3

The type is a slightly smaller individual than the preceding species, displaying a very different aspect partly because flattening has been nearly vertical instead of lateral. This shell expands from 9 mm. and 11 mm. to 22 mm. and 28 mm. in the 25 mm. of the phragmocone. The living chamber has a length of 29 mm. forming a high dome, in which the features of the aperture are not at once obvious. The hyponomic sinus can be seen on the left of the center of the oblique ventral surface (Pl. 1, fig. 1), where the narrow middle portion is practically closed. We have been unable to see any trace of lateral sinuses. The evidence indicates that the main part of the aperture was pyriform and typical of the *Gomphoceras*.

*Discussion.*—This form, found in association with *Mandaloceras chaceæ*, was at first believed to belong to the same species. The living chamber is very different in shape, being not only higher, but domelike rather than subconical, the sides curving much more strongly as they approach the aperture. The hyponomic sinus is clearly much shorter, and the shell margins show no trace of outward curvature along it. The main part of the aperture, though not plainly preserved, is obviously without the two long sinuses of a *Mandaloceras* but is instead small and round.

*Type.*—Cornell University Collection, No. 38961.

*Occurrence.*—Cherty limestone of the Clinton (Irondequoit limestone), Lockport, N. Y.

*Tetrameroceras corallophilum* (Clarke) Plate 1, fig. 4; Pl. 2, fig. 4

*Phragmoceras?* Hall, 1851, Paleontology of New York, vol. 2, p. 351 (45), pl. 76, fig. 3a-b.

*Phragmoceras corallophilum* Clarke, 1893, New York State Geologist, 12th Ann. Rep. (for 1892), p. 90.

The two types by which this species is represented are both laterally crushed individuals, representing a large-sized phragmoconoid. The first of these, the original of Hall's figure 3a, retains a considerable part of the phragmocone, but the dorsal portion of the living chamber is missing. The second specimen, however, retains the complete aperture and shows that this species has the apertural characteristics of a *Tetrameroceras*. This specimen I select as the holotype in order that no question as to generic position of the species may arise.

The base of the phragmocone is obscure in the holotype, but the ventral profile is evidently concave adapically, becoming slightly convex over the adoral part of the phragmocone, a condition which persists to the aperture where the curve is interrupted by the protruding hyponomic sinus. The dorsum is more strongly and apparently uniformly convex throughout. The living chamber in its present condition has a basal height of 72 mm., a maximum length of 70 mm. The ventral profile is convex for 40 mm., where the protruding hyponomic sinus begins. This extends obliquely outward with an aperture 15 mm. high. The aperture is slitlike for 48 mm. where it joins the main part of

the aperture which develops two long sinuses on each side, the dorsal one long and straight, the ventral one shorter and curved with the convexity directed dorsad. The living chamber is 72 mm. high at mid-length, 69 mm. high at the aperture. The plane of the aperture is inclined about 30 degrees to the plane of the suture.

The sutures are essentially transverse, developing slight lateral lobes. The type shows three adoral cameræ, very faint, which are gerontically shortened; normal cameræ are of moderate depth.

The paratype displays the form of the early part of the shell better than does the holotype, and the spacing of the cameræ can be clearly seen. It fails, however, to show more than the ventral half of the aperture, leaving doubt as to the true generic position of the species. The proportions of the two specimens are quite similar.

*Types*.—Lectoholotype and paratype, New York State Museum.

*Occurrence*.—Cobleskill limestone, Schoharie, N. Y.

*Hexameroceras bollmanæ* Flower, n. sp. Plate 2, figs. 5-7

Conch strongly curved adapically, less curved and strongly gibbous on mature portion. Sutures subparallel. The phragmocone increases from 20 mm. and 28 mm. to 41 mm. and 33 mm.; ventral length 16 mm.; dorsal length 22 mm. Living chamber with height of 34 mm. attaining 45 mm. and 35 mm. at gibbous region. The ventral profile is strongly and nearly uniformly convex throughout; dorsal profile faintly concave adapically, nearly straight, and then slightly convex over the middle of living chamber. The aperture bears a long narrow ventral sinus, 28 mm. long, which is not so produced as is normal in the genus, and does not extend out over the ventral profile. The main part of the aperture is unfortunately obscure. A curious feature is an elevation of the internal mold on the mid-dorsal region, faintly and deceptively suggestive of the type of aperture for which the genus *Septameroceras* was erected. This is believed to be a feature connected with the slight distortion to which the adoral end of the living chamber has been subjected.

The eight normal cameræ increase in depth from 2 mm. to 4

mm., and are followed on the type by a gerontic faint crenulated zone representing one or two more incipient septa.

*Discussion.*—In form this species is perhaps closest to *Hexamerocheras* cf. *hertzeri* Foerste (1930, pl. 22, fig. 3a) but differs in a slightly larger size, sutures which are more closely spaced and essentially parallel, instead of sloping increasingly orad on the venter in adoral camerae.

*Type.*—New York State Museum, No. 10518.

*Occurrence.*—Cobleskill limestone, Stafford, N. Y.

Genus **PHRAGMOCERINA** Flower, n. gen.

Genotype.—*Gomphoceras osculum* Ruedemann

This genus is erected for the reception of two Upper Silurian species which differ from both *Phragmoceras* and *Gomphoceras* to such an extent that the wisest course seems to be to place them in a genus by themselves. The shells are endogastric and moderately (in contrast to strongly) compressed. The apical part of the shell is faintly curved, the adoral part of the phragmocone and the mature living chamber become nearly straight. The ventral profile becomes convex over the greater part of the length of the living chamber, so that the shell contracts toward the aperture, but the hyponomic sinus is projected beyond the ventral profile in a short spoutlike production of the shell. The living chamber is abnormally straight for *Phragmoceras*, the apertural plane being essentially parallel to the last septum. Further, the adoral septa are subparallel, and not strongly oblique, as is typical of true *Phragmoceras* owing to the greater curvature of the shell. The aperture consists of a rounded faintly transverse main aperture on the dorsal side of the shell, modified by a long narrow hyponomic sinus which is slightly inflated at its tip.

*Discussion.*—While *Phragmoceras* exhibits considerable diversity of form, the species here set apart in *Phragmocerina* are clearly distinct in the relatively straight form of the anterior part of the shell, the inflation of the middle of the living chamber, its adoral contraction, and the ventral spoutlike projection of the hyponomic sinus. The known species of *Phragmocerina* are relatively small in comparison with typical *Phragmoceras*, and while the siphuncle is not known, it is evidently small and,



by all analogy, relatively simple.

The compression of the cross section is relatively slight, and the development of lateral lobes of the sutures is essentially vestigial. The straightness of the anterior part of the shell is expressed by the subparallel condition of the anterior septa; in *Phragmoceras* they diverge from venter to dorsum. Likewise the shell in profile shows the sutures to be parallel to the straight anterior surface marking the long narrow hyponomic sinus. Species of *Phragmoceras* which approach *Phragmocerina* in these respects, show living chambers which expand uniformly to a point near the mature aperture. Here expansion may be increased, so that the diverging sides become concave in profile, but these do not follow regions, as in *Phragmocerina*, in which the profiles are convex, and when such expansion does occur it is normally more accentuated on the dorsum than on the venter.

Typical *Gomphoceras* has a pyriform or domelike living chamber contracting over the adoral end of the shell, and there is never any marked prolongation of the hyponomic sinus or a spoutlike production of the ventral wall of the conch to accommodate it.

The genus is erected for the reception of two Upper Silurian species, the genotype and *Phragmocerina litchfieldensis*, described below.

***Phragmocerina litchfieldensis*** Flower, n. sp.

Plate 2, figs. 1-3

The type and only known specimen consists of a living chamber and three attached cameræ. The dorsum is largely missing. The shell is essentially straight, the sutures and the plane of the aperture being subparallel. Cross section at the base subcuneate, the venter narrow and subangular, the dorsum more broadly rounded. The septum is shallow, the siphuncle indicated by a small pit close to the ventral wall of the shell. The three cameræ which increase slightly adorally in depth occupy a length of 6 mm. The sides in lateral profile diverge to a point oral of the middle of the living chamber, so that 10 mm. beyond the base of the specimen a width of 19 mm. is reached. From there the sides converge, arching toward the narrow aperture. The living chamber has a basal width of 18 mm., an estimated height of 20 mm. At its most gibbous portion the width is 19

mm., the estimated height 22 mm. The living chamber is 20 mm. long. The ventral profile is nearly straight below, becoming convex over the middle of the living chamber, the curvature being abruptly reversed adorally to form a short spoutlike process for the reception of the long hyponomic sinus, which projects conspicuously beyond the otherwise smooth shell outline, though it does not extend outward beyond the convexity of the venter, as in *P. oscula*. The apertural profile, only slightly inclined to the plane of the septum, carries at one end the small rounded hyponomic sinus, connected by a narrow slit with the main part of the aperture, an oval 5 mm. long and 3 mm. wide.

*Discussion.*—This species is the only phragmoceroid shell thus far known from the Manlius limestone. Its strong similarity with *Phragmocerina oscula* (Ruedemann) is shown by the striking similarity in form. It differs in that the aperture is more strongly closed, the hyponomic sinus is less strongly produced over the ventral profile. The species differ further in minor features of proportion, among the most significant of which are the larger size of *P. litchfieldensis* and the more marked domelike contraction of the lateral walls of the shell over the adoral part of the living chamber.

*Holotype.*—Cornell University Collection, No. 7974.

*Occurrence.*—Manlius limestone, Litchfield, Herkimer County, New York.

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3



4



5



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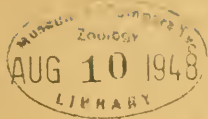






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**Vol. 32**

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**No. 130**

CRINOID STUDIES

PART I. TWO NEW SPECIES OF ALLAGECRINUS  
FROM THE PENNSYLVANIAN OF KANSAS AND  
TEXAS

PART II. APOGRAPHIOCRINUS FROM THE  
ALTAMONT LIMESTONE OF OKLAHOMA

By

HARRELL L. STRIMPLE

*July 28, 1948*

Paleontological Research Institution  
Ithaca, New York





## CRINOID STUDIES

### PART I

#### TWO NEW SPECIES OF *ALLAGECRINUS* FROM THE PENNSYLVANIAN OF KANSAS AND TEXAS

By

HARRELL L. STRIMPLE

### ABSTRACT

Description of two new species of *Allagecrinus*, from the Stull shale of Kansas and the Brownwood shale of Texas, increase the geologic and stratigraphic range of these forms. Material studied consisted of 32 dorsal cups and crowns collected by Allen Graffham from near Melvern, Kansas, and four dorsal cups, together with ten free brachials collected by Wm. T. Watkins and Frank Crane from Kyle Mountain near Palo Pinto, Texas.

### INTRODUCTION

The purpose of this paper is to record two interesting new species of *Allagecrinus*. A remarkable series of dorsal cups and crowns, found by Mr. Allen Graffham of the University of Nebraska in the Stull shale near Melvern, Kansas, is described in his honor as *Allagecrinus graffhami*, n. sp. The presence of *Allagecrinus* in the Pennsylvanian of Texas was disclosed on a field trip made during the summer of 1947 by Wm. T. Watkins of San Antonio, Texas, and Mr. Frank Crane of Fort Worth, Texas. Four dorsal cups were found in the Brownwood shale at a small exposure north of Palo Pinto, Texas, near the southeastern extremity of Kyle Mountain and is described as *Allagecrinus kylensis*, n. sp.

### SYSTEMATIC DESCRIPTIONS

*Allagecrinus graffhami*, n. sp.

Plate 1, figs. 1-11

*Description.*—Crown slender and elongate; dorsal cup mildly lobate with rather erect lateral sides in maturity. Three unequal BB comprise the basal circlet, which is readily visible in side view of cup. Five unequal BB form most of the dorsal cup; 1. post. B is the largest and carries as many as four arms in maturity; ant. R and r, ant. R normally carry three arms in full development; r. post. R and l. ant. R each carry only one arm which is normally slightly larger than the other arms. In ma-

turity the left shoulder of r. post. R is sharply lowered and supports a brachial-like anal plate.

Arms are slender and elongate, composed of a short primibrach followed by elongate brachials. A third primibrach is present even in the youngest observed crown. As many as 12 arms have been noted.

In proximal portion the column is composed of rapidly tapering, wafer thin columnals which terminate in a beadlike ossicle, thereafter having the construction of a normal, slow tapering, inadunate column, with rather elongate columnals.

The entire surface of the crown is strongly granular appearing.

*Measurements.*—

	Holotype	Paratype
Length of crown	*10.2 mm.	—
Width of dorsal cup	3.1 mm.	4.0 mm.
Height of dorsal cup	2.0 mm.	2.4 mm.

*Remarks.*—This species is very close to *Allagecrinus bassleri* Strimple (1938). The later species has a lower calyx, produces more arms, and the single rays of r. post. and l. ant. are proportionately more robust. The small crown of *Allagecrinus graffhami* is of considerable interest because it is one of the youngest complete specimens of the genus to come to the attention of this writer. Comparison with paratypes of comparable size discloses the presence of the oral circling at this stage of development. In the young form there is no appreciable difference in the size of the five arms preserved.

*Types.*—Holotype and figured paratypes to be deposited in the U. S. National Museum.

*Occurrence.*—Stull shale formation, Shawnee group, Virgil series, Pennsylvanian; near Melvern, Kansas.

*Allagecrinus kylensis*, n. sp.

Plate 1, figs. 12-20

*Description.*—Dorsal cup low, strongly lobate. BB circling very low, not visible in side view of cup. Five unequal RR comprise the entire height of dorsal cup; l. post. R very prominent and wide; l. ant. R smaller than other RR; r. post. R is protruded

\*Entire length of arms not preserved.

and at middle age is the most prominent element due to the presence of the extra facet for the anal plate. Maximum number of arm facets is ten as shown by the holotype. Body cavity is almost spherical except for the parabolic notch.

Arms are only known from numerous associated free ossicles, which are probably of the r. post. and l. ant. rays. At a stage of development where the arms apparently consisted of a short first primibrach and an elongate second primibrach, the latter element is very distinctive appearing. The base is narrow and thin, both thickening and widening takes place as the midportion is reached, and termination is rather abrupt.

The entire surface of the crown is granular appearing, and in mature specimens a few small pustule-like knobs are formed on the RR.

*Measurements.*—

	Holotype	Paratype
Height of dorsal cup	5.8 mm.	5.0 mm.
Height of dorsal cup	2.5 mm.	2.1 mm.

*Types.*—Holotype and figured paratype to be deposited in the U. S. National Museum.

*Occurrence.*—Brownwood shale, Grayford formation, Canyon group (Missouri series) Pennsylvanian; north of Palo Pinto, Texas, near the southeastern extremity of Kyle Mountain.

*Remarks.*—This species is comparable in size to *Allagecrinus bassleri* Strimple but is more strongly lobed and does not produce so many arms. *A. constellatus* Moore is the only described species which closely resembles *A. kylensis* and the former has pear-shaped RR in medium-sized specimens.

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## PART II

APOGRAPHIOCRINUS FROM THE ALTAMONT LIMESTONE  
OF OKLAHOMA

## ABSTRACT

A remarkable group of ornamented apographiocrinids are presented from the Altamont limestone, Des Moines series, of northeastern Oklahoma. Four new species are proposed. The forms are quite different from the ornamented *Apographiocrinus* species described by Moore and Plummer from the Missouri series of Texas.

## INTRODUCTION

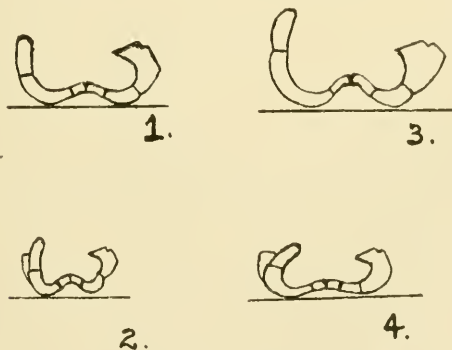
A remarkable assemblage of crinoids is present in the Altamont limestone of northeastern Oklahoma. Many specimens have been found by Bob Stevens, L. R. Laudon, Raymond C. Moore, Arthur Bowsher, and others. Laudon (1937) identified a large specimen as *Amphicrinus carbonarius* Springer. Special mention of the fauna was made by Moore and Plummer (1940), and Moore has described several species from the formation, *i.e.*, *Allagecrinus constellatus* Moore (1940), *Allagecrinus cignatus* Moore (1940), and *Galateacrinus stevensi* Moore (1939). *Metacillocrinus bulbosus* Moore and Strimple (1942) is another peculiar form from the horizon.

The author and his wife, Melba Strimple, have collected 25 specimens belonging to the unique genus *Apographiocrinus*. All are limited to dorsal cups, or partial cups, and no two are identical in every respect. This indicates a plastic condition probably brought about by a rapidly changing environment. All specimens have three things in common,—there is a small round stem; ornamentation is present either mildly or decisively; and there is a scarlike development below the articular facets which is considerably different from the normal appearance of the radials. This peculiar development is common among the described species from the Missouri series of Texas (see Moore and Plummer (1940) ) but is not so prevalent in the Missouri series of Oklahoma. Critical scrutiny of the material in hand indicates the desirability of division to four species which are described herein as *Apographiocrinus rotundus*, n. sp., *Apographiocrinus obtusus*, n. sp., *Apographiocrinus quietus*, n. sp., and *Apographiocrinus angulatus* n. sp.

A more extensive division of species has been avoided due to the evidence provided in the remarkable studies of individual variations made by James Wright (1926, 1927) with *Phanocrinus calyx*, *Zacrinus konincki*, *Ureocrinus globularis* and *Hydrcionocrinus*, from the Scottish Lower Carboniferous (Mississippian). Such observations have been substantiated in America by a study of numerous *Phanocrinus* specimens from the Chester (Mississippian) of northeastern Oklahoma, (final MS. submitted to Jour. Paleont. Jan. 24, 1948) *Peremistocrinus* from the Dewey limestone (Pennsylvanian) of northeastern Oklahoma, (1948) and *Delocrinus subhemisphericus* from the Iola formation of southeastern Kansas (MS. submitted to Geol. Mag., May 27, 1948). Considerable latitude for variants has been allowed in the present study.

The author desires to express his gratitude to Frank Crane of Fort Worth, Texas, and Wm. T. Watkins of San Antonio, Texas, for the loan of specimens from the Pennsylvanian of Texas for comparative study. It might be noted that the Texas *Apogradio-crinus* species appear to be more stable than the forms under consideration.

#### SYSTEMATIC DESCRIPTIONS



Figures 1-4. Diagrammatic cross sections, enlarged twice natural size. 1. Holotype, *Apogradio-crinus obtusus*, n. sp. 2. Holotype, *Apogradio-crinus angulatus*, n. sp. 3. Holotype, *Apogradio-crinus rotundus*, n. sp. 4. Holotype, *Apogradio-crinus quietus*, n. sp.

Genus **APOGRAPHIOCRINUS** Moore and Plummer, 1940**Apographiocrinus rotundus**, n. sp.

Plate 2, figs. 9-12; text fig. 3

*Description.*—This is the largest form observed from the Altamont limestone. The dorsal cup is full all around, rather deep, and the outer extension of the radials (RR) into the inter-facial regions is pronounced. Ornamentation consists of fine elongate ridges and depressions, with small rounded granules clustered on the distal portions of infrabasals (IBB) and proximal portions of basals (BB). IBB circlet is subhorizontal in position with the scar of the proximal columnal forming a deep impression. Tumidity of BB creates a shallow basal concavity. Post. B. is rather large, other BB are normal elements of subequal size. Each radial is divided into two parts, the proximal portion has normal convexity but the upper portion is flattened and appears somewhat like a scar, with only occasional granules present except where the elongate ridges extend part way up from the lower area. Articular facets are well developed. The single anal rests solidly within the dorsal cup on the truncated tip of post. B. however, its greatest development is within the interbrachial area. Sutures rest in a slight depression but are not deeply impressed.

*Measurements*—

	Holotype	Paratype
Height of dorsal cup	4.8 mm.	5.0 mm.
Greatest width of cup	11.9 mm.	12.3 mm.
Diameter of stem impression	1.7 mm.	2.1 mm.
Diameter of IBB circlet	2.5 mm.	3.0 mm.

*Relationship.*—*Apographiocrinus rotundus* is readily distinguished from all other described species in the full, deep cup and distinctive ornamentation.

*Occurrence and horizon.*—Upper part of the Altamont limestone, Marmaton group, Des Moines series, Pennsylvanian (Upper Carboniferous); road cut on eastward extension of 31st Street, at southeast edge of Tulsa, Oklahoma.

*Types.*—To be deposited in the U. S. National Museum.

**Apographiocrinus obtusus**, n. sp.

Plate 2, figs. 1-4; text fig. 1

*Description.*—Dorsal cup broad, shallow, and is most distinc-



tive in the possession of large, vertical facets which occupy almost the entire width and height of the RR. In side view of dorsal cup, these facets form most of the height of the calyx and the remainder of the RR repose in a subhorizontal position. There is a shallow basal concavity. Five IBB are slightly down-flared and form a pentagonal-shaped disk. Sutures between plates are in a mild depression but there is a decided lack of tumidity to the calyx elements as compared to other species of the genus.

With the aid of magnification the ornamentation is seen to consist of small rounded granules. They are especially prominent in the areas between the vertical facets of the RR, and in the proximal portions of BB. Elongate ridges accentuate the scar-like development of RR which is covered by delicate granules. Weak elongate ridges are sometimes visible over the normal surfaces of RR and BB.

Articular facets of RR are well defined but are shallow when compared with some species of *Apographiocrinus*. They slope inward only slightly.

*Measurements.*—

	Holotype
Width of dorsal cup	10.2 mm.
Height of cup	3.7 mm.
Diameter of stem impression	1.5 mm.
Width of IBB circlet	2.5 mm.

*Relationship.*—*Apographiocrinus obtusus* is distinctive in the wide, shallow nature of the dorsal cup, and the unusually strong, vertically developed, arcuate area below the articular facet of each radial plate. No other described species is comparable.

*Occurrence and horizon.*—Upper part of the Altamont limestone, Marmaton group, Des Moines series, Pennsylvanian (Upper Carboniferous); road cut on eastward extension of 31st Street at southeast edge of Tulsa, Oklahoma.

*Types.*—To be deposited in the U. S. National Museum.

*Apographiocrinus quietus*, n. sp.

Plate 2, figs. 13-16; text fig. 4

*Description.*—This is the most common species in the group

under consideration. There are minor variations but substantially the form is a moderately deep cup with a scalloped appearance when viewed from above or below. Basal concavity is small and rather shallow, except for the columnar scar which is deeply impressed. Five IBB form a small pentagon and are subhorizontal in outer portions. BB are tumid and are sharply divided from adjoining RR. There is a small arcuate area below the articular facet of each radial. Entire surface of cup is marked by minute rounded granules, and in the holotype, the scarlike areas of the RR are strongly granular. This latter characteristic is not so pronounced in some of the paratypes. Interfacetal extensions of outer surface of RR form pronounced protuberances. Articular facets are sharply defined and slope slightly inward.

*Measurements.*—

	Holotype
Width of dorsal cup	0.6 mm.
Height of dorsal cup	3.6 mm.
Diameter of stem impression	1.0 mm.
Width of IBB circlet	1.8 mm.

*Relationship.*—In general appearance this species is quite similar to *Apoglyphiocrinus exculptus* Moore and Plummer, *A. decoratus* Moore and Plummer, *A. facetus* Moore and Plummer and/or *A. calycinus* Moore and Plummer, all from the Missouri series of Texas. The dorsal cup of *A. facetus* and *A. exculptus* are deeper, and *A. quietus* has a more scalloped outline when viewed from above or below than found in *A. calycinus* and *A. decoratus*. In addition, *A. quietus* has granules covering the entire surface of the cup, which condition is not reported for any of the Texas species and has not been observed in any of the specimens under loan or in the collections of the author.

*Occurrence and horizon.*—Upper part of the Altamont limestone, Marmaton group, Des Moines series, Pennsylvanian (Upper Carboniferous); road cut on eastward extension of 31st Street at southeast edge of Tulsa, Oklahoma.

*Types.*—To be deposited in the U. S. National Museum.

*Aprographiocrinus angulatus*, n. sp. Plate 2, figs. 5-8; text fig. 2

*Description.*—This is the most exciting species under consideration. When the dorsal cup is viewed from above or below there is a most pronounced scalloped appearance augmented in lateral view by the sharply depressed areas at the apices of FB and RR. Basal concavity is rather broad, shallow, and has the center portion sharply impressed for the reception of proximal columnal. Arcuate facet is present below the articular facets of RR but is considerably smaller than in other species from this horizon. Interfacetal extensions of outer surface of RR are exceptionally prominent. Articular facets are small, slope slightly inward, and are well defined. Entire surface of the dorsal cup is covered by minute, rounded granules which are weak in the area below the facets of RR. The single anal plate is normal for the genus; *i.e.*, larger in the interbrachial region than within the dorsal cup where it is seen to make solid contact with exceptionally large posterior basal.

*Measurements.*—

	Holotype
Greatest width of dorsal cup	7.2 mm.
Height of cup	3.0 mm.
Diameter of stem impression	0.9 mm.
Width of IBB circlet	1.9 mm.

*Relationship.*—The specific characteristics given above are sufficient to distinguish this from other described species of *Aprographiocrinus*. Extreme scalloped appearance together with the depressed apices of RR and BB serve to quickly set it apart. Except for the generic characteristics, which are well shown, *A. angulatus* might be confused with some species of *Endlocrinus*.

*Occurrence and horizon.*—Upper part of Altamont limestone formation, Marmaton group, Des Moines series, Pennsylvanian (Upper Carboniferous); road cut on eastward extension of 31st Street at southeast edge of Tulsa, Oklahoma.

*Type.*—To be deposited in the U. S. National Museum.

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PLATES

PLATE I (3)

## Explanation of Plate 1 (3)\*

Figure	Page
1-11. <i>Allagecrinus graffhami</i> , n. sp. . . . .	3
Figs. 1-2. Right posterior and left anterior views of holotype. 3-5. Summit, basal, and posterior views of mature paratype. 6-8. Summit, basal, and posterior views of paratype. 9-10. Left posterior and anterior views of immature crown. 11. Left anterior view of young partial crown. Stull shale, near Melvern, Kansas.	
12-20. <i>Allagecrinus kylensis</i> , n. sp. . . . .	4
Figs. 12-14. Summit, basal, and right posterior views of holotype. 15-17. Summit, basal, and right posterior views of paratype. 18-20. Side, internal and external views of typical second primibrach, Brownwood shale, Kyle Mountain, near Palo Pinto, Texas.	

\* All figures approximately three times natural size, natural photographs.

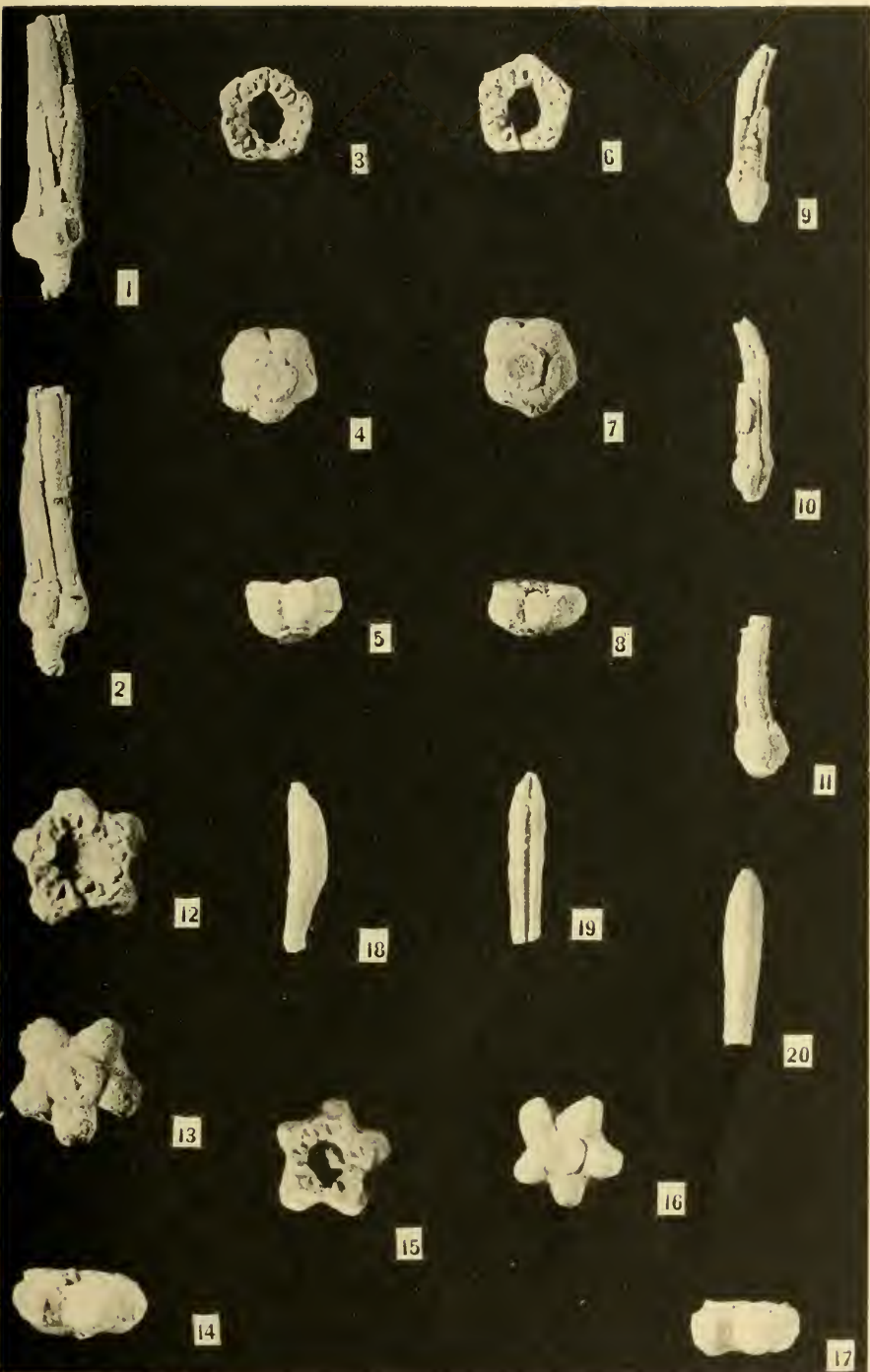




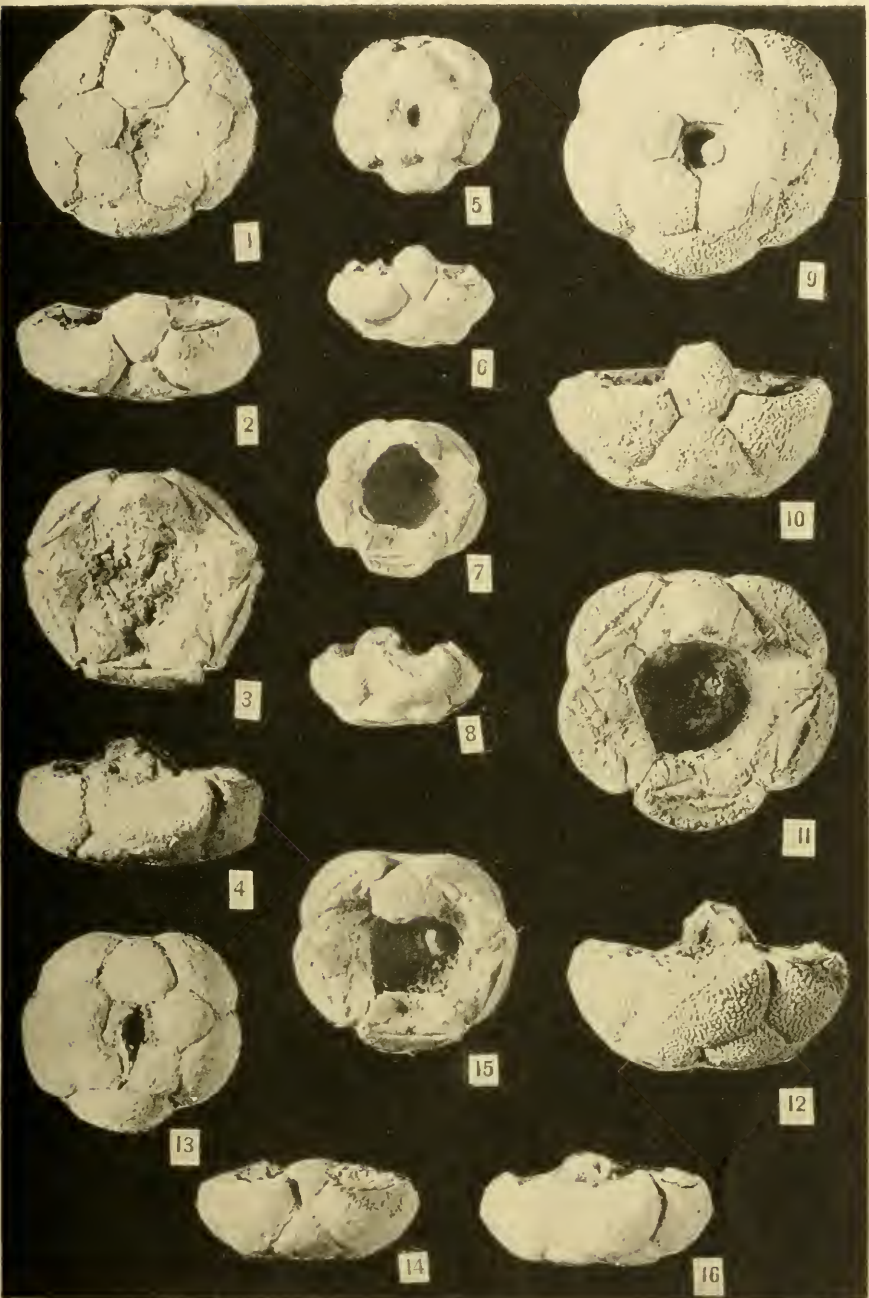


PLATE 2 (4)

## Explanation of Plate 2 (4)\*

Figure	Page
1-4. <b>Apographiocrinus obtusus</b> , n. sp. Holotype. View from below, posterior side, summit and anterior side.	8
5-8. <b>Apographiocrinus angulatus</b> , n. sp. Holotype. View from below, posterior side, summit and anterior side.	11
9-12. <b>Apographiocrinus rotundus</b> , n. sp. Holotype. View from below, posterior side, summit and anterior side.	8
13-16. <b>Apographiocrinus quietus</b> , n. sp. Holotype. View from below, posterior side, summit and anterior side.	9

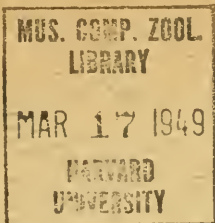
\* All figures are unretouched photographs enlarged three times.











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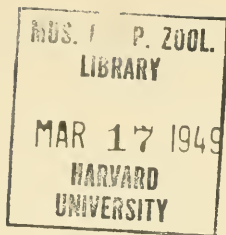
**EOCENE AND OLIGOCENE FORAMINIFERA  
FROM LITTLE STAVE CREEK, CLARKE COUNTY, ALABAMA**

By  
Orville L. Bandy  
Indiana University

*March 4, 1949*

Palaeontological Research Institute  
Ithaca, New York





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2. Generalized columnar section, Little Stave Creek	see 8

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1. Ranges and abundance of species	see 146
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EOCENE AND OLIGOCENE FORAMINIFERA  
FROM LITTLE STAVE CREEK, CLARKE COUNTY,  
ALABAMA

By

ORVILLE L. BANDY\*

Indiana University

ABSTRACT

Two hundred and eighty-three species and varieties of Foraminifera are described and figured from middle and upper Eocene and lower and middle Oligocene strata, along the upper course of Little Stave Creek, Clarke County, Alabama. The rocks are exposed along the stream's course for a distance of over one mile with a stratigraphic thickness of over 400 feet. Samples were collected at frequent intervals from all horizons. Three genera and one hundred and two species and varieties are described as new, and the relative abundance and stratigraphic ranges of all species have been determined. A new fauna is reported from the Tallahatta formation.

INTRODUCTION

The present study is the determination of the stratigraphic occurrence of the smaller Foraminifera found in a sequence of middle and upper Eocene, as well as lower and middle Oligocene strata, exposed along the upper course of Little Stave Creek, Clarke County, Alabama. A knowledge of the occurrence of the Foraminifera in these strata is especially desirable, since this sequence of strata is of considerable importance in subsurface petroleum exploration of much of the southern Gulf coastal area. It is hoped that the present study will aid in a better understanding of stratigraphic and faunal relationships in related areas.

The region is about two and one-half miles north of the town of Jackson (Fig. 1). The headwaters of the stream are in section 21, T. 7 N., R. 2 E., and from there it flows westward along the southern border of section 20, intersecting the northerly striking Jackson fault in the general vicinity of the northeast corner of section 30.

Although the area is within the coastal plain province where the regional dip is mostly to the south, the strata dip gently to the east about  $1\frac{1}{2}^{\circ}$ - $2^{\circ}$ . The deviation of dip is directly attributable to the influence of the Hatchitigbee anticline, located some eight miles to the northwest (C. W. Cooke, Geol. Survey

\*Effective 1948, Assistant Professor of Geology, University of Southern California.

Alabama, Spec. Rept. 14, 1926, p. 252). The Jackson fault in this area has a displacement of over 400 feet, and in the Little Stave Creek section it results in the juxtaposition of Lower Claiborne Eocene on the east side of the fault plane with beds of Oligocene age on the west.

In August, 1946, while the writer was employed by the Humble Oil and Refining Company, Houston, Texas, several geologists of the company and the writer made a Lurton compass traverse of Little Stave Creek, collecting samples at close intervals, as indicated in Figures 1 and 2. This study deals with 67 samples collected over a distance in excess of one mile between the Jackson fault on the west, where the Claiborne group is exposed, and the uppermost exposure of the Marianna limestone near the headwaters of the creek to the east. The columnar thickness of this section (Fig. 2) is about 400 feet, and considerable effort was made to secure samples at frequent intervals and from all horizons. Every attempt has been made to describe, figure, and plot the ranges and relative abundance of all of the common, abundant, and most of the rare, small Foraminifera found in the samples. In the fall of 1947, the writer mapped the section with plane table and telescopic alidade in order to check the elevations of several outcrops and to establish better the collecting localities (Fig. 1).

This section was previously mapped by R. H. Smith *et al* (Field Trip, Southeastern Geol. Soc., June, 1944) and the columnar section which they prepared gave some of the more important megafossils and a few diagnostic Foraminifera. The positions of the megafossils reported by them are essentially the same as those indicated in Figure 2. The vertical ranges of the smaller Foraminifera indicated on their column have been found to be somewhat greater.

#### ACKNOWLEDGMENTS

The field work was begun while the writer was employed by the Humble Oil and Refining Company, Houston, Texas. To the directors of that company and to Morgan Davis, Chief Geologist, and to F. W. Rolshausen, Chief Paleontologist, the



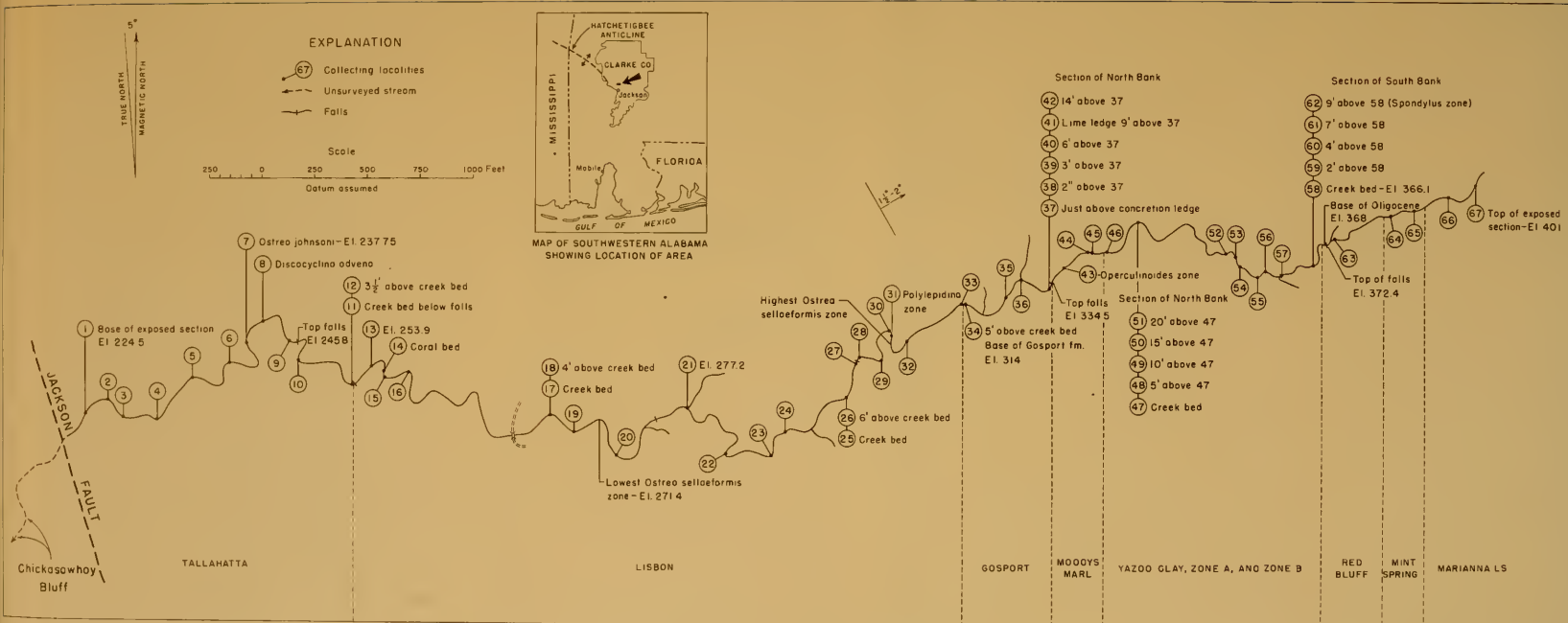


FIGURE I. MAP OF THE UPPER COURSE OF LITTLE STAVE CREEK, CLARKE COUNTY, ALABAMA

Surveyed by O. L. Bondy and R. M. Weidman, Nov., 1947

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writer extends many thanks.

The research program was commenced in September, 1946, under an Indiana Department of Conservation Fellowship in Geology at Indiana University—Professor Charles F. Diess, being State Geologist and Chairman of the Department of Geology. The study was done under the supervision and helpful guidance of Dr. J. J. Galloway, Professor of Geology and Paleontology, Indiana University, and to him the writer extends his deepest appreciation and thanks.

Many thanks are also due the Shell Oil Company for the granting of a generous research fellowship and expense account for the 1947-48 academic year toward the furthering of the research, completion of, and publication of this study.

The figures were drawn by the author, using a camera lucida for outlining the structures. The map, columnar section, and table of ranges and abundance, were drafted by William Moarn.

All of the types are catalogued and deposited in the Paleontological Laboratory at Indiana University.

#### GENERAL FAUNAL RELATIONSHIPS

The zoning of important species is discussed under the Stratigraphic Analysis, but the general relationships of the faunas encountered in the present study are worthy of note. The Claiborne fauna is very similar to the other faunas of the Gulf Coast with very few outside forms present. The same statement holds true for the faunas of the Jackson and Oligocene in general. An exception appears to be the miliolid fauna of the lower Yazoo clay member of the Jackson formation. Several new species of miliolids are present and may be of rather limited geographic range. The hitherto unreported fauna from the Tallabatta cannot be compared with others, inasmuch as little foraminiferal work has been published upon the Lower Claiborne. At locality 58, Jackson Eocene, abundant forms were found which are common to much of the Gulf coastal area of the United States and Mexico. A few forms common to the Eocene of Cuba and Venezuela were found, the most important being the abundantly occurring *Planulina venezuelana* Nuttall reported from Venezuela, and the common form, *Saracenaria ornatula* Bermudez reported from Cuba.

In general, the faunal elements are mostly cosmopolitan with minor provincial elements. Many of the new forms reported may be found to be cosmopolitan with further work in other areas.

### CONDITIONS OF DEPOSITION

The occurrence of orbitoidal Foraminifera in most of the section (Fig. 2), the presence of large faunas of small Foraminifera, and the limy nature of many of the strata of the Little Stave Creek section, all indicate a predominantly warm, shallow sea with relatively little turbidity. The presence of considerable glauconite in the Claiborne formations further corroborates the shallow, stable element. As indicated by silts and clays, there were periods of turbid conditions, especially in the Tallahatta and Yazoo beds. The turbidity, however, was not great enough to prevent the development of benthonic Foraminifera, among them many miliolids.

The environment of deposition indicated above accords well with the paleogeographic discussions of Stephenson (*Amer. Jour. Sci.*, ser. 5, vol. 16, 1928, pp. 281-98). According to Stephenson's paleogeographic maps, the southern part of Alabama was a part of the neritic zone throughout the Eocene and Oligocene epochs.

### THE STRATIGRAPHIC ANALYSIS OF COMMON AND DIAGNOSTIC SPECIES OF FORAMINIFERA IN THE LITTLE STAVE CREEK SECTION

The 283 species of Foraminifera described herein include mainly the smaller forms, many of which are of considerable stratigraphic value in the section studied. The forms considered to be most important and diagnostic, along with some of the larger well-known Foraminifera, are listed under the respective formations given below. In addition, some species which are common, but not restricted to certain formations, are included in the following lists preceded by an asterisk, and it is suggested that Table 1 be consulted for a clearer understanding

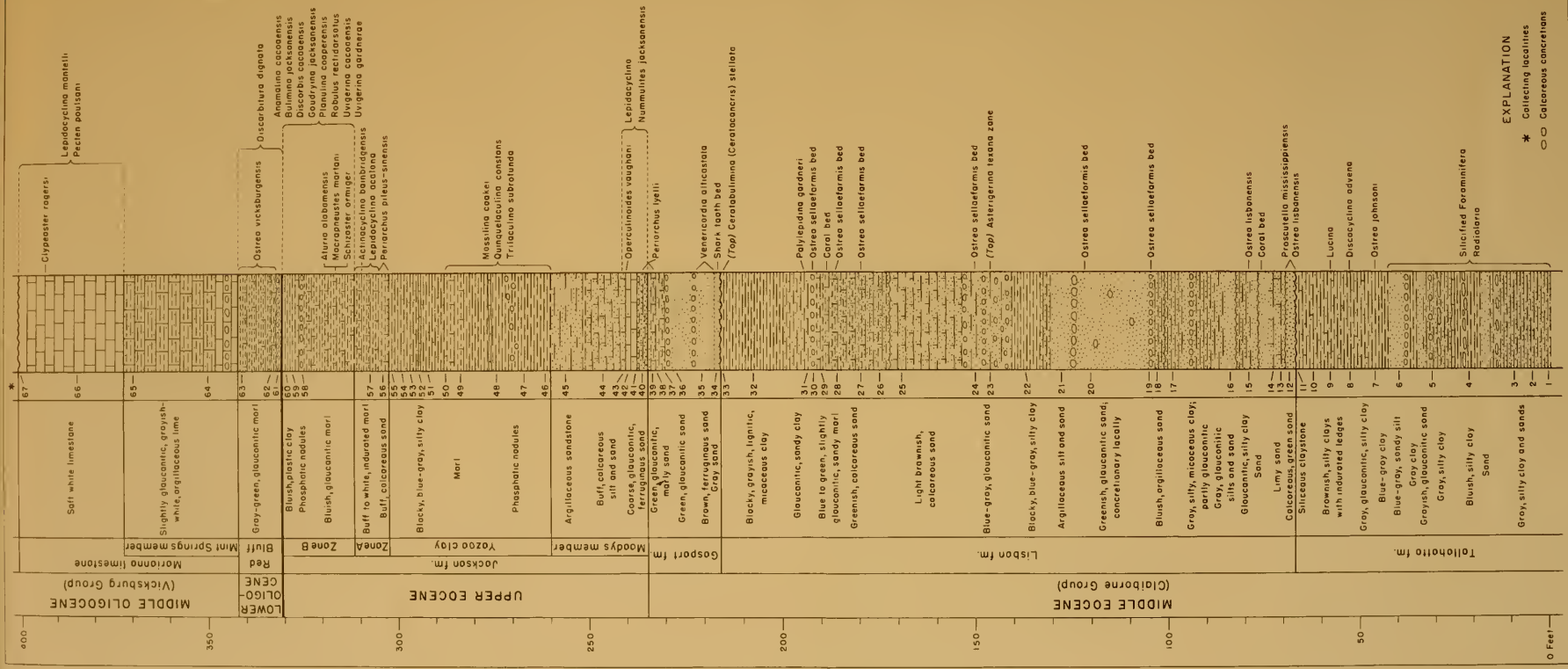


FIGURE 2. GENERALIZED COLUMNAR SECTION OF LITTLE STAVE CREEK, CLARKE COUNTY, ALABAMA

EXPLANATION  
 \* Collecting localities  
 □ Calcareous concretions



of their relative abundance and stratigraphic ranges. The formations are discussed in ascending order.

### EOCENE EPOCH

#### MIDDLE EOCENE, CLAIRBORNE GROUP

*Tallahatta formation.*—The Tallahatta formation is about 140 to 200 feet thick in the general area (Toulmin, Field Trip, Southeastern Geol. Soc., June, 1944, p. 10), but only about 65 feet of the upper portion is exposed in this section. The formation is of marine origin and is composed of a series of clays, some siliceous claystone, aluminous sandstone which is glauconitic in part, and the upper 10 to 15 feet are composed of brown clay in which there are numerous indurated ledges. Radiolaria are fairly common in the lower 30 to 40 feet of exposed section and are very well preserved. The Foraminifera are very rare in the lower part of the exposed Tallahatta, but the few which are present are characteristically silicified (Table 1, localities 1-6). In this lower zone are specimens of *Discorbis mauricensis* Howe and Roberts and *Glandulina elliptica* Reuss, typical calcareous Foraminifera which are uniquely preserved with siliceous material. In some cases the tests appear to be composed of quartz grains cemented together with silica, in other cases, the tests are composed of clear silica, similar to chalcedony. In the upper part of the Tallahatta (localities 7-11) there is no indication of this type of preservation. A considerably well-preserved fauna was found in the upper part of the exposed portion of the Tallahatta including several new species.

Diagnostic Foraminifera of the Tallahatta Formation, Illustrated as Follows:

<i>Anomalina costiana</i> .....	pl. 17, figs. 6a-c
<i>Bolivina denticulata</i> .....	pl. 25, figs. 3a-b
<i>Bolivina regularis</i> .....	pl. 25, figs. 10a-b
<i>Cibicides pippeni stavensis</i> .....	pl. 19, figs. 6a-c
* <i>Cibicides pseudozenellorstorfi</i> .....	pl. 20, figs. 3a-c
<i>Cibicides tallahattensis</i> .....	pl. 20, figs. 5a-c
<i>Cibicidina blanpiedi</i> .....	pl. 15, figs. 4a-c
<i>Cibicidina mauricensis subinvoluta</i> .....	pl. 16, figs. 5a-c

\* Common but not restricted.

*Discocyclina advena* (Cushman), 1921, U. S. Geol. Survey, Prof. Paper 128-E, p. 139, pl. 22, figs. 1-5.

- \**Discorbis tallahattensis* ..... pl. 16, figs. 7a-c  
 \**Gümbeliteria stavensis* ..... pl. 24, figs. 5a-b  
*Haplophragmoides tallahattensis* ..... pl. 3, figs. 3a-b  
 \**Lamarckina biconvexa* ..... pl. 12, figs. 3a-c  
*Loxostomum serrula* ..... pl. 25, figs. 11a-b  
*Nonion tallahattensis* ..... pl. 11, figs. 11a-b  
 \**Trifarina wilcoxensis* ..... pl. 27, figs. 11a-b  
 \**Valvulineria danvillensis gyroidinoides* ..... pl. 13, figs. 3a-c

*Lisbon formation*.—Approximately 150 feet of marine fossiliferous, predominantly calcareous and glauconitic sands and silty clays, comprise the Lisbon formation of this section. A minor disconformity separates this formation from the underlying Tallahatta. The fauna for the most part is fairly abundant and well preserved. Examination of Table 1 indicates that there is considerable faunal zonation within the Lisbon formation.

Diagnostic Foraminifera of the Lisbon Formation, Illustrated as Follows:

- Anomalina umbonata* ..... pl. 18, figs. 3a-c  
*Articulina terquemi* ..... pl. 1, figs. 6a-b  
*Asterigerina texana* (L. Lisbon) ..... pl. 22, figs. 3a-c  
*Cancris claibornensis* ..... pl. 12, figs. 2a-c  
 \**Ceratobulimina (Ceratocancris) stellata* ..... pl. 13, figs. 6a-c  
*Cibicides mimulus* ..... pl. 19, figs. 1a-c  
*Cibicidina mauricensis* ..... pl. 15, figs. 5a-c  
*Clavulinoides guayabalensis* (U. Lisbon) ..... pl. 4, figs. 4a-b  
*Discorbis yeguaensis* ..... pl. 17, figs. 2a-c  
*Eponides lisbonensis* (L. Lisbon) ..... pl. 14, figs. 2a-c  
 \**Eponides mexicanus* (U. Lisbon) ..... pl. 14, figs. 5a-c  
 \**Lamarckina biconvexa* (L. Lisbon) ..... pl. 12, figs. 3a-c  
 \**Nonion mauricensis* ..... pl. 10, figs. 12a-b  
*Nonion stavensis* (U. Lisbon) ..... pl. 11, figs. 5a-b  
*Polylepidina gardneri* (U. Lisbon) Cole, 1929, Bull. Amer. Paleont., vol. 15, p. 60, pl. 1, figs. 1-6; pl. 2, figs. 1-2.

\* Common but not restricted.



<i>Pseudobulimina glaessneri</i> (U. Lisbon)	pl. 13, figs. 2a-c
<i>Quinqueloculina harrisi</i>	pl. 1, figs. 5a-c
<i>Quinqueloculina mauricensis apertaexpansa</i>	pl. 1, figs. 9a-c
<i>Siphonina claibornensis</i>	pl. 21, figs. 4a-c
<i>Spiroloculina lisbonensis</i>	pl. 1, figs. 3a-c
<i>Textularia claibornensis</i>	pl. 4, figs. 15a-b
<i>Valkulineria jacksonensis persimilis</i>	pl. 13, figs. 4a-c

*Gosport formation.* Toulmin (Field Trip, Southeastern Geol. Soc., June, 1944) reports *Nonionella cockfieldensis* Cushman and Ellisor as being present throughout this formation, but no typical specimens were discovered in the material collected for this analysis. The section is about 18 feet thick in this area and is composed of very fossiliferous glauconitic and ferruginous sands. The megafossils are much more abundantly represented than the microfauna for the most part. The sample from locality 39 (see Fig. 2 and Table 1) contains a few of the diagnostic Claiborne species and is assigned to the top of the Gosport.

Diagnostic Foraminifera of the Gosport Formation, Illustrated as follows:

* <i>Eponides mexicanus</i>	pl. 14, figs. 5a-c
* <i>Nonion rolshauseni</i>	pl. 11, figs. 3a-b
* <i>Siphonina claibornensis</i>	pl. 21, figs. 4a-c
* <i>Textularia claibornensis</i>	pl. 4, figs. 15a-b

#### UPPER EOCENE, JACKSON FORMATION

*Moodys marl member.* This member of the Jackson group is about 25 feet in thickness and lies conformably on the Gosport formation. It consist of marine fossiliferous calcareous silt, sands, and some blue glauconitic, silty, marl. Many larger, diagnostic Foraminifera occur near the base of this formation. The basal part (locality 40) contains *Miliola jacksonensis* Cushman and *Nummulites jacksonensis* (Cushman), two good indices of the Moodys marl.

Diagnostic Foraminifera of the Moodys Marl Member, Illustrated as Follows:

* <i>Bolivina salebrosa</i>	pl. 25, figs. 6a-b
* <i>Cibicides truncatus</i>	pl. 19, figs. 2a-c

\* Common but not restricted.

- \**Discorbis hemisphaericus* ..... pl. 16, figs. 2a-c  
 \**Miliola jacksonensis* ..... pl. 2, figs. 6a-c  
*Nummulites jacksonensis* (Gravell and Hanna), 1935, Jour. Paleont., vol. 9, p. 331, pl. 29, figs. 1-5, 7-8, 10-11, and 13-14. According to Opinion 192 (Jour. Paleont., vol. 20, 1946, p. 294) of the International Rules of Zoological Nomenclature, the rules are suspended in favor of *Nummulites* Lamarck, 1801, hence *Camerina* is no longer correctly used for this species (localities 40-43).

*Operculinoides vaughani* (Cushman), 1921, U. S. Geol. Survey, Prof. Paper 128-E, p. 128, pl. 19, figs. 6-7.

- \**Reusella moodysensis* ..... pl. 25, figs. 13a-b  
*Sphaerogypsina globulus* ..... pl. 21, fig. 5

*Yazoo clay member*.—The Yazoo clay conformably overlies the Moodys marl member of the Jackson group in this section and is composed of about 42 feet of marine, fossiliferous, bluish-plastic clay which breaks into blocks having somewhat conchoidal fracture. The clay when processed and washed for foraminiferal separation is found to actually contain considerable quantities of mostly fine sand and silt. The fauna is fairly abundant and well preserved. Many of the miliolids are siliceous, as for example, *Massilina cookei* Cushman, *Massilina yazooensis*, n. sp., *Quinqueloculina constans*, n. sp., and *Triloculina subrotunda*, n. sp. In some cases the walls of these miliolids are composed of quartz grains with siliceous cement, in other cases the walls are of clear silica, similar to chalcedony. Although miliolids may have sand grains added to the exterior of their walls (Galloway, A Manual of Foraminifera, 1933, p. 118) and in some cases be entirely siliceous, it is believed that the siliceous character of the forms of the Yazoo member is the result of silicification. The supporting evidence for this conclusion is that specimens of *Discorbis*, *Glandulina*, and a few other genera which are never known to have siliceous tests, have the same type of preservation in the lower part of the Tallahatta formation. In addition, the type of *Massilina cookei* Cushman is apparently porcellaneous and the representatives of that species in this section are also mostly siliceous.

\* Common but not restricted.

Diagnostic Foraminifera of the Yazoo Clay Member, Illustrated as Follows:

<i>Ammobaculites pseudorostratus</i> .....	pl. 3, figs. 7a-b
<i>Ammobaculites yazooensis</i> .....	pl. 3, figs. 6a-b
* <i>Cibicidina yazooensis</i> .....	pl. 15, figs. 6a-c
<i>Massilina cookei</i> .....	pl. 3, figs. 1a-c
<i>Massilina yazooensis</i> .....	pl. 3, figs. 2a-c
* <i>Nonion advena</i> .....	pl. 10, figs. 8a-b
* <i>Nonion inc excavatus</i> .....	pl. 10, figs. 9a-b
* <i>Nonionella spissa</i> .....	pl. 11, figs. 2a-c, 4a-c
<i>Quinqueloculina constans</i> .....	pl. 1, figs. 4a-c
<i>Spiroplectammina pseudoelongata</i> .....	pl. 4, figs. 9a-b
* <i>Textularia adalta</i> .....	pl. 4, figs. 13a-b, 14a-b
* <i>Textularia dibollensis</i> .....	pl. 4, figs. 12a-b
<i>Triloculina subrotunda</i> .....	pl. 1, figs. 10a-c

*Zone A.*—This zone is about nine feet thick and is characterized by numerous specimens of *Pecten* and abundant Bryozoa. The lower portion is a buff-colored, limy sand, the upper part is a light buff indurated marl. The foraminiferal fauna is similar to that of locality 58 (Fig. 2), but the species are not so abundant. Most of the smaller Foraminifera range through this zone upward into the overlying member, many specimens of *Pecten* and Bryozoa, however, are confined to this zone. *Lepidocyclina ocalana* Cushman (1920, U. S. Geol. Surv., Prof. Paper 125-D, p. 71) is also abundantly represented and is restricted to this zone. *Actinocyclina bainbridgensis* Vaughan is restricted to a thin bed within this zone (Fig. 2).

#### Diagnostic Foraminifera of Zone A

*Actinocyclina bainbridgensis* Vaughan, 1928, Florida Geol. Survey, 19th Ann. Rept., p. 158, pl. 1, fig. 5.

*Lepidocyclina ocalina* Cushman, 1920, U. S. Geol. Survey, Prof. Paper 125-D, p. 71, pl. 28, figs. 3-4; pl. 29, figs. 1-3.

*Zone B.*—This unit includes the formation termed "Shubuta Hill Clay" by Smith (Field Trip, Southeastern Geol. Soc., June, 1944) and part of the overlying plastic blue clay. As noted in Table 1, many diagnostic forms extend throughout the three localities involved, and it is for this reason that the two units

\* Common but not restricted.

are lumped together as Zone B. The general lithology of this unit is rather similar to that of the Yazoo clay which occurs lower in the section, but the faunas are very different and it is unlikely that this is a part of that member. Only some of the more important Foraminifera are listed below, inasmuch as about 150 species were found in this one zone, many of which are restricted to the lower part.

Diagnostic Foraminifera of Zone B, Illustrated as Follows:

<i>Anomalina cocoaensis</i> .....	pl. 17, figs. 5a-c.
<i>Asterigerinella gallozwayi</i> .....	pl. 22, figs. 1a-c.
<i>Bolivina dalli</i> .....	pl. 24, figs. 6a-b.
<i>Bulimina jacksonensis</i> .....	pl. 26, figs. 5a-b.
<i>Bulimina jacksonensis cuneata</i> .....	pl. 26, fig. 4.
<i>Discorbis cocoaensis</i> .....	pl. 16, figs. 3a-c.
<i>Cancris cocoaensis</i> .....	pl. 12, figs. 7a-c.
<i>Cibicidina walli</i> .....	pl. 15, figs. 5a-c.
<i>Gaudryina jacksonensis</i> .....	pl. 3, figs. 10a-b.
<i>Marginulina cocoaensis</i> .....	pl. 6, figs. 1a-b.
<i>Saracenaria ornatula</i> .....	pl. 5, figs. 8a-b.
<i>Robulus davisi</i> .....	pl. 8, figs. 4a-b.
<i>Robulus inusitatus</i> .....	pl. 8, figs. 6a-b.
<i>Robulus rectidorsatus</i> .....	pl. 8, figs. 5a-b.
<i>Uvigerina cocoaensis</i> .....	pl. 26, fig. 14
<i>Vulvulina advena</i> .....	pl. 5, figs. 3a-b, 4a-b.

## OLIGOCENE EPOCH

### LOWER OLIGOCENE

*Red Bluff clay*.—(Lower Vicksburg of most authors). The classification of F. Stearns MacNeil (Bull. A.A.P.G., vol. 28, 1944, p. 1316), excluding the Red Bluff clay from the Vicksburg group, is followed in this study. The Red Bluff is about 12 feet thick in this section, based upon faunal analysis. This includes a small portion of the plastic blue-gray clay at the base. The general lithologic character is essentially a light, greenish-gray, glauconitic marl. The foraminiferal fauna is a transitional assemblage with numerous mixed Oligocene and Eocene forms. A few of the diagnostic forms are listed below.

Diagnostic Foraminifera of Red Bluff Clay, Illustrated as follows:

<i>Angulogerina byramensis</i> .....	pl. 27, figs. 9a-b.
* <i>Bolivina mississippiensis</i> .....	pl. 25, figs. 4a-b.
* <i>Bolivina retifera</i> .....	pl. 24, figs. 10a-b.
<i>Cibicides cookei</i> .....	pl. 18, figs. 5a-c.
<i>Discorbitura dignata</i> .....	pl. 17, figs. 3a-c.
* <i>Globorotalia mariannensis</i> .....	pl. 12, figs. 8a-c.
* <i>Gyroidina obesa</i> .....	pl. 14, figs. 4a-c.
* <i>Rotorbinella packardii</i> .....	pl. 15, figs. 1a-c.
* <i>Uvigerina vicksburgensis</i> .....	pl. 27, fig. 5.

MIDDLE OLIGOCENE, VICKSBURG GROUP

*Marianna limestone*.—About 60 feet of Marianna limestone is exposed on Little Stave Creek, the lower 30 feet of which has been designated as equivalent to the Mint Spring marl by Smith *et al* (Field Trip, Southeastern Geol. Soc., June, 1944). Smith's classification is followed in this analysis, although most of the smaller Foraminifera are essentially alike throughout. The lower part, which is designated Mint Spring marl, is a grayish-white, slightly glauconitic lime. The upper 30 feet of the section contains considerable numbers of specimens of *L. mantelli* (Morton) and is the typical soft white "chimney rock."

Common Species of Foraminifera in the Mint Spring Member, Illustrated as follows:

* <i>Ammobaculites subagglutinans</i> .....	pl. 3, figs. 5a-b.
* <i>Bitubulogenerina hozcei</i> .....	pl. 25, figs. 12a-b.
* <i>Bolivina mississippiensis</i> .....	pl. 25, figs. 4a-b.
* <i>Bulimina byramensis</i> .....	pl. 25, figs. 14a-b.
* <i>Cibicides pseudoungerianus</i> .....	pl. 19, figs. 7a-c.
* <i>Gaudryina stavensis</i> .....	pl. 3, figs. 6a-b.

Common Species of Foraminifera in the Marianna Limestone, Illustrated as follows:

* <i>Ammobaculites subagglutinans</i> .....	(See above).
* <i>Globorotalia mariannensis</i> .....	do
<i>Lepidocyclina mantelli</i> (Morton), 1833, Amer. Jour. Sci. Arts, vol. 23, p. 291, pl. 5, fig. 9.	
* <i>Planorbulina mediterraneensis</i> .....	pl. 21, figs. 2a-c.
* <i>Uvigerina vicksburgensis</i> .....	pl. 27, fig. 5.

\* Common but not restricted.

## SUMMARY

The more significant results of this investigation are as follows:

1. The figuring and describing of 283 species of Foraminifera with the determination of their vertical range and relative abundance within the section.
2. The discovery of 102 new species and varieties and 3 new genera of Foraminifera.
3. The discovery of new morphological characters associated with two of the new genera reported.
4. The exclusion from the genera *Discorbis*, *Cibicides* and *Anomalina*, forms in which the dorsal spire is mostly concealed by the involute final whorl and which have fine to medium perforations (see *Cibicidina*).
5. The report of a hitherto undescribed fauna from the Tallahatta formation of the Claiborne group and many new species from the Yazoo clay member of the Jackson.
6. An exact determination of the sequence of faunules in the complete section studied, thereby providing evidence for the more precise definition of other reported foraminiferal faunas as to stratigraphic position.
7. The discovery of several new, good fossil indices, *e. g.*

<i>Discorbitura dignata</i> .....	Red Bluff.
<i>Asterigerinella gallozwayi</i> .....	uppermost Jackson
<i>Cibicidina walli</i> .....	do
<i>Robulus davisi</i> .....	do
<i>Robulus euglypheus</i> .....	do
<i>Robulus rectidorsatus</i> .....	do
<i>Nonion rolshauseni</i> .....	Gosport formation
8. The determination that most of the plastic blue clay at the top of the Jackson formation is of Jackson age and not Oligocene.
9. The determination that the Moodys marl member in this section begins with a basal ferruginous, glauconitic sand with the appearance of typical Moodys marl fossils (see discussion under Stratigraphic Analysis).



10. The extension of the vertical ranges of forms previously considered to be good index markers. Some outstanding examples of this are: (1) presence of the Eocene form, *Planulina cocoaensis* Cushman in the Oligocene; (2) the presence of the typically Oligocene fossil, *Cibicides pippeni* Cushman and Garrett, in upper Jackson strata; (3) the presence of *Hantkenina alabamaensis* Cushman, an Eocene index species, in the Red Bluff beds; (4) and the occurrence of *Palmula henbesti* (Bermudez), an Eocene form described from Cuba, in Eocene and Oligocene strata.

11. The discovery of a small entirely silicified foraminiferal fauna in the lower part of the exposed Tallahatta formation, localities 1-6.

### SYSTEMATIC DESCRIPTION OF SPECIES

Family **SPIRILLINIDÆ** Reuss, 1861

Genus **SPIRILLINA** Ehrenberg, 1843

*Spirillina vicksburgensis* Cushman Plate 1, figs. 1a-c  
*Spirillina vicksburgensis* Cushman, 1935, Contr. Cushman Lab. Foram. Res., vol. 11, p. 34, pl. 5, fig. 6 Vicksburg, Oligocene, Miss.; Cushman and Todd, 1946, *idem*, vol. 22, p. 96, pl. 16, fig. 11 Byram marl, Oligocene, Miss.

Test planispiral, evolute, biconvex; edge obliquely truncate, the dorsal side somewhat broader than the ventral; sutures distinct, slightly depressed on the ventral side; wall hyaline, white, surface on the dorsal side with single row of coarse pits, ventral side transversely, finely and regularly striate, causing the sutures to appear crenulate; aperture crescentic. Diameter, 0.24 mm.; thickness, 0.06 mm. Rare.

*Plesiotype*.—No. 5033, locality 63, lower Oligocene.

Family **MILIOLIDÆ** d'Orbigny, 1839

Genus **CORNUSPIRA** Schultze, 1854

*Cornuspira lisbonensis*, new species Plate 1, figs. 2a-b

Test planispiral, composed of a round or oval tube enlarging gradually, the sides of the tube rounded, not flattened; in end view, apertural end higher than broad; suture distinct, slightly depressed; wall porcellaneous with embedded clear, spicular grains; aperture oval. Diameter, 0.63 mm.; thickness, 0.10 mm. Rare.

*C. olygogyra* Hantken (1875, Magy. kir földt. int. Évkönyve, vol. 4, p. 16, pl. 1, fig. 10) with which this species is sometimes confused, has a chamber with flattened sides, and the tube is

rectangular in section, whereas in this form the tube is oval to round in section. *C. byramensis* Cushman (1935, Contr. Cushman Lab. Foram. Res., vol. 11) is composed of a tube of even diameter for most of the early part of the test, then the tube rapidly increases in diameter for the last two or three coils.

*Holotype*.—No. 4858, locality 30, Lisbon fm., Claiborne, Eocene.

Genus **SPIROLOCULINA** d'Orbigny, 1826

**Spiroloculina lisbonensis**, new species

Plate 1, figs. 3a-c

Test about  $1\frac{1}{2}$  times as long as broad, biconcave, edge truncate, slightly concave or sometimes convex on the last chamber; chambers rather indistinct due to nearly complete overlapping of early chambers by the last two, quadrate in transverse section, widest at the edge where there is a slightly thickened rounded angle at each side; basal end of test overhanging; sutures mostly concealed by overlapping flaps of the last two chambers; wall porcellaneous with brownish tinge; surface smooth, glistening; aperture with short neck, quadrate, with simple tooth on the inner margin and some indications of another smaller one opposite. Length, 0.58 mm.; breadth, 0.38 mm.; thickness, 0.17 mm. Common.

This species differs from *S. bidentata* Hadley (1935, Bull. Amer. Paleont., vol 22) in lacking the prominent lateral ridges, which are thickened margins of chambers extending out of the plane of coiling, and in the much greater overhanging of the basal portion of the last chamber. This form is also much smaller; it may well be the ancestral form to Hadley's species. Some of the subsequent forms attributed to *S. bidentata* may belong in this species.

*Holotype*.—No. 5034, locality 21, Lisbon fm., Claiborne, Eocene.

Genus **QUINQUELOCULINA** d'Orbigny, 1826

**Quinqueloculina constans**, new species

Plate 1, figs. 4a-c

Test twice as long as broad, somewhat compressed, periphery smooth, edge rounded; chambers distinct, somewhat inflated, of nearly uniform diameter, the ends only slightly extended; the last two chambers in nearly one plane, circular in cross section;



sutures distinct, depressed; wall rather smooth, composed of clear quartz grains with a small amount of silicious cement, probably due to silification; apertural neck distinct, rather short with a strong lip, aperture circular with simple tooth. Length, 0.92 mm.; breadth, 0.43 mm.; thickness, 0.18 mm. Common.

This form slightly resembles *Q. aspera* d'Orbigny (1826, Ann. Sci. Nat., ser. 1, vol. 7, p. 301) but differs in having an even or smooth periphery, slight neck with strong lip, and in the more tapering form of the test. *Q. laevigata* d'Orbigny (1826, Ann. Sci. Nat., vol. 7, p. 301, No. 6) is not so compressed as seen in end view, and it lacks the distinct lip that characterizes this variety.

*Holotype*.—No. 4989, locality 47, Yazoo clay, Jackson, Eocene.

**Quinqueloculina harrisi** Howe and Roberts

Plate 1, figs. 5a-c

*Quinqueloculina harrisi* Howe and Roberts, 1939, Louisiana Dept. Cons. Geol. Bull. 14, p. 35, pl. 2, figs. 13-15; Cook Mt. fm., middle Eocene, La.

Test comparatively small, broad, smooth, slightly compressed, oval in outline; chambers rotund; periphery broadly rounded; sutures very slightly depressed; wall porcellaneous, with brownish tinge; surface smooth, glistening; aperture semicircular without neck, with small tooth. Length, 0.53 mm.; breadth, 0.41 mm.; thickness, 0.27 mm. Common.

*Plesiotype*.—No. 4990, locality 21, Lisbon fm., Claiborne, Eocene.

**Quinqueloculina hermosa** Cole

Plate 1, figs. 7a-c

*Quinqueloculina hermosa* Cole, 1927, Bull. Amer. Paleont., vol. 14, No. 51, p. 13, pl. 2, figs. 28, 29, middle Eocene, Mex.

Test large, elongate, somewhat fusiform in side view; chambers narrow, of about uniform width; edge rather abruptly rounded; wall porcellaneous, brownish; surface glistening; aperture terminal, at the end of a long neck, circular with bifid tooth which is usually broken, appearing simple; sutures distinct, somewhat depressed. Length, 0.88 mm.; width, 0.42 mm.; thickness, 0.26 mm. Rare.

*Plesiotype*.—No. 4991, locality 20, Lisbon fm., Claiborne, Eocene.

**Quinqueloculina mauricensis** Howe

Plate 1, figs. 8a-c

*Quinqueloculina mauricensis* Howe, 1939, Louisiana Dept. Cons., Geol. Bull. 14, p. 35, pl. 4, figs. 8-10 Cook Mt. fm., middle Eocene, La.; Cushman and Todd, 1945, Contr. Cushman Lab. Foram. Res., vol. 21, p. 12, pl. 3, figs. 5, 6 Lisbon fm., Claiborne, Eocene, Ala.

Test slightly less than twice as long as broad, apertural end exserted, subtriangular in cross section, the periphery keeled; chambers distinct, somewhat triangular in cross section; sutures distinct; wall porcellaneous, smooth, unornamented except for the lighter colored keel-like peripheral edges; aperture comparatively small, subcircular. Length, 0.68 mm.; breadth, 0.30 mm.; thickness, 0.18 mm. Common.

*Plesiotype*.—No. 4992, locality 20, Lisbon fm., Claiborne, Eocene.

**Quinqueloculina mauricensis apertaexpansa**, new variety

Plate 1, figs. 9a-c

Test about twice as long as broad, the apertural end exserted and flaring, subtriangular in cross section, the periphery keeled; chambers distinct, somewhat triangular in cross section; sutures distinct, somewhat depressed; wall porcellaneous, with brownish tinge, glistening; apertural terminal, round, at the end of a definite flaring neck and with small bifid tooth. Length, 0.67 mm.; breadth, 0.32 mm.; thickness, 0.19 mm. Abundant.

This variety differs from *Q. mauricensis* Howe only in the flaring exserted lip, a stable characteristic.

*Holotype*.—No. 4993, locality 31, Lisbon fm., Claiborne, Eocene.

**Quinqueloculina mauricensis lisbonensis** Cushman and Todd

Plate 2, figs. 1a-c

*Quinqueloculina mauricensis lisbonensis* Cushman and Todd, 1945, Contr. Cushman Lab. Foram. Res., vol. 21, p. 12, pl. 3, figs. 7, 8 Lisbon fm., Claiborne, Eocene, Ala.; 1945, *idem*, p. 81, pl. 13, figs. 9, 10 Moodys marl member, Jackson, Eocene, Miss.

Test slightly less than twice as long as broad, the apertural end somewhat produced; chambers distinct, subtriangular in cross section; sutures distinct; wall porcellaneous, slightly leached; surface matte, ornamented with numerous very fine striae; aperture small, subcircular with a small bifid tooth. Length, 0.88 mm.; breadth, 0.47 mm.; thickness, 0.25 mm. Rare.

*Plesiotype*.—No. 4994, locality 40, Moodys marl member, Jackson, Eocene.

**Quinqueloculina stavensis**, new species

Plate 2, figs. 2a-c

Test elongate ovate in side view, length slightly over twice the breadth, thickness about two-thirds the breadth; periphery rounded tending to appear angled due to flattened flanks; chambers distinct, subtriangular in cross section; sutures rather deeply depressed; wall porcellaneous, glistening; surface of all the chambers with longitudinal rows of coarse puncta; apertural end slightly produced, aperture ovate with tooth. Length, 1.06 mm.; breadth, 0.47 mm.; thickness, 0.33 mm. Rare.

This form differs from *Q. lacunosa* Karrer (1867, K. Akad. Wiss. Wien, Math-Naturw. Cl., Sitzber., Wien, Osterreich, Bd. 55, Abth. 1, p. 362, pl. 3, fig. 6a-c) in the subtriangular cross section of the chambers and the ovate aperture.

*Holotype*.—No. 4995, locality 46, Yazoo clay, Jackson, Eocene.

**Quinqueloculina substriata**, new species

Plate 2, figs. 3a-c

Test slender, elongate, roughly triangular in cross section; chambers quadrate in transverse section; length of test nearly three times the width, width about two-thirds the thickness; wall porcellaneous, white, glistening; sutures distinct only slightly depressed; aperture terminal, round, produced, with simple tooth. Length, 0.63 mm.; breadth, 0.26 mm.; thickness, 0.17 mm. Rare.

The quadrate transverse section and the striate character of this form distinguishes it from most similar forms. *Q. parisiensis* d'Orbigny (type figure in Fornasini, 1905, mem. R. Accad. Sci. Ist. Bologna, ser. 6, vol. 2, pl. 2, fig. 9) lacks the quadrate cross sectional character; *Q. striata* d'Orbigny (1843, Guérin-Ménéville, F. E. *Iconographie du Règne Animal de G. Cuvier*, Paris, France, J. B. Baillièrè, Mollusques, p. 10) is nearly bilaterally symmetrical in that the last ultimate and penultimate chambers are added in a plane whereas in this species these chambers are not in the same plane. *Q. limbata* d'Orbigny (1905, R. Accad. Sci. Ist. Bologna, Mem. Sci. Nat., Bologna, Italia, ser. 6, tomo 2, p. 66) is much more heavily costate.

*Holotype*.—No. 4996, locality 47, Yazoo clay, Jackson, Eocene.

**Quinqueloculina yeguaensis** Weinzierl and Applin Plate 2, figs. 4a-c, 5a-c  
*Quinqueloculina seminulum* Stadnichenko (not Linné), 1927, Jour. Paleont., vol. 1, p. 226, pl. 38, fig. 28 Yegua fm., middle Eocene, Tex.  
*Quinqueloculina yeguaensis* Weinzierl and Applin, 1929, Jour. Paleont., vol. 3, p. 393, pl. 44, fig. 4 Claiborne, Eocene, Texas; Cushman and Todd, 1945, Contr. Cushman Lab. Foram. Res., vol. 21, p. 12, pl. 3, figs. 3, 4 Lisbon fm., Claiborne, Eocene, Ala.

Test smooth, slightly compressed, oval in outline, peripheral chambers nearly cylindrical; chambers distinct, enlarging regularly in size; wall porcellaneous, white; surface smooth, glistening; sutures distinct, slightly depressed; apertural end with a short neck; aperture terminal, oval, with bifid tooth. Length of unbroken specimen, 0.66 mm.; breadth, 0.31 mm.; thickness, 0.24 mm. Common.

*Plesiotype*.—No. 4997, locality 38 (Fig. 4); plesiotype, No. 4998, locality 37 (Fig. 5), Gosport fm., Claiborne, Eocene.

Genus **MILIOLA** Lamareck, 1804

**Miliola jacksonensis** Cushman Plate 2, figs. 6a-c  
*Miliola jacksonensis* Cushman, 1933, Contr. Cushman Lab. Foram. Res., vol. 9, p. 2, pl. 1, figs. 2, 3 upper Eocene, Miss.; Cushman and Todd, 1945, Contr. Cushman Lab. Foram. Res., vol. 21, p. 83, pl. 13, fig. 13 Moodys marl member, Jackson, Eocene, Miss.

Test elongate fusiform, pentagonal in cross section, with five subequal external chambers; chambers with rounded backs; sutures distinct, strongly depressed; wall silicious, white, surface ornamented with numerous fine longitudinal costellæ with one, two, or three rows of small rounded puncta between each pair, of costellæ; aperture at the end of a very short neck, cribrate in the adult without distinct trematophore. Length, 1.13 mm.; diameter, 0.37 mm. Common.

The costellæ are variable in length and size, most specimens having only traces of them while other specimens have them rather well developed. The Yazoo specimens are more like the paratype than the holotype.

*Plesiotype*.—No. 4954, locality 46, Yazoo clay, Jackson, Eocene.

Genus **TRILOCULINA** d'Orbigny, 1826

**Triloculina mindenensis** Howe Plate 2, figs. 9a-c  
*Triloculina mindenensis* Howe, 1939, Louisiana Dept. Cons., Geol. Bull.

14, p. 37, pl. 3, figs. 11-13 middle Eocene, La.; Cushman and Applin 1943, Contr. Cushman Lab. Foram. Res., vol. 19, p. 32, pl. 7, fig. 10 Yegua fm., middle Eocene, Tex.

Test oval,  $1\frac{1}{2}$  times as long as wide; chambers inflated, with broadly rounded backs; sutures slightly depressed; wall porcellaneous; surface smooth, glistening or dull; aperture terminal, large, semicircular, with a short broad tooth. Length, 0.53 mm.; breadth, 0.34 mm. Common.

The form figured by Cushman and Applin is much more ovate than the type figure and the specimens from Little Stave Creek are slightly less broad.

*Plesiotype*.—No. 5050, locality 31, Lisbon fm., Claiborne, Eocene.

**Triloculina subrotunda**, new species

Plate 1, figs. 10a-c

cf. *Triloculina rotunda* var. Howe and Wallace, 1932, Louisiana Dept. Cons., Geol. Bull. 2, p. 23, pl. 2, fig. 4 upper Eocene, La.

Test oval,  $1\frac{1}{2}$  times as long as wide; chambers rotund, the last chamber with depressed back, increasing rapidly in size as added; sutures depressed; surface smooth; wall composed of clear quartz grains with silicious cement, probably silicified; aperture very large, flattened ovate, with a distinct slightly flaring rim or lip and a bifid tooth which projects slightly above the outline of the aperture. Length, 0.61 mm.; breadth, 0.43 mm.; thickness, 0.28 mm. Common.

*T. rotunda* d'Orbigny has a smaller aperture and comparatively larger or broader last chamber than this species and the chambers of this new form are more nearly the same diameter throughout their length.

*Holotype*.—No. 5051, locality 47, Yazoo clay, Jackson, Eocene.

**Triloculina subtumidifrons**, new species

Plate 2, figs. 10a-c

Test subcircular in outline, only slightly longer than wide, somewhat compressed; edge rather abruptly rounded; chambers distinct, subtriangular in cross section, successive chambers increasing rapidly in size, the last one nearly enveloping the antepenultimate chamber; wall porcellaneous; surface glistening; sutures distinct, very slightly depressed; apertural end not produced; aperture terminal, oval, with a simple tooth. Length, 0.37

mm.; width, 0.35 mm.; thickness, 0.20 mm. Rare.

This form is much smaller, comparatively thinner, and the edge is not so broadly rounded as compared with *T. gilboei* Beck (1943, Jour. Paleont., vol. 17, p. 594). *T. mindenensis* Howe is not so circular in outline and the last chamber doesn't encompass as much of the third from the last chamber.

*Holotype*.—No. 5052, locality 40, Moodys marl member, Jackson, Eocene.

Genus *MASSILINA* Schlumberger, 1893

*Massilina cookei* Cushman

Plate 3, figs. 1a-c

*Massilina cookei* Cushman, 1935, U. S. Geol. Sur., Prof. Paper 181, p. 13, pl. 3, fig. 17, upper Eocene, Miss.

Test quinqueloculine in early stages, later the chambers are added in one plane, much compressed; periphery acute, slightly carinate; chambers of the early portion less flattened, those of the adult very much compressed, widest near the inner margin, which stands above the remainder of the surface; ends projecting, especially the apertural end which has a short cylindrical neck; surface very finely striate or smooth; wall composed of quartz grains, with some parts of porcellaneous calcium carbonate, and the later parts composed of clear, nongranular silica, probably the result of silicification. Length, 1.50 mm.; breadth, 0.91 mm.; thickness, 0.16 mm. Abundant.

The figured specimen is much larger than the type; there is considerable range in size among the specimens found.

*Plesiotype*.—No. 4950, locality 49, Yazoo clay member, Jackson, Eocene.

*Massilina decorata* Cushman

Plate 2, figs. 7a-b

*Massilina decorata* Cushman, 1922, U. S. Geol. Sur., Prof. Paper 129-F, p. 143, pl. 34, fig. 7 Vicksburg, Oligocene, Miss.; Bergquist, 1942 Mississippi State Geol. Sur., Bull. 49 (Fossils), p. 22, pl. 1, fig. 26 upper Eocene, Miss.

Test much flattened, elliptical or oval, basal and apertural ends projecting, the apertural end narrowing to a small cylindrical neck, nearly in the longitudinal axis of the test; sutures rather indistinct; wall porcellaneous; surface smooth, ornamented by very fine pits giving the surface a finely granular, matte appearance; aperture nearly round with a small tooth. Length, 0.47 mm.; breadth, 0.30 mm.; thickness, 0.06 mm. Abundant.

*Plesiotype*.—No. 4951, locality 60, Jackson, Eocene.



**Massilina jacksonensis punctato-costata** Cushman Plate 2, figs. 8a-c  
*Massilina jacksonensis punctato-costata* Cushman, 1933, Contr. Cushman  
 Lab. Foram. Res., vol. 9, p. 3, pl. 1, figs. 5, 6 upper Eocene, Miss.  
 Cushman and Todd, 1945, vol. 21, p. 82, pl. 13, fig. 18 Moody's marl  
 member, Jackson, Eocene, Miss.

Test broadly oval or elliptical, much compressed, periphery subacute, apertural end slightly projecting; early chambers quinqueloculine, later ones in a single plane; sutures distinct, slightly depressed; wall siliceous, transparent, not granular, the chamber cavity filled with opaque white material, probably silicified; surface ornamented with a series of low longitudinal curved costæ between rows of puncta, those near the periphery more strongly developed than those nearer the inner margin of the chambers; aperture at the end of a distinct neck, round or oval with simple tooth. Length, 0.63 mm.; breadth, 0.53 mm.; thickness, 0.10 mm. Common.

*Plesiotype*.—No. 4952, locality 46, Yazoo clay, Jackson, Eocene.

**Massilina yazoensis**, new species Plate 3, figs. 2a-c

Test elongate ovate in outline, with the apical end projecting very little and the apertural end with a rather short but definite cylindrical neck; in edge view much compressed ordinarily not in one plane but with sides essentially parallel; edge rounded; milioloid stage rather small, about four chambers in the planispiral portion of the test; surface smooth, some trace of striae in some individuals; wall composed of quartz grains with silica cement, probably silicified; aperture terminal, with a fairly short round cylindrical neck, flaring lip, and a bifid tooth. Length, 0.94 mm.; width, 0.50 mm.; thickness, 0.11 mm. Common.

This species differs from *M. mansfieldi* Cushman and Cahill (1933, U. S. Geol. Survey, Prof. Paper 175-A) in having slightly fewer chambers in the planispiral portion and in the flaring aperture with bifid tooth.

*Holotype*.—No. 4953, locality 47, Yazoo clay, Jackson, Eocene.

Genus **ARTICULINA** d'Orbigny, 1826

**Articulina terquemi** Cushman Plate 1, figs. 6a-b

*Articulina terquemi* Cushman, 1933, Contr. Cushman Lab. Foram. Res.,

vol. 9, p. 3, pl. 1, fig. 7 upper Eocene, Miss.; Cushman, 1944, Lab. Foram. Res., Special Publ. No. 10, p. 6, pl. 1, figs. 16, 17 Jackson, Eocene, Miss.

Test small, early portion triloculine, moderately compressed, periphery rounded; chambers of the early portion not distinct, except the last one or two; nearly involute, uniserial chamber rounded; sutures indistinct in early portion; wall porcellaneous, brownish; surface ornamented by prominent longitudinal costæ, in general parallel to the periphery; aperture terminal, circular, with a very distinct, slightly flaring lip. Length, 0.60 mm.; breadth, 0.30 mm. Common.

The few coarse costæ serve to distinguish this species from *A. nitida* d'Orbigny (1826, Ann. Sci. Nat., vol. 7). This form is common at locality 31 in the Lisbon formation of the Claiborne group.

*Plesiotype*.—No. 4794, locality 31, Lisbon fm., Claiborne, Eocene.

Family TROCHAMMINIDÆ Schwager, 1877

Genus HAPLOPHRAGMOIDES Cushman, 1910

**Haplophragmoides tallahattensis**, new species Plate 3, figs. 3a-b

Test nautiloid, subglobose, planispiral, biumbilicate, slightly compressed, subcircular in side view; in edge view the umbilici appear flattened, the edge broadly rounded and the flanks somewhat flattened; periphery slightly lobulate; chambers seven to eight in the last whorl, increasing gradually in size; sutures radial, very slightly curved, mostly flush with the surface, the later ones may be very slightly depressed; surface mostly finely arenaceous with much cement, smoothly finished, but some individuals have sporadic coarser areas; apertural face convex, curved, the aperture a moderately high arch sunken into the apertural face at its base, with an upper lip. Diameter, 0.46 mm.; thickness of the last chamber, 0.29 mm. Common.

This species differs from "*Nonionina*" *latidorsata* Borneman (1855, Deutsch. Geol. Ges. Zeitschr., Berlin, Deutschland, Bd. 7, Heft 2, p. 339, pl. 16, fig. 4) in the flattened flanks, and the narrower test in general, especially in the later portion. *H. subglobosum* G. O. Sars (1910, U. S. Nat. Mus., Bull. 71, pt. 1, p. 105, figs. 162-164, p. 106) lacks the flattened flanks of this species and its apertural face is very low.

*Holotype*.—No. 4926, locality 10, Tallahatta fm., Claiborne, Eocene.



Genus **AMMOBACULITES** Cushman, 1910

**Ammobaculites flariformis**, new species Plate 3, figs. 4a-b

Test elongate, flattened, planispiral portion biumbilicate, rectilinear portion oval in transverse section when well preserved; chambers slightly inflated, five or six in the outer whorl of the planispiral portion, four to five in the rectilinear part; sutures somewhat depressed; wall coarsely arenaceous; aperture round, terminal. Length, 1.33 mm.; breadth, 0.44 mm.; thickness, 0.22 mm. Common.

This form is quite distinct in possessing a larger rectilinear section, both in diameter and length, as compared to the planispiral portion. Although the last pair of chambers of the holotype are slightly crushed, there is still an indication of the original ovate cross section.

*Holotype*.—No. 4780, locality 49, Yazoo clay, Jackson, Eocene.

**Ammobaculites pseudorostratus**, new species Plate 3, figs. 7a-b

Test thick walled, planispiral becoming evolute, compressed, umbilical region depressed on both sides; chambers closely appressed, about six in the final whorl, the last chamber somewhat produced; sutures very slightly depressed; wall composed of fine sand grains with many larger grains included, giving a rough appearance to the wall; aperture round or oval at the end of a short neck on the peripheral edge of the last septal face. Length, 1 mm.; thickness, 0.22 mm. Abundant.

The absence of a carina and the smaller size of this form distinguish it from *A. rostratus* Heron-Allen and Earland (1929, Roy. Micr. Soc. Jour., London, England, ser. 3, vol. 49, pt. 4, art. 27, p. 326).

*Holotype*.—No. 4781, locality 50, Yazoo clay, Jackson, Eocene.

**Ammobaculites subagglutinans**, new species Plate 3, figs. 5a-b

Test elongate, planispiral portion close coiled with broadly rounded edge, rectilinear portion round in section; chambers closely appressed throughout, about six in the last whorl of the planispiral portion, two or three in the rectilinear part; sutures flush, very indistinct; surface rough, covered with angular sand

grains; aperture simple terminal opening. Length, 1.2 mm.; thickness, 0.44 mm. Common.

This species differs from *A. agglutinans* (d'Orbigny) in the more appressed chambers and in being round rather than oval in transverse section.

*Holotype*.—No. 4782, locality 66, Marianna limestone, Vicksburg, Oligocene.

*Ammobaculites yazooensis*, new species

Plate 3, figs. 6a-b

Test elongate, planispiral portion small with broadly rounded edge, rectilinear portion oval to round in well-preserved specimens; five to six chambers in planispiral portion, slightly inflated; four to six chambers in the rectilinear portion, somewhat inflated, becoming smaller in diameter toward the apertural end; sutures slightly depressed throughout; wall coarsely arenaceous; aperture terminal. Length, 0.83 mm.; breadth, 0.26 mm.; thickness, 0.20 mm. Common.

*A. formosensis* Nakamura (1937, Japanese Jour. Geol., Trans. Abstr., vol. 14, p. 133, pl. 10, fig. 1a-b) is very similar to this form. However, this species tapers toward the apertural end and the planispiral portion is not so flattened as in Nakamura's species. There is also some similarity between this form and *A. midwayensis* Plummer (1933, Texas Univ. Bull., No. 3201), but this species, though coarsely arenaceous, is much more smoothly finished than Plummer's species and is almost round in transverse section.

*Holotype*.—No. 4783, locality 49, Yazoo clay, Jackson, Eocene.

Family ATAXOPHRAGMIIDÆ Schwager, 1877

Genus DOROTHIA Plummer, 1931

*Dorothia heteroclita*, new species

Plate 3, figs. 11a-b

Test elongate, about twice longer than wide, stout, greatest width above the middle or near the apertural end in young specimens, apertural end truncate, apex rather bluntly pointed, nearly circular in cross section; chambers closely appressed, early whorls with four or five chambers to the whorl becoming triserial in the middle portion of the test, and with one or two pairs of biserial chambers in the adult; sutures nearly flush in the early portion, slightly depressed in the later part, somewhat oblique; wall smoothly arenaceous with considerable calcareous

cement; aperture a rather low arched opening at the base of the last septal face in a broad re-entrant. Length, 1.00 mm.; greatest breadth, 0.50 mm.; thickness, 0.41 mm. Rare.

The very short biserial section, the somewhat fusiform outline of the test, and the smoothly finished surface are distinctive.

*Holotype*.—No. 4880, locality 58, Jackson, Eocene.

Genus GAUDRYINA d'Orbigny, 1839

*Gaudryina gardneræ* Cushman Plate 3, figs. 9a-c

*Gaudryina gardneræ* Cushman, 1926, Contr. Cushman Lab. Foram. Res., vol. 2, p. 33, pl. 5, figs. 2a-b, upper Eocene, Ala.; 1937, Cushman Lab. Foram. Res., Special Publ. 7, p. 51, pl. 8, figs. 2, 3 upper Eocene, Gulf Coastal Plain, U. S. and Mex.

Test elongate, early portion triserial and trihedral, the angles somewhat rounded, sides flattened or slightly convex, the later portion biserial with straight sides, round tending toward polygonal in transverse section; chambers indistinct, especially in the early portion; sutures flush and indistinct in the early part, slightly depressed in the biserial part and more distinct; wall rather coarsely arenaceous; aperture a low rounded or arched opening at the base of the last septal face. Length, 0.81 mm.; maximum diameter, 0.38 mm. Rare.

*Plesiotype*.—No. 4891, locality 46, Yazoo clay, Jackson, Eocene.

*Gaudryina* (*Pseudogaudryina*) *jacksonensis* Cushman

Plate 3, figs. 10a-b

*Gaudryina jacksonensis* Cushman, 1926, Contr. Cushman Lab. Foram. Res., vol. 2, p. 33, pl. 5, fig. 1, upper Eocene, S. C., Ala., Miss., Alab. clay, Mex.

*Gaudryina* (*Pseudogaudryina*) *jacksonensis* Cushman, 1946, Cushman Lab. Foram. Res., Special Publ. 16, p. 4, pl. 1, fig. 5 upper Eocene, Ala.

• Test large, elongate, irregularly triangular in section, angles subacute, triserial portion short; biserial portion angular, angles almost carinate; chambers distinct, very slightly inflated; sutures distinct, slightly depressed; wall composed of fine sand grains with a large amount of cement, surface smoothly finished; aperture a small arch at the base of a semicircular re-entrant in the last septal face. Length, 0.73 mm.; maximum breadth, 0.33 mm. Abundant.

*Plesiotype*.—No. 4892, locality 58, Jackson, Eocene.

*Gaudryina stavensis*, new species

Plate 3, figs. 8a-b

Test elongate, tapering, enlarging rather abruptly at the initial end which is roughly triangular in cross section, enlarging more gradually toward the apertural end, triserial portion com-

prising about one-fifth of the test, the biserial portion somewhat polygonal or rounded in cross section with five or six pairs of chambers; sutures slightly depressed, nearly transverse; wall of coarse arenaceous material roughly finished largely obscuring the sutures; aperture a low arched opening on the inner margin of the last septal face. Length, 1.20 mm.; diameter, ca. 0.55 mm. Common.

*G. gardneræ* Cushman is similar to this species; however, the triserial portion of this species is much shorter, not so well defined. This form was apparently derived from *G. gardneræ* by the acceleration out of some of the triserial portion. *G. quadrangularis* Bagg (1908, Proc. U. S. Nat. Mus., vol. 34) tapers more abruptly throughout to the initial end and has much lower chambers. Young specimens of this species may appear something like Bagg's species.

*Holotype*.—No. 4893, locality 64, Mint Spring marl, lower Oligocene.

Genus **LIEBUSELLA** Cushman, 1933

**Liebusella byramensis turgida** (Cushman) Plate 3, figs. 12a-b

*Clavulina byramensis turgida* Cushman, 1923, U. S. Geol. Sur., Prof.

Paper 133, p. 22, pl. 2, figs. 4, 5, Vicksburg, Oligocene, Miss., Ala.

*Liebusella byramensis turgida*, Cushman, 1946, Cushman Lab. Foram. Res., Special Publ. 16, p. 5, pl. 1, figs. 8-10, upper Eocene, Ala.

Test elongate, subcylindrical, the early chambers triserial, forming but a small portion of the test, later ones uniserial, both portions rounded; chambers in the uniserial portion variable in number, four to eight usually; wall of test thick, composed of agglutinated foreign particles, not labyrinthic or vesicular; interior of chambers in transverse section with indefinite radial projections extending inward a short distance, but the chamber interiors are not labyrinthic; surface arenaceous with a great deal of cement, smoothly finished; aperture round, terminal and central at the end of a tapering necklike projection of the last chamber. Length of figured specimen, 1.93 mm.; diameter, 0.62 mm. Common.

*Plesiotype*.—No. 4938, locality 58, Jackson, Eocene.

Genus **KARRERIELLA** Cushman, 1933

**Karrerrella advena** (Cushman) Plate 4, figs. 2a-b

*Gaudryina advena* Cushman, 1923, U. S. Geol. Sur., Prof. Paper 133,

p. 22, pl. 3, fig. 1, Vicksburg, Oligocene, Miss.

*Karrerella advena* Cushman, 1937, Cushman Lab. Foram. Res., Special Publ. 8, p. 130, pl. 15, fig. 10; Cushman and Todd, 1948, Contr. Cushman Lab. Foram. Res., vol. 24, p. 8 (list), pl. 1, fig. 2, Red Bluff clay, lower Oligocene, Miss.

Test elongate, tapering, somewhat compressed, greatest breadth near the apertural end, early portion triserial, the later part biserial; chambers slightly inflated in the later portion, closely appressed in the early part; sutures slightly depressed; wall arenaceous with a smooth finish; aperture in adult elongate horizontally with a distinct lip and located above the base of the last septal face. Length, 1.04 mm.; breadth, 0.41 mm.; thickness, 0.29 mm. Rare.

*Plesiotype*.—No. 4929, locality 58, Jackson, Eocene. There are other specimens from this locality, but they are not common.

Genus **LISTERELLA** Cushman, 1933

**Listerella petrosa** Cushman and Bermudez Plate 4, figs. 1a-b

*Listerella petrosa* Cushman and Bermudez, 1937, Contr. Cushman Lab. Foram. Res., vol. 13, p. 6, pl. 1, figs. 24-26, Eocene, Cuba; Cushman, 1937, Cushman Lab. Foram. Res., Special Publ. 8, p. 139, pl. 16, figs. 26-28.

Test elongate, slender, slightly enlarging as chambers are added, early triserial portion triangular in section, angles rounded, sides flattened; chambers distinct except in the early portion, about six or seven in the uniserial part; sutures indistinct in the triserial portion, depressed in the uniserial portion; wall coarsely arenaceous, calcareous; surface roughly finished; aperture terminal, rounded, small, with tapering neck. Length, 2.18 mm.; diameter, 0.44 mm. Rare.

This form is more smoothly finished than the type, and the neck is slightly better developed in some specimens.

*Plesiotype*.—No. 4940, locality 58, Jackson, Eocene.

Genus **PSEUDOCLAVULINA** Cushman, 1936

**Pseudoclavulina cocoaensis** Cushman Plate 4, figs. 3a-b

*Pseudoclavulina cocoaensis* Cushman, 1936, Cushman Lab. Foram. Res., Special Publ. No. 6, p. 18, pl. 3, figs. 6a-b, upper Eocene, Ala.; 1937, Cushman Lab. Foram. Res., Special Publ. 7, p. 114, pl. 15, figs. 29-31; 1948, Contr. Cushman Lab. Foram. Res., vol. 24, table p. 6, pl. 1, fig. 1, Red Bluff, lower Oligocene, Miss.

Test small, composed of few chambers, early triserial portion of a few chambers, edges broadly rounded, sides somewhat flattened; uniserial portion comprising major portion of test in

most specimens, rounded with depressed sutures; wall finely arenaceous, of calcareous grains, with considerable cementing material, smoothly finished; aperture terminal, round, with a low rim. Length, 0.49 mm.; diameter of last chamber, 0.14 mm. Common.

*Plesiotype*.—No. 4087, locality 58, Jackson, Eocene.

Genus **CLAVULINOIDES** Cushman, 1936

**Clavulinoides guayabalensis** (Cole)

Plate 4, figs. 4a-b

*Clavulina guayabalensis* Cole, 1927, Bull. Amer. Paleont., vol. 14, p. 13, pl. 1, fig. 11. Guayabal, middle Eocene, Mex.

*Clavulinoides guayabalensis* Howe, 1939, Louisiana Dept. Cons., Geol. Bull. 14, p. 33, pl. 2, figs. 11, 12. Cook Mt., Claiborne, Eocene, La.

Test elongate, triangular in section, tricarinate; triserial portion short, expanding rapidly to form the uniserial portion, the sides of the uniserial portion parallel and composed of three to about six chambers; wall composed of relatively coarse sand grains with a large amount of cement, giving a smooth finish to the test; sutures rather indistinct, aperture terminal, round with a slight raised lip. Length, 1.44 mm.; breadth, about 0.44 mm. Abundant.

*Plesiotype*.—No. 4857, locality 31, Lisbon fm., Claiborne, Eocene.

Family **TEXTULARIIDÆ** d'Orbigny, 1846

Genus **SPIROPLECTAMMINA** Cushman, 1927

**Spiroplectammina alabamensis** (Cushman)

Plate 4, figs. 5a-b

*Textularia mississippiensis alabamensis* Cushman, 1923, U. S. Geol. Sur., Prof. Paper 133, p. 17, pl. 1, fig. 4, middle Oligocene, Ala.

*Spiroplectammina alabamensis* Stuckey, 1946, Jour. Paleont., vol. 20, p. 164, pl. 29, figs. 4, 5.

Test elongate, fairly broad, thickest in the middle, biconvex in end view; edge acute, usually with a very narrow carina; chambers low and broad in the early stages, becoming somewhat higher in the adult chambers; sutures depressed, especially in the later half of the test, curved; wall finely arenaceous, with much cement, smoothly finished; aperture a low arched opening at the base of the septal face. Length, 0.78 mm.; breadth, 0.51 mm.; thickness, 0.22 mm. Common.

The depressed sutures and the thicker form are very diagnostic of this species. There is considerable variation in the



amount of taper, some specimens are slightly narrower and more elongate.

*Plesiotype*.—No. 5035, locality 66, Marianna ls., Vicksburg, Oligocene.

***Spiroplectamina alabamensis diminutiva***, new variety

Plate 4, figs. 8a-b

Test small, fairly broad, thickest in the middle, rhomboidal in end view; periphery with a poorly developed carina; edge sharp; planispiral portion minute, scarcely showing the spire; chambers low and broad in the early biserial part, the last few somewhat higher; sutures slightly depressed, curved; wall finely arenaceous, smoothly finished; aperture a small arched opening at the base of the last septal face in a distinct re-entrant in the septal face. Length, 0.46 mm.; breadth, 0.30 mm. thickness, 0.17 mm. Common.

The Lisbon variety is a small form which is fairly common at locality 31. It is somewhat more biconvex in end view and comparatively thicker than the species.

*Holotype*.—No. 5036, locality 31, Lisbon fm., Claiborne, Eocene.

***Spiroplectamina gracilentia***, new species

Plate 4, figs. 7a-b

Test very elongate, thin, with bluntly rounded apex, flattened rhomboidal in cross section; edges gradually expanding; chambers planispirally arranged in the early portion, biserial for  $\frac{9}{10}$  of the length, about 10 pairs in the rectilinear portion, somewhat loosely appressed and becoming rather inflated in the later portion; periphery decidedly lobulate in the upper half of the test, edge sharp; sutures flush in the early part, becoming depressed in the upper portion of the test; aperture a small low arch at the base of the last septal face, at the inner margin in a slight re-entrant. Length of holotype, 0.69 mm.; breadth, 0.28 mm.; thickness, 0.11 mm. Rare.

*S. alabamensis* (Cushman) is much broader and has a flange or carina; this form is much more elongate, more compressed, has no carina, and is lobulate in the later portion of the test.

*Holotype*.—No. 5037, locality 58, Jackson, Eocene.

***Spiroplectamina latior***, new species

Plate 4, figs. 6a-b

Test elongate, about twice longer than broad, flattened, thick-

est along the median line, early coiled portion broadly rounded in outline, sides of the rectilinear portion nearly parallel; edge sharp, with narrow carina; about eight pairs of chambers in the rectilinear portion; sutures depressed but not along the median zone, nearly transverse, slightly curved; wall finely arenaceous, smoothly finished; aperture a low arch at the base of the septal face. Length, 0.76 mm.; breadth, 0.39 mm.; thickness, 0.18 mm. Common.

*Spiroplectammina howei* Stuckey (1946, Jour. Paleont., vol. 20) differs in having a thickened limbate median line and in the conspicuous arenaceous character of the sutures.

*Holotype*.—No. 5038, locality 64, Mint Spring marl, Vicksburg, Oligocene.

***Spiroplectammina mississippiensis*** (Cushman) Plate 4, figs. 10a-b

*Textularia mississippiensis* Cushman, 1922, U. S. Geol. Sur., Prof. Paper 129-E, p. 90, pl. 14, fig. 4 middle Oligocene, Miss.; 1935, U. S. Geol. Sur., Prof. Paper 181, p. 7, pl. 1, figs. 3, 4 upper Eocene, Miss., Tex.

*Spiroplectammina mississippiensis* Cushman and Todd, 1945, Contr. Cushman Lab. Foram. Res., vol. 21, p. 80, pl. 13, fig. 1 Moody marl member, Jackson, Eocene, Miss.; Stuckey, 1946, Jour. Paleont., vol. 20, p. 163, pl. 29, figs. 6, 11 (?) 7.

Test elongate, kite shaped, broad, thickest in the middle, bi-convex in end view; periphery irregularly carinate; edge acute; chambers low and broad, especially in the early stages, becoming higher in the adult and often less broad so that the test may become slightly narrower at the apertural end; sutures covered by coarser arenaceous material, appearing darker than the chamber walls; chamber walls smoothly finished; aperture a small arched opening at the base of the last septal face. Length, 0.51 mm.; breadth, 0.32 mm.; thickness, 0.13 mm. Common.

*Plesiotype*.—No. 5039, locality 58, Jackson, Eocene.

***Spiroplectammina pseudoelongata***, new species Plate 4, figs. 9a-b

(?) *Textularia mississippiensis elongata* Davis, 1941, Jour. Paleont., vol. 15, p. 151, pl. 24, figs. 21 a, b Whitsett, Jackson, Eocene, Tex.

Test very elongate, compressed, gradually tapering to rounded initial end; coiled portion small, composed of about five chambers, biserial chambers low, closely appressed, about 10 on a side; edge sharp, periphery even, slightly lobulate in the later portion, with narrow carina; sutures slightly raised, arenaceous, strongly curved downward near the periphery, zigzag



along the middle; wall thin, appearing nearly transparent, extremely finely arenaceous, with much calcareous cement; surface ornamentation consisting only of the white, arenaceous sutures and carina; aperture nearly circular at the base of the last septal face surrounded by a rim. Length, 0.85 mm.; breadth, 0.33 mm.; thickness, 0.11 mm. Abundant.

Davis's name has been preoccupied several times and is hence not valid. His type may be somewhat more compressed and there is little to indicate the nature of the early coiled portion. The two forms are probably identical. *S. howei* Stuckey (1946, Jour. Paleont., vol. 20) is much larger, broader, less tapered, with a relatively larger, more ragged carina.

*Holotype*.—No. 5040, locality 47, Yazoo clay, Jackson, Eocene.

Genus **TEXTULARIA** DeFrance, 1824

**Textularia adalta** Cushman

Plate 4, figs. 13a-b, 14a-b

*Textularia adalta* Cushman, 1926, Contr. Cushman Lab. Foram. Res., vol. 2, p. 29, pl. 4, figs. 2 a, b upper Eocene, Ala.; Bergquist, 1942, Mississippi State Geol. Sur., Bull. 49 (Fossils), p. 11, pl. 1, figs. 7, 9 upper Eocene, Miss.

Test very elongate, slender, early portion gradually tapering and compressed, adult portion thicker with nearly parallel sides; chambers 10 or more on a side, the later five to nine making up half of the test, earlier ones indistinct, low and broad, later ones more inflated, higher; sutures distinct, especially in the later portion where they are somewhat depressed, usually oblique; wall finely arenaceous, slightly roughened; aperture a high arched opening in the central part of the base of the last chamber, with a slight, indistinct upper lip. Length of largest specimen, 1.75 mm.; breadth, 0.40 mm.; thickness, 0.29 mm. Abundant.

The more gradually tapering initial end and the greater inflation of the chambers distinguish this from *T. recta* Cushman (1923, U. S. Geol. Sur., Prof. Paper 133).

*Plesiotype*.—No. 5041, locality 49; plesiotype, No. 5042, locality 58, Jackson, Eocene.

**Textularia claibornensis** Wienzierl and Applin

Plate 4, figs. 15a-b

*Textularia claibornensis* Wienzierl and Applin, 1929, Jour. Paleont., vol. 3, p. 392, pl. 44, figs. 1 a, b Claiborne, Eocene, Tex.; Davis, 1941, Jour. Paleont., vol. 15, p. 147, pl. 24, figs. 5 a, b, 6 middle Eocene, Tex.

Test elongate, rounded or oval in section in the later part, compressed somewhat in the early portion; chambers in the early portion low, those in the later half much higher, distinct, inflated; sutures indistinct in the early part of the test, distinct and slightly depressed in the later portion; walls smooth, finely arenaceous with much cement; aperture a broad rather deep arched opening at the base of the last septal face. Length, 0.90 mm.; breadth, 0.40 mm.; thickness, 0.36 mm. Common.

*Plesiotype*.—No. 5043, locality 39, Gosport fm., Claiborne, Eocene.

***Textularia dibollensis* Cushman and Applin** Plate 4, figs. 12a-b

*Textularia dibollensis* Cushman and Applin, 1926, Bull. Amer. Assoc. Petr. Geol., vol. 10, p. 165, pl. 6, figs. 12-14 upper Eocene, Texas; Cushman, 1935, U. S. Geol. Sur., Prof. Paper 181, p. 8, pl. 1, figs. 13-16 upper Eocene, Fla., Ala., Tex.; Cushman and Herrick, 1945, Contr. Cushman Lab. Foram. Res., vol. 21, p. 56, pl. 9, fig. 4 McBean fm., Eocene, Ga.

Test small, short, broad, suboval, moderately compressed, initial end rounded, apertural end broadly truncate; margin rounded; chambers about seven pairs, rapidly increasing in breadth as added, becoming high in adult with nearly parallel sides, the later four chambers making up about half of the test; sutures somewhat indistinct, nearly straight, especially in the later portion; wall finely arenaceous, rather smoothly finished; aperture a low broad arch at the inner margin of the last septal face. Length, 0.49 mm.; breadth, 0.25 mm.; thickness, 0.16 mm. Rare.

*Plesiotype*.—No. 5044, locality 47, Yazoo clay, Jackson, Eocene.

***Textularia dibollensis humblei* Cushman and Applin**

Plate 4, figs. 17a-b

*Textularia dibollensis humblei* Cushman and Applin, 1926, Bull. Amer. Assoc. Petr. Geol., vol. 10, p. 165, pl. 6, fig. 9 upper Eocene, Texas; Bergquist, 1942, Mississippi State Geol. Sur., Bull. 49 (Fossils), p. 13, pl. 1, fig. 13 upper Eocene, Miss.

Test tapering with greatest breadth near the apertural end, moderately compressed, elongate; edge narrowly rounded; chambers increasing rapidly in breadth as added, closely appressed; sutures distinct, somewhat depressed, nearly straight; wall very finely arenaceous, with much cement; aperture a broad low arch

at the base of the last septal face. Length, 1.08 mm.; breadth, 0.42 mm.; thickness, 0.20 mm. Common.

The specimens of this species from Little Stave Creek seem to correspond closely with the type form, being perhaps not so broad and the sutures more depressed.

*Plesiotype*.—No. 5045, locality 52, Jackson, Eocene.

*Textularia dibollensis stavensis*, new variety Plate 4, figs. 11a-c

Test small, short, broad, moderately compressed in the early portion, nearly circular in cross section in the adult portion, initial end rather acute, apertural end truncate; edge of the early part subacute, adult chambers round; periphery smooth, becoming slightly lobulate in the later part; chambers six to eight pairs, somewhat indistinct, rapidly increasing in breadth as added in the early part, nearly equal in the later portion; sutures indistinct, nearly flush with the surface, at right angles to the peripheral margin; wall finely arenaceous, locally somewhat coarser; aperture a rather wide arched opening at the inner margin of the last-formed chamber, the apertural face of the chamber evenly rounded. Length of holotype, 0.61 mm.; breadth of apertural end, 0.27 mm.; thickness, 0.25 mm. Common.

This variety is distinguished by the nearly circular apertural end whereas *T. dibollensis* Cushman and Applin is considerably more flattened.

*Holotype*.—No. 5046, locality 32, Lisbon formation, middle Eocene.

*Textularia distincta* (Cushman) Plate 4, figs. 16a-b

*Spiroplectamina mississippiensis distincta* Cushman, 1946, Cushman Lab. Foram. Res., Special Publ. 16, p. 3, pl. 1, figs. 1, 2 upper Eocene, Ala.

Test very elongate, tapering rather gradually, rhomboidal in end view; chambers low, not inflated, about 12 pairs with no indication of a coil at the apex; sutures slightly depressed in the later part, flush in the early part, covered with very finely arenaceous material, becoming rather strongly turned downward near the edge; periphery with wide flange, irregular; aperture an arched opening at the base of the septal face in a distinct re-en-

trant. Length, 0.81 mm.; breadth, 0.43 mm.; thickness, 0.19 mm. Common.

This species is much like *Spiroplectammina pseudoelongata*, n. sp. but lacks the spiral juvenarium and has a wide flange.

*Plesiotype*.—No. 5047, locality 60, Jackson, Eocene.

**Textularia hannai** Davis

Plate 5, figs. 1a-b

*Textularia hannai* Davis, 1941, Jour. Paleont., vol. 15, p. 149, pl. 24, figs. 11-13, 19 Yegua fm., middle Eocene, Texas; Cushman and Herrick, 1945, Contr. Cushman Lab. Foram. Res., vol. 21, p. 57, pl. 9, fig. 5 McBean fm., Eocene, Ga.

Test fairly short, apex bluntly pointed, oval in end view; chambers about seven pairs, steadily or abruptly increasing in size after the first four pairs; sutures indistinct in the early stages and slightly oblique, depressed and approximately transverse in the later portion; wall very finely arenaceous, with much cement; periphery rounded; aperture a long opening at the base of the last chamber. Length, 0.59 mm.; breadth, 0.34 mm.; thickness, 0.24 mm. Rare.

These specimens are smaller than the type as reported. However, not sufficient specimens were found to determine the amount of variation in size.

*Plesiotype*.—No. 5048, locality 40, Moodys marl member, Jackson, Eocene.

**Textularia ouachitaensis** Howe and Wallace

Plate 5, figs. 2a-b

*Textularia ouachitaensis* Howe and Wallace, 1932, Louisiana Dept. Cons. Geol. Bull., No. 2, p. 20, pl. 1, figs. 1 a, b upper Eocene, La.; Bergquist, 1942, Mississippi State Geol. Sur., Bull. 49 (Fossils), p. 16, pl. 1, figs. 11 a, b upper Eocene, Miss.

Test small, elongate, tapering, nearly circular in transverse section; chambers six or eight pairs, those of the later part slightly inflated; sutures slightly depressed in the later part, transverse sometimes obscure; wall arenaceous, roughly finished; aperture a small arch at the base of the last septal face in a distinct re-entrant. Length, 0.61 mm.; breadth, 0.30 mm.; thickness, 0.26 mm.. Common.

*Plesiotype*.—No. 5049, locality 58, Jackson, Eocene.

Genus VULVULINA d'Orbigny, 1826

**Vulvulina advena** Cushman

Plate 5, figs. 3a-b, 4a-b

*Vulvulina advena* Cushman, 1926, Contr. Cushman Lab. Foram. Res., vol. 2, p. 32, pl. 4, figs. 9 a, b upper Eocene, Ala.; (?) Cushman,

1939, Contr. Cushman Lab. Forum. Res., vol. 15, p. 50, pl. 9, figs. 9, 10 lower Oligocene.

Test compressed, elongate, periphery acute but not keeled; early chambers planispiral then immediately biserial, later chambers uniserial, as many as five in the uniserial portion; later chambers of the uniserial portion becoming slightly inflated; sutures of the biserial portion flush with the surface, the whole early portion smooth, in the later portion the sutures are depressed; wall smoothly finished, each angle of the chambers at the periphery with a short spinose projection, even in the uniserial portion; aperture terminal, elongate and narrow. Length, 0.75 mm.; breadth, 0.40 mm.; thickness, 0.10 mm. Common.

*Plesiotype*.—No. 5070, figs. 3a-b, and plesiotype, No. 5071, figs. 4a-b, locality 58, Jackson, Eocene.

Family **NODOSARIIDÆ** Schultze, 1854

Genus **SARACENARIA** DeFrance, 1824

**Saracenaria böttcheri** (Reuss)

Plate 5, figs. 5a-b, 6a-b

*Cristellaria böttcheri* Reuss, 1863, K. Akad. Wiss., Math. Naturw. Cl., Sitzber., Wien, Osterreich, Bd. 48, Abt. 1, p. 49, pl. 3, figs. 38-42 Oligocene, Germany.

Test elongate, triangular in cross section, early portion close-coiled, later portion uncoiled; chambers numerous, five to eight in number, those of the rectilinear portion somewhat inflated; outer periphery smooth or slightly lobulate, inner periphery lobulate; edge rounded; sutures in the coiled portion radial, nearly straight, flush with the surface; wall calcareous, smooth, finely perforate; aperture terminal, round, radiate, with about six radial teeth, usually located at the peripheral margin of the last chamber. Length of the larger specimen, 0.90 mm.; breadth, 0.23 mm.; thickness, 0.17 mm. Common.

The terminal chambers of the elongate forms tend to become distorted. Because of the trihedral character, this form belongs under *Saracenaria*.

*Plesiotype*.—No. 5019 (Figs. 6a-b); plesiotype, No. 5072 (young specimen, Figs. 5a-b), locality 59, Jackson, Eocene.

**Saracenaria moresiana** Howe and Wallace

Plate 5, figs. 7a-b

*Saracenaria moresiana* Howe and Wallace, 1932, Louisiana Dept. Cons., Geol. Bull., No. 2, p. 42, pl. 2, fig. 8 upper Eocene, La.

Test short, robust, triangular in cross section; edge angular; apertural face inflated, the three sides subequal, the outer

two slightly convex, the inner face nearly flat; chambers few, about six to eight visible, each succeeding chamber being broader; sutures distinct, flush in the early part, slightly depressed in the later part, slightly curved; surface smooth, aperture, round, radiate, slightly projecting. Length, 0.88 mm.; breadth of test, 0.60 mm.; thickness of test, 0.56 mm. Abundant.

*Plesiotype*.—No. 5020, locality 58, Jackson, Eocene.

**Saracenaria ornatula** Cushman and Bermudez Plate 5, figs. 8a-b

*Saracenaria ornatula* Cushman and Bermudez, 1937, Contr. Cushman Lab. Foram. Res., vol. 13, p. 11, pl. 1, fig. 35 Eocene, Cuba.

Test elongate, triangular in end view, coiled portion fairly small, rectilinear portion forming most of the test; angles acute, ventral face concave, the other two faces slightly convex or flat; chambers distinct, increasing rapidly in size as added, especially in the rectilinear portion; sutures fairly distinct, raised, the earlier ones with a series of short, rounded spines, later ones forming raised costæ which project at the ventral margin into short spines; wall smooth except for the ornamentation of the sutures; aperture round, produced, radiate, at the outer edge of the septal face. Length, 1.15 mm.; breadth, 0.57 mm.; thickness, 0.57 mm. Abundant.

*Plesiotype*.—No. 5021, locality 58, Jackson, Eocene.

**Saracenaria ornatula regia**, new variety Plate 5, figs. 9a-b

Test large, elongate, coiled portion prominent, thin; rectilinear portion triangular in end view; angles acute, ventral face slightly convex, the other two sides also slightly convex; edge carinate; chambers distinct, increasing gradually in size as added; sutures distinct, beaded in the early portion, becoming thickened and raised in the later part, forming costæ which grade from flush on the peripheral margin to prominent ribs on the inner margin, where they project slightly; surface smooth excepting for the sutural ornamentation and the low longitudinal costæ; the costæ are much reduced in some individuals, and the beading of sutures more pronounced farther upon the rectilinear portion; aperture round, radiate, with slight extension downward, at the outer margin of the septal face. Length, 1.17 mm.; breadth, 0.46 mm.; thickness, 0.51 mm. Not common.

This variety is easily distinguished by the large, much com-

pressed coiled portion and the longitudinal costæ.

*Holotype*.—No. 5022, locality 58, Jackson, Eocene.

*Saracenaria stavensis*, new species

Plate 5, figs. 10a-b

Test robust, triangular in transverse section, outer edge acute, tending to be carinate; chambers about 10 visible, closely appressed, early chambers in a complete coil, later chambers evolute, slanting toward the coiled portion; sutures flush or slightly depressed toward the inner side; surface smooth; apertural face broad, slightly convex, the inner face concave, inner angles projecting; aperture radiate, at the outer margin of the septal face, projecting slightly, with about six teeth, and a narrow slit extending into the apertural face. Length, 0.85 mm.; thickness of last chamber, 0.40 mm. Common.

This species differs from *S. hantkeni* Cushman (1933, Contr. Cushman Lab. Foram. Res., vol. 9) and *S. moresiana* Howe and Wallace in the concave inner face. Some of the Oligocene forms compared with other species may belong here.

*Holotype*.—No. 5023, locality 65, Mint Spring marl, Vicksburg, Oligocene.

Genus *ASTACOLUS* Montfort, 1808

*Astaculus danvillensis* (Howe and Wallace)

Plate 5, figs. 11a-b

*Planularia danvillensis* Howe and Wallace, 1932, Louisiana Dept. Cons., Geol. Bull., No. 2, p. 36, pl. 3, fig. 1 Jackson, Eocene; Bergquist, 1942, Mississippi State Geol. Sur., Bull. 49 (Fossils), p. 34, pl. 3, fig. 10 upper Eocene, Miss.

Test planispiral, compressed, elongate, the early portion bi-umbonate, coiled, later part becoming evolute; chambers closely appressed, numerous, 12 or more, as many as 20 or 25 when all of the early chambers can be seen; periphery keeled for the first 8 to 10 chambers in adult specimens; edge sharp; sutures clear, broad, and moderately curved, more so toward the outer periphery in the evolute portion; surface smooth, aperture terminal, at the outer end of the last chamber, round, radiate. Length, 1.31 mm.; thickness, 0.13 mm. Common.

This species and other similar forms rightfully belong under *Astaculus* (see type, *A. crepidulus* (Fichtel and Moll) Montfort, 1808, Conch. Syst., vol. 1, p. 262) which is planispiral in the early portion becoming evolute in the later portion, particularly the outer margin, with the chambers very oblique and reaching



back, or nearly back, to the involute portion. The genus *Planularia* should be restricted to those species similar to the type (*P. auris* DeFrance, 1824, Dict. Sci. Nat., vol. 32, p. 178; see Galloway, Manual of Foraminifera, for reproduction of the original figure). In the literature, many species of *Planularia* are wrongly placed under *Vaginulina*.

*Plesiotypic*.—No. 4705, locality 58, Jackson, Eocene.

**Astacolus subtilius** (Nuttall)

Plate 5, figs. 13a-b

*Cristellaria subtilius* Nuttall, 1932, Jour. Paleont., vol. 6, p. 11, pl. 1, figs. 13, 14 lower Oligocene, Mex.

*Astacolus subtilius* Galloway and Heminway, 1941, New York Acad. Sci., Sci. Survey of Porto Rico and the Virgin Islands, vol. 3, pt. 4, p. 335, pl. 8, figs. 11 a, b Oligocene, Porto Rico.

*Marginulina subtilius* Bergquist, 1942, Mississippi State Geol. Sur., Bull. 49, (Fossils), p. 38, pl. 4, figs. 1, 3 upper Eocene, Miss.

Test elongate, much compressed; edge subacute, sharper on the back, especially in the early part; early part with a narrow keel which extends about halfway up the test in most specimens; chambers distinct, enlarging gradually in length, the last two or three not reaching back to the preceding whorl; sutures narrow, oblique, flush, very slightly limbate; aperture terminal, round, radiate, nearly in the middle of the last chamber. Length, 0.62 mm.; breadth, 0.19 mm.; thickness, 0.08 mm. Common.

*Plesiotypic*.—No. 4706, locality 58, Jackson, Eocene.

Genus **HEMICRISTELLARIA** Stache, 1864

**Hemicristellaria costifera** (Cole)

Plate 5, figs. 14a-b

*Vaginulina costifera* Cole, 1927, Bull. Amer. Paleont., vol. 14, No. 51, p. 20, pl. 2, fig. 16 Guayabal, middle Eocene, Mex.

Test small, elongate, flattened, early portion planispirally coiled, later part uncoiled with the sutures tending to become transverse; chambers about three in the linear portion; sutures indistinct, somewhat oblique in the uncoiled portion; surface with prominent costæ, four to six on a side, continuous across the sutures; aperture at the end of a small neck, on the outer edge of the septal face, radiate. Length, 0.41 mm.; breadth, 0.19 mm.; thickness, 0.09 mm. Rare.

A single specimen was found which seems referable to this species. The species is included in *Hemicristellaria* since the type *Vaginulina* has no early coiled portion.

*Plesiotypic*.—No. 4927, locality 58, Jackson, Eocene.



**Hemicristellaria gladius** (Philippi)

Plate 5, figs. 17a-b

*Marginulina gladius* Philippi, 1843, Beitr. Kennt. Nordwest Deutsch-lands, p. 40, pl. 1, fig. 37; Cushman, 1939, Contr. Cushman Lab. Foram. Res., vol. 15, p. 54, pl. 9, fig. 32 Eocene; off the eastern coast of N. A.

Test large, elongate, compressed; coiled portion fairly large, most of the test evolute with the sutures somewhat oblique, but tending to become at right angles to the axis of the test; test flattened to ovate in transverse section, abruptly rounded on the margins; chambers closely appressed, not inflated excepting the last one or two; sutures flush with the surface, distinct and somewhat limbate; wall smooth, finely perforate; aperture produced, at the outer margin of the last chamber, radiate. Length, 1.05 mm.; breadth, 0.40 mm.; thickness of the last chamber, 0.22 mm. Common.

*Plesiotype*.—No. 4928, locality 58, Jackson, Eocene.

Genus **PLANULARIA** DeFrance, 1824

**Planularia stavensis**, new species

Plate 5, figs. 12a-b

Test large, strongly compressed, parallel sides; edges flattened, broad, extending beyond the side wall of the test, forming a raised rim around each side of the entire test excepting for the border of the apertural face; chambers numerous, about 12 to 15 in number, increasing very gradually in height as added, fairly rapidly in breadth; sutures oblique, not strongly curved, thickened somewhat and in some individuals raised slightly; wall mostly smooth excepting for the raised rim which borders the test on each side at right angles to the plane of coiling, the slightly raised sutures in some cases, and an inflation of later chambers in some older individuals; aperture at the outside margin of the last septal face, round, radiate. Length, 1.35 mm.; breadth, 0.55 mm.; thickness, 0.13 mm. Rare.

This species differs from *P. cubensis* Bermudez (1937, Soc. Cubana Hist. Nat., Mem., vol. 11) in that the sutures are not so thickened and raised. They do not exhibit so strong a tendency to curve downward toward the coiled portion, and there is no ornamentation nor thickening in the early coiled portion.

*Holotype*.—No. 4980, locality 58, Jackson, Eocene.

Genus **FLABELLINELLA** Schubert, 1900**Flabellinella lanceolata**, new species

Plate 5, figs. 16a-b

Test very flat and narrow, lanceolate, tapering to blunt point at both ends; chambers numerous, narrow, closely appressed, the earlier six or seven chambers added as in *Vaginulina*, later chambers suddenly equitant, reaching back and embracing more than half of the vaginuline stage; sutures very slightly depressed or almost flush with the surface; surface smooth; aperture terminal, radiate. Length, 1.33 mm.; breadth, 0.36 mm.; thickness, 0.07 mm. Common.

This species differs from *Palmula budensis* (Hantken) (1875, Magy. kir. földt. int. Évkönyve, Bd. 4, p. 37, pl. 4, fig. 17) in its much narrower test and vaginuline early part.

*Holotype*.—No. 4977, locality 58, Jackson, Eocene.

Genus **PALMULA** Lea, 1833**Palmula henbesti** (Bermudez)

Plate 5, figs. 15a-b

*Flabellina henbesti* Bermudez, 1937, Soc. Cubana Hist. Nat., Mem., vol. 11, p. 142, pl. 17, fig. 11 Eocene, Cuba.

Test large, flabellate, flaring, much compressed, apertural end with edges at right angles, early 1/4 to 1/3 of test coiled, followed gradually by equitant chambers; surface ornamented with round, oval or irregular cells separated by high, thin partitions, completely obscuring the sutures in the first third or half of the test, reduced in the later part of the test where the sutures are demarked by sharp ridges; edge of the early part with round spines, followed by a thin irregular or fimbriate keel on both edges, the apertural end smooth; aperture terminal, oval, with inwardly projecting teeth. Length, 1.00 mm.; breadth, 0.59 mm.; thickness, 0.10 mm. Common.

This form is close to *P. calata* (Cushman) (1923, U. S. Geol. Sur., Prof. Paper 133) differing mainly in the fimbriate and spinose periphery.

*Plesiotype*.—No. 4978, locality 58, Jackson, Eocene.

Genus **FRONDICULARIA** DeFrance, 1826**Frondicularia tenuissima** Hantken

Plate 6, figs. 2a-b

*Frondicularia tenuissima* Hantken, 1875, Magy. kir. földt. int. Évkönyve, vol. 4, p. 36, pl. 13, fig. 11 upper Eocene, Hungary; Coryell and Embich, 1937, Jour. Paleont., vol. 11, p. 296, pl. 41, fig. 21 upper Eocene, Panama.

Test large, elliptical, compressed with parallel sides, initial end rounded with a pointed apex, apertural end pointed; chambers about nine, very narrow and elongate, equitant, all chambers extending nearly back to the base at either side; sutures distinct, slightly depressed; surface smooth; aperture terminal, small oval, not radiate. Length, 1.46 mm; breadth, 0.54 mm.; thickness, 0.04 mm. Rare.

*F. vaderensis* Beck (1943, Jour. Paleont., vol. 17, p. 601, pl. 107, fig. 18) seems to be conspecific with Hantken's species. Beck says, regarding chambers, "early ones loosely coiled," but his figure shows no coil. Nuttall's figure (1935, Jour. Paleont., vol. 9, p. 125, pl. 14, fig. 11) and Cushman's figures (1946, Cushman Lab. Foram. Res., Spec. Publ. 16, p. 15, pl. 4, figs. 3, 4) show a vaginuline juvenarium characteristic of *Flabellinella*; hence, their specimens can scarcely belong to *Fronicularia* or to Hantken's species.

*Plesiotype*.—No. 4890, locality 58, Jackson, Eocene.

Genus MARGINULINA d'Orbigny, 1826

**Marginulina cocoaensis** Cushman

Plate 6, figs. 1a-b

*Marginulina cocoaensis* Cushman, 1925, Contr. Cushman Lab. Foram.

Res., vol. 1, pt. 3, p. 67, pl. 10, figs. 9, 10 upper Eocene, Ala.; Cushman and Herriek, 1945, Contr. Cushman Lab. Foram. Res., vol. 21, p. 58, pl. 9, figs. 8-13 McBean fm., Eocene, Ga.

Test elongate, little compressed, initial end blunt, composed of a few chambers in a partial coil, later and major portion composed of six to eight chambers; sutures distinct, not depressed; surface with nine or ten sharp costæ running from the initial end to the base of the last chamber in adults, the last chamber smooth in old individuals; aperture small on the peripheral side of the apertural face, vaguely radiate, at the end of a distinct neck. Length, 0.89 mm.; breadth, 0.18 mm.; thickness, 0.15 mm. Common.

*Plesiotype*.—No. 4942, locality 58, Jackson, Eocene.

**Marginulina crossota**, new species

Plate 6, figs. 3a-b

Test elongate, sigmoid in outline, early part with remnant of a coil, later portion uncoiled, slightly compressed in the lower half of the test, gradually becoming round toward the apertural end; chambers about seven, gradually increasing in size as added, early chambers little if at all inflated, later chambers strongly

inflated; sutures of the early part flush with the surface and beaded, those of the later part thickened, raised, slightly oblique and not broken into beads, appearing as bands in the depressions between the inflated chambers; wall ornamented by numerous rather fine but variable costæ, oblique and confined to individual chambers, those of the early portion indistinct and fewer; aperture radiate, projecting at the outer periphery with about 12 radial teeth. Length, 1.36 mm.; diameter of the last chamber, 0.36 mm. Rare.

The raised and thickened sutures of the later part and the beaded sutures of the early part distinguish this form from *M. multiplicata* Bergquist.

*Holotype*.—No. 4943, locality 58, Jackson, Eocene.

*Marginulina digitalis*, new species

Plate 6, figs. 6a-b

Test elongate, digitate, early portion curved, later part uncoiled, early part slightly compressed with angled back, later part becoming circular in section; chambers distinct, about six forming the uncoiled portion, increasing gradually in size in the curved section, about of equal size in the uncoiled portion or increasing very little, becoming inflated; sutures distinct, limbate, ornamented with faint or very low beads in the early part evolving into raised unbeaded sutures in the later part of the test, slightly oblique to nearly transverse; wall nearly smooth, sometimes with faint indication of striæ on the early portion; aperture terminal, at the outer edge of the septal face, round, radiate. Length, 0.98 mm.; breadth of last chamber, 0.28 mm.; thickness, 0.24 mm. Common.

*Holotype*.—No. 4944, locality 58, Jackson, Eocene.

*Marginulina hantkeni*, new name

Plate 6, figs. 9a-b

*Marginulina subbullata* Hantken, 1875, Magy. kir. földt. int. Évkönyve, vol. 4, p. 39, pl. 4, figs. 9, 10 lower Oligocene, Hungary (not *M. subbullata* Gümbel, 1861); Bergquist, 1942 Mississippi State Geol. Sur., Bull. 49 (Fossils), p. 38, pl. 4, figs. 4-6 upper Eocene, Miss.

Test stout, circular in cross section, initial end bluntly rounded, early part loosely coiled, later portion rectilinear; chambers four to six, loosely appressed, especially in the adult portion; sutures distinct and depressed; surface smooth; aperture produced, radiate, terminal but eccentric toward the outer side of

the last chamber. Length, 0.78 mm.; diameter of the last chamber, 0.31 mm. Not common.

The specific name *M. subbullata* Hantken is preoccupied by that of Gümbel (1861, Geognostische Beschreibung des Bayerischen Alpengebirges und seines Vorlandes, Bd. 1, p. 508).

*Plesiotype*.—No. 4948, locality 58, Jackson, Eocene.

**Marginulina jacksonensis** (Cushman and Applin) Plate 6, figs. 7a-b  
*Cristellaria jacksonensis* Cushman and Applin, 1926, Bull. Amer. Assoc. Petr. Geol., vol. 10, p. 172, pl. 8, fig. 10<sup>1</sup> upper Eocene, Texas.  
*Marginulina jacksonensis*, Cushman, 1935, U. S. Geol. Sur., Prof. Paper 181, p. 18, pl. 7, figs. 5 a, b Alazan clay, Mex.

Test elongate, greatest width at base which is close-coiled, later part uncoiled, consisting of five or six chambers, much inflated toward the apertural end; early part with acute edge, progressively becoming rounded toward the apertural end, last chamber circular in transverse section; sutures distinct, those of the later part depressed; wall smooth, finely perforate; aperture radiate, terminal. Length, 1.08 mm.; diameter, 0.21 mm. Common.

*Plesiotype*.—No. 4945, locality 58, Jackson, Eocene.

**Marginulina laeviuscula** Cushman and Bermudez Plate 6, figs. 5a-b  
*Marginulina laeviuscula* Cushman and Bermudez, 1937, Contr. Cushman Lab. Foram. Res., vol. 13, p. 10, pl. 1, figs. 33, 34 Eocene, Cuba.

Test elongate, slender, early portion somewhat compressed, consisting of about half a coil, uncoiled portion made up of elongate, nearly cylindrical chambers; chambers and sutures indistinct in early portion, distinct, transverse and somewhat depressed in the uncoiled portion; surface smooth; aperture radiate, terminal. Length, 0.69 mm.; diameter of last chamber, 0.14. Rare.

The aperture has only six radial teeth, which may be at variance with the type; in which case it might be of varietal significance.

*Plesiotype*.—No. 4946, locality 58, Jackson, Eocene.

**Marginulina multiplicata** Bergquist Plate 6, figs. 4a-b  
*Marginulina multiplicata* Bergquist, 1912, Mississippi State Geol. Sur. Bull. 49 (Fossils), p. 37, pl. 4, figs. 14 a, b upper Eocene, Miss.

Test elongate, somewhat sigmoid in outline, tapering slightly compressed in the early portion, nearly round in cross section

in the later part; chambers about seven in number, rapidly enlarging, later three chambers comprising over one-half of the test; sutures distinct, oblique, depressed on the inflated portion; wall ornamented by numerous fine oblique costæ, confined to individual chambers; aperture radiate, projecting at the periphery. Length, 0.85 mm.; diameter, 0.25 mm. Rare.

*Plesiotype*.—No 4947, locality 58, Jackson, Eocene.

*Marginulina stavensis*, new species

Plate 6, figs. 8a-b

Test curved cylindrical, early part composed of  $\frac{1}{2}$  coil or less, uncoiled for most of the length; round in cross section throughout, planispiral portion with broadly rounded edge; chambers about two to four in the uncoiled portion, five or six in the coiled portion, early chambers indistinct, small, later chambers much more elongate; sutures flush with the surface in the early part, somewhat depressed in the later part, becoming transverse almost immediately in the uncoiled portion; wall smooth, finely perforate; aperture terminal, radiate, with about six radial teeth, centrally located. Length, 0.86 mm.; diameter, 0.23 mm. Not common.

The nearly transverse sutures and the fewer number of chambers in the uncoiled portion distinguish this form from *M. havanensis* Cushman and Bermudez (1937, Contr. Cushman Lab. For. Res., vol. 13), the lack of compression of the planispiral portion is also diagnostic.

*Holotype*.—No. 4949, locality 58, Jackson, Eocene.

Genus GLANDULINA d'Orbigny, 1839

*Glandulina conica* Neugeboren

Plate 6, figs. 10a-b, 11a-b

*Glandulina conica* Neugeboren, 1850, Verh. Mitth. Siebenburg. Ver. Nat., vol. 1, p. 51, pl. 1, figs. 5 a, b Tertiary, Rumania.

*Pseudoglandulina conica* Cushman and Barksdale, 1930, Contrib. Dept. Geol. Stanford Univ., vol. 1, No. 2, p. 65, pl. 12, figs. 1, 2, 3 Martinez fm., Eocene, Calif.

Test of moderate size for the genus, stout, tapering from the greatest diameter near the apertural end to the apex; chambers nine or ten in the microspheric form, about six in the megaspheric form; the apex of the megaspheric form bluntly rounded, that of the microspheric form pointed but not apiculate; sutures flush, rather indistinct in the early portion, slightly de-

pressed in the later part, transverse throughout; surface smooth; aperture conspicuous, protuberant, with from 12 to about 15 radial teeth. Length of largest specimen figured, 0.63 mm.; diameter of same specimen, 0.33 mm. Common.

There is considerable variation in the amount of taper in the forms from Little Stave Creek. However, many of them compare very closely with the type.

*Plesiotype*.—No. 4894 (megaspheric specimen, Fig. 10); plesiotype No. 4895 (microspheric specimen, Fig. 11) locality 58, Jackson, Eocene.

***Glandulina elliptica* Reuss**

Plate 6, figs. 12a-b

*Glandulina elliptica* Reuss, 1863, K. Akad. Wiss., Math.-Naturw. Cl., Sitzber., Bd. 48, Abt. 1, p. 47 Oligocene, Germany.

Test of moderate size for the genus, short, elliptical in outline, with the greatest width about the middle or slightly above; chambers about five to seven or eight in number with the last-chamber occupying about one-half of the test; sutures nearly flush, somewhat indistinct in the early portion, transverse; surface smooth; aperture radiate, terminal, slightly produced. Length, 0.68 mm.; diameter, 0.36 mm. Common.

*Plesiotype*.—No. 4896, locality 46, Yazoo clay, Jackson, Eocene.

***Glandulina laevigata* d'Orbigny**

Plate 6, figs. 13a-b

*Nodosaria (Glandulina) laevigata* d'Orbigny, 1826, Ann. Sci. Nat., vol. 7, p. 252, No. 1, pl. 10, figs. 1-3.

*Glandulina laevigata* d'Orbigny, 1846, Foraminifères fossiles du bassin Tertiaire de Vienne, p. 29, pl. 1, figs. 4, 5 Miocene, Vienna Basin; Howe, 1939, Louisiana Dept. Cons., Geol. Bull. 14, p. 54, pl. 6, fig. 27 Cook Mt., middle Eocene, La.

Test small, elliptical, slope slightly concave to both apex and aperture from the largest diameter about in the middle; chambers about six to eight in the adult; sutures mostly transverse, sometimes at an angle, due to inheritance from a coiled ancestry; surface smooth; aperture radiate, slightly projecting. Length, 0.31 mm.; diameter, 0.19 mm. Rare.

*Plesiotype*.—No. 4897, locality 58, Jackson, Eocene.

***Glandulina occidentalis* Cushman**

Plate 6, figs. 14a-b

*Nodosaria (Glandulina) laevigata occidentalis* Cushman, 1923, U. S.



Nat. Mus., Bull. 104, pt. 4, p. 64, pl. 12, fig. 8 Recent, Atlantic Ocean.

*Glandulina laevigata occidentalis*, Toulmin, 1941, Jour. Paleont., vol. 15, p. 595, pl. 80, figs. 12, 13 Salt Mt. ls., Wilcox, Eocene, Ala.

Test subovate, circular in section, greatest diameter usually slightly above the middle; chambers few, greatly embracing; wall smooth, the initial end apiculate; sutures flush with the surface, mostly transverse, sometimes at an angle due to the lower portion of one of a chamber extending down slightly further than the other side; aperture round, radiate. Length, 0.54 mm.; diameter, 0.28 mm. Rare.

*Plesiotype*.—No. 4898, locality 46, Yazoo clay, Jackson, Eocene.

**Glandulina ovata** Cushman

Plate 6, figs. 15a-b

*Nodosaria (Glandulina) laevigata ovata* Cushman and Applin, 1926, Bull. Amer. Assoc. Petr. Geol., vol. 10, p. 169, pl. 7, figs. 12, 13 upper Eocene, Texas.

*Glandulina laevigata ovata* Cushman, 1935, U. S. Geol. Sur., Prof. Paper 181, p. 29, pl. 10, figs. 16, 17.

Test ovate, longer than broad, circular in transverse section, widest toward the apertural end; chambers overlapping, few, somewhat indistinct, earlier ones irregularly overlapping; sutures flush, rather indistinct; wall smooth; aperture radiate, very slightly projecting in most specimens. Length, 0.60 mm.; diameter, 0.37 mm. Rare.

*Plesiotype*.—No. 4899, locality 46, Yazoo clay, Jackson, Eocene.

Genus **OOLINA** d'Orbigny, 1839

**Oolina spherica**, new species

Plate 7, fig. 20

Test nearly spherical, with small spine on the base; wall very finely perforate; surface smooth, mottled, perhaps from fossilization; aperture small, very little above the general surface, finely radiate. Diameter, 0.27 mm. Rare.

*Holotype*.—No. 4976, locality 58, Jackson, Eocene.

Genus **DENTALINA** d'Orbigny, 1839

**Dentalina acuta** d'Orbigny

Plate 6, figs. 16a-b

*Dentalina acuta* d'Orbigny, 1846, Foraminifères fossiles du bassin Tertiaire de Vienne, p. 56, pl. 2, figs. 40-43 Miocene, Vienna Basin; Cush-



man, 1929, Contr. Cushman Lab. Foram. Res., vol. 5, p. 85, pl. 12, fig. 22 Tertiary, Venezuela; Berquist, 1942, Mississippi State Geol. Sur., Bull. 49 (Fossils), p. 40, pl. 4, fig. 25 upper Eocene, Miss.

Test slender, subcylindrical, arcuate, initial end with a spine; chambers nine to twelve, increasing gradually in size as added, only the last chamber somewhat inflated; sutures fairly distinct, not depressed excepting near the apertural end; wall ornamented with few strong continuous costæ, about four in young specimens and in the early part of adults, between eight and ten in adult specimens; aperture terminal, radiate, at the end of a tapering protuberance. Length, 2.06 mm.; diameter, 0.20 mm. Rare.

There is sufficient variation in the forms in the Jackson formation of Little Stave Creek to warrant the placing of this form under *D. acuta*. The only point of consistent difference is perhaps in the somewhat smaller size of these specimens as compared with the type.

*Plesiotype*.—No. 4860, locality 58, Jackson, Eocene.

*Dentalina cocoensis crucifera*, new variety Plate 7, figs. 2a-b

*Dentalina cocoensis* Cushman, 1935, U. S. Geol. Sur., Prof. Paper 181, p. 19, pl. 8, figs. 1, (2, ?) upper Eocene, Ala., Miss.

Test elongate, rather slender, arcuate; chambers slightly inflated, initial chamber nonapiculate, increasing very little in length in the early portion of the test, very rapidly in the middle and later portions; chamber diameter increasing very gradually to the penultimate, the last chamber being much reduced in diameter toward the aperture, sutures depressed in the later portion; wall smooth, finely perforate; aperture cruciform, kerflike, produced. Length, 1.18 mm.; diameter of last chamber, 0.13 mm. Common.

The nonapiculate initial chamber and the distinct cruciform aperture distinguish this variety from *D. cocoensis* (Cushman), (1925, Contr. Cushman Lab. Foram. Res., vol. 1), *D. cooperensis gracilescata* Cushman (1946, Contr. Cushman Lab. Foram. Res., Spec. Publ. 16) is distinct in having more oblique sutures and an apiculate apex.

*Holotype*.—No. 4861, locality 58, Jackson, Eocene.

*Dentalina* cf. *communis* d'Orbigny

Plate 6, fig. 17

*Nodosaria* (*Dentalina*) *communis* d'Orbigny, 1826, Ann. Sci. Nat., vol. 7, p. 254, No. 35; Cushman, 1931, Contr. Cushman Lab. Res., vol. 7, pl. 8, figs. 22, 23 Recent, Rimini, Italy; Beek, 1943, Jour. Paleont., vol. 17, p. 598, pl. 105, fig. 22 Eocene, Wash.

Very few specimens of this form were found.

*Plesiotype*.—No. 4862, locality 60, Jackson, Eocene.

*Dentalina cooperensis nonapicalis*, new variety

Plate 7, figs. 1a-b

Test elongate, gently curved, very little compressed, tapering gradually; periphery only slightly lobulate; apical end rounded, nonapiculate; chambers about 10 in the adult; sutures distinct, limbate, slightly oblique, more so in the early part in some individuals, flush in the early part of the test and somewhat depressed in the later part; wall smooth, finely perforate; aperture near the periphery of the last chamber, radiate and slightly projecting. Length, 1.57 mm.; breadth, 0.30 mm. Common.

This common form is similar to many figures which have been assigned to *D. cooperensis* Cushman (1946, Cushman Lab. Foram. Res., Special Publ. 16, pl. 3, fig. 13, not 14) but is distinctly separate from the original (1933, Contr. Cushman Lab. Foram. Res., vol. 9) in lacking the apiculate or pointed apex.

*Holotype*.—No. 4863, locality 58, Jackson, Eocene.

*Dentalina cucarensis* Cole

Plate 7, figs. 3a-b

*Dentalina cucarensis* Cole, 1927, Bull. Amer. Paleont., vol. 14, No. 51, p. 14, pl. 3, fig. 14 Guayabal fm., middle Eocene, Mex.

Test elongate, arcuate, very slightly compressed, initial end rounded; chambers inflated, gradually enlarging in size; periphery lobulate on the outside, inner portion much less; sutures oblique, of clear shell material, depressed; aperture terminal, radiate, near the inner margin. Length, 0.71 mm.; diameter of last chamber, 0.14 mm. Rare.

*Plesiotype*.—No. 4864, locality 58, Jackson, Eocene.

*Dentalina indifferens* Reuss

Plate 7, figs. 6a-b

*Nodosaria* (*Dentalina*) *indifferens* Reuss, 1863, K. Akad. Wiss., Math.-Naturw. Cl. Sitzber., Bd. 48, Abt. 1, p. 44, pl. 2, figs. 15-16 middle Oligocene, Germany.

Test elongate, slender, slightly curved, first chamber much inflated larger than the immediately subsequent chambers in diameter, later portion slightly compressed; chambers about four

to as many as ten, of nearly uniform width, somewhat inflated, increasing very slightly in size as added after the large initial chamber; sutures distinct, depressed, varying from transverse to slightly oblique within the same test, slightly limbate or thickened; wall smooth, finely perforate; aperture near the inner margin of the last chamber, radiate, with slight neck. Length, 0.88 mm.; diameter of last chamber, 0.15 mm. Common.

Many specimens, all exhibiting an enlarged proloculum, were found in the Red Bluff material. The first chamber is transparent permitting ready determination of its unilocularity.

*Plesiotype*.—No. 4865, locality 63, Red Bluff, lower Oligocene.

**Dentalina jacksonensis** (Cushman and Applin) Plate 7, figs. 7a-b

*Nodosaria jacksonensis* Cushman and Applin, 1926, Bull. Amer. Assoc. Petr. Geol., vol. 10, p. 170, pl. 7, figs. 14-16 upper Eocene, Tex.

*Dentalina jacksonensis* Cushman, 1946, Cushman Lab. Foram. Res., Special Publ. 16, p. 13, pl. 3, fig. 9 upper Eocene, Ala.

Test elongate, circular in cross section, somewhat arcuate, gently tapering; periphery lobulate, especially in the later half, early portion smooth; apical end with single spine; chambers usually 10 or more in the adult, often indistinct; sutures fairly distinct, nearly transverse; wall smooth, matte; aperture at the periphery of the last chamber, slightly projecting. Length, 1.28 mm.; diameter of last chamber, 0.24 mm. Common.

The thick wall and lack of radiate aperture indicate that this form may actually be a *Nodosarella*.

*Plesiotype*.—No. 4866, locality 58, Jackson, Eocene.

**Dentalina soluta** Reuss Plate 7, figs. 5a-b

*Dentalina soluta* Reuss, 1851, Deutsch. Geol. Gesell. Zeitschr., vol. 3, p. 60, pl. 3, fig. 4 Oligocene, Germany; Plummer, 1931, Univ. Texas Bull. 3101, p. 150, pl. 11, fig. 14 Upper Cretaceous, Tex.; Toulmin, 1941, Jour. Paleont., vol. 15, p. 587, pl. 79, figs. 23, 24 Salt Mt. ls., Eocene, Ala.

Test slightly curved, chambers round in section, apical end with a small spine; chambers few, inflated, increasing somewhat rapidly in size as added; sutures straight, deeply constricted; wall smooth, finely perforate; aperture terminal, eccentric, protruding and radiate. Length of last three chambers, 1.06 mm.; diameter of last chamber, 0.31 mm. Rare.

*Plesiotype*.—No. 4867, locality 58, Jackson, Eocene.

**Dentalina vertebralis albatrossi** (Cushman)

Plate 7, fig. 4

*Nodosaria vertebralis albatrossi* Cushman, 1933, U. S. Nat. Mus., Bull. 104, pt. 4, p. 87, pl. 15, fig. 1 Recent, Atlantic Ocean.

*Dentalina vertebralis albatrossi* Cushman and Todd, 1945, Cushman Lab. Foram. Res., Special Publ. 15, p. 22, pl. 3, fig. 21 Miocene, Jamaica; Cushman, 1946, Cushman Lab. Foram. Res., Special Publ. 16, p. 13, pl. 3, figs. 10-12 upper Eocene, Ala.

Test large, gradually tapering, slightly curved; chambers up to 15, distinct in the later part, not inflated, except those near the apertural end; sutures broad, of clear shell material, not depressed except near the apertural end; wall ornamented by 15 to 18 longitudinal costæ which are continuous from chamber to chamber; initial end of the test apiculate; aperture radiate, slightly extended. Length, 5.35 mm.; diameter, 0.45 mm. Abundant.

The character of the aperture in the Little Stave Creek specimens may differ from that in the holotype of this species.

*Plesiotype*.—No. 4868, locality 58, Jackson, Eocene.

Genus **NODOSARIA** Lamarck, 1812**Nodosaria globifera** (Batsch)

Plate 7, figs. 8a-b

*Nautilus (Orthoceras) globifer* Batsch, 1791, Seebs Kupfertafeln mit Conchylien des Seesandes, pl. 3, figs. 9 a-c.

*Nodosaria globifera* Cushman, 1931, Contr. Cushman Lab. Foram. Res., vol. 7, p. 68, pl. 9, figs. 1-4 Recent, Rimini.

Test nearly straight, composed of elongate, nearly cylindrical chambers, the initial chamber being large and globular in the megaspheric specimens; sutures transverse, very little depressed; surface smooth; aperture not seen. Length, 0.76 mm.; diameter, 0.12 mm. Rare.

At locality 7 a single specimen was found which is very similar to Cushman's reproductions of Batsch's specimens.

*Plesiotype*.—No. 4957, locality 7, Tallahatta fm., Claiborne, Eocene.

**Nodosaria latejugata** Gümbel

Plate 7, figs. 13a-b, 14a-b

*Nodosaria latejugata* Gümbel, 1868 (1870), K. bayer. Akad. Wiss. München, Cl. 2, Abh., vol. 10, p. 619, pl. 1, fig. 32 Eocene, Germany; Hantken, 1875 (1876), Magy. kir. földt. int. Evkönyve, vol. 4, p. 21 pl. 2, figs. 6 a-d Eocene, Oligocene, Hungary; Bergquist, 1942, Mississippi State Geol. Sur., Bull. 49 (Fossils), p. 45, pl. 4, figs. 12, 13 upper Eocene, Miss.

Test elongate, subcylindrical, initial end with spine; chambers distinct, slightly inflated; sutures distinct, of clear shell material,

slightly depressed, especially in the later portion; surface ornamented with a few prominent longitudinal costae, averaging about eight to ten, continuous from initial to apertural ends, final chamber in adults commonly smooth; apertural end slightly produced, aperture radiate. Length of adult specimen, 1.33 mm.; diameter of last chamber, 0.15 mm. Rare

*Plesiotypes*.—No. 4958 (Fig. 13), locality 58, Jackson, Eocene; No. 4959 (Fig. 14), locality 65, Mint Spring marl, Vicksburg. Oligocene.

*Nodosaria* cf. *longiscata* d'Orbigny Plate 7, fig. 10  
*Nodosaria longiscata* d'Orbigny, 1846, Foraminifères fossiles du bassin Tertiaire de Vienne, p. 32, pl. 1, figs. 10-12 Miocene, Vienna; Howe and Wallace, 1932, Louisiana Dept. Cons., Geol. Bull. 2, p. 35, pl. 7, fig. 8 upper Eocene, La.; Howe, 1939, Louisiana Dept. Cons. Bull. 14, p. 47, pl. 5, fig. 10 middle Eocene, La.; Bergquist, 1942, Mississippi State Geol. Sur., Bull. 49 (Fossils), p. 46, pl. 4, fig. 26 upper Eocene, Miss.

Test very elongate, slender, curved; chambers four or more, elongate, smooth, cylindrical; sutures transverse, slightly depressed; wall smooth, finely perforate; aperture not preserved, probably round and radiate. Length of the four chambers, 1.30 mm.; diameter, 0.13 mm. Rare.

The chambers are shorter than in D'Orbigny's figures.

*Plesiotype*.—No. 4960, locality 58, Jackson, Eocene.

*Nodosaria* cf. *pyrula* d'Orbigny Plate 7, figs. 9a-b  
*Nodosaria pyrula* d'Orbigny, 1826, Ann. Sci. Nat., vol. 7, p. 253; Brady, 1884, rep. Voy. *Challenger*, Zoology, vol. 9, p. 497, pl. 62, figs. 10-12 Recent; Galloway and Morrey, 1929, Bull. Amer. Paleont., vol. 15, No. 55, p. 16, pl. 1, fig. 16 late Eocene or lower Oligocene, Ecuador; Cushman and Todd, 1945, Cushman Lab. Foram. Res., Special Publ. 15, p. 28, pl. 4, figs. 17, 18 Miocene, Jamaica.

A few broken specimens of one or two chambers each were found. The chambers are fusiform to pyriform, the intervening necks not so well defined as in most figures of this species; surface smooth; wall finely perforate, recrystallized; aperture absent. Length, 0.61 mm.; diameter, 0.10 mm. Rare.

*Plesiotype*.—No. 4961, locality 58, Jackson, Eocene.

Genus *LAGENA* Walker and Boys, 1784

*Lagena elliptica*, new species Plate 7, fig. 16

Test elliptical, greatest diameter below the middle, twice as long as wide, with narrow abrupt neck of even diameter half as long as the body, without phialine lip; surface matte, minutely

pitted. Length, 0.3 mm., including neck. Rare.

This species differs from *Lagena laevis* (Montagu) (see Williamson, 1848. Ann. Mag. Nat. Hist., p. 12, pl. 1, figs. 1, 2) in the abrupt neck and lack of a lip.

*Holotype*.—No. 4931, locality 10, Tallahatta fm., Claiborne Eocene.

**Lagena gracilicosta** Reuss

Plate 7, figs. 11a-b

*Lagena gracilicosta* Reuss, 1862. K. Akad. Wiss. Math. Naturw. cl. Sitz. Wien, Bd. 46, Abt. 1, p. 327, pl. 3, figs. 42, 43; Franke, 1927, Danmarks geologiske Undersogelse 11, Raekke, Nr. 46, p. 20, pl. 2, fig. 2, Paleocene, Denmark.

Test ovate, circular in end view; base rounded, apertural end produced into a short cylindrical neck; surface ornamented with 30 or 40 rather fine longitudinal costæ; aperture round at the end of a short cylindrical neck which is without costæ. Length, 0.24 mm.; diameter, 0.13 mm. Rare.

The form from Little Stave Creek has somewhat fewer costæ than the type figure exhibits. However, it agrees well in all other respects.

*Plasiotype*.—No. 4930, locality 58, Jackson, Eocene.

**Lagena laevis stavensis**, new variety

Plate 7, figs. 15a-b

*Lagena laevis*, var. Bergquist (not Montagu), 1942, Mississippi State Geol. Sur., Bull. 49 (Fossils), p. 51, pl. 5, fig. 7 upper Eocene, Miss.

Test globular ovoid, widest below the middle, circular in cross section; base rounded without apicule; neck elongate,  $1/5$  to  $1/7$  the length of the body, smooth, tapering; wall smooth, finely perforate; aperture round, without lip. Length, 0.27 mm.; diameter, 0.17 mm. Not common.

This form is not so elongate as *L. laevis* (Montagu) and lacks the surface ornamentation of other species of similar shape. *L. globosa* (Montagu) (1803, Test. Brit., p. 523) lacks the definite elongate neck of this variety.

*Holotype*.—No. 4932, locality 58, Jackson, Eocene.

**Lagena humerifera**, new species

Plate 7, fig. 17

Test pyriform, consisting of a globular body, a shoulder and a neck, circular in cross section; surface ornamented with about 12 costæ, four being more prominent and extending up to the neck, the other eight joining in pairs at a shoulder below the neck, some pairs with a short, intercalated costa; neck short, smooth, without lip. Length, 0.25 mm.; diameter, 0.13. Rare.



*Holotype*.—No. 4933, locality 64, Mint Spring marl, Vicksburg, Oligocene.

**Lagena ouachitaensis alabamensis**, new variety Plate 7, figs. 12a-b

Test elongate, pyriform, circular in cross section; surface ornamented with about 28 longitudinal costæ, about half extending up onto the base of the neck, the others terminating farther back; neck elongate, slender, ornamented with several ringlike costæ. Length, 0.34 mm.; diameter, 0.16 mm. Rare.

This variety is distinguished by having double the number of costæ present in *L. ouachitaensis* Howe and Wallace (1932, Louisiana Dept. Cons., Geol. Sur., Bull. 2).

*Holotype*.—No. 4934, locality 30, Lisbon fm., Claiborne, Eocene.

**Lagena sulcata spirata**, new variety Plate 7, fig. 18

*Lagena sulcata* Brady (part), 1884, Rept. Voy. *Challenger*, Zool., vol. 9, pl. 57, fig. 23 Recent; Cushman, 1923, U. S. Nat. Mus., Bull. 104, pt. 4, p. 57, pl. 2, fig. 1 Recent, Atlantic Ocean.

Test subglobose, slightly longer than broad, the neck about half as long as the body, slightly tapering; surface ornamented with about 24 rounded costæ, extending from the base of the test to the base of neck, two continued in a spiral manner the length of the neck itself. Length, 0.20 mm.; diameter, 0.17 mm. Rare.

This variety is rare and is similar to many figured specimens identified with *L. sulcata*. It differs from that species, however, in the spiral costæ on the neck.

*Holotype*.—No. 4935, locality 7, Tallahatta fm., Claiborne, Eocene.

**Lagena wallacei**, new species Plate 7, fig. 19

*Lagena*, sp. (B) Howe and Wallace, 1932, Louisiana Dept. Cons., Geol. Bull. 2, p. 30, pl. 6, fig. 10 upper Eocene, La.; Bergquist, 1942, Mississippi State Geol. Sur., Bull. 49 (Fossils), p. 53, pl. 5, fig. 26 upper Eocene, Miss.

Test ampullaceous in shape, circular in cross section; surface ornamented with about 36 fine costæ, evenly spaced, but extending various distances toward the base of the chamber; neck long, very little tapering, with four or more raised annulations; aperture circular, at the end of the neck, without lip. Length, 0.41 mm.; diameter, 0.19 mm. Rare.

This species is rather widespread and stable in its characters.

It is named in honor of William E. Wallace, one of the authors of the original publication of this form.

*Holotype*.—No. 4936, locality 64, Mint Spring marl, Vicksburg, Oligocene.

Genus **ROBULUS** Montfort, 1808

**Robulus alato-limbatus** (Gümbel) Plate 8, figs. 1a-b

*Robulina alato-limbata* Gümbel, 1868 (1870), K. Bayer. Akad. Wiss., München, Cl. 2, Abh., vol. 10, p. 641, pl. 2, figs. 70 a, b upper Eocene, central Europe.

*Robulus alato-limbatus* Bergquist, 1942, Mississippi State Geol. Sur., Bull. 49 (Fossils), p. 26, pl. 3, fig. 7 upper Eocene, Miss.

Test lenticular, close-coiled, biumbonate, with large central umbos not projecting greatly above the general surface but distinct; edge angled, with narrow keel; periphery smooth; chambers distinct, not inflated, about seven or eight in number; sutures distinct, limbate, flush, oblique and gently curved; aperture at the peripheral edge of last septal face, radiate with a slight extension down into the septal face. Diameter, 0.49 mm.; thickness, 0.22 mm. Rare.

*Plesiotype*.—No. 5003, locality 10, Tallahatta fm., Claiborne, Eocene.

**Robulus carolinianus** Cushman Plate 8, figs. 2a-b

*Robulus arcuato-striatus carolinianus* Cushman, 1933, Contr. Cushman Lab. Foram. Res., vol. 9, p. 4, pl. 1, fig. 9 upper Eocene, Ala.; 1946, Cushman Lab. Foram. Res., Special Publ. 16, p. 10, pl. 1, fig. 14 upper Eocene, Ala.

Test subcircular, lenticular, close-coiled throughout, strongly umbonate; edge angular, with a fairly wide thin carina; chambers very distinct, eight or nine in the last whorl, increasing very slightly in size as added; sutures distinct, strongly limbate, very strongly curved, particularly as they approach the umbo of clear shell material; aperture somewhat protruding at the peripheral angle of the last septal face, radiate, apertural face slightly concave, edges thickened. Diameter, 0.77 mm.; thickness, 0.42 mm. Common.

*Plesiotype*.—No. 5004, locality 60, Jackson, Eocene.

**Robulus convergens** (Bornemann) Plate 8, figs. 3a-b

*Cristellaria convergens* Bornemann, 1855, Zeitschrift Deutsch. Geol. Gesell., vol. 7, p. 327, pl. 13, fig. 16 Oligocene, Germany; Cushman, 1923, U. S. Geol. Sur., Prof. Paper 133, p. 28, pl. 4, fig. 2 middle Oligocene, Miss.



*Lenticulina* (?) *convergens* Cushman and Dusenbury, 1934, Contr. Cushman Lab. Foram. Res., vol. 10, p. 54, pl. 7, figs. 7 a, b Eocene, Calif.  
*Lenticulina convergens* Cushman, 1935, U. S. Geol. Sur., Prof. Paper 181, p. 17, pl. 6, figs. 4 a, b upper Eocene, Ga.; Bergquist, 1942, Mississippi State Geol. Sur., Bull. 49 (Fossils), p. 33 upper Eocene, Miss.

Test subcircular to ovate, discoidal, close-coiled, thickest in the umbonal region with distinct umbonal areas of clear shell material, flush with the surface; chambers few, about five to seven, the last one beaklike; sutures fairly distinct, curving strongly into the umbos, not depressed, tending to be limbate, apertural face strongly convex; aperture at the peripheral angle on the last septal face, radiate with a slight extension downward onto the septal face. Diameter, 0.53 mm.; thickness, 0.26 mm. Common.

This form is similar to many of those referred to Bornemann's species; however, it may be found to differ from the type in regard to the clear umbonal areas.

*Plesiotypic*.—No. 5005, locality 60, Jackson, Eocene.

***Robulus davisii***, new species

Plate 8, figs. 4a-b

Test thick, lenticular, biumbonate; edge sharply rounded not angled nor carinate; periphery smooth; chambers eight to ten in the last whorl; sutures narrowly limbate, flush, oblique; umbonal region filled with a large area of clear shell material; aperture radiate at the peripheral edge of the last septal face, with a narrow extension downward. Diameter, 0.68 mm.; thickness, 0.35 mm. Scarce.

This species is unusual in the rounded edge, with no indication of a keel.

*R. davisii* is named in honor of Mr. Morgan Davis, Chief Geologist of the Humble Oil and Refining Company, Houston, Texas.

*Holotype*.—No. 5006, locality 58, Jackson, Eocene.

***Robulus euglyphicus***, new species

Plate 8, figs. 7a-b

(?) *Robulus dumblei* Cushman (not Weinzierl and Applin), 1946. Cushman Lab. Foram. Res., Special Publ. 16, p. 10, pl. 2, fig. 9 upper Eocene, Ala.

Test large, biumbonate, strongly biconvex; edge acute, with prominent keel; periphery smooth; chambers eight to twelve, increasing very gradually in size as added; umbonal areas filled

with clear shell material; sutures with raised limbations which fuse with the central boss, strongly curved toward the periphery; wall smooth, finely perforate excepting for the raised limbations of the sutures; the periphery slopes down sharply to the last septal face with the aperture conspicuously located about midway between the top and base of the last chamber, with an elongate extension downward to the base of the septal face in most adult specimens. Diameter, 1.37 mm.; thickness, 0.64 mm. Abundant.

This species differs from *R. carolinianus* Cushman (1933, Contr. Cushman Lab. Foram. Res., vol 9) in that the sutures fuse directly into the central umbonate areas in a radial fashion rather than being strongly curved forward as they approach the center and also in the much lower location of the aperture on the final septal face. *Robulus dumblei* Weinzierl and Applin has much stronger sutural ornamentation than this form, and the apertural character of this new species is also much different. This form is abundant and a nearly complete range from small to large and gerontic forms can be found, all exhibiting the peculiar apertural characteristic and rather low sutural limbations.

*Holotype*.—No. 5007, locality 58, Jackson, Eocene.

***Robulus inusitatus*** Cushman

Plate 8, figs. 6a-b

*Robulus inusitatus* Cushman, 1946, Cushman Lab. Foram. Res., Special Publ. 16, p. 7, pl. 2, figs. 1-7 upper Eocene, Ala.

Test close-coiled at least in the early portion, tending to uncoil in the later stages; edge angular; periphery with a very distinct keel; chambers distinct, very slightly, if at all, inflated, increasing very gradually in size as added, later ones becoming narrower but more inflated as they tend to uncoil; sutures distinct, only slightly curved, in the coiled portion raised and more or less beaded, in the later portion without ornamentation and slightly depressed; wall with various degrees of ornamentation along the suture lines, some slightly raised with a single bead at the inner end, others with a series of small beads, largest at the inner end, wall between the sutures usually smooth; aperture at the outer peripheral angle which is distinctly projecting. Diameter, 1.40 mm.; thickness, 0.59 mm. Common.

As indicated in the type description, the carinate periphery distinguishes this form from *R. cocoaensis*

*Plesiotype*.—No. 5008, locality 58, Jackson, Eocene.

**Robulus jugosus** Cushman and Thomas Plate 9, figs. 3a-b  
*Robulus jugosus* Cushman and Thomas, 1930, Jour. Paleont., vol. 4, p. 36, pl. 3, figs. 4 a, b middle Eocene, Tex.; Cushman and Applin, 1943, Contr. Cushman Lab. Foram. Res., vol. 19, p. 34, pl. 7, fig. 14 Yegua fm., middle Eocene, Tex.

Test somewhat ovate in outline, little compressed, edge subacute with narrow, blunt keel; chambers distinct, five to seven in the last whorl, earlier ones somewhat indistinct, later ones increasing gradually in length as added; sutures somewhat limbate, slightly raised excepting near the periphery; earlier ones somewhat nodose or beaded, later ones smooth; wall smooth excepting for beading and sutures; aperture terminal, radiate, at the peripheral margin of the last septal face, peripheral face broad and slightly convex. Length, 0.43 mm.; breadth, 0.28 mm.; thickness, 0.20 mm. Rare.

The specimen figured is a megaspheric form almost lacking in the characteristic ornamentation.

*Plesiotype*.—No. 5009, locality 7, Tallahatta fm., Claiborne, Eocene.

**Robulus limbosus** (Reuss) Plate 8, figs. 8a-b  
*Cristellaria (Robulina) limbosa* Reuss, 1863, K. Akad. Wiss. Math. Naturw. cl. Sitzber. Wien, Bd. 48, Abt. 1, p. 55, pl. 6, fig. 69 Oligocene, Germany.

*Robulus limbosus* Cushman, 1946, Cushman Lab. Foram. Res., Special Publ. 16, p. 6, pl. 1, fig. 13 upper Eocene, Ala.

Test biumbonate, close-coiled, with a broad, thin, platelike, transparent keel; chambers distinct, eight to ten in the last whorl; sutures distinct, curved, somewhat limbate, of clear material which fuses into the clear material of the umbonal areas; wall smooth; apertural face small, slightly concave; aperture on the peripheral angle of the last septal face, radiate, with slit extending down halfway on the septal face. Diameter, 0.57 mm.; thickness, 0.26 mm. Common.

*Plesiotype*.—No. 5010, locality 58, Jackson, Eocene.

**Robulus pseudovortex** Cole Plate 8, figs. 9a-b, 10a-b  
*Robulus pseudovortex* Cole, 1927, Bull. Amer. Paleont., vol. 14, No. 51, p. 19, pl. 1, fig. 12 middle Eocene, Mex.; Cushman and McMasters, 1936, Jour. Paleont., vol. 10, p. 510, pl. 74, figs. 12 a, b middle Eocene, Calif.

Test biconvex, biumbonate, six chambers comprising the last whorl; chambers elongate, curved, enlarging as they approach the periphery; sutures slightly raised, whirling out from the central umbo; edge acute, not keeled but with a rim of clear shell material; surface smooth, finely perforate, unornamented excepting for the umbos and slightly raised sutures; last septal face small, triangular; aperture radiate, with rimmed fissure extending down two-thirds of the septal face. Diameter, 1.03 mm.; thickness, 0.51 mm. Common.

The two forms figured are very similar and both are assigned to this species. The apertures are slightly different as seen in the figures. This may be found to be sufficiently diagnostic to set up a variety.

*Plesiotypes*.—No. 5012, locality 58; No. 5011, locality 59, Jackson, Eocene.

***Robulus rectidorsatus***, new species

Plate 8, figs. 5a-b

Test large, biumbonate, lenticular, close-coiled, the last chamber much produced in gerontic specimens; edge bluntly angular; periphery not carinate but composed of straight-backed chambers in the adult portion, which intersect at low angles; chambers distinct, not inflated, closely appressed; sutures raised and limbate becoming higher toward the umbonal areas, there breaking into knobs usually; wall smooth excepting for the raised sutures and knobbed umbonal areas; aperture at the outer peripheral angle which is distinctly projecting, radiate, oval, with small downward fissure. Diameter, 1.15 mm.; thickness, 0.59 mm. Abundant.

The radial, raised, limbate sutures, the straight-backed chambers in the later portion of the test, and the noncarinate periphery distinguish this species from *R. imusitatus* Cushman. *R. cocoaensis* (Cushman) (1925, Contr. Cushman Lab. Foram. Res., vol. 1, pt. 3) has a much more beaded test and lacks the straight-raised limbate sutures as well as being less produced at the apertural angle.

*Holotype*.—No. 5013, locality 58, Jackson, Eocene.

**Robulus texanus** (Cushman and Applin)

Plate 9, figs. 2a-b

*Cristellaria articulata texana* Cushman and Applin, 1926, Bull. Amer. Assoc. Petr. Geol., vol. 10, p. 170, pl. 8, figs. 1, 2 upper Eocene Tex.

*Robulus articulatus texanus* Cushman, 1935, U. S. Geol. Sur., Prof. Paper 181, p. 16, pl. 4, figs. 16, 17 upper Eocene, Tex., S. Car.; Bergquist, 1942, Mississippi State Geol. Sur., Bull. 49 (Fossils), p. 28, pl. 3, fig. 6 upper Eocene, Miss.

Test lenticular, close-coiled, biumbonate, with large low central umbo of clear shell material in adult specimens; edge angular with a narrow keel; periphery smooth; chambers distinct, not inflated, nine to twelve in the final whorl; sutures distinct, flush, oblique and somewhat curved; aperture at the peripheral edge of the last septal face, radiate with a slight extension down into the septal face. Diameter, 0.88 mm.; thickness, 0.40 mm. Common.

*Plesiotype*.—No. 5014, locality 58, Jackson, Eocene.

**Robulus vicksburgensis** (Cushman)

Plate 8, figs. 11a-b

*Cristellaria vicksburgensis* Cushman, 1922, U. S. Geol. Sur., Prof. Paper 129, p. 130, pl. 31, figs. 6, 7 middle Oligocene, Miss.; 1923, U. S. Geol. Sur., Prof. Paper 133, p. 29 middle Oligocene, Ala., Miss.

*Robulus vicksburgensis* Ellisor, 1933, Bull. Amer. Assoc. Petr. Geol., vol. 17, No. 11, pl. 2, fig. 2; Cushman and Todd, 1946, Contr. Cushman Lab. Foram. Res., vol. 22, p. 84, pl. 14, fig. 23 Vicksburg, Oligocene, Miss., Ala., Fla., Tex.

Test biconvex, planispiral, becoming evolute in the last portion of the final whorl; edge angled, carinate in early portion; chambers seven to eight in the visible coil; sutures marked by rather broad, curved, raised ridges, those near the earlier part of the coil broken into rounded knobs, especially near the umbilical area, the later ones more continuous; wall mostly smooth but with small papillæ scattered irregularly between the sutures, finely perforate; apertural face smooth and somewhat concave with acute projecting angles; aperture radiate at the peripheral angle of the last chamber, with small downward fissure. Length, 0.81 mm.; thickness, 0.38 mm. Abundant.

Although the scattered papillate character was not emphasized in the original description, the original figure has an indication of such ornamentation. In the last reference under the synonymy above, the figure given is very similar to the figure herein.

*Plesiotype*.—No. 5015, locality 65, Mint Spring marl, Vicksburg, Oligocene.

**Robulus westermanni** (Pijpers)

Plate 9, figs. 1a-b

*Cristellaria* (*Planularia*) *westermanni* Pijpers, 1933, Geology and Palaeontology of Bonaire (Dutch West Indies), Geog. Geol. Med., Physiogr. Geol. Reeks, No. 8, p. 61, tfs. 39-40 upper Eocene, Bonaire.

Test compressed, suboval, biumbonate, tending to be evolute; edge sharp, with a broad keel of clear shell material; chambers seven or eight in the last whorl, evenly but rather rapidly increasing in size; spiral sutures of the last whorl depressed; sutures distinct, flush with the surface in the early part, becoming depressed between the last two or three chambers, slightly curved and narrowly limbate; surface smooth, finely perforate, umbos made of clear shell material; aperture at the peripheral edge of the last septal face an elongate slit which is parallel to the plane of coiling; radiations obsolete. Diameter, 0.57 mm.; thickness at the umbos, 0.17 mm. Common.

The original figure (39) was apparently made with transmitted light causing the apertural necks of the previous chambers to show through.

*Plesiotype*.—No. 5016, locality 58, Jackson, Eocene.

Genus **LINGULINA** d'Orbigny, 1826**Lingulina subcrassa**, new species

Plate 9, figs. 5a-b

Test ovate in end view, greatest width at last chamber, tapering from there rapidly to the apex, apertural end rather blunt; edge angled, not carinate; chambers few, about five in the adult, increasing rapidly in size as added, the lower margin of the last tending to overhang the preceding one along the periphery; sutures slightly depressed or flush with the surface, arcuate; wall smooth, finely perforate; aperture terminal, produced, an elongate slit parallel to the compression of the test. Length, 0.96 mm.; breadth, 0.71 mm.; thickness, 0.44 mm. Common.

This species is distinguished from closely related forms by its noncarinate periphery, relatively short, wide, thick shape, and protruding aperture.

*Holotype*.—No. 4939, locality 58, Jackson, Eocene.

Genus **FISSURINA** Reuss, 1850**Fissurina crassicarinata**, new species

Plate 9, figs. 6a-b

Test lenticular, subcircular, bordered by a thickened keel along



edge; surface smooth; aperture terminal, a long narrow slit. Length, 0.43 mm.; thickness, 0.37 mm. Rare.

*Fissurina marginata* (Walker and Jacob) (1784, Test. Min. p. 2, pl. 1, fig. 7) differs in having a thinner keel and in being more elongate.

*Holotype*.—No. 4888, locality 58, Jackson, Eocene.

**Fissurina mauricensis** (Howe and Roberts) Plate 9, figs. 11a-b

*Ellipsolagena* (?) *mauricensis* Howe and Roberts, 1939, Louisiana Dept. Cons., Geol. Bull. 14, p. 72, pl. 9, figs. 12, 13 Cook Mt. Claiborne, Eocene, La.

Test ovate in side and end views, edge rounded, not keeled, wall smooth, finely perforate; aperture a terminal elongate slit with lip. Length, 0.26 mm.; breadth, 0.22 mm; thickness, 0.19 mm. Not common.

The figured specimen is larger than the type.

*Plesiotype*.—No. 4889, locality 14, Lisbon fm., Claiborne, Eocene.

Family **POLYMORPHINIDÆ** d'Orbigny, 1846

Genus **POLYMORPHINA**<sup>1</sup> d'Orbigny, 1826

**Polymorphina liosoma**, new species Plate 9, figs. 7a-b

Test elongate ovate, much compressed, apex pointed with a small spine, sides nearly parallel, maximum width of test about midway of the length of the test; edge flattened with rounded angles; sutures strongly oblique, flush with the surface, slightly curved; chambers about eight pairs enlarging evenly and gradually in length and height; wall smooth, finely perforate; aperture terminal, radiate, with about six radial teeth. Length, 0.51 mm.; breadth, 0.21 mm.; thickness, 0.03 mm. Not common.

The elongate test, rounded edge, smooth surface, and spined apex are distinctive, readily separating this species from other forms.

*Holotype*.—No. 4984, locality 58, Jackson, Eocene.

**Polymorphina nuda** Howe and Roberts Plate 9, figs. 8a-b

*Polymorphina advena nuda* Howe and Roberts, 1939, in Howe, Louisiana Dept. Cons., Geol. Bull. 14, p. 56, pl. 7, fig. 4 Cook Mt., middle Eocene, La.; Cushman, 1946, Cushman Lab. Foram. Res., Special Publ. 16, p. 20, pl. 4, fig. 19 upper Eocene, Ala.

<sup>1</sup>The two species included under this genus are atypical as compared with the genotype, *Polymorphina bardigalensis* d'Orbigny (1826, Ann. Sci. Nat., vol. 7, p. 265, No. 2 Modèle No. 29).

Test much compressed, broadly ovate; chambers five or six pairs, elongate, biserial; sutures slightly depressed in the later portion of the test, otherwise nearly flush; surface smooth, finely perforate; edge rounded; aperture terminal, radiate, with about 12 radial teeth. Length, 0.47 mm.; breadth, 0.25 mm.; thickness, 0.05 mm. Rare.

The rounded edge and the more acute apical end distinguish this form from *P. frondosa* (Cushman). For a discussion of these two species refer to Contr. Cushman Lab. Foram. Res., vol. 21, p. 91.

*Plesiotype*.—No. 4985, locality 58, Jackson, Eocene.

Genus **SIGMOIDELLA** Cushman and Ozawa, 1928

*Sigmoidella lisbonensis*, new species

Plate 9, figs. 9a-b

Test compressed, ovate in end view, broadly rounded at base, apertural end pointed; edge angular to subangular with a rather blunt keel on most chambers; chambers somewhat compressed arranged in clockwise sigmoid series, each succeeding chamber embracing the earlier one, the later two chambers in adults not extending down to the initial end; sutures slightly depressed, bordered by the raised keel of the adjacent chamber on the lower side; wall smooth, finely perforate; aperture radiate, terminal, round. Length, 0.89 mm.; breadth, 0.53 mm.; thickness, 0.26 mm. Common.

*S. plummeræ* Cushman and Ozawa differs from this species in lacking the peripheral keels which stand out on the surface of the test, forming low ridges bordering the sutures.

*Holotype*.—No. 5024, locality 16, Lisbon fm., Claiborne, Eocene.

*Sigmoidella plummeræ* Cushman and Ozawa

Plate 9, figs. 4a-b

*Sigmoidella plummeræ* Cushman and Ozawa, 1930, U. S. Nat. Mus., Proc., vol. 77, art. 6, p. 142, pl. 39, figs. 3 a, b Cook Mt. fm., middle Eocene, Tex.; Cushman, 1935, U. S. Geol. Sur., Prof. Paper 181, p. 29, pl. 10, figs. 13 a, b upper Eocene, S. C.; Howe, 1939, Louisiana Dept. Cons., Geol. Bull. 14, p. 56, pl. 7, fig. 14 Cook Mt., middle Eocene, La.

Test compressed, ovate, broadly rounded at the base, acute at the apertural end; edge angular; chambers elongate, more or less compressed, arranged in a clockwise sigmoid series, each



succeeding chamber embracing the earlier one, but often the last chamber not extending down to the initial end; sutures nearly flush with the surface, usually distinct; wall smooth, finely perforate; aperture radiate, terminal, round. Length, 0.73 mm.; breadth, 0.45 mm.; thickness, 0.23 mm. Rare.

*Plesiotype*.—No. 5025, locality 58, Jackson, Eocene.

Genus **SIGMOMORPHINA**<sup>2</sup> Cushman and Ozawa, 1928

**Sigmomorphina costifera** Cushman Plate 9, figs. 10a-b  
*Polymorphina jacksonensis* Cushman var. *costifera* Cushman, 1926, Contr. Cushman Lab. Foram. Res., vol. 2, p. 35 upper Eocene, Ala.  
*Sigmomorphina jacksonensis costifera* Bergquist, 1942, Mississippi State Geol. Sur., Bull. 49 (Fossils), p. 57, pl. 6, figs. 2, 3 upper Eocene, Miss.

Test fairly large for the genus, broad and compressed; periphery broadly rounded, base rounded; apertural end narrowed to a slightly produced aperture; chambers elongate, very slightly inflated, embracing, arranged in a clockwise, sigmoid series, each chamber removed farther from the base; sutures very slightly depressed, distinct, slightly curved; wall smooth, finely perforate and ornamented with many rounded longitudinal striations. Length, 0.68 mm.; breadth, 0.32 mm.; thickness, 0.16 mm. Rare.

This form is slightly thicker than the type. However, this variety has been reported from the Claiborne before so that it is probably identical.

*Plesiotype*.—No. 5026, locality 18, Lisbon fm., Claiborne Eocene.

**Sigmomorphina jacksonensis** (Cushman) Plate 9, figs. 13a-b  
*Polymorphina jacksonensis* Cushman, 1926, Contr. Cushman Lab. Foram. Res., vol. 2, p. 35, pl. 5, fig. 5 upper Eocene, Fla., N. C., S. C., Ala., and Miss.  
*Sigmomorphina jacksonensis* Cushman, 1946, Cushman Lab. Foram. Res., Special Publ. 16, p. 19, pl. 4, fig. 17 upper Eocene, Ala.

Test fairly broad, considerably compressed, base rounded; periphery smooth; edge rounded; chambers elongate, slightly inflated, embracing, arranged in sigmoid series, each succeeding chamber removed farther from the base; sutures very slightly depressed, distinct, slightly curved; wall smooth, finely perforate; aperture radiate, at the end of the much produced last chamber.

<sup>2</sup> I have some doubt as to the validity of this genus, for it is more like the genotype of *Polymorphina* d'Orbigny (1826, Ann. Sci. Nat., vol. 7, p. 265, No. 2, Modèle No. 29) than are the flattened biserial forms.

Length, 0.85 mm.; breadth, 0.45 mm.; thickness, 0.18 mm. Rare.

The figured specimen from the Lisbon formation is very similar to the type figure. It is, perhaps, somewhat broader at the base and has slightly more angulate edges.

*Plesiotype*.—No. 5027, locality 58, Jackson, Eocene.

Genus **GUTTULINA** d'Orbigny, 1839

**Guttulina byramensis** (Cushman)

Plate 9, figs. 14a-b

*Polymorphina byramensis* Cushman, 1922, U. S. Geol. Sur., Prof. Paper 129-E, p. 94, pl. 17, fig. 2 Byram marl, middle Oligocene, Miss.

*Guttulina byramensis* Cushman and Todd, 1946, Contr. Cushman Lab. Foram. Res., vol. 22, p. 86, pl. 15, fig. 3 Byram marl, middle Oligocene, Miss.

Test short and broad, triangular, composed of a few chambers, usually only four on the outside, all except a fifth chamber extending back to the center of the base of the test, forming a flat or concave base; chambers moderately inflated; sutures depressed, distinct; surface smooth, finely perforate; aperture finely radiate, only slightly produced. Length, 0.65 mm.; breadth, 0.54 mm.; thickness, 0.38 mm. Common.

*Plesiotype*.—No. 4918, locality 58, Jackson, Eocene.

**Guttulina communis** (d'Orbigny)

Plate 9, figs. 12a-b

*Polymorphina* [*Guttulina*] *communis* d'Orbigny, 1826, Ann. Sci. Nat., ser. 1, vol. 7, p. 266, pl. 12, figs. 1-4.

*Guttulina irregularis* Cushman (not d'Orbigny), 1935, U. S. Geol. Sur., Prof. Paper 181, p. 24, pl. 9, figs. 13-16 upper Eocene, Ala.; Oligocene, Mex.; Bergquist (not d'Orbigny), 1942, Mississippi State Geol. Sur., Bull. 49 (Fossils), p. 54, pl. 6, figs. 5, 6 upper Eocene, Miss.

Test oval, equilaterally triangular with rounded sides and angles excepting the acute apertural end; chambers elongate, each chamber, excepting the last two in full-grown specimens, coming down to the base; sutures depressed, distinct; surface smooth; aperture terminal, radiate. Length, 0.64 mm.; breadth, 0.65 mm.; thickness, 0.43 mm. Common.

*G. irregularis* (d'Orbigny) (1846, Foraminifères fossiles du bassin Tertiaire de Vienne, p. 226, pl. 13, figs. 9, 10 is more nearly round in side view, with flattened sides and a very different appearance in end view. *G. communis* (d'Orbigny) as seen in end view is flat on one side and convex on the other.

*Plesiotype*.—No. 4921, locality 58, Jackson, Eocene.

**Guttulina consobrina** (Fornasini)

Plate 10, figs. 7a-c

*Polymorphina sororia consobrina* Fornasini, 1900-1902, Mem. R. Accad. Sci. Ist. Bologna, ser. 5, vol. 18, p. 69, fig. 21 (text) Pliocene, Italy.

*Globulina consobrina* Cushman and Ozawa, 1930, U. S. Nat. Mus., Proc., vol. 77, art. 6, p. 85, pl. 21, figs. 6a-c Miocene, Hungary, Austria, France.

*Globulina ampulla* Bergquist (not Jones), Mississippi State Geol. Sur., Bull. 49 (Fossils), p. 55, pl. 6, fig. 10 upper Eocene, Miss.

Test short fusiform, pointed at both ends; chambers rounded, little inflated, arranged three to a whorl; sutures little depressed but distinct; surface smooth, aperture finely radiate, terminal. Length, 0.93 mm.; breadth, 0.52 mm.; thickness, 0.41 mm. Rare.

This species is assigned to *Guttulina* because of the somewhat swollen character of the early chambers.

*Plesiotype*.—No. 4919, locality 12, Lisbon fm., Claiborne, Eocene.

**Guttulina hantkeni** Cushman and Ozawa

Plate 10, figs. 1a-b

*Polymorphina acuta* Hantken, 1875 (not d'Orbigny), Magy. kir. földt. int. Évkönyve, vol. 4, p. 51, pl. 8, fig. 4 Eocene, Hungary.

*Guttulina hantkeni* Cushman and Ozawa, 1930, U. S. Nat. Mus., Proc., vol. 77, art. 6, p. 33, pl. 15, figs. 4-6 Eocene, Hungary.

Test somewhat botryoidal, high-spined, more or less rounded at the base, acute at the aperture, greatest breadth above the middle; chambers inflated, ovate, embracing but little, three chambers to a whorl, each succeeding chamber removed farther from the base; sutures much depressed, very distinct excepting for the earlier ones; wall smooth, aperture radiate, produced. Length, 0.65 mm.; breadth, 0.47 mm.; thickness, 0.39 mm.; Common.

*Plesiotype*.—No. 4920, locality 58, Jackson, Eocene.

**Guttulina stavensis**, new species

Plate 10, figs. 8a-c

Test fusiform, pointed at the base, acute at the apertural end, greatest breadth about the middle; chambers rather few, about twice as long as wide, each succeeding chamber of the adult form reaching back from about one-half to two-thirds of the way to the base of the preceding chamber; sutures distinct, only slightly depressed; wall smooth, finely perforate; aperture radiate, terminal, about 10 radial teeth present. Length, 0.53 mm.; diameter, 0.24 mm. Rare.

This species differs from *G. wacoensis* Cushman and Ponton

(1932, Contr. Cushman Lab. Foram. Res., vol. 8, pt. 3) in the less depressed sutures and the slightly broader chambers. The acute initial end separates it from many other related forms.

*Holotype*.—No. 4922, locality 15, Lisbon fm., Claiborne, Eocene.

**Guttulina**, sp.

Plate 10, figs. 2a-b

The figured specimen is a young form which has not yet acquired sufficient adult characters to be determined. Length, 0.33 mm.; breadth, 0.23 mm.; thickness, 0.19 mm. Rare.

*Plesiotype*.—No. 4923, locality 10, Tallahatta fm., Claiborne, Eocene.

Genus **RAPHANULINA**<sup>3</sup> Zborzewski, 1834

**Raphanulina gibba** (d'Orbigny)

Plate 10, figs. 4a-b

*Globulina gibba* d'Orbigny, 1826, Ann. Sci. Nat., vol. 7, p. 266, Modèle No. 63, 1826; Cushman, 1946, Cushman Lab. Foram. Res., Special Publ. 16, p. 18, pl. 4, fig. 16 upper Eocene, Ala.

Test globular, variable in details of shape, transverse section almost circular; chambers few, inflated, rounded, three in the last whorl; sutures nearly flush, usually distinct; wall smooth, finely perforate; some specimens with fistulose tubes at the apertural end; aperture terminal, radiate. Length, 0.64 mm.; breadth, 0.47 mm.; thickness, 0.43 mm. Common.

*Plesiotype*.—No. 4999, locality 58, Jackson, Eocene.

**Raphanulina inæqualis** (Reuss)

Plate 10, figs. 5a-b

*Globulina inæqualis* Reuss, 1850, K. Akad. Wiss. Wien Denkschr., vol. 1, p. 377, pl. 48, fig. 9 Miocene, Germany; Cushman and Ozawa, 1930, U. S. Nat. Mus., Proc., vol. 77, art. 6, p. 73, pl. 18, figs. 2-4; Bergquist, 1942, Mississippi State Geol. Surv., Bull. 49 (Fossils), p. 56 upper Eocene, Miss.

Test ovate, compressed, broadly rounded at the base, tapering toward the apex; chambers few, inflated, much overlapping, arranged in a nearly triserial series; sutures flush with the surface, distinct; wall smooth, finely perforate; aperture radiate, terminal. Length, 0.29 mm.; breadth, 0.20 mm.; thickness, 0.12 mm. Rare.

*Plesiotype*.—No. 5000, locality 32, Lisbon fm., Claiborne, Eocene.

**Raphanulina tuberculata** (d'Orbigny)

Plate 10, figs. 6a-b

*Globulina tuberculata* d'Orbigny, 1846, Foraminifères fossiles du bas-

<sup>3</sup> *Raphanulina* is incorrectly called *Globulina* by most authors, although Zborzewski's name is valid and was published five years before that of D'Orbigny's.

sin Tertiaire de Vienne, p. 230, pl. 13, figs. 21, 22 Miocene, Vienna.  
*Globulina gibba tuberculata* Bergquist, 1942, Mississippi State Geol.  
 Sur., Bull. 49 (Fossils), p. 56, pl. 6, figs. 13, 18 upper Eocene, Miss.

Test globular to subglobular, transverse section nearly circular; chambers few, inflated, rounded, arrangement nearly triserial; sutures flush; surface covered with small, narrow, high papillae; aperture terminal, radiate. Length, 0.58 mm.; breadth, 0.56 mm.; thickness, 0.50 mm. Rare.

*Plesiotype*.—No. 5001, locality 58, Jackson, Eocene.

Genus **DIMORPHINA** d'Orbigny, 1826

*Dimorphina danvillensis subtenais*, new variety Plate 10, figs. 11a-b  
*Dendolina lasitorta* Bergquist (not Cushman), 1942, Mississippi State  
 Geol. Sur., Bull. 49 (Fossils), p. 40, pl. 5, fig. 15 (not 16 a, b) upper Eocene, Miss.

Test very elongate, slender, circular in cross section, somewhat arcuate, initial end pointed with small spine, early portion triserial, later uniserial; chambers distinct, the early ones elongate, very slightly inflated, later chambers inflated, becoming more and more elongate as added; sutures distinct, strongly oblique throughout the uniserial portion, depressed; surface smooth; aperture terminal, radiate, about six radial teeth. Length, 0.60 mm.; diameter, 0.11 mm. Rare.

This form differs from the Cretaceous *Dimorphina basitorta* (Cushman) (1938, Contr. Cushman Lab. Foram. Res., vol. 14) in having strongly oblique sutures throughout and in the increase in length of the chambers as added. No specimens were found which were as stout as *D. danvillensis* Howe and Wallace (1932, Geol. Bull. 2, Louisiana Dept. Conservation).

*Holotype*.—No. 4869, locality 58, Jackson, Eocene.

Family **NONIONIDÆ** Reuss, 1860

Genus **NONION** Montfort, 1898

*Nonion advena* (Cushman) Plate 10, figs. 8a-b  
*Nonionina advena* Cushman, 1922, U. S. Geol. Sur., Prof. Paper 129-F,  
 p. 139, pl. 32, fig. 8 middle Oligocene, Miss.; Cushman and Applin,  
 1926, Bull. Amer. Assoc. Petr. Geol., vol. 10, p. 181, pl. 10, figs. 16,  
 17 upper Eocene, Tex.

*Nonion advena* Howe, 1928, Jour. Paleont., vol. 2, p. 175 (list), Red Bluff clay, lower Oligocene, Miss.

*Nonion advenum* Cushman and Herrick, 1945, Contr. Cushman Lab. Foram. Res., vol. 21, p. 61, pl. 10, fig. 9 McBeam fm., Eocene, Ga.

Test small, subcircular in side view, biconvex; edge rounded;

\*Montfort used *Nonion* as a masculine noun in his original discussion of this genus (Conchy. Syst., 1808, p. 211), hence masculine endings should be used in forming adjectival specific names.

periphery smooth; nine to eleven chambers in the last whorl; umbilical region on both sides occupied by a boss of clear shell material; surface smooth; sutures curved, slightly sigmoid, the inner portions excavated and broadened; aperture a series of about 10 small pores at the base of the septal face. Diameter, 0.35 mm.; thickness, 0.12 mm. Common.

This species looks much like an *Elphidium*, but several well-preserved specimens fail to show pores along the sutures.

*Plesiotype*.—No. 4962, locality 50, Yazoo clay, Jackson, Eocene.

***Nonion danvillensis*** Howe and Wallace Plate 10, figs. 10a-b

*Nonion danvillensis* Howe and Wallace, 1932, Louisiana Dept. Cons., Geol. Bull. No. 2, p. 51, pl. 9, fig. 3 upper Eocene, La.

*Nonion danvillense* Cushman and Todd, 1945, Contr. Cushman Lab. Foramin. Res., vol. 21, p. 92, pl. 15, fig. 4 Moodys marl, upper Eocene, Miss.

Test ovate, regularly involute to umbilicus and tending to become evolute; periphery lobulate; edge round; chambers about six or seven in the last whorl, rapidly enlarging in all dimensions, inflated; sutures distinct, radial, slightly curved and much depressed; wall smooth, finely perforate, umbilici deep with a thin papillate filling; aperture a wide slit at the base of the septal face with thin upper lip. Diameter, 0.31 mm.; maximum thickness of last chamber, 0.17 mm. Common.

Although the figured specimen displays the same number of chambers that the original of *N. micrus* Cole (1927, Bull. Amer. Paleont., vol. 14, No. 51) has, it is placed under this species on the basis of the less globular chambers and papillate umbilicus.

*Plesiotype*.—No. 4963, locality 58, Jackson, Eocene.

***Nonion inexcavatus*** (Cushman and Applin) Plate 10, figs. 9a-b

*Nonionina advena inexcavata* Cushman and Applin, 1926, Bull. Amer. Assoc. Petr. Geol., vol. 10, p. 182, pl. 10, figs. 18, 19 upper Eocene, Tex.

*Nonion inexcavatum* Ellisor, 1933, Bull. Amer. Assoc. Petr. Geol., vol. 17, No. 11, pl. 2, fig. 7; Cushman, 1935, U. S. Geol. Sur., Prof. Paper 181, p. 30, pl. 11, figs. 5-8; 1945, Contr. Cushman Lab. Foramin. Res., vol. 21, p. 5, pl. 1, fig. 16 Twiggs clay, Eocene, Ga.

Test of medium size, circular to oval in outline, biconvex; periphery faintly to moderately lobulate; edge sharply rounded;



chambers 12 to 15 in the last whorl, distinct, slightly inflated, especially on the sides; sutures slightly curved, slightly depressed; umbilical areas with small knob of clear shell material and additional pustulose ornamentation, especially toward the aperture; surface smooth; aperture a series of small pores at the base of the septal face, and a few pores on the septal face. Diameter, 0.51 mm.; thickness, 0.17 mm. Common.

The figured specimen tends to be evolute, is not so circular, and the periphery is less lobulate than in other specimens. There are indications of pores along the sutures in some specimens, but they are so faint that it is considered advisable to retain this species under *Nonion*.

*Plesiotypic*.—No. 4964, locality 47, Yazoo clay, Jackson, Eocene.

*Nonion mauricensis* Howe and Ellis Plate 10, figs. 12a-b

*Nonion mauricensis* Howe and Ellis, 1939, Louisiana Dept. Cons., Geol. Bull. 14, p. 57, pl. 8, figs. 1, 2 Cook Mt., Claiborne, Eocene, La.; Cushman and Todd, 1945, Contr. Cushman Lab. Foram. Res., vol. 21, p. 15, pl. 3, figs. 27, 28 Lisbon fm., middle Eocene, Ala.

Test small, subcircular in the side view, biconvex; periphery slightly lobulate; edge rounded; eight or nine chambers in the last coil; sutures moderately depressed, curved; umbilici strongly papillate; aperture in some specimens a low arch at the base of the septal face, partially filled with a secondary deposit, in others, as in the specimen figured, the arch is absent and there are a few pores at the base and lower down on the septal face. In a broken specimen the arched aperture was observed at the base of the septal face in septa prior to the last, much as in Howe and Ellis's figure. Diameter, 0.36 mm; thickness, 0.15 mm. Common.

*Plesiotypic*.—No. 4965, locality 26, Lisbon fm., middle Eocene.

*Nonion nicobarensis* Cushman Plate 10, figs. 13a-b

*Nonionina umbilicata* Brady (not Montagu), 1884, Rep. Voy. *Challenger*, Zoology, vol. 9, p. 726, pl. 109, figs. 8, 9 Recent, West Indies and all oceans; Cushman and Applin, 1926, Bull. Amer. Assoc. Petr. Geol., vol. 10, p. 182, pl. 10, figs. 14, 15 upper Eocene, Tex.

*Nonion nicobarensis* Cushman, 1936, Contr. Cushman Lab. Foram. Res., vol. 12, p. 67, pl. 12, figs. 9 a, b Pliocene, Kar Nikobar.

*Nonion nicobarensis* Galloway and Heminway, 1941, New York Acad. Sci., Sci. Survey of Porto Rico and the Virgin Islands, vol. 3, pt. 4, p. 357, pl. 10, figs. 1 a, b Oligocene and Miocene, Porto Rico.

Test small for the genus, subcircular in outline, periphery smooth not lobulate; back rounded; test biumbilicate; nine to eleven chambers in the final whorl, gradually increasing in size; sutures nearly radial, slightly curved, flush with the surface and limbate, the limbations fusing around the umbilicus to form a continuous limbate ring; surface smooth; wall coarsely perforate; apertural face slightly convex, nearly equidimensional; aperture a narrow elongate arch on the inner margin of the last septal face with a strong upper lip. Diameter, 0.33 mm.; thickness, 0.16 mm. Common.

*Plesiotype*.—No. 4966, locality 58, Jackson, Eocene.

*Nonion planatus* Cushman and Thomas

Plate 11, figs. 1a-b

*Nonion planatum* Cushman and Thomas, 1939, Jour. Paleont., vol. 4, p. 37, pl. 3, figs. 5 a, b middle Eocene, Tex.; Cushman and Dusenbury, 1934, Contr. Cushman Lab. Foram. Res., vol. 10, p. 60, pl. 8, figs. 6 a, b Eocene, Poway congl., Calif.; Cushman and Applin, 1943, Contr. Cushman Lab. Foram. Res., vol. 19, p. 37, pl. 7, fig. 24 Yegua fm., middle Eocene, Tex.

Test planispiral, biumbilicate; edge rounded; periphery smooth, very slightly lobulate in the later portion; chambers 9 to 10 in the final whorl, mostly distinct, increasing gradually in size; sutures flush, slightly depressed in the later portion, ending in a thickened ring with slight inward projections about the umbilici; surface smooth; wall finely but conspicuously perforate; aperture a low arch at the base of the septal face. Diameter, 0.29 mm.; greatest thickness, 0.12 mm. Common.

*Plesiotype*.—No. 4967, locality 7, Tallahatta fm., Claiborne, Eocene.

*Nonion rolshauseni*, new species

Plate 11, figs. 3a-b

Test lenticular, close-coiled planispirally, the umbilical area on each side with a large boss,  $1/4$  to  $1/3$  the diameter of the entire test; edge angled; periphery smooth, slightly lobulate on the last few chambers; chambers distinct, 11 or 12 in the last whorl, gradually increasing in size as added; sutures distinct prominently excavated halfway to the periphery, slightly curved, umbonal material sometimes extending a very short distance out along some of the sutures; surface smooth with papillæ around the umbos; wall finely perforate; aperture indistinct, in some specimens a row of pores at the base of the last septal face may be seen, as in the figure, and some rather small perforations can be seen scattered about on the last septal face. Diameter, 0.46 mm.; thickness, 0.24 mm.



This species differs from *N. chapapotensis* Cole (1928, Bull. Amer. Paleont., vol. 14, No. 53) in being lenticular with very large bosses, the papillate character of the apertural sides of the umbonal bosses, excavated sutures, and the apertural character. It is easily distinguished from *N. incarcavatus* (Cushman and Applin) (1926, Bull. Amer. Assoc. Petr. Geol., vol. 10) by its lenticular, slightly keeled form and the very large umbonal bosses as well as the other characters mentioned above. In some specimens a very faint trace of pores along a portion of some of the sutures can be detected, indicating the affiliation of *Nonion* with *Elphidium*. Abundant.

This species is named in honor of Mr. F. W. Rolshausen, Chief Paleontologist for the Humble Oil and Refining Company, Houston, Texas.

*Holotype*.—No. 4968, locality 36, Gosport fm., Claiborne, Eocene.

*Nonion stavensis*, new species

Plate 11, figs. 5a-b

Test fairly large, subcircular in side view with a lobulate periphery; involute just to the umbilicus but umbilicate on both sides; chambers enlarging very gradually, eight to ten in number, becoming rather inflated in the later part of the last whorl; surface smooth; wall very finely perforate; umbilical areas ornamented with papillae, papillae extending out along the later sutures and giving a false appearance of retral processes and sutural pores; sutures depressed, curved; aperture a series of small round pores at the base of the septal face. Diameter, 0.51 mm; thickness, 0.22 mm. Abundant.

This form differs from *N. mauricensis* Howe and Ellis in having a more lobulate periphery, chambers more inflated, more deeply umbilicate, aperture consisting of a series of pores at the base of the apertural face, and in being much larger. In the Little Stave Creek section, these forms do not occur together.

*Holotype*.—No. 4969, locality 33, Lisbon fm., Claiborne, Eocene.

*Nonion tallakattensis*, new species

Plate 11, figs. 11a-b

Test small, nautiloid, lenticular in edge view, subcircular in side view, very slightly lobulate in the last few chambers; umbilici about  $1/4$  the diameter of the test, flattened and papillate;

chambers distinct, about nine in the last whorl; sutures nearly straight, radial, depressed very little excepting in the last part of the final coil, some with inconspicuous puncta resembling sutural pores, but not of the strength of those in *Elphidium*; surface smooth excepting for the papillate umbilical areas; wall finely perforate: aperture a series of pores at the base of septal face. Diameter, 0.35 mm.; thickness, 0.13 mm. Common.

*N. tallahattensis* resembles *E. nautiloideum* Galloway and Hemingway (1941, New York Acad. Sci., Sci. Survey Porto Rico, vol. 3, pt. 4) but lacks the definite sutural pores of that form. The papillate umbilici, radial sutures, and relatively smooth periphery are the distinctive features. It differs from *N. mauricensis* in the nearly straight sutures.

*Holotype*.—No. 4882, locality 10, Tallahatta fm., Claiborne, Eocene.

Genus **HANTKENINA** Cushman, 1925

**Hantkenina alabamensis** Cushman Plate 11, figs. 9a-b  
*Hantkenina alabamensis* Cushman, 1924, U. S. Nat. Mus., Proc., vol. 66, art. 30, p. 3, pl. 1, figs. 1-6 upper Eocene, Ala.; 1946, Cushman Lab. Foram. Res., Special Publ. 16, p. 37, pl. 7, fig. 17 upper Eocene, Ala.

Test planispiral, compressed, adult whorl with five or six chambers, periphery slightly lobulate; wall finely but conspicuously perforate, papillate below the aperture, each chamber with a hollow, slender, acicular spine at the periphery pointing somewhat anteriorly; aperture tripartite, with an elongate slit along each side of the base of the apertural face, and the third, median, extending up into the septal face from the base of the apertural face; aperture with overhanging flaps. Diameter exclusive of spines, 0.50 mm.; thickness, 0.26 mm. Common.

*Plesiotype*.—No. 4925, locality 58, Jackson, Eocene.

Genus **CRIBROHANTKENINA** Thalmann, 1942

**Cribrohantkenina mccordi** (Howe and Wallace) Plate 11, figs. 10a-b  
*Hantkenina mccordi* Howe and Wallace, 1932, Louisiana Dep. Cons. Geol. Bull. No. 2, p. 55, pl. 10, fig. 1 upper Eocene, La.; 1934, Jour. Paleont., vol. 8, p. 36, pl. 5, fig. 15; Thalmann, 1942, Stanford Univ. Publ., Univ. Ser., Geol. Sci., vol. 3, No. 1, p. 6 (table).  
*Hantkenina danvillensis* Howe and Wallace, 1934, Jour. Paleont., vol. 8, p. 37, pl. 5, figs. 14, 17 upper Eocene, La.; Thalmann, 1942, Stanford Univ. Publ., Univ. Ser., Geol. Sci., vol. 3, No. 1, p. 6 (table).  
*Cribrohantkenina mccordi* Cushman, 1946, Cushman Lab. Foram. Res., Special Publ. 16, p. 38, p. 7, figs. 18-22 upper Eocene, La.

Test planispiral, bilaterally symmetrical, involute to umbilicus; periphery lobate; chambers inflated, five in the last whorl, increasing rapidly in size, each with a fairly long hollow spine located on the periphery near the contact with the next younger chamber; surface smooth; wall conspicuously perforate; sutures much depressed and nearly radial, slightly curved; aperture consisting of round, collared openings on the apertural face, with a crescentic opening at the base of the septal face. Diameter without spines, 0.52 mm.; width of last chamber, 0.38 mm. Common.

The few specimens found at locality 58 exhibit considerable variation as to the character of the aperture. The figured specimen has flaps over small lateral remnants of the basal aperture, and there is no plate on the apertural face, only tubular openings in the septal face itself. In one specimen the apertural face is covered with a papillate, secondary deposit.

*Plesiotypic*.—No. 4859, locality 58, Jackson, Eocene.

Genus **NONIONELLA** Cushman, 1926

**Nonionella jacksonensis spiralis**, new variety Plate 11, figs. 7a-b

Test very small, somewhat ovate in outline, longer than broad, ventral side completely involute, last chamber just covering the umbilical region, dorsal side showing the complete spire; edge sharply rounded; periphery smooth; chambers distinct, about eight in the final whorl, becoming increasingly elongate in the adult; sutures distinct, slightly, if at all, depressed; surface smooth; wall finely perforate; aperture a low arch extending from the periphery a short distance toward the ventral umbilicus along the base of the last septal face with an upper lip. Length, 0.19 mm.; breadth, 0.12 mm.; thickness, 0.08 mm. Rare.

This variety is distinct from the species (Cushman Contrib. Foram. Res., vol. 9, p. 10) in its extremely small size, the comparatively larger spire as compared with the adult chambers and the character of the ventral lobe of the last chamber which does not extend across the umbilical area.

*Holotypic*.—No. 4970, locality 9, Tallahatta fm., Claiborne, Eocene.

**Nonionella longicamerata**, new species Plate 11, figs. 8a-b

Test small, longer than broad, ventral side nearly involute, with central papillate umbilicus, dorsal side evolute; edge ab-

ruptly rounded; periphery smooth, not lobulate; chambers eight to ten in the last whorl, distinct, increasing rapidly in length as added, the last chamber elongate and overhanging the early part; sutures distinct, slightly depressed, especially toward the umbilicus, slightly curved toward the periphery; surface smooth; wall finely perforate, ventral umbilicus papillate, papillæ usually obscured by foreign material; aperture obscured by the much elongated and overhanging last chamber. Length, 0.28 mm.; breadth, 0.18 mm.; thickness, 0.11 mm. Rare.

The evolute overhanging terminal chamber and the papillate umbilicus serve to distinguish this small species from *N. turgida* (Williamson) (1858, Rec. Foram., Great Britain).

*Holotype*.—No. 4971, locality 7, Tallahatta fm., Claiborne, Eocene.

***Nonionella spissa* Cushman**

Plate 11, figs. 2a-c, 4a-c

*Nonionella hantkeni spissa* Cushman, 1931, Contr. Cushman Lab. Foram. Res., vol. 7, p. 58, pl. 7, fig. 13 upper Eocene, S. C.; Cushman, 1939, U. S. Geol. Sur., Prof. Paper 191, p. 30, pl. 8, fig. 5; Cushman and Herrick, 1945, Contr. Cushman Lab. Foram. Res., vol. 21, p. 63, pl. 10, fig. 12 McBean fm., Eocene, Ga.

Test rather thick, somewhat longer than broad, subovate in outline; periphery nearly smooth, entire; edge sharply rounded; slightly evolute on one side; sutures distinct, slightly curved, very little depressed excepting in the later portion of the test; surface smooth; wall finely perforate with papillate umbilicus on the involute side; aperture a very low arch at the base of the septal face, extending slightly farther toward the involute side. Maximum diameter, 0.53 mm.; thickness, 0.24 mm. Common.

*Plesio*type.—No. 4972, locality 46, Jackson, Eocene; plesio-type, No. 4973, locality 10, Tallahatta fm., Claiborne, Eocene.

***Nonionella winniana* Howe**

Plate 11, figs. 6a-c

*Nonionella winniana* Howe, 1939, Louisiana Dept. Cons., Geol. Bull. 14, p. 60, pl. 7, figs. 26, 27 Cook Mt., middle Eocene, La.

Test elongate ovate, thick, two sides nearly symmetrical but slightly evolute on one side; edge rounded; periphery smooth; chambers eight or nine in the last whorl, increasing gradually in size as added; surface smooth; wall finely perforate, umbilicus on ventral side covered with papillæ, dorsal spire with papillæ also; sutures radial, very little curved, flush; aperture reduced,

not apparent, covered with papillæ if present. Maximum diameter, 0.55 mm.; thickness, 0.22 mm. Rare.

*Plesiotypic*.—No. 4974, locality 31, Lisbon fm., Claiborne, Eocene.

Genus **PULLENIA** Parker and Jones, 1862

**Pullenia quinqueloba** *aplata*, new variety Plate 12 figs. 5a-b

*Pullenia quinqueloba angusta* Cushman (not Cushman and Todd), 1946, Cushman Lab. Foram. Res., Special Publ. 16, p. 37, pl. 7, fig. 11 upper Eocene, Ala.

Test considerably compressed, subcircular, periphery slightly lobulate; edge subangular; chambers  $5\frac{1}{2}$  in the adult, increasing very gradually in size as added; sutures very slightly depressed or flush with the surface, nearly radial, slightly curved; surface smooth; wall finely perforate; aperture obscure, pores on or at the base of the septal face, or a low opening extending to the umbilicus on either side and filled with secondary deposit; apertural face comparatively high, slightly convex. Diameter of holotype, 0.43 mm.; thickness, 0.18 mm. Common.

This variety differs from *P. quinqueloba angusta* Cushman and Todd in having a more angular edge and in being slightly more compressed, and in the obscure aperture. The figures in Contr. Cushman Lab. Foram. Res., vol. 19, pt. 1 of *P. angusta* readily show the distinction.

*Holotype*.—No. 4988, locality 58, Jackson, Eocene.

Family **ROTALIIDÆ** Reuss, 1860

Genus **GLOBOROTALIA** Cushman, 1927

**Globorotalia cocoensis** Cushman Plate 12, figs. 1a-c

*Globorotalia cocoensis* Cushman, 1928, Contr. Cushman Lab. Foram. Res., vol. 1, p. 75, pl. 10, fig. 3 upper Eocene, Ala.; Cushman, 1946, Cushman Lab. Foram. Res., Special Publ. 16, p. 38, pl. 7, figs. 14-16 upper Eocene, Ala., Ga., S. C., Fla., Miss., La., Tex., Panama, and from the Eocene of Borneo.

Test small, with low, rounded dorsal spire, and strongly convex ventral side; periphery somewhat lobulate; edge abruptly rounded to subacute; chambers distinct, usually four in the last whorl, last chamber much more inflated than the others; sutures distinct on the dorsal side, oblique and curved; ventral sutures nearly radial, straight, depressed; surface smooth; wall finely but conspicuously perforate, ventral portion of test near the aperture usually papillate or spinose; aperture a rather large

open arch extending from near the periphery to the umbilicus, with thickened lip. Diameter, 0.57 mm.; thickness, 0.37 mm. Common.

*Plesiotyfe*.—No. 4912, locality 58, Jackson, Eocene.

**Globorotalia crassata densa** (Cushman) Plate 12, figs. 4a-c

*Pulvinulina crassata densa* Cushman, 1925, Bull. Amer. Assoc. Petr. Geol., vol. 9, p. 301 Eocene, Mex.

*Globorotalia crassata densa* Cushman and Barksdale, 1930, Contrib. Dept. Geol. Stanford Univ., vol. 1, No. 2, p. 68, pl. 12, figs. 8 a, b middle Eocene, Calif.

Test small, planoconvex, dorsal side flattened, ventral side strongly convex and umbilicate; edge rather abruptly rounded; periphery lobulate; chambers four to five in the last whorl, inflated somewhat dorsally and strongly so on the ventral side; sutures distinct, slightly depressed dorsally and curved, strongly depressed on the ventral side and nearly radial; surface spinose or papillate; aperture an elongate arch on the inner edge of the ventral face with an outer lip, extending into the umbilicus. Diameter, 0.33 mm.; thickness, 0.22 mm. Common.

*Plesiotyfe*.—No. 4913, locality 7, Tallahatta fm., Claiborne, Eocene.

**Globorotalia mariannensis** (Cushman) Plate 12, figs. 8a-c

*Pulvinulina mariannensis* Cushman, 1923, U. S. Geol. Sur., Prof. Paper 133, p. 44, pl. 7, figs. 1-3 Marianna ls. middle Oligocene, Ala.

Test biconvex, dorsal side slightly convex, ventral side rather strongly so in many specimens; edge acute; periphery very slightly lobulate with thickened narrow keel; chambers six to eight in number, fairly rapidly increasing in size as added; dorsal sutures strongly limbate and raised, obliquely curved; ventral sutures nearly radial, depressed and terminating in a calloused area which surrounds the umbilicus; aperture an elongate opening narrowest at the periphery and widening toward the umbilicus, usually with a narrow lip which is mostly concealed by the projecting curvature of the last septal face. Diameter, 0.97 mm.; thickness, 0.44 mm. Abundant.

*Plesiotyfe*.—No. 4914, locality 65, Mint Spring marl, Vicksburg, Oligocene.

Genus **CANCERIS** Montfort, 1808**Canceris claibornensis** Howe

Plate 12, figs. 2a-c

*Canceris claibornensis* Howe, 1939, Louisiana Dept. Cons., Bull. 14, p. 78, pl. 10, figs. 20, 21 Eocene, La.; Cushman, 1942, Contr. Cushman Lab. Foram. Res., vol. 18, p. 86, pl. 22, figs. 5-7 Eocene, Miss.

Test transparent, small, compressed, biconvex, longer than wide, composed of two whorls, with chambers arranged in a low rotaloid spire; dorsal side moderately convex, ventral side less convex, with small deep umbilicus; periphery with sharp, narrow flange which is wider on the last chamber; edge acute; sutures limbate on both sides, curved and almost flush dorsally, depressed and radial ventrally; chambers nine in number, five in the last whorl, the last chamber comprises about  $2/5$  of the entire test; wall finely perforate, with an oval glassy area toward the umbilical portion of each chamber ventrally; aperture opening into the umbilicus, covered by a short lobe with narrow lip, the lobe an extension of the last septal face. Length, 0.41 mm.; width, 0.30 mm.; thickness, 0.16 mm. Common.

*Plesiotype*.—No. 4826, locality 18, Lisbon fm., Claiborne, Eocene.

**Canceris cocoensis** Cushman

Plate 12, figs. 7a-c

*Canceris bronquartii* Cushman (not d'Orbigny), 1935, U. S. Geol. Sur., Prof. Paper 181, p. 48, pl. 20, fig. 1 upper Eocene, N. C., S. C., and Miss.

*Canceris*, sp. Cushman and Todd, 1942, Contr. Cushman Lab. Foram. Res., vol. 18, p. 90, pl. 23, figs. 3, 4 upper Eocene, N. C., S. C., and Miss.

*Canceris cocoensis* Cushman, 1946, Cushman Lab. Foram. Res., Special Publ. 16, p. 35, pl. 7, fig. 5 upper Eocene, Ala.

Test oval in side view, biconvex, more so ventrally, ventral umbilicus; edge acute; periphery with a thin keel, particularly in the later part, somewhat lobulate in adult portion; chambers about six in the final whorl, moderately inflated ventrally, flattened dorsally, increasing evenly but rather rapidly as added; sutures distinct, nearly radial and depressed on the ventral side, slightly curved on the dorsal surface and narrowly limbate; wall smooth, finely perforate, with a clear area on the ventral border of the last-formed chamber; aperture opening into the umbilicus with a large flap concealing most of the umbilicus in well-preserved specimens. Diameter, 0.65 mm.; thickness, 0.23 mm. Common.

*Plesiotype*.—No. 4827, locality 58, Jackson, Eocene.



*Canceris*, sp.

Plate 12, figs. 6a-c

This form may be an abnormal specimen of *C. cocoaensis* Cushman inasmuch as only one specimen of this was found at locality 58 where an abundance of *cocoaensis* specimens occurs. Rare.

*Plesiotype*.—No. 4828, locality 58, Jackson, Eocene.

Genus **LAMARCKINA** Berthelin, 1881

*Lamarckina biconvexa*, new species

Plate 12, figs. 3a-c

Test subcircular, biconvex, with about two coils showing on the convex dorsal side, ventral side undulating, convex with central umbo and deep, oval vestibule between umbilicus and periphery; edge acute; periphery smooth in most specimens, gerontic forms, such as that one figured, becoming lobulate in the later portion of the test; sutures strongly limbate and raised dorsally, coalescing near the umbo to obscure the spire; ventral sutures very indistinct, usually nearly obscured by thickening excepting near the periphery; wall smooth, finely perforate excepting for the secondary tissue which is imperforate, polished over much of the ventral surface in the region of thickening; aperture modified by the ventral thickening into an oval vestibule, with toothlike extension of the last chamber, the aperture has migrated from the umbilical (now umbonal) region toward the periphery. Diameter, 0.45 mm.; thickness, 0.24 mm. Common.

This species differs from *L. claibornensis* Cushman (1926, Contr. Cushman Lab. Foram. Res., vol. 2, pt. 1, p. 10) in being strongly convex on the ventral surface with prominent umbonal thickening resulting in a strongly biconvex test.

*Holotype*.—No. 4937, locality 7, Tallahatta fm., Claiborne, Eocene.

Genus **VALVULINERIA** Cushman, 1926

*Valvulineria danvillensis gyroidinoides*, new variety Plate 13, figs. 3a-c

Test small, trochoid, ventral side strongly convex, dorsal side flattened, ventral umbilicus small, covered by the extension of the last chamber; edge rounded with a dorsal shoulder, periphery slightly lobulate or smooth and entire; chambers about eight or nine in the last whorl, slightly inflated; sutures distinct, ventrally radial and somewhat limbate, dorsally oblique, curved,



and limbate, the limbations becoming raised slightly in the early part of the spire; wall smooth, finely perforate, ornamented only with the sutural limbations; aperture a low opening on the ventral side extending from near the periphery into the umbilicus along the liplike extension of the last chamber. Diameter, 0.29 mm.; thickness of the last chamber, 0.17 mm. Common.

This variety differs from *V. danzillensis* (Howe and Wallace) (1932, Louisiana Dept. Cons., Bull. 2, p. 69, pl. 13, fig. 3) in the limbate sutures and the greater number of chambers per whorl.

*Holotype*.—No. 5063, locality 7, Tallahatta fm., Claiborne, Eocene.

*Valvulineria jacksonensis persimilis*, new variety Plate 13, figs. 4a-c

Test biconvex, somewhat compressed, dorsal side with a low spire, ventrally convex toward the periphery, but depressed in the umbilical region, which is finely papillate; edge rounded; periphery smooth in the early part, lobulate in the last portion; chambers distinct, eight or nine in the final whorl, of uniform shape, gradually increasing in size as added, the later ones becoming somewhat inflated, with flaplike extensions toward the umbilicus ventrally; sutures distinct, dorsally slightly curved, limbate, and raised somewhat in the early part, depressed in the later part of the last whorl; ventral sutures slightly curved, nearly radial, somewhat raised and limbate in the early part, becoming depressed in the later portion; wall smooth excepting for the papillate umbilicus and the raised limbate sutures, rather finely but conspicuously perforate; aperture, a low arch extending from the periphery into the umbilicus under the valvular flap of the last chamber, with a lip. Diameter of holotype, 0.45 mm.; thickness, 0.17 mm. Common.

This variety is distinguished from *V. jacksonensis* Cushman (1933, Contr. Cushman Lab. Foram. Res., vol. 9) in being comparatively thicker, with more inflated chambers toward the later part of the final whorl; the sutures tend to be more thickened and raised in the early part of the last coil, and the ventral sutures are curved, not nearly straight as in the species.

*Holotype*.—No. 5064, locality 33, Lisbon fm., Claiborne, Eocene.

**Valvulineria octocamerata** (Cushman and Hanna) Plate 13, figs. 1a-c

*Gyroidina soldanii octocamerata* Cushman and Hanna, 1927, Calif. Acad. Sci., Proc., ser. 4, vol. 16, p. 223, pl. 14, figs. 16-18 Eocene, Calif.; Cushman, 1935, U. S. Geol. Surv., Prof. Paper 181, p. 45, pl. 18, fig. 18 upper and middle Eocene, Ala., Mex., Calif.; Howe, 1939, Louisiana Dept. Cons., Geol. Bull. 14, p. 75, pl. 9, figs. 34-36 Cook Mt. fm., Claiborne, Eocene, La.; Cushman, 1946, Cushman Lab. Foram. Res., Special Publ. 16, p. 31, pl. 6, fig. 15 upper Eocene, Ala.

Test small, dorsal side flattened, central side very convex, composed of about three coils, the last one consisting of about eight chambers; edge broadly rounded with a dorsal shoulder; periphery smooth becoming somewhat lobulate in the later part; ventral side strongly umbilicate; chambers distinct, increasing gradually in size as added; sutures distinct, slightly depressed, ventrally nearly radial and slightly curved, dorsally somewhat oblique; wall finely perforate, smooth; aperture elongate, a very low arch extending from near the periphery along the base of the last septal face into the umbilicus under a thin, valvular flap, which is frequently somewhat broken. Diameter, 0.51 mm.; thickness of last chamber, 0.28 mm. Abundant.

The valvular flap, though partially broken in most specimens, with the aperture extending into the umbilicus beneath it are diagnostic of *Valvulineria*. If this well-known Gulf Coast form actually differs from the California type in these characteristics, then this form should be renamed.

*Plesiotype*.—No. 5065, locality 61, Red Bluff, lower Oligocene.

**Valvulineria texana** Cushman and Ellisor Plate 13, figs. 5a-c

*Valvulineria texana* Cushman and Ellisor, 1931, Contr. Cushman Lab. Foram. Res., vol. 7, p. 56, pl. 7, fig. 9 upper Eocene, Tex.; Cushman, 1946, Cushman Lab. Foram. Res., Special Publ. 16, p. 31, pl. 6, fig. 13 upper Eocene, Ala.

Test small, slightly longer than broad; edge broadly rounded; periphery smooth, only very slightly lobulate if at all; chambers about five in the final whorl, inflated ventrally with a distinct valvular lip extending out over the umbilicus; ventral sutures depressed, distinct, slightly curved, radial; dorsal sutures nearly flush with the surface, curved; wall smooth, finely but conspicuously perforate; aperture an elongate slit below the valvular lip. Diameter, 0.27 mm.; thickness, 0.12 mm. Rare.

*Plesiotypic*.—No. 5066, locality 61, Red Bluff, lower Oligocene.

Genus **CERATOBULIMINA** Toulou, 1915

Subgenus **CERATOCANCERIS** Finlay, 1939

*Ceratobulimina* (*Ceratocanceris*) *stellata*, new species Plate 13, figs. 6a-c

Test oval in side view, longer than broad, biconvex, both sides markedly convex, with central, deep umbilicus ventrally; periphery very slightly lobulate in the later portion, smooth in the early portion of the last whorl; edge broadly rounded; chambers about eight in the final whorl increasing gradually in size as added, with pronounced stellate, calloused areas on the inner portions ventrally; dorsal sutures oblique, limbate and raised, the later ones with a conspicuous angle near the inner end, becoming flush and not limbate as they cross the periphery; ventral sutures radial and becoming much depressed between the thickened inner ends of the chambers; spiral suture bordered on outside edge by raised limbation; wall smooth, polished and very finely perforate; aperture a high arch extending upward into the last septal face, and covered by a subtriangular plate in most specimens. Length, 0.64 mm.; breadth, 0.51 mm.; thickness, 0.36 mm. Common.

Forms similar to this species have long been referred to *C. erimia* (Rzehak) (1888, Ann. K. K. Nat. Hofmuseums, vol. 3 p. 263, pl. 11, figs. 7a-c); however, *C. erimia* is relatively unornamented. The stellate thickening so prominently displayed on the ventral surface and the raised, limbate dorsal sutures make this form distinctive. The apertural character places it in the subgenus *Ceratocanceris* Finlay (1939, New Zealand Foraminifera: Key Species in Stratigraphy, No. 2, Roy. Soc. New Zealand, Trans. Proc., Wellington, N. Z., vol. 69, pt. 1, pp. 115, 117). *C. erimia* Howe (1939, Louisiana Dept. Cons., Bull. No. 14, p. 80, pl. 11, figs. 12, 13) may belong to this species.

*Holotypic*.—No. 4832, locality 32, Lisbon fm., Claiborne, Eocene.

Genus **PSEUDOBULIMINA** Earland, 1934

*Pseudobulimina* *glaessneri* Howe and Roberts Plate 13, figs. 2a-c

*Pseudobulimina glaessneri* Howe and Roberts, 1939, in Howe, Louisiana Dept. Cons., Geol. Bull. 14, p. 81, pl. 11, figs. 9-11 Cook Mt., Claiborne, Eocene, La.; Cushman and Todd, 1945, Contr. Cushman Lab. Foram. Res., vol. 21, p. 20, pl. 4, figs. 19, 20 Lisbon fm., Claiborne, Eocene, Ala.

Test coiled in a low, helicoid spire of about one whorl in the early part, the later part evolute and arcuate with a small set of chambers on the inner or concave side which are variable in size and do not alternate with the larger outer chambers; 10 or 11 outer chambers in the last coil, increasing gradually in size as added, about eight smaller chambers; wall very finely perforate; surface polished; early sutures flush, bordered by low bands of thickening which are usually of lighter color, the later sutures slightly depressed; aperture of the larger chambers a narrow virguline slit oblique to the plane of coiling, extending from basal suture up into the septal face; aperture of the small chambers a narrow slit at the base of the main aperture and transverse to it. Length, 0.49 mm.; breadth of last chamber, 0.23 mm.; thickness of last chamber, 0.18 mm. Common.

*Plesiotype*.—No. 4986, locality 33, Lisbon fm., Claiborne, Eocene.

Genus **EPONIDES** Montfort, 1808

***Eponides ellisorae*** Garrett

Plate 13, figs. 7a-b

*Eponides ellisorae* Garrett, 1939, Jour. Paleont., vol. 13, p. 579, pl. 66, figs. 6-8 Oligocene, Tex.; Galloway and Hemingway, 1941, New York Acad. Sci., Sci. Survey Porto Rico and Virgin Islands, vol. 3, pt. 4, p. 372, pl. 17, fig. 4 Oligocene, Porto Rico; Cushman and Ellis, 1945, Jour. Paleont., vol. 19, p. 569 Anahuac fm., Oligocene, Tex.

Test nearly equally biconvex, varying in relative convexity of the dorsal and ventral sides, dorsal side with obscured spire due to thickening; edge acute; periphery somewhat lobulate; chambers about six in the final whorl; sutures narrow, dorsal sutures nearly tangential to the previous whorl, flush; ventral sutures nearly radial, little depressed; wall smooth, finely perforate; aperture an elongate low arch extending from near the periphery almost to the umbilicus. Diameter, 0.50 mm.; thickness, 0.30 mm. Common.

*E. ouachitensis* as figured by Cushman and Todd (1948, Contr. Cushman Lab. Foramin. Res., vol. 24, pl. 1, fig. 12) is very similar to this form. *E. ouachitensis* Howe and Wallace (1932, Louisiana Dept. Cons., Geol. Bull. 2) exhibits an elongate aperture extending completely into the umbilicus. The less tangential dorsal sutures of this species distinguish it from *E. jacksonensis* (Cushman and Applin).

*Plesiotype*.—No. 4883, locality 66, Marianna ls., Vicksburg, Oligocene.

*Eponides jacksonensis* (Cushman and Applin) Plate 14, figs. 1a-c

*Pulvinulina jacksonensis* Cushman and Applin, 1926, Bull. Amer. Assoc. Petr. Geol., vol. 10, p. 181, pl. 9, figs. 24, 25 upper Eocene, Tex.

*Eponides jacksonensis* Cushman, 1935, U. S. Geol. Sur., Prof. Paper 181, p. 46, pl. 19, figs. 4-8; Cushman, 1946, Cushman Lab. Foram. Res., Special Publ. 16, p. 34, pl. 7, figs. 1, 2 upper Eocene, Ga., S. C., Fla., Ala., Miss., Tex. and Panama.

Test biconvex, spire high, somewhat obscured by thickening, much more convex than the ventral side; edge acute, not keeled; periphery smooth, very little lobulate; chambers six to eight in the last whorl; dorsal sutures straight and completely tangential to the earlier whorl, ventral sutures radial, slightly curved and somewhat depressed; wall smooth, conspicuously but finely perforate; aperture forming a distinct angle in the border of the test and extending to near the umbilicus with a ventral lip. Diameter, 0.75 mm.; thickness, 0.41 mm. Common.

*Plesiotype*.—No. 4884, locality 58, Jackson, Eocene.

*Eponides lisbonensis*, new species Plate 14, figs. 2a-c

Test subcircular, unequally biconvex, dorsal side moderately convex, ventral side strongly convex with a small, rather deep umbilicus; edge abruptly rounded to subacute, periphery very slightly lobulate; whorls  $2\frac{1}{2}$  to 3 with about six chambers in the last coil; chambers enlarging very gradually in size as added; ventral sutures nearly radial and very slightly curved, limbate and flush with the surface; dorsal sutures flush with the surface, limbate, and very slightly curved, making an angle of  $60^{\circ}$ - $70^{\circ}$  with the radius, or  $20^{\circ}$ - $30^{\circ}$  with the earlier whorl; surface smooth, rather finely but conspicuously perforate; aperture a low elongate arch extending from near the umbilicus to near the periphery, at the base of the last septal face, with slight ventral lip. Diameter, 0.45 mm.; thickness, 0.25 mm. Common.

*E. lisbonensis* differs from *E. mexicanus* (Cushman) in the fewer chambers, lack of umbonal thickening on the ventral side, and in the much deeper ventral side. The sutures are thickened but flush with the surface in this rather common form which is apparently ancestral to *E. mexicanus*. It occurs only in the lower

part of the Lisbon fm. in the Little Stave Creek section.

*Holotype*.—No. 4885, locality 15, Lisbon fm., Claiborne, Eocene.

***Eponides lotus* (Schwager)**

Plate 14, figs. 3a-c

*Pulvinulina lotus* Schwager, 1883, *Palaeontographica*, vol. 30, Pal. Theil, p. 132, pl. 28 (5), figs. 9a-c middle Eocene, northern Africa.

*Eponides lotus* Cushman and Ponton, 1932, *Contr. Cushman Lab. Foram. Res.*, vol. 8, p. 71, pl. 9, figs. 8a-c lower Eocene, Wilcox, Ala.; Cushman and Todd, 1942, *Contr. Cushman Lab. Foram. Res.*, vol. 18, p. 40, pl. 7, figs. 13-14 lower Eocene, Naheola fm., Ala.

Test subcircular to oval, dorsal side strongly convex, ventral side moderately convex, umbilicate; edge sharply rounded; periphery slightly lobulate; whorls about three; chambers six in the last whorl, increasing gradually in size; ventral sutures slightly curved, moderately depressed; dorsal sutures flush, slightly curved, almost tangential to the previous whorl; surface smooth, spire of dorsal side somewhat obscure because of slight thickening; pores fine but conspicuous; aperture a low arch without upper lip, at the base of the last septal face, extending from near the periphery to near the umbilicus, there becoming much narrower and entering the umbilicus. Diameter, 0.77 mm.; thickness, 0.45 mm. Common.

In a previous paper (1944, *Jour. Paleont.*, vol. 18, p. 370) this species was placed under *Globorotalia* because its aperture extends into the umbilicus, a diagnostic feature of the above genus. The aperture proper is actually wider at the base of the apertural face and becomes very narrow as it enters the umbilicus, hence the determination of the species is returned to *Eponides*.

*Plesiotype*.—No. 4886, locality 58, Jackson, Eocene.

***Eponides mexicanus* (Cushman)**

Plate 14, figs. 5a-c

*Pulvinulina mexicana* Cushman, 1925, *Bull. Amer. Assoc. Petr. Geol.*, vol. 9, No. 2, p. 300, pl. 7, figs. 7, 8 Eocene, Mex.

*Eponides mexicana* Cushman, 1927, *Jour. Paleont.*, vol. 1, No. 2, p. 165, pl. 26, figs. 6, 7 Eocene, Mex.; Howe, 1939, *Louisiana Dept. Cons., Geol. Bull.* 14, p. 75, pl. 9, figs. 31-33, (?) pl. 10, figs. 1-3 Cook Mt., middle Eocene, La.

*Eponides mexicanus* Cushman, 1943, *Contr. Cushman Lab. Foram. Res.*, vol. 19, p. 41, pl. 8, fig. 2 Yegua fm., middle Eocene, Tex.

Test biconvex, dorsal side forming a low cone, ventral side less convex, with a moderate-sized umbilicus, surrounded by a raised rim of secondary shell material or callous; edge subacute;



periphery mostly smooth, very slightly lobulate, with a slight tendency toward a keel in some specimens; chambers closely appressed, 8 to 10 or perhaps more in the last whorl; sutures distinct, slightly limbate dorsally, ventrally slightly depressed toward the periphery, becoming limbate toward the umbilicus, and fusing with the calloused ring; wall smooth, finely but conspicuously perforate; aperture an elongate arch at the base of the last septal face, extending from near the periphery to near the umbilicus, with ventral lip. Diameter, 0.78 mm.; thickness, 0.43 mm. Abundant.

As first indicated by Dr. Howe (above reference), an intergradation of forms was noted between *E. mexicanus* (Cushman) and *E. guayabalensis* Cole (1927, Bull. Amer. Paleont., vol. 14, No. 51). One of the intermediate forms is figured here.

*Plesiotypic*.—No. 4887, locality 21, Lisbon fm., Claiborne, Eocene.

#### Genus ALABAMINA Toulmin, 1941

##### *Alabamina scitula*, new species

Plate 14, figs. 6a-c

Test subcircular in side view, biconvex, the ventral side much deeper; edge subacute; periphery smooth, very little lobulate; chambers five to six in the last whorl, increasing gradually in size as added; whorls few, about three, the last one not involute beyond the periphery dorsally, completely involute ventrally; spiral suture flush; dorsal sutures narrowly limbate, moderately oblique, slightly curved; ventral sutures radial, narrowly limbate and slightly curved; wall smooth, finely perforate; aperture a low arch at the base of the last septal face, extending from near the umbilical region outward toward the periphery and terminating at the base of the supplementary indentation which is characteristic of this genus. Diameter, 0.41 mm.; thickness, 0.20 mm. Common.

This species has a higher arched aperture than *A. wilcoxensis* Toulmin (1941, Jour. Paleont., 15), the spiral suture is smoothly spiral, and the dorsal sutures do not display the irregular thickening present in Toulmin's figures. *Pulvinulinella exigua obtusa* (Burrows and Holland) (1897, Proc. Geol. Assoc., vol. 14) is relatively thicker, has a more obtuse periphery, and differs in the apertural character.

*Holotype*.—No. 4779, locality 62, Red Bluff, lower Oligocene.

Genus **GYROIDINA** d'Orbigny, 1826

**Gyroidina obesa**, new species

Plate 14, figs. 4a-c

Test rotaliform, somewhat globose, composed of about three whorls, nearly circular in outline, nearly planoconvex, ventral side very strongly convex, dorsal side slightly convex; periphery smooth, very little lobulate if at all; edge broadly rounded; chambers five or six in the last whorl; sutures only slightly if at all depressed, only those of the last-formed coil distinct, narrowly limbate; wall smooth, finely perforate; aperture a low arched opening in the middle of the last septal face with a slight ventral lip. Diameter, 0.60 mm.; thickness, 0.49 mm. Rare at type locality, common at Red Bluff.

*Holotype*.—No. 4924, locality 60, Jackson, Eocene.

Genus **ROTALIA** Lamarck, 1804

**Rotalia similis**, new species

Plate 15, figs. 2a-c

Test biconvex, dorsal side raised in a high conical spire, ventral side moderately convex; edge angled, bluntly keeled; chambers few, about five in the last whorl, increasing very slowly in size as added; early dorsal spire obscured by thickening, dorsal sutures moderately curved, somewhat limbate and very slightly raised in the last whorl; ventral sutures radial, slightly curved and incised; wall finely perforate; umbilicus with low boss; aperture a very low arch extending from near the periphery nearly to the umbilicus along the base of the last septal face. Diameter, 0.40 mm.; thickness, 0.19 mm. Not common.

This species somewhat resembles *R. cushmani* Applin and Jordan (1945, Jour. Paleont., vol. 19) but differs in the greater convexity of the ventral side, fewer chambers, and smaller size.

*Holotype*.—No. 5018, locality 61, Red Bluff, lower Oligocene.

Genus **ROTORBINELLA** Bandy, 1944

**Rotorbinella packardi**, new species

Plate 15, figs. 1a-c

Test rather large, oval in side view, biconvex in edge view, strongly convex dorsally, moderately convex ventrally; edge angled, bluntly keeled; periphery slightly lobulate; chambers 8 to 10 in the last whorl increasing gradually in size, not inflated; whorls not involute on the dorsal side, the earlier ones some-



what obscured by the coalescing of strong heavy thickening along both the spiral and radial sutures; ventral side with a large umbilical plug projecting slightly above the surface; sutures on the dorsal side slightly curved, oblique, with heavily raised and irregular thickening which obscures much of the spire ordinarily; sutures on the ventral side flush or slightly thickened and raised, slightly oblique, gently curved; wall coarsely perforate; aperture a low, broad arch at the base of the septal face, about midway between periphery and boss. Diameter, 1.07 mm.; thickness, 0.57 mm. Common.

This species is named in honor of Dean E. L. Packard, Professor of Geology, Oregon State College, under whom I began the study of paleontology.

*Holotype*.—No. 5017, locality 63, Red Bluff member, lower Oligocene.

Genus **CIBICIDINA**, new genus

*Genotype*.—*Cibicidina walli*, new species

Test free, rotaloid, dorsal spire nearly or quite concealed by the involute last whorl, only the last whorl visible on the ventral side; ventral side convex to conical and sometimes umbilicate, dorsal side flat to concave; chambers numerous, closely appressed; edge sharp or bluntly angled; wall hyaline, medium to finely perforate, smooth or with limbate sutures or secondary thickening and papillae, sometimes with central bosses; aperture a small arched opening at the base of the last septal face in the plane of coiling, extending under the involute dorsal flap of the last chamber. Diameter up to about 1.00 mm. Common.

This planoconvex genus differs from *Cibicides* in the involute character of the dorsal side and in the finer perforations. *Anomalina* differs in lacking the dorsal aperture, having a rounded back, and being more evolute dorsally. *Discorbis* lacks the dorsal aperture and the involute character of the dorsal side.

*Cibicidina blanpiedi* (Toulmin)

Plate 15, figs. 4a-c

*Cibicides blanpiedi* Toulmin, 1941, Jour. Paleont., vol. 15, p. 609, pl. 82, figs. 11-13. W. Alex. Eocene, Ala.

Test subcircular, planoconvex, dorsal side flat, with flaps extending inward concealing much of the spire, ventral side very

convex, subconical, involute to umbilicus; edge acute; periphery smooth, not lobate; chambers distinct, closely appressed, eight or nine in the final whorl; dorsal sutures flush, distinct, limbate, curved, some with curved re-entrants; ventral sutures distinct, flush, curved and somewhat sigmoid in later portion of test; wall smooth, finely perforate; aperture a low arch at the base of the last septal face on the periphery extending onto the dorsal side under the flaplike dorsal projection of the last chamber. Diameter, 0.25 mm.; thickness, 0.15 mm. Common.

*Plesiotypc.*—No. 4851, locality 7, Tallahatta fm., Claiborne, Eocene.

*Cibicidina danvillensis* (Howe and Wallace) Plate 14, figs. 7a-c

*Cibicides danvillensis* Howe and Wallace, 1932, Louisiana Dept. Cons., Geol. Bull. No. 2, p. 77, pl. 14, fig. 5 upper Eocene, La.; Cushman and Herrick, 1945, Contr. Cushman Lab. Foram. Res., vol. 21, p. 72, pl. 11, fig. 14 McBean fm., Claiborne, Eocene, Ga.; Cushman, 1946, Cushman Lab. Foram. Res., Special Publ. 16, p. 39, pl. 8, figs. 7, 8 upper Eocene, Ala.

Test planoconvex, trochoid, subcircular in outline, ventral side convex with central clear boss of calcareous material, dorsal side flat to slightly concave; edge acute or subacute; periphery smooth, not lobulate; chambers seven to eight in the last whorl with extensions of the inner ends nearly to the center in young specimens, only becoming slightly evolute in adult and gerontic specimens; sutures limbate, nearly flush, curved on both dorsal and ventral sides; wall smooth, finely perforate; aperture a low arch at the base of the last septal face extending across the periphery and continuing along the base of the last chamber dorsally for a distance of one or two chambers. Diameter, 0.41 mm.; thickness, 0.15 mm. Common.

The figured specimen exhibits a broken edge along the inner ends of the later two chambers on the dorsal side thereby causing it to appear more evolute than it is. Other specimens, particularly slightly smaller ones, are more nearly like the original figure of this species, being involute to the umbilicus dorsally.

*Plesiotypc.*—No. 4852, locality 58, Jackson, Eocene.

**Cibicidina mauricensis** (Howe and Roberts) Plate 15, figs. 3a-c

*Cibicides mauricensis* Howe and Roberts, 1939, Louisiana Dept. Cons., Geol. Bull. 14, p. 87, pl. 13, figs. 4, 5 Cook Mt., Claiborne, Eocene, La.; Cushman and Todd, 1945, Cushman Lab. Forum. Re., vol. 21, p. 20 Lisbon fm., Claiborne, Eocene, Ala.

Test small, subcircular, planoconvex, ventral side moderately convex with a small central boss, dorsal side flat or slightly concave with small central boss (proloculus ?); edge acute; periphery smooth, with a slight rim of clear shell material on the dorsal side; chambers about 8 to 10, regularly increasing in size; sutures curved on both sides, dorsally broadly limbate and flush with the surface, ventrally very narrow, flush; wall smooth, finely perforate, with minor granulations or papillæ around the central boss; aperture peripheral and extending onto the dorsal side along the base of the last three or four chambers. Diameter, 0.27 mm.; thickness, 0.09 mm. Rare.

The figured specimen has a more flattened central area than is usual.

*Plesiotype*.—No. 4853, locality 30, Lisbon fm., Claiborne, Eocene.

**Cibicidina mauricensis subinvoluta**, new variety Plate 16, figs. 5a-c

Test subcircular, planoconvex, dorsal side flat to slightly concave, ventral side evenly convex, with small dorsal and ventral umbos, nearly involute to umbos on both sides; edge subacute; periphery smooth; chambers closely appressed, eight or nine, increasing evenly and rapidly in size; sutures distinct, slightly limbate and somewhat curved on both sides; wall smooth, rather finely perforate; aperture a low slit extending from the periphery below the inner edges of the last four or five chambers on the dorsal side, with a slight upper lip near the periphery. Diameter, 0.22 mm.; thickness, 0.06 mm. Common.

This variety differs from the species in lacking the papillæ around the dorsal umbo, in being nearly completely involute on this side, and the dorsal sutures are narrower.

*Holotype*.—No. 4874, locality 7, Tallabatta fm., Claiborne, Eocene.

**Cibicidina mississippiensis** (Cushman) Plate 15, figs. 7a-c

*Anomalina mississippiensis* Cushman, 1922, U. S. Geol. Sur., Prof. Paper

129-E, p. 98, pl. 21, figs. 6-8 Byram marl, middle Oligocene, Miss.; Cole and Ponton, 1930, Florida State Geol. Sur., Bull. 5, p. 46, pl. 9, figs. 2, 3 lower Oligocene, Fla.

*Cibicides mississippiensis* Ellisor, 1933, Bull. Amer. Assoc. Petr. Geol., vol. 17, No. 11, pl. 5, fig. 6 (not fig. 7) Jackson, Eocene, Tex.; Cushman, 1935, U. S. Geol. Sur., Prof. Paper 181, p. 54, pl. 22, fig. 3 (?); Cushman, 1946, Cushman Lab. Foram. Res., Special Publ. 16, p. 39, pl. 8, figs. 5, 6 Jackson, Eocene, Ga., N. and S. C., Fla., Ala., and Miss. and lower Oligocene of Fla., Ala., and Tex.

Test oval in side view, planoconvex, dorsal side flattened to slightly concave, involute to proloculus, ventral side very convex, involute to umbilicus with large umbilical depression; periphery smooth, very slightly lobulate; edge broadly rounded with sharply rounded shoulder; chambers six to eight in the last whorl, much inflated in the later part, increasing rapidly in size, especially the last few; sutures curved on the dorsal side, broad, limbate and flush with the surface, on the ventral side much narrower, slightly limbate in the early portion of the last whorl, depressed in the remainder; wall thin and translucent, with medium, conspicuous perforations, fewer on the dorsal side; aperture a narrow slit extending dorsally from the periphery along the base of the last chamber to the base of the last septal face. Diameter, 0.50 mm.; maximum thickness, 0.28 mm. Common.

*Plesiotype*.—No. 4854, locality 58, Jackson, Eocene.

*Cibicidina subminuens*, new species

Plate 16, figs. 6a-c

Test small, biconvex, dorsal side more flattened than the ventral; edge subangular, with a blunt keel; periphery mostly smooth; dorsal sutures curved, limbate, strongly raised; ventral sutures strongly limbate, curved, also raised; chambers about eight or nine, gradually increasing in size; wall conspicuously but not coarsely perforate; aperture a low slit extending from near the periphery under the inner edge of the last five or six chambers on the dorsal side, with a slight lip or flap. Diameter, 0.33 mm.; thickness, 0.15 mm. Common.

This species differs from *C. mirandensis* (Nuttall) (1935, Jour. Paleont., vol. 9) in its smaller size, more strongly limbate and raised sutures, and fewer chambers. *C. washburni* (Garrett) (1941, Jour. Paleont., vol. 15) has radial sutures, a less pronounced keel, and a lobulate periphery.

*Holotype*.—No. 4875, locality 37, Gosport fm., Claiborne, Eocene.

*Cibicidina walli*, new species

Plate 15, figs. 5a-c

Test concavoconvex, dorsal side concave with small central depression, ventral side convex with slight umbilicus, subcircular in side view; edge acute; periphery smooth or very slightly lobate in the last portion of the final whorl, with narrow keel; chambers about seven or eight, rapidly increasing in size as added, closely appressed; dorsal sutures curved, only very narrowly limbate if at all, ventral sutures rather strongly curved back toward the periphery; wall smooth, perforations fine to medium; aperture a very small low arch at the base of the last septal face on the periphery and extending onto the dorsal side along the base of the last whorl nearly to the center of the spire. Diameter, 0.58 mm.; thickness, 0.25 mm. Common.

This species is named for John H. Wall, Micropaleontologist of Imperial Oil Limited.

*Holotype*.—No. 4855, locality 58, Jackson, Eocene.

*Cibicidina yazooensis* (Cushman)

Plate 15, figs. 6a-c

*Cibicides yazooensis* Cushman, 1931, Contr. Cushman Lab. Foram. Res., vol. 7, p. 59, pl. 7, figs. 12 a-c Yazoo fm., Jackson, Eocene, Miss.; Cushman, 1935, U. S. Geol. Sur., Prof. Paper 181, p. 53, figs. 2 a-c upper Eocene, Miss., Ala.; Cushman and Todd, 1945, Contr. Cushman Lab. Foram. Res., vol. 21, p. 104, pl. 16, figs. 16, 17 Moodys marl member, Jackson, Eocene, Miss.

Test oval in outline, compressed, periphery very slightly lobulate; edge angled, tending to be keeled; ventral side convex, dorsal side slightly convex, nearly involute on both sides; chambers distinct, about eight in the last whorl; sutures distinct, strongly limbate on the dorsal side, somewhat raised in the early part on the ventral side; wall with medium perforations; aperture a narrow slit under the inner edge of the last three chambers, extending inward from the periphery on the dorsal side. Diameter, 0.55 mm.; thickness, 0.20 mm. Common.

*Plesiotype*.—No. 4856, locality 43, Moodys marl, Jackson, Eocene.

Genus **DISCORBIS** Lamareck, 1804

*Discorbis alveatus stavensis*, new variety

Plate 16, figs. 1a-c

Test small, planoconvex, dorsal side conical, ventral side nearly flat, umbilical area filled with an uneven secondary de-

posit; edge acute, slightly keeled; periphery smooth becoming slightly lobulate in the adult portion; chambers distinct, about four in the final whorl, the last chamber much larger than the others; dorsal sutures distinct, flush with the surface, slightly limbate, curved and oblique; ventral sutures nearly radial, slightly curved and somewhat depressed; wall smooth, except for the rough umbilical area; perforations small, conspicuous on the dorsal side; aperture a large arch near the inner end of the base of the septal face, on the ventral side of the test, with a slight lip which may be obscured by the secondary deposit. Diameter, 0.26 mm.; thickness, 0.12 mm. Rare.

This variety is more conical than *D. alveatus* Cushman (1933, Contr. Cushman Lab. Foram. Res., vol. 9, p. 16) and has only four chambers typically.

*Holotype*.—No. 4870, locality 39, Gosport fm., Claiborne, Eocene.

*Discorbis cocoaensis* Cushman and Garrett Plate 16, figs. 3a-c

*Discorbis subaravaucana* Cushman, 1935 (not 1922), U. S. Geol. Sur., Prof. Paper 181, p. 43, pl. 18, figs. 1 a-c upper Eocene, Ala.

*Discorbis cocoaensis* Cushman and Garrett, 1938, Contr. Cushman Lab. Foram. Res., vol. 14, p. 63, pl. 11, fig. 1 upper Eocene, Ala.

Test unequally biconvex, dorsal side usually more convex, ventral side convex toward the periphery but flattened to concave centrally with large shallow umbilicus; periphery smooth in early portion becoming very slightly lobulate in the later portion; edge rather abruptly rounded; chambers six to eight in the adult whorl, increasing rather rapidly in size as added, later ones slightly inflated; sutures much the same on the two sides, curved, distinct, earlier ones strongly limbate and sometimes raised, the later sutures depressed slightly; wall conspicuously perforate, excepting for the hyaline limbation; aperture low, extending from the periphery into the umbilicus, with a slight ventral lip. Diameter, 0.58 mm.; thickness, 0.21 mm. Very abundant.

*Plesiotype*.—No. 4871, locality 58, Jackson, Eocene.

*Discorbis hemisphaericus* Cushman Plate 16, figs. 2a-c

*Discorbis hemisphaericus* Cushman, 1931, Contr. Cushman Lab. Foram. Res., vol. 7, p. 59, pl. 7, fig. 14 upper Eocene, Miss.; Ellisor, 1933, Bull. Amer. Assoc. Petr. Geol., vol. 17, No. 11, pl. 3, figs. 17, 18 Caddell, upper Eocene, Tex.; Howe, 1939, Louisiana Dept. Cons., Geol.



Bull. 14, p. 73, pl. 10, figs. 16-19 Cook Mt., Claiborne, Eocene, La.; Cushman and Todd, 1945, Contr. Cushman Lab. Foram. Res., vol. 21, p. 100, pl. 15, figs. 30, 31 Moody marl member, Jackson, Eocene, Miss.

Test small, hemispherical, dorsal side strongly convex, ventral side slightly convex with three or four large, inflated supplementary chambers in the umbilical area; edge rounded and with slight carina which is somewhat ragged in some specimens; periphery somewhat lobulate; chambers four in the last whorl; sutures distinct, oblique and slightly depressed dorsally; ventral sutures nearly radial, slightly depressed; wall coarsely and conspicuously perforate on both sides; aperture a large high opening on the ventral side of the test, extending from near the periphery to the umbilicus, with a prominent lip. Diameter, 0.30 mm.; thickness, 0.20 mm. Common.

This species greatly resembles *Tretomphalus*. The supplementary chambers resemble megaspheric agamonts and the ragged carina may be the line of attachment of the float.

*Plesiotype*.—No. 4872, locality 46, Yazoo clay, Jackson, Eocene.

***Discorbis mauricensis* Howe and Roberts**

Plate 16, figs. 4a-c

*Discorbis mauricensis* Howe and Roberts, 1939, Louisiana Dept. Cons., Geol. Bull. 14, p. 74, pl. 9, figs. 28-30 Cook Mt., middle Eocene, La.

Test small, gently arched dorsally, slightly concave ventrally with central umbilicus; periphery faintly lobate with a slight tendency to a keel; edge abruptly rounded; chambers about six in the last whorl, lobate near their inner ends ventrally; sutures curved dorsally, not limbate; ventral sutures nearly radial, slightly curved with irregular inner ends; wall smooth, rather finely perforate; aperture a very low arched slit at the base of the last septal face on the ventral side, extending from the periphery into the umbilicus with narrow lip. Diameter, 0.35 mm.; thickness, 0.10 mm. Common.

*Plesiotype*.—No. 4873, locality 10, Tallahatta fm., Claiborne, Eocene.

***Discorbis tallahattensis*, new species**

Plate 16, figs. 7a-c

Test small, oval in outline, about equally biconvex, the dorsal side usually slightly more convex, ventral side convex but with a concave slope from the central raised area to the periphery, ventral umbilicus rather deep; peripheral margin narrowly car-

inate, slightly lobulate; edge sharp; chambers about eight in the final coil, increasing rather rapidly in size, the last chamber forming a considerable portion of the test ventrally, inner portions of the chambers on the ventral side with flaps projecting toward or into the umbilicus, a slight tendency for re-entrants to develop; walls moderately perforate, smooth; sutures curved, somewhat limbate, and flush with the surface excepting for the last one or two on the ventral surface which are somewhat depressed; dorsal sutures curved, limbate, in the early part more strongly limbate and raised, slightly depressed in the later part; aperture at the base of the last septal face on the ventral side, extending from near the periphery inward to the umbilicus beneath the valvular flap. Diameter, 0.33 mm.; thickness of last chamber, 0.10 mm. Common.

This species is much smaller and more compressed than *D. yeguaensis* Weinzierl and Applin and has a tendency to develop sutural re-entrants on the ventral side.

*Holotype*.—No. 4876, locality 10, Tallahatta fm., Claiborne, Eocene.

*Discorbis tallahattensis subnitens*, new variety Plate 17, figs. 1a-c

Test small, oval in outline, biconvex, dorsal side slightly more convex, ventral side umbilicate; peripheral margin smooth, only slightly lobulate, abruptly rounded and not keeled in the early portion, slight keel present in the last chamber; chambers about eight in the final coil increasing rather rapidly in size, the last chamber forming a prominent part of the test ventrally, inner portions of the chambers on the ventral side with flaps projecting into the umbilicus and with a slight tendency for the development of re-entrants; walls rather finely perforate, smooth, ventral sutures curved, somewhat limbate, and flush with the surface, becoming somewhat depressed in the later portion of the test; dorsal sutures curved, oblique, thickened and raised in the early portion, becoming depressed slightly in the later part; aperture at the base of the last septal face on the ventral side extending from near the periphery into the umbilicus and with a slight upper lip. Diameter, 0.36 mm.; thickness, 0.13 mm. Common.

This variety is distinguished by the rounded edge in the early part, becoming only slightly carinate in the last chamber or



two, and in lacking the concavity of the ventral slope.

*Holotype*.—No. 4877, locality 7, Tallahatta fm., Claiborne, Eocene.

*Discorbis yeguaensis* Weinzierl and Applin Plate 17, figs. 2a-c

*Discorbis yeguaensis* Weinzierl and Applin, 1929, Jour. Paleont., vol. 3, No. 4, p. 405, pl. 44, figs. 5 a-c Yegua fm., Claiborne, Eocene, Tex.

Test oval in outline, unequally biconvex, dorsal side convex, ventral side somewhat flattened; peripheral margin carinate, slightly lobulate; chambers seven or eight in the last whorl, increasing rather rapidly in size as added, the last chamber forming about one-third of the ventral surface; ventral side umbilicate with the valvular lip of the last chamber usually partially covering it; walls conspicuously perforate, smooth; sutures curved, strongly limbate in the early part dorsally, depressed in the later portion, slightly depressed on both sides; aperture an irregular, elongate opening at the base of the umbilical margin of the last chamber, usually modified by the valvular flap. Diameter, 0.50 mm.; thickness, 0.20 mm. Common.

The specimens from Little Stave Creek agree rather closely with the type. The figured specimen is somewhat gerontic and is more circular in outline than ephebic individuals.

*Plesiotype*.—No. 4878, locality 14, Lisbon fm., Claiborne, Eocene.

Genus **DISCORBITURA**, new genus

Genotype.—*Discorbitura dignata*, new species

Test free, rotaloid, only the last whorl visible ventrally; spire visible dorsally, this side usually more convex than the ventral side; chambers numerous, moderately or closely appressed; dorsal sutures flush and somewhat limbate or raised and thickened, ventral sutures may be flush, depressed, or incised, usually channeled with re-entrants; wall smooth, finely perforate; aperture a circular opening on the periphery with a raised rim encircling it. Diameter, 0.25-0.45 mm. Geologic range, Eocene (?). Oligocene.

*Discorbis farishi* Cushman and Ellisor (1932, Contr. Cushman Lab. Foramin. Res., vol. 8, pt. 2, p. 43, pl. 6, figs. 6a-c) may belong to this genus. The type figure of their species may have the same kind of aperture characteristic of this genus, and the type should be re-examined. If *D. farishi* is found to fall

within this category, then it probably is the Eocene ancestor of the Oligocene genotype *D. dignata*, n. sp.

*Discorbitura dignata*, new species

Plate 17, figs. 3a-c

Test concavoconvex, dorsal side moderately convex, ventral side slightly concave, dorsal side with all the chambers visible, involute ventrally; edge acute, periphery with distinct keel, slightly lobulate; chambers distinct, about seven in the last whorl, increasing gradually in size as added; sutures on the dorsal side strongly limbate and raised, curved and oblique; ventral sutures somewhat incised with a complex system of re-entrants, resulting in a stellate pattern; wall on the dorsal side smooth, finely perforate, ventral surface mostly smooth, excepting for the stellate re-entrants, slightly umbilicate; aperture a small circular opening at the base of the last chamber on the periphery and completely encircled by a raised lip. Diameter, 0.40 mm.; thickness, 0.08 mm. Common.

This species differs from *D. farishi* Cushman and Ellis (1932, Contr. Cushman Lab. For. Res., vol. 8, pt. 2, p. 43, pl. 6, figs. 6 a-c) in the strongly raised and thickened sutures on the dorsal side, the planoconvex shape of the test, and the lack of the elongate raised areas on the dorsal side. The re-entrants in this species become very complex in some individuals, breaking the ventral surface into irregular segments appearing almost similar to papillæ when stained.

*Holotype*.—No. 4879, locality 62, Red Bluff, lower Oligocene.

Genus ANOMALINA d'Orbigny, 1826

*Anomalina bilateralis* Cushman

Plate 17, figs. 7a-c

*Anomalina bilateralis* Cushman, 1922, U. S. Geol. Sur., Prof. Paper 129-E, p. 97, pl. 21, figs. 1, 2 middle Oligocene, Miss.; Cushman, 1935, U. S. Geol. Sur., Prof. Paper 181, p. 50, pl. 21, figs. 4, 5 upper Eocene, Ala., Miss., Ga.; Cushman and Todd, 1945, Contr. Cushman Lab. For. Res., vol. 21, p. 103, pl. 16, figs. 14, 15 Moodys marl, Jackson, Eocene, Miss.

Test of about four coils, biconvex, dorsal side only slightly convex with a rather prominent umbonal boss, ventral side moderately convex with a small inconspicuous umbonal boss; periphery smooth in the early portion of the test, slightly lobulate in the later part; edge abruptly rounded, somewhat angled; chambers about 10 to 12 in the last whorl; sutures gently curved,

limbate and tending to be slightly raised on both sides; wall coarsely perforate; aperture a narrow arched opening at the base of the last septal face on the edge and extending dorsally along the bases of the last two or three chambers. Diameter, 0.67 mm.; thickness, 0.24 mm. Common.

In some of the horizons inspected in this study, this species becomes considerably larger and somewhat gerontic.

*Plesiotype*.—No. 4788, locality 50, Jackson, Eocene.

**Anomalina cocoensis** Cushman

Plate 17, figs. 5a-c

*Anomalina cocoensis* Cushman, 1928, Contr. Cushman Lab. Foram. Res., vol. 4, p. 75, pl. 10, figs. 4a-c upper Eocene, Ala.; Cushman, 1935, U. S. Geol. Surv., Prof. Paper 181, p. 51, pl. 21, figs. 13a-c upper Eocene, Ala., Miss.

Test concavoconvex, ventral side strongly convex, dorsal side gently concave; ventral side with a cluster of irregular bosses in the umbilical region; dorsal side with a low, smooth, raised spire, moderate concavity between spire and periphery; edge rounded; periphery smooth; chambers 10 to 12 in the last whorl, enlarging very gradually in size; sutures on dorsal side flush, limbate, slightly oblique and curved; sutures on the ventral side raised, limbate, terminating toward the umbilical region in slightly larger knobs; wall conspicuously and coarsely perforate ventrally, relatively few pores on the dorsal surface; aperture peripheral, a moderate arch with a distinct lip. Diameter, 0.56 mm.; thickness, 0.23 mm. Abundant.

*Plesiotype*.—No. 4789, locality 58, Jackson, Eocene

**Anomalina costiana** Weinzierl and Applin

Plate 17, figs. 6a-c

*Anomalina costiana* Weinzierl and Applin, 1929, Jour. Paleont., vol. 3, p. 409, pl. 44, fig. 7 Yegua fm., Claiborne, Eocene, Tex.; Howe, 1939, Louisiana Dept. Cons., Geol. Bull. 14, p. 86, pl. 13, figs. 9-11 Cook Mt. fm., Claiborne, Eocene, La.; Beck, 1943, Jour. Paleont., vol. 17, p. 609, pl. 109, fig. 12, 19, 23 Eocene, Wash.

Test small, subcircular in side view, biconvex, dorsal side slightly convex with small irregular bosses in the umbilical area, ventral side moderately convex with a distinct boss over the umbilical region; chambers 10 to 12 in the last whorl, increasing gradually in size; edge subangular or abruptly rounded in the early part of the test; evenly rounded in the later part of the test; periphery nearly smooth in the early part of the test, be-

coming slightly lobulate in the later portion; sutures on the dorsal side gently curved, strongly limbate and raised; ventral sutures also gently curved, strongly limbate but only slightly raised, merging into the low central umbo of clear shell material; wall coarsely perforate, some of the pores infringing on the sutural limbations; aperture a low arch at the base of the last septal face, extending onto the dorsal surface along the base of the last chamber. Diameter, 0.35 mm.; thickness, 0.14 mm. Common.

This form displays a certain amount of variation in the angularity of the edge and the amount of limbation, older individuals being rounder backed and with somewhat stronger limbation.

*Plesiotype*.—No. 4790, locality 7, Tallahatta fm., Claiborne, Eocene.

**Anomalina umbonata** Cushman

Plate 18, figs. 3a-c

*Anomalina umbonata* Cushman, 1925, Bull. Amer. Assoc. Petr. Geol., vol. 9, p. 300, pl. 7, figs. 5, 6 Eocene, Moctezuma River, Mex.; Cushman, 1927, Jour. Paleont., vol. 1, p. 170, pl. 27, figs. 10, 11 Eocene, Mex.; Howe, 1939, Louisiana Dept. Cons., Geol. Bull., No. 14, p. 86, pl. 13, figs. 6-8 Cook Mt., Eocene, La.

Test planoconvex, dorsal side nearly flat or slightly concave with a central spiral umbonate mass, ventral side moderately convex with a rather large raised umbo of clear shell material; periphery smooth becoming slightly lobulate in the last portion of the final coil; edge rounded; chambers 10 to 12 in the final whorl, closely appressed; sutures distinct, those of the ventral side flush or very slightly depressed and gently curved, those of the dorsal side raised and limbate in the early portion of the test becoming flush between the last few chambers, the inner ends of the dorsal sutures become fused in the early portion giving rise to the spiral umbonate mass in the umbilical region; wall medium to coarsely perforate; aperture a narrow arch at the base of the last chamber on the periphery and extending about one chamber back between the whorls dorsally. Diameter, 0.47 mm.; thickness, 0.13 mm. Common.

*Plesiotype*.—No. 4793, locality 14, Lisbon fm., Claiborne, Eocene.

Genus **CIBICIDES** Montfort, 1808**Cibicides cocoaensis** (Cushman)

Plate 18, figs. 4a-c

*Eponiæes cocoaensis* Cushman, 1928, Contr. Cushman Lab. Foram. Res., vol. 4, p. 73, pl. 10, fig. 2 upper Eocene, Ala.; Cushman, 1935, U. S. Geol. Sur., Prof. Paper 181, p. 47, pl. 19, figs. 1, 2 (?); Cushman, 1946, Cushman Lab. Foram. Res., Special Publ. 16, p. 34, pl. 6, fig. 16 Jackson, Eocene, Ga., S. C., Ala. Miss., Calif.

Test conical, ventral side only slightly convex, with central, low, small umbo, dorsal side more strongly so with broadly rounded spire, circular in side view; periphery smooth, not lobulate and with very narrow keel; edge acute; chambers numerous, not inflated, about 12 in the last whorl, all but the last few indistinct from the dorsal side; sutures on ventral side nearly radial, gently curved and very slightly depressed; dorsal side with the spiral suture distinct and somewhat limbate, sutures between chambers oblique, not depressed, limbate; wall coarsely perforate, smooth except for the ventral boss; aperture a very small, low slit at the base of the last septal face next to the periphery and extending very slightly over the periphery to the dorsal side, more so in some individuals than others. Diameter, 0.43 mm.; thickness, 0.20 mm. Common.

*Plesiotype*.—No. 4833, locality 58, Jackson, Eocene.

**Cibicides cookei** Cushman and Garrett

Plate 18, figs. 5a-c

*Cibicides cookei* Cushman and Garrett, 1938, Contr. Cushman Lab. Foram. Res., vol. 14, p. 65, pl. 11, fig. 3 Red Bluff, lower Oligocene, Ala.

Test unequally biconvex, dorsal side less convex, slightly umbilicate on the ventral side; edge abruptly rounded; periphery smooth, very slightly lobate in the last part of the test; chambers distinct, little inflated, seven to nine in number, increasing slowly and gradually in size; sutures dorsally strongly limbate, not depressed, strongly curved; ventral sutures somewhat curved, very narrowly limbate, the later ones slightly depressed; wall coarsely perforate, otherwise smooth; aperture peripheral extending a short distance both dorsally and ventrally with distinct upper lip. Diameter, 0.80 mm.; thickness, 0.40 mm. Common.

This is a large distinct form which appears to have a slight shallow umbilicus not shown in the original figure.

*Plesiotype*.—No. 4834, locality 63, Red Bluff, lower Oligocene.

**Cibicides crassidiscus**, new species

Plate 18, figs. 7a-c

*Cibicides* cf. *pseudowallerstorfi* Howe (not Cole), 1939, Louisiana Dept. Cons., Geol. Bull. 14, p. 88, pl. 13, figs. 1-3 Cook Mt., middle Eocene, La.

(?) *Anomalina*, sp. Cushman and Todd, 1942, Contr. Cushman Lab. Foram. Res., vol. 18, p. 45, pl. 8, fig. 12 (not 11) Naheola fm., lower Eocene, Ala.

Test planoconvex, moderately convex ventrally, flat to slightly convex dorsally, nearly circular in outline; edge abruptly rounded; periphery smooth, not lobulate, with a blunt, thick keel; chambers about nine in the final whorl, increasing gradually in size as added; sutures moderately curved, strongly limbate, slightly raised, on the ventral side coalescing in the middle to form a hollowed out umbonal area, much thickened dorsally, combining with the limbate spiral suture, covering the center of the spire; wall very coarsely and sparsely punctate, with considerable thickening over the entire surface; aperture an arch at the base of the last septal face extending onto the dorsal side along the base of the last two chambers, with an upper lip. Diameter, 0.33 mm.; thickness, 0.13 mm. Common.

*Holotype*.—No. 4835, locality 7, Tallahatta fm., Claiborne, Eocene.

**Cibicides floridanus diminutivus**, new variety

Plate 17, figs. 4a-c

Test subcircular, biconvex, ventral side with prominent central boss; periphery smooth, with a thin border of a clear shell material; edge acute to subacute; chambers 11 to 13 in the last whorl, increasing gradually in size; ventral sutures gently curved, limbate, raised and coalescing with the umbo; dorsal sutures little curved, limbate, raised; spiral sutures limbate, raised, the earlier chambers reduced at the surface as a spire of round depressions; wall coarsely perforate; aperture a slit at the base of the apertural face extending from the edge onto the dorsal side, continuing between the last two chambers and the previous whorl. Diameter, 0.32 mm.; thickness, 0.14 mm. Common.

This variety differs from the species in the smaller size and radial dorsal sutures (see *T. floridana* Cushman, 1918, U. S. Geol. Sur., Bull. 676, p. 62, pl. 19, fig. 2).

*Holotype*.—No. 4791, locality 58, Jackson, Eocene.



**Cibicides lawi** Howe

Plate 18, figs. 2a-c

*Cibicides lawi* Howe, 1939, Louisiana Dept. Cons., Geol. Bull. 14, p. 87, pl. 13, figs. 12-14 Cook Mt., Claiborne, Eocene.

Test small, subcircular, biconvex, ventral side slightly more convex with central low umbo; periphery smooth, only very slightly lobulate if at all, with narrow carina; edge acute; eight or nine chambers in the last whorl increasing gradually in size; sutures straight dorsally, strongly oblique, flush; ventral sutures narrow, flush or slightly depressed, little curved, radial; wall smooth, coarsely perforate; aperture an arched slit at the base of the last septal face on the inner periphery extending onto the dorsal side and along the spiral suture for a distance of about one-half of the last chamber. Diameter, 0.28 mm.; thickness, 0.12 mm. Common.

*Plesiotypic*.—No. 4836, locality 7, Tallahatta fm., Claiborne, Eocene.

**Cibicides lobatus** (d'Orbigny)

Plate 19, figs. 3a-c

*Truncatulina lobata* d'Orbigny, 1839, in Barker, Webb and Berthelot, Hist. Nat. Iles Canaries, vol. 2, pt. 2, "Foraminifères," p. 134, pl. 2, figs. 22-24 Recent, Canaries.

*Truncatulina lobatula* d'Orbigny, 1846, Foraminifères fossiles du bassin Tertiaire de Vienne, p. 178, pl. 9, figs. 18-23 middle Miocene, Vienna Basin.

*Cibicides lobulatus* Cushman, 1935, U. S. Geol. Surv., Prof. Paper 181, p. 52, pl. 22, fig. 4 (not 5 and 6) upper Eocene, southeastern U. S.

*Cibicides lobatulus* Galloway and Wissler, 1927, Jour. Paleont., vol. 1, pp. 64, 65 pl. 11, fig. 1 Pleistocene, Calif.; Galloway and Hemingway, 1941, New York Acad. Sci., Sci. Survey Porto Rico and the Virgin Islands, vol. 3, pt. 4, p. 393, pl. 2, figs. 4a-c middle Oligocene, upper Oligocene, and lower Miocene, Porto Rico.

Test planoconvex, much compressed, dorsal side flat or concave, ventral side moderately convex; edge acute; periphery moderately lobate; chambers irregularly increasing in size, about seven in last whorl; sutures curved, flush, limbate dorsally, on the ventral side depressed and somewhat less curved; wall coarsely perforate; aperture at base of septal face on periphery with slight lip above, extending on dorsal side along suture line between last two whorls for a distance of two or three chambers. Diameter, 0.45 mm.; thickness, 0.12 mm. Rare.

*Plesiotypic*.—No. 4837, locality 58, Jackson, Eocene.

**Cibicides cf. Incidus** (Reuss)

Plate 18, figs. 6a-b

*Truncatulina laevis* Reuss, 1866, K. Akad. Wiss. Wien, Math.-Naturw. Cl., Denkschr., Wien, Oesterreich, Bd. 25, Abt. 1, p. 160, pl. 4, fig. 15 middle Oligocene, Germany.

Test planoconvex, dorsal side moderately convex, ventral side strongly convex, subcircular in side view; periphery slightly lobulate, with narrow keel; edge acute; about three whorls, gradually enlarging, only very slightly overlapping the earlier whorls in the last part of the final whorl on the dorsal side, involute ventrally; chambers seven or eight in the last whorl, gradually enlarging in size; dorsal sutures and outer edge of chambers form a smooth, arcuate curve, limbate, flush; ventral sutures curved; somewhat depressed; wall conspicuously perforate, pores of medium size; aperture a small arch at the base of the last septal face near the edge, extending over the edge and along the spiral suture for a distance of one or two chambers, with upper lip. Diameter, 0.38 mm.; thickness, 0.19 mm. Common.

*Plesiotype*.—No. 4838, locality 7, Tallahatta fm., Claiborne, Eocene.

***Cibicides mimulus***, new species

Plate 19, figs. 1a-c

Test planoconvex, dorsal side slightly convex, ventral side strongly convex, with moderate, ventral umbilicus, subcircular in side view; periphery slightly lobulate, with narrow keel; edge acute; about  $2\frac{1}{2}$  or 3 whorls, gradually enlarging, slightly overlapping earlier whorls on dorsal side, involute ventrally; chambers seven to nine in the last whorl; dorsal sutures curved, slightly limbate, flush; ventral sutures curved, somewhat depressed; wall conspicuously perforate, pores of medium size; aperture a small arch at the base of the last septal face near the edge, extending across the periphery and along the spiral suture for a distance of two or three chambers. Diameter, 0.37 mm.; thickness, 0.19 mm. Common.

This species is similar to *C. lucidus* (Reuss) but is thicker and with less arcuate chambers.

*Holotype*.—No. 4839, locality 14, Lisbon fm., Claiborne, Eocene.

***Cibicides pippeni*** Cushman and Garrett

Plate 19, figs. 4a-c, 5a-c

*Cibicides pippeni* Cushman and Garrett, 1938, Contr. Cushman Lab.

Foram. Res., vol. 14, p. 64, pl. 11, fig. 2 Red Bluff, lower Oligocene, Ala.

Test nearly planoconvex, dorsal side flattened except the



slightly umbonate central portion, ventral side strongly convex, flattened centrally; edge subacute; periphery with a distinct thickened keel; chambers numerous, 10 to 12 in the adult whorl, increasing gradually in size as added, not inflated; sutures distinct, strongly limbate throughout, ventrally gently curved terminating in a thickened area over the umbilical region, on the dorsal side strongly oblique in the early portion, becoming less oblique but somewhat sigmoid later, the spiral suture much thickened, coalescing in the umbonal area forming a thickened covering; wall coarsely perforate, fewer perforations in the dorsal umbonate covering; aperture a slit with upper lip extending across the periphery at the base of the last septal face and continuing on the dorsal side for a short distance. Diameter, 0.66 mm.; thickness, 0.30 mm. Common.

This form is abundant at locality 62 and displays some variation in the smoothness of the periphery, some specimens being slightly lobulate and others being smooth as the one figured. *C. fortunatus* Martin (1943, Stanford Univ. Publ., Geol. Sci., vol. 3, No. 3) may be conspecific with this species.

*Plesiotype*.—No. 4841, locality 62; plesiotype, No. 4840, locality 61, Red Bluff, lower Oligocene.

***Cibicides pippeni stavensis***, new variety

Plate 19, figs. 6a-c

Test biconvex, dorsal side moderately convex, ventral side rather strongly convex with central umbo; edge rather abruptly rounded to subacute; periphery with a thickened keel, smooth, only very slightly lobate if at all; chambers about 10 in number in the final whorl increasing gradually in size as added, not inflated; sutures very distinct, markedly limbate and coalescing dorsally with the limbate spiral suture to form a large thickened area obscuring the spire, the ventral sutures coalesce also in the umbilical area to form an irregular umbonal area; wall coarsely punctate, sparingly so in the thickened or calloused region of the dorsal side; aperture a very low narrow arch at the base of the last septal face on the periphery, and extending onto the dorsal side along the base of the last two chambers. Diameter, 0.41 mm.; thickness, 0.19 mm. Common.

This variety differs from the ordinary form in being coarser in general, with stronger limbations, slightly rounded edge, more

biconvexity, and larger fused umbonal areas, both ventrally and dorsally.

*Holotype*.—No. 4842, locality 7, Tallahatta fm., Claiborne, Eocene.

***Cibicides pseudoungerianus* (Cushman)**

Plate 19, figs. 7a-c

*Truncatulina pseudoungeriana* Cushman, 1922, U. S. Geol. Sur., Prof. Paper 129-E, p. 97, pl. 20, fig. 9 middle Oligocene, Miss.

*Cibicides pseudoungeriana* Cushman, 1931, U. S. Nat. Mus., Bull. 104, pt. 8, p. 123, pl. 22, figs. 3-7 Recent, Atlantic.

*Cibicides pseudoungeriana* Cushman and Herriek, 1945, Contr. Cushman Lab. Foram. Res., vol. 21, p. 73 McBean fm., Eocene, Ga.

Test nearly equally biconvex, subcircular in side view; dorsal surface with thickening concealing the early spire, the ventral side nearly involute with a central umbilical filling of clear shell material, about flush with the chambers; edge subacute; periphery slightly lobulate in the later half, slightly keeled and mostly smooth in the early part of the last whorl; chambers 9 to 11 in the last whorl increasing gradually in size; sutures distinct and limbate dorsally, curved and oblique; ventral sutures narrowly limbate, gently curved; wall on the dorsal side coarsely perforate, ventral wall more finely perforate, otherwise smooth; aperture an arch with upper lip at the base of the last septal face on the periphery and extending along the spiral suture dorsally for a distance of two chambers. Diameter, 0.50 mm.; thickness, 0.15 mm. Common.

The original description fits these specimens exactly with respect to the height of the umbilical filling, the coarse dorsal perforations and finer ventral ones, the dorsal thickening, and in all other respects. The specimen figured in U. S. National Museum, Bulletin 104, pt. 8, pl. 22, fig. 3, also appears very similar to this form in general character. Those forms with a prominent ventral umbo which have been assigned to this species by various authors are probably not conspecific.

*Plesiotype*.—No. 4844, locality 64, Mint Spring marl, Vicksburg, Oligocene.

***Cibicides pseudoungerianus lisbonensis*, new variety**

Plate 20, figs. 1a-b

Test biconvex, nearly equally so, with strong umbonate boss in the ventral umbilical region, subcircular in side view; periphery smooth or very slightly lobulate with a narrow border of clear shell material; edge angled to sharply rounded; whorls about

three, the last one slightly overlapping earlier whorls; early whorls on dorsal side somewhat obscured by shelly thickening; about 10 chambers in the last whorl, gradually enlarging in size as added; sutures gently curved on both sides, ventral sutures narrowly limbate, dorsal sutures with wide limbations; wall coarsely perforate on the dorsal side, pores few and enlarged in the dorsal thickened area, less coarsely perforate ventrally; aperture a small low arch with upper lip at the base of the septal face on the inner periphery, continuing a distance of about two chambers dorsally along the spiral suture. Diameter, 0.34 mm.; thickness, 0.18 mm. Abundant.

This variety differs mainly in the possession of a prominent ventral umbo. In the original description of *C. pseudoungerianus* (Cushman) (1922, U. S. Geol. Sur., Prof. Paper 120-E) and in all of the early figures, there is only a filling which is flush with the surface in the umbilical region.

*Holotype*.—No. 4845, locality 28, Lisbon fm., Claiborne, Eocene.

***Cibicides pseudowuellerstorfi* Cole**

Plate 20, figs. 3a-c

*Cibicides pseudowuellerstorfi* Cole, 1927, Bull. Amer. Paleont., vol. 14, No. 51, p. 36, pl. 1, figs. 13, 14 Guayabal fm., middle Eocene, Mex.; Cushman and Dusenbury, 1934, Contr. Cushman Lab. Foram. Res., vol. 10, p. 64, pl. 9, figs. 4a-c Poway congl., Calif.; Cushman and Applin, 1943, Contr. Cushman Lab. Foram. Res., vol. 19, p. 46, pl. 8, fig. 13 Yegua fm., middle Eocene, Tex.

Test planoconvex, flat or slightly concave dorsally, convex ventrally with central boss of clear shell material; edge angulate; periphery slightly lobate, with keel; chambers 9 to 12 in the final whorl, gradually increasing in size; sutures on dorsal side limbate and curved, coalescing with the limbate spiral suture to conceal much of the spire; ventral sutures only narrowly limbate if at all, curved; wall smooth, perforations of medium size on both sides; aperture a small arch on the periphery and extending onto the dorsal side for a distance of one chamber. Diameter, 0.40 mm.; thickness, 0.18 mm. Common.

The perforations in these specimens appear to be finer than as indicated by Cole; in addition, there is much thickening on the dorsal side which is not indicated in the original description.

*Plesiotype*.—No. 4846, locality 7, Tallahatta fm., Claiborne, Eocene.

**Cibicides sassei** Cole

Plate 20, figs. 4a-c

*Cibicides sassei* Cole, 1927, Bull. Amer. Paleont., vol. 14, No. 51, p. 35, pl. 4, figs. 10, 11 middle Eocene, Mex.; Cushman and Thomas, 1929, Jour. Paleont., vol. 3, p. 182, pl. 24, figs. a-c; 1930, vol. 4 p. 41, pl. 4, fig. 4 Claiborne, Eocene, Tex.; Howe, 1939, Louisiana Dept. Geol., Geol. Bull. 14, p. 88, pl. 13, figs. 18, 19 Cook Mt. Claiborne, Eocene, La.; Cushman and Applin, 1943, Contr. Cushman Lab. Foramin., vol. 19, p. 46, pl. 8 fig. 12 Yegua fm., Claiborne, Eocene, Tex.; Cushman and Todd, 1945, Contr. Cushman Lab. Foramin. Res., vol. 21, p. 20 Lisbon fm., Claiborne, Eocene, Ala.

Test planoconvex in adults to somewhat biconvex in younger individuals, dorsal side nearly flat or somewhat concave in gerontic forms, ventral side moderately convex with central boss of clear shell material; edge subacute to acute; periphery very slightly lobulate; chambers distinct, 8 to 10 in the final whorl, increasing gradually in size as added, slightly if at all inflated; sutures on the dorsal side slightly raised near the central portion, fusing into a mass of shell material, curved and oblique; ventral sutures limbate and raised in the early part, slightly depressed in the later part, curved especially toward the peripheral edge; wall coarsely perforate, especially on the ventral side; aperture a low arch on the periphery extending slightly onto the ventral side and along the base of the last chamber on the dorsal side, with upper lip. Diameter, 0.27 mm.; thickness, 0.12 mm. Common.

This form displays considerable variation in the involuteness of the ventral side, in younger and ephelic specimens, this side is involute to the boss and the dorsal side is slightly convex. There is a tendency for the last few chambers to become evolute ventrally in gerontic individuals, and in these older forms the dorsal side appears flattened or slightly concave. The Little Stave Creek specimens seem identical with *C. sassei* as figured by Cushman and Thomas (*loc. cit.*), but there is some doubt that they are the same as Cole's species.

*Plesiotypic*.—No. 3847, locality 12, Lisbon fm., Claiborne, Eocene.

**Cibicides tallahattensis**, new species

Plate 20, figs. 5a-c

Test subcircular, flat or slightly concave dorsally with the spire covered with much thickening; ventral side convex with a prominent smooth translucent boss; edge acute; periphery smooth, with slight keel; chambers seven to nine, increasing regu-

larly in size; sutures gently curved, dorsally limbate, early ones slightly depressed; surface smooth, medium to coarsely perforate; aperture a small arch at the base of the septal face on the periphery extending dorsally along the base of the last chamber and one-half. Diameter, 0.27 mm.; thickness, 0.10 mm. Common.

This form is very near *C. howelli* Toulmin (1941, Jour. Paleont., vol. 15) differing mainly in being more evolute dorsally and with slightly more rapidly enlarging chambers. It differs from *C. mimulus*, n. sp. in having an umbo on the ventral side.

*Holotype*.—No. 4848, locality 7, Tallahatta fm., Claiborne, Eocene.

*Cibicides truncatus*, new species

Plate 19, figs. 2a-e

Test subcircular, dorsal side flattened or slightly concave, ventral side a truncated cone, with small, shallow umbilicus; edge acute; periphery keeled, moderately lobate; chambers about seven in the last whorl, increasing very gradually in size as added; sutures strongly curved and limbate on the dorsal side, curved, narrowly limbate and raised on the ventral side; wall coarsely perforate, more so on the dorsal side; aperture at the periphery, with distinct upper lip, extending over onto the dorsal side and continuing along the spiral suture for a distance of two or three chambers. Diameter, 0.31 mm.; thickness, 0.15 mm. Common.

The truncate ventral side is distinctive, separating the new species from *C. plano-concavus* Cushman and Todd (1945, Contr. Cushman Lab. Foram. Res., vol. 21, p. 104, pl. 16, figs. 18, 19).

*Holotype*.—No. 4843, locality 21, Lisbon fm., Claiborne, Eocene.

*Cibicides* cf. *vicksburgensis* (Cushman)

Plate 20, figs. 6a-c

*Rotalia vicksburgensis* Cushman, 1922, U. S. Geol. Sur., Prof. Paper 129-F, p. 139, pl. 35, figs. 3, 4 Mint Spring marl, Oligocene, Miss.; Nuttall, 1932, Jour. Paleont., vol. 6, p. 29, pl. 4, figs. 8, 9 lower Oligocene, Mex.

*Cibicides vicksburgensis* Cushman and Todd, 1946, Contr. Cushman Lab. Foram. Res., vol. 22, p. 102, figs. 30-32 Byram marl, Vicksburg, Oligocene, Miss.

Test oval to subcircular in side view, dorsal side flattened, ventral side strongly convex, umbilicate; about eight inflated chambers in the last whorl; sutures distinct, slightly depressed; surface smooth; wall coarsely perforate; aperture an arched

opening at the base of the last septal face near the periphery, extending across and onto the dorsal side along the spiral sutures for a distance of from two to four chambers. Diameter, 0.59 mm.; thickness, 0.21 mm. Common.

This form appears to be conspecific with this species. However, the type figures, description, and subsequent figures fail to bring out all of the necessary characters.

*Plesiotype*.—No. 4849, locality 67, Marianna ls., Vicksburg, Oligocene.

***Cibicides westi* Howe**

Plate 20, figs. 7a-c

*Cibicides westi* Howe, 1939, Louisiana Dept. Cons., Geol. Bull. 14, p. 88, pl. 13, figs. 20-22 Cook Mt., Claiborne, Eocene, La.; Cushman and Herrick, 1946, Contr. Cushman Lab. Foramin. Res., vol. 21, p. 72, pl. 11, fig. 15 McBean fm., Eocene, Ga.

Test small, planoconvex, dorsal side flat showing slightly more than two whorls, ventral side conical, circular in side view; periphery smooth, very little lobate; edge angular but not carinate; chambers about eight in the last whorl, increasing gradually in size, each chamber deeper ventrally; wall smooth, perforations medium to coarse; sutures curved and oblique dorsally and slightly limbate, sigmoid and flush ventrally; aperture an elongate slit on the periphery, extending over onto the dorsal side and continuing along the spiral suture for a distance of one chamber. Diameter, 0.39 mm.; thickness, 0.29 mm. Common.

The specimens from Little Stave Creek exhibit a deeper ventral side than *C. westi* Howe (*loc. cit.*) and have no umbilicus as is seen in the type figure. The figure of Cushman and Herrick (*loc. cit.*) shows the aperture in the middle of the base of the septal face as in *Gyrogonina* and is probably incorrectly drawn.

This species belongs to the *C. refulgens* Montfort group, but, unfortunately, Montfort's species has never been accurately described and figured.

*Plesiotype*.—No. 4850, locality 26, Lisbon fm., Claiborne, Eocene.

Genus **PLANULINA** d'Orbigny, 1826

***Planulina cocoensis* Cushman**

Plate 20, figs. 2a-c

*Planulina cocoensis* Cushman, 1928, Contr. Cushman Lab. Foramin. Res., vol. 4, p. 76, pl. 10, fig. 1 upper Eocene, Ala.; Cushman, 1946, Cushman



Lab. Foram. Res., Special Publ. 16, p. 39, pl. 8, figs. 3, 4 upper Eocene, Ala.

Test subcircular, discoidal and much compressed, dorsal side flat, ventral side slightly convex and umbilicate with low rounded boss; periphery slightly lobulate with narrow keel; edge acute; chambers 9 to 12 in the last whorl, distinct, the last-formed ones slightly inflated, especially ventrally; sutures distinct, limbate, slightly raised in the early portion of the dorsal side, otherwise nearly flush or slightly depressed, strongly curved on both sides; wall fairly smooth, coarsely perforate, the dorsal spire with irregular bosses; aperture at the base of the last septal face in the plane of coiling, extending over onto the dorsal side and continuing along the base of the last two chambers, with distinct upper lip. Diameter, 0.71 mm.; thickness, 0.21 mm. Common.

*Plesiotypic*.—No. 4981, locality 59, Jackson, Eocene.

*Planulina cooperensis* Cushman

Plate 21, figs. 1a-c

*Planulina cocoaensis cooperensis* Cushman, 1933, Contr. Cushman Lab. Foram. Res., vol. 9, p. 20, pl. 2, figs. 12 a-c upper Eocene, S. C.; Bergquist, 1942, Mississippi State Geol. Sur., Bull. 49 (Fossils), p. 99, pl. 10, figs. 5, 6 upper Eocene, Miss.

Test much compressed, periphery slightly lobulate, spire visible on both sides; chambers about eight in the last whorl, very slightly inflated; sutures distinct, strongly curved, slightly depressed, narrowly limbate; wall coarsely perforate, otherwise smooth and unornamented; aperture a small narrow arch at the base of the last septal face with an upper lip, extending along the dorsal side for a distance of two or three chambers. Diameter, 0.50 mm.; thickness of the last chamber, 0.08 mm. Common.

*Plesiotypic*.—No. 4982, locality 58, Jackson, Eocene.

*Planulina subinfiata*, new species

Plate 18, figs. 1a-c

Test subcircular in side view, somewhat compressed, concavo-convex; ventral side moderately convex, evolute showing spire; dorsal side flattened or concave, somewhat more involute than the ventral side; edge subangular; periphery lobulate; more strongly so in the last half whorl; some of the earlier whorls show on both sides of the test; chambers somewhat inflated on the ventral side, enlarging gradually in size as added, about seven or eight in the final whorl; ventral sutures limbate and raised in the spire, depressed in the later part of the last coil,

curved; dorsal sutures limbate, mostly flush with the surface in the early part, becoming depressed in the later portion of the final whorl; wall coarsely perforate; aperture moderate in size at the base of the last septal face in the plane of coiling, with an extension dorsally along the base of the last chamber for a distance of one chamber, with a distinct upper lip. Diameter, 0.52 mm.; thickness, 0.18 mm. Common.

This species has characters of *Planulina*, *Cibicides*, and *Anomalina*. The spire shows on both sides. There is a sharp edge and the test is somewhat flattened nearly throughout; hence it is placed in *Planulina*.

*Holotype*.—No. 4792, locality 64, Mint Spring fm., Vicksburg, Oligocene.

*Planulina venezuelana* Nuttall

Plate 21, figs. 3a-c

*Planulina venezuelana* Nuttall, 1935, Jour. Paleont., vol. 9, p. 130, pl. 15, figs. 22-24 upper Eocene, Venezuela.

Test much compressed, nearly equilateral with the first coil of the ventral side not visible; chambers about 10 to 12 in the last whorl, slightly inflated in the later part; sutures moderately curved, limbate and raised excepting in the later portion of the last whorl where they become slightly depressed; periphery smooth in the early portion, somewhat lobulate in the last part of the final whorl, with a narrow keel; surface coarsely perforate, early chambers obscured on both sides by prominent fused limbations of the early sutures; aperture narrow, at the base of the last septal face in the plane of coiling, extending dorsally a short distance along the base of the last chamber. Diameter, 0.78 mm.; thickness, 0.10 mm. Abundant.

*Plesiotype*.—No. 4983, locality 58, Jackson, Eocene.

Genus **SIPHONINA** Reuss, 1850

*Siphonina advna* Cushman

Plate 21, figs. 6a-c

*Siphonina advna* Cushman, 1922, U. S. Geol. Sur., Prof. Paper 129-E, p. 98, pl. 22, figs. 1, 2 Vicksburg, Oligocene, Miss.; Cole and Gillespie, 1930, Bull. Amer. Paleont., vol. 15, No. 57-B, p. 12, pl. 4, figs. 5, 6 Meson fm., Oligocene, Mex.; Cushman and McGlamery, 1942, U. S. Geol. Sur., Prof. Paper 197-B, p. 74, pl. 7, figs. 2, 3 Vicksburg, Oligocene, Gulf Coastal Plain.

Test unequally biconvex, ventral side usually more convex; periphery slightly lobulate; edge subacute; four chambers make up the last whorl; sutures distinct, flush and somewhat limbate



on the dorsal side, slightly depressed on the ventral side and narrow; surface smooth; wall coarsely perforate; aperture elliptical, with short neck and phialine lip. Diameter, 0.58 mm.; thickness, 0.29 mm. Common.

*Plesiotype*.—No. 5028, locality 65, Mint Spring marl, Vicksburg, Oligocene.

***Siphonina advena eocenica*** Cushman and Applin Plate 21, figs. 7a-c

*Siphonina advena eocenica* Cushman and Applin, 1926, Bull. Amer. Assoc. Petr. Geol., vol. 10, p. 180, pl. 9, figs. 10-9 upper Eocene, Tex.; Cushman, 1935, U. S. Geol. Sur., Prof. Paper 181, p. 49, pl. 20, figs. 1-11 upper Eocene, Tex.

Test biconvex, ventral side more convex, periphery with very narrow transparent keel; edge fairly smooth and entire; chambers usually four to five in the last whorl; sutures on the ventral side nearly radial, somewhat curved, those on the dorsal side about flush with the surface, oblique, and slightly curved; spiral suture rather indistinct, flush; wall smooth, rather coarsely perforate; aperture elliptical with a short neck and a distinct broad lip. Diameter, 0.45 mm.; thickness, 0.23 mm. Common.

There is little to distinguish this variety from the species. The edge of the variety seems to be sharper.

*Plesiotype*.—No. 5029, locality 58, Jackson, Eocene.

***Siphonina claibornensis*** Cushman Plate 21, figs. 4a-c

*Siphonina claibornensis* Cushman, 1927, U. S. Nat. Mus., Proc., vol. 72, art. 20, p. 4, pl. 3, figs. 5 a-c Lisbon fm., middle Eocene, Miss.; Cushman and Applin, 1943, Contr. Cushman Lab. Foram. Res., vol. 19, p. 42, pl. 8, fig. 7 Yegua fm., middle Eocene, Tex.

Test small, nearly circular, biconvex, somewhat compressed; edge sharp; periphery with slight keel, somewhat variable, lobulate; chambers usually five in the last whorl, slightly inflated ventrally; dorsal sutures distinct, strongly oblique, slightly curved, somewhat limbate; ventral sutures nearly radial, depressed; wall smooth, very coarsely and conspicuously perforate; aperture elongate, narrowly elliptical, occupying the entire height of the chamber, with a distinct lip but no definite neck. Diameter, 0.33 mm., thickness, 0.13 mm. Common.

*Plesiotype*.—No. 5030, locality 7, Tallahatta fm., Claiborne, Eocene.

***Siphonina danvillensis*** Howe and Wallace Plate 21, figs. 8a-c

*Siphonina danvillensis* Howe and Wallace, 1932, Louisiana Dept. Cons., Geol. Bull. 2, p. 70, pl. 13, fig. 1 upper Eocene, La.; Bergquist, 1942,

Mississippi State Geol. Sur., Bull. 49 (Fossils), p. 89, pl. 9, figs. 3 a-c upper Eocene, Miss.; Cushman, 1946, Cushman Lab. Foram. Res., Special Publ. 16, p. 35, pl. 7, figs. 3, 4 upper Eocene, Ala.

Test biconvex, trochoid, the last whorl with about five chambers; periphery with a broad, thin, denticulate keel; edge sharp; chambers distinct on the ventral side, rather indistinct dorsally; sutures on the ventral side nearly radial, slightly curved and somewhat depressed; dorsal sutures oblique to periphery, somewhat curved, and indistinct, especially in the spire; aperture elongate, elliptical, slightly on the ventral side of the plane of coiling, distinct short neck, thin flaring lip. Diameter, 0.54 mm.; thickness, 0.23 mm. Common.

This form is thicker and lacks the reticulate and spinose ornamentation of *S. jacksonensis* Cushman and Applin (1910, Bull. Amer. Assoc. Petr. Geol., vol. 10).

*Plesiotype*.—No. 5031, locality 58, Jackson, Eocene.

Genus **PLANORBULINA** d'Orbigny, 1826

**Planorbulina mediterraneensis** d'Orbigny Plate 21, figs. 2a-c

*Planorbulina mediterraneensis* d'Orbigny, 1826, Ann. Sci. Nat., vol. 7, p. 280, No. 2, pl. 14, figs. 4-6; Modèles, No. 79; Cushman, 1931, U. S. Nat. Mus., Bull. 104, pt. 8, p. 129, pl. 24, figs. 5-8 Recent; Palmer, 1945, Bull. Amer. Paleont., vol. 29, No. 115, p. 76 Miocene, Jamaica.

Test usually attached, early chambers distinctly spiral, later ones becoming somewhat irregular, often irregularly annular in their arrangement, more or less lobulated on the ventral face; periphery irregular, edge often angular; wall very coarsely perforate, early chambers somewhat indistinct; sutures depressed, often clearly marked on the dorsal face by a distinct band of shell material; apertures at either side of the chamber in the adult, simple, with a raised lip. Diameter, 0.61 mm., thickness, 0.18 mm. Rare.

*Plesiotype*.—No. 4979, locality 67, Marianna ls., Vicksburg-Oligocene.

Family **ACERVULINIDÆ** Schultz, 1854

Genus **SPHÆROGYPSINA** Galloway, 1933

**Sphærogypsina globulus** (Reuss) Plate 21, fig. 5

*Ceritopora globulus* Reuss, 1847, Haidinger's Naturwiss. Abh., vol. 2, p. 33, pl. 5, fig. 7 middle Miocene, Austria.

*Gypsina globulus* Brady, 1884, Rep. Voy. Challenger, Zool., vol. 9, p. 717, pl. 101, fig. 8 Recent, British Islands; Cushman, 1935, U. S.

Geol. Sur., Prof. Paper 181, p. 54, pl. 23, figs. 4, 5 upper Eocene, southeastern U. S.

*Spharogypsina globulus* Galloway, 1933, Manual of Foraminifera, p. 309, pl. 28, figs. 13, 14; Galloway and Heminway, 1941, New York Acad. Sci., Sci. Survey of Porto Rico and the Virgin Islands, vol. 3, pt. 4, p. 406, pl. 27, fig. 7 lower Miocene, Oligocene, Porto Rico.

Test small, spheroidal; surface pustulose or pitted with a more or less regular polygonal network formed by the walls of the outside chambers; wall with fine but distinct perforations with no distinct aperture other than the perforations. Diameter, 0.71 mm. Abundant.

*Plesiotype*.—No. 5032, locality 43, Moody marl member, Jackson, Eocene.

Family **ASTERIGERINIDÆ** d'Orbigny, 1839

Genus **ASTERIGERINA** d'Orbigny, 1839

*Asterigerina texana* (Stadnichenko) Plate 22, figs: 3a-c

*Eponides texana* Stadnichenko, 1927, Jour. Paleont., vol. 1, p. 232, pl. 38, figs. 1-5 Cook Mt., Eocene, Tex.

*Asterigerina texana* Cushman and Thomas, 1929, Jour. Paleont., vol. 3, p. 181, pl. 24, figs. 5 a-c Mt. Seaman greensand, middle Eocene, Tex.

*Asterigerina lisbonensis* Cushman and Todd, 1945, Contr. Cushman Lab. Foram. Res., vol. 21, pt. 1, p. 19, pl. 4, figs. 15-18 Lisbon fm., Claiborne, Eocene, Ala.

Test trochoid, thickly biconvex, ventral side usually more convex with a strong umbonal boss, dorsal side less convex and becoming flattened toward the periphery; edge acute, carinate; whorls about  $3\frac{1}{2}$ ; chambers 8 to 10 in the last whorl, with well-developed rosette of supplementary chambers on the ventral side, which alternate with the main chambers and extend about half-way toward the periphery; spiral suture of the dorsal side thickened and slightly raised in some specimens, ventral sutures nearly radial, dorsal sutures oblique; wall finely perforate; surface on dorsal side smooth, ventral side with earlier half prominently papillate, some gerontic specimens with entire ventral surface strongly beaded; aperture a low sinuous arch extending from the periphery inward to the area of supplementary chambers on the ventral side, with well-developed lip. Diameter, 0.60 mm.; thickness, .034 mm. Abundant.

The original description and figures of this species display an acute, carinate edge, and prominent spiral suture, the distinguishing feature given for *A. lisbonensis*; hence, the latter is placed in synonymy.

*Plesiotypic*.—No. 4797, locality 18, Lisbon fm., Claiborne, Eocene.

Genus *ASTERIGERINELLA*, new genus

Genotype.—*Asterigerinella gallowayi*, new species

Test free, complanate, planispiral, spire visible on both sides; whorls about two to three; peripheral margin smooth, lobulate or carinate; edge angled; chambers numerous, closely appressed, enlarging gradually; the ventral side with one series of chamberlets which alternate with the chambers to form a star pattern; wall calcareous, finely perforate, smooth or papillate; aperture an elongate slit extending from the base, or near the base, of the last apertural face up into the face, with slightly developed encircling lip. Diameter up to 1.3 mm.

This genus apparently evolved from *Asterigerina* by becoming planispiral or nearly so, and tending to become evolute, showing the spire on both sides. The only described species which may belong to this genus is *Asterigerina tombigbeensis* Cushman and Garrett (1940, Contr. Cushman Lab. Foram. Res., vol. 16).

*Asterigerinella gallowayi*, new species

Plate 22, figs. 1a-c

Test ovate in side view, planispiral, compressed, spire visible on both sides; periphery slightly lobulate, with prominent thin, serrate carina, which may be ragged, partly due to poor preservation; edge sharp; chambers seven to nine in the final whorl, closely appressed, increasing rather rapidly in height; sutures raised and limbate on both sides in the early inner portion; dorsal sutures limbate, moderately curved, slightly depressed in the last whorl except for the last two or three which are slightly raised; ventral sutures slightly depressed in the last whorl, moderately curved, meeting the periphery at an angle of about 60 degrees, the juncture with secondary sutures about  $\frac{2}{5}$  of the distance from the periphery, secondary sutures slightly depressed; wall rather finely perforate, variably papillate, some smaller specimens with only a few widely scattered papillae; aperture a vertical elongate slit extending from near the base of the last apertural face upward about half the height of the face. Diameter of type, 1.17 mm.; thickness, 0.17 mm. Common.

This form was probably derived from *Asterigerina tombigbeensis* Cushman and Garrett (1940, Contr. Cushman Lab.

Foram. Res., vol. 16, p. 26) of the Wilcox Eocene and differs from that form in the septal aperture, in being planispiral, more evolute, and much more compressed. *A. gallowayi* is rather common and many specimens were collected from locality 58.

This species is named in honor of Professor J. J. Galloway, Indiana University, an inspiring teacher and scientist.

*Holotype*.—No. 4798, locality 58, Jackson, Eocene.

Family: **ORBULINIDÆ** Schultze, 1854

Genus **GLOBIGERINA** d'Orbigny, 1826

**Globigerina bulloides** d'Orbigny Plate 23, figs. 5a-c

*Globigerina bulloides* d'Orbigny, 1826, Ann. Sci. Nat., vol. 7, p. 277, No. 1; Modèles No. 76 Recent, Adriatic Sea; Howe and Wallace, 1932, Louisiana Dept. Cons., Geol. Bull. 2, p. 73, pl. 10, fig. 10 upper Eocene, La.; Galloway and Heminway, 1941, New York Acad. Sci., Sci. Surv. Porto Rico and the Virgin Islands, vol. 3, pt. 4, p. 411, pl. 29, figs. 1 a-b middle Oligocene—lower Miocene, Porto Rico.

Test longer than wide, consisting of  $2\frac{1}{2}$  to 3 whorls arranged in a low, helicoid spire; chambers about 12 in number, inflated, somewhat appressed, subglobular, rapidly enlarging, about  $3\frac{1}{2}$  to 4 in the last whorl; sutures depressed ventrally, less dorsally; wall thick, coarsely reticulate; aperture a large semicircular opening into the umbilicus, with upper lip. Length, 0.50 mm.; breadth, 0.40 mm.; thickness of the last chamber, 0.35 mm. Common.

*Plesiotype*.—No. 4906, locality 58, Jackson, Eocene.

**Globigerina dissimilis** Cushman and Bermudez Plate 22, figs. 2a-c

*Globigerina dissimilis* Cushman and Bermudez, 1937, Contr. Cushman Lab. Foram. Res., vol. 13, pt. 1, p. 25, pl. 3, figs. 4-6 Eocene, Cuba.

Test subglobular, spire convex, periphery lobulate; chambers four in the adult whorl, inflated, subglobular, ventrally small supplementary chamber covering the umbilicus, quadrangular in side view; sutures strongly depressed; wall coarsely cancellated excepting for that of the last chamber which is much smoother; aperture opening into the umbilicus at the lower edge of the supplementary chamber. Diameter, 0.57 mm.; thickness, 0.47 mm. Common.

This species differs from *G. onachitaensis* only in the final, diminutive chamber, a feature of doubtful specific value.

*Plesiotype*.—No. 4901, locality 58, Jackson, Eocene.

**Globigerina dutertrei** d'Orbigny

Plate 22, figs. 4a-c

*Globigerina dutertrei* d'Orbigny, 1839, in De la Sagra, Hist. Phy. Pol. Nat. Cuba Foraminifères, p. 84, pl. 4, figs. 19-21 recent, Cuba; Cushman, 1945, Contr. Cushman Lab. Forum. res., vol. 21, p. 75, pl. 12, figs. 8, 11.

Test helicoid, ventral side with deep umbilicus, dorsal side convex; slightly over four chambers in the last whorl, chambers globular, only slightly appressed, increasing rather rapidly but evenly in size in the early portion, gradually in the later part; sutures depressed; wall coarsely perforate; aperture oval, of moderate size with a narrow distinct lip. Length, 0.62 mm.; breadth, 0.55 mm.; thickness, .45 mm. Rare.

The surface of the specimens from Little Stave Creek is reticulate, appearing similar to the surface of the figured specimens (8a-c) of the last publication listed above under the synonymy. There is some doubt as to the identity of the Eocene specimens with the Recent ones.

*G. dutertrei*, *G. ouachitaensis*, *G. ouachitaensis senilis*, and *G. dissimilis* form a phyletic series of tighter coiling in the last whorl and reduction in size of the final chamber.

*Plesiotype*.—No. 4902, locality 58, Jackson, Eocene.

**Globigerina eocaenica** Terquem

Plate 23, figs. 2a-c

*Globigerina eocaenica* Terquem, 1882, Soc. Géol. France, Mém., ser. 3, vol. 2, p. 86, pl. 9, fig. 4 Eocene, France; Bandy, 1944, Jour. Paleont., vol. 18, p. 376, pl. 62, figs 5 a-c middle Eocene, Oregon.

Test subglobular slightly compressed, three chambers in the final whorl; edge broadly rounded, periphery slightly lobulate; chambers inflated, moderately appressed, the last chamber much larger than the previous one, sutures much depressed; wall thick, reticulate, coarsely perforate; aperture, a small low arched opening, with upper lip, located at the base of the last apertural face and to one side of the center of the last chamber. Length, 0.53 mm.; breadth, 0.43 mm.; thickness, 0.38 mm. Common.

*Plesiotype*.—No. 4903, locality 58, Jackson, Eocene.

**Globigerina increbescens**, new species

Plate 23, figs. 3a-c

Test helicoid, dorsal side slightly convex, ventral side very deep as a result of a rapid increase in height of the chambers; periphery moderately lobulate; edge evenly rounded; whorls about three, the last with four chambers; sutures depressed, slight-

ly curved; wall coarsely and conspicuously perforate; aperture a moderately high arch on the ventral side extending from near umbilicus to near periphery, with upper lip. Diameter 0.48 mm.; height, 0.38 mm. Abundant.

This form is more coarsely perforate than *G. inflata* d'Orbigny, 1839, in Barker, Webb and Berthelot, Hist. Nat. Iles Canaries, vol. 2, pt. 2, Foraminifères, p. 134, pl. 2, figs. 7-9) and is not so high, the spire is more rounded, and the aperture is much shorter.

*Holotype*.—No. 4004, locality 58, Jackson, Eocene.

***Globigerina ouachitaensis*** Howe and Wallace Plate 23, figs. 4a-c  
*Globigerina ouachitaensis* Howe and Wallace, 1932, Louisiana Dept. Cons., Geol. Bull. 2, p. 74, pl. 10, figs. 7 a-b upper Eocene, La.; Howe, 1939, Louisiana Dept. Cons., Geol. Bull. 14, p. 83, pl. 12, figs. 18, 19 middle Eocene, La.

Test subglobular, trochoid, with convex spire; periphery lobate; chambers about 12 visible dorsally, the later ones spheroidal, four in the last whorl, slightly enlarging, but increasing rapidly in thickness dorso-ventrally; chambers inflated; sutures deeply depressed; wall coarsely perforate; aperture high, opening into the subquadrate umbilical vestibule. Diameter, 0.65 mm.; thickness, 0.43 mm. Rare.

*Plesiotype*.—No. 4005, locality 58, Jackson, Eocene.

***Globigerina ouachitaensis senilis***, new variety Plate 22, figs. 5a-c  
 (?) *Globigerina conglomerata* Galloway and Morrey, 1929, Bull. Amer. Paleont., vol. 15, No. 55, p. 9, pl. 3, fig. 7 late Eocene or lower Oligocene, Ecuador.

Test subglobular, spire convex; chambers elongate dorso-ventrally, much inflated, the last one smaller than the penultimate, four in the last whorl, forming a restricted, rectangular, deep vestibule; sutures deep; wall coarsely perforate and reticulate; aperture opening into the vestibule, scarcely visible from the exterior. Diameter, 0.40 mm.; thickness, 0.32 mm. Common.

This variety differs from the species in being more globular with higher, more appressed chambers.

*Holotype*.—No. 4000, locality 59, Jackson, Eocene.

***Globigerina rotundata jacksonensis***, new variety Plate 23, figs. 6a-c

Test subglobular, trochoid, dorsal side rather convex, ventral side very deep due to the very rapid increase in height of the chambers except for the last one, which is always very low and flattened; periphery lobulate; edge broadly rounded, only



a very slight shoulder; whorls about three, the last having nearly four chambers; sutures considerably depressed, slightly curved; wall rather coarsely reticulate but fairly smooth; aperture a moderately high arch on the septal face of the final small chamber opening above a very small umbilicus. Diameter, 0.53 mm.; thickness, 0.46 mm. Common.

The contrast of the antepenultimate and penultimate chambers with the small, flattened last chamber is a characteristic which easily distinguishes this variety from *G. rotundata* (see Fornasini, 1898, *Le Globigerine fossili d'Italia, Italia*, vol. 4, p. 208, ff. 3).

*Holotype*.—No. 4907, locality 58, Jackson, Eocene.

*Globigerina spinuloinflata*, new species

Plate 23, figs. 1a-c

Test helicoid, dorsal side flattened or slightly convex, ventral side very deep as a result of the rapid increase in height of the chambers; periphery moderately lobulate; edge rather abruptly rounded, with shoulder; whorls  $2\frac{1}{2}$  to 3, the last with about  $4\frac{1}{2}$  chambers; sutures depressed, on the dorsal side curved and oblique, ventrally nearly radial; wall coarsely perforate, conspicuously spinose, rather reduced on the last chamber; aperture a moderately low arch opening into the umbilicus, with an upper lip. Length, 0.42 mm.; breadth, 0.34 mm.; thickness, 0.29 mm. Rare.

*G. topilensis* Cushman (1925, *Contr. Cushman Lab. Foraminifera*, vol. 1, pt. 1) is very much more lobulate in the adult form than this rather regular species.

*Holotype*.—No. 4908 locality 7, Tallahatta fm., middle Eocene.

*Globigerina trilocularis* d'Orbigny

Plate 24, figs. 2a-c

*Globigerina trilocularis* d'Orbigny, 1826, *Ann. Sci. Nat.*, vol. 7, p. 277, No. 2 Miocene France; Bandy, 1944, *Jour. Paleont.*, vol. 18, p. 376, pl. 62, figs. 7 a-b middle Eocene, Oregon.

Test subglobular, trochoid, about  $3\frac{1}{2}$  chambers making up the final whorl, the last chamber making up one-third or more of the entire test in size; wall coarsely punctate; aperture an arch at the base of the last chamber with an upper lip. Maximum diameter, 0.54 mm.; thickness of last chamber, 0.37 mm. Common.

This form is similar to *G. triloculinoides* Plummer (1926,



Texas Univ., Bull. 2644) but differs in less globular and more appressed chambers.

*Plesiotypic*.—No. 4909, locality 58, Jackson, Eocene.

Genus **GLOBIGERINOIDES** Cushman, 1927

**Globigerinoides pseudodubia**, new species Plate 24, figs. 1a-c

Test large, coiled in a regular low-spined helix,  $\frac{1}{4}$  to  $\frac{1}{2}$  chambers in the final whorl; ventral side with a small, deep umbilicus; periphery lobulate; chambers globular, increasing rapidly in length dorso-ventrally, but increasing slowly in the radial direction, so that the later chambers appear nearly of equal size; sutures depressed; wall hispid, rather coarsely perforate; ventral aperture a circular arch, opening partly into the umbilicus on the dorsal side at the intersection of the radial and spiral sutures. Diameter, 0.45 mm.; thickness, 0.31 mm. Common.

This form is similar to *Globigerina dubia* Egger (1857, Neues Jahrb. Min. Geogn. Geol. Petref., p. 281), differing mainly in the accessory apertures on the dorsal side, and in the chambers of the dorsal spire increasing very rapidly in size at first, then more gradually in the later part.

*Holotypic*.—No. 4911, locality 7, Tallahatta fm., Claiborne, Eocene.

Genus **GLOBIGERINELLA** Cushman, 1927

**Globigerinella pseudovoluta**, new species Plate 24, figs. 4a-b

Test planispiral, involute about one-third of the width of a whorl; about six chambers in the last coil, increasing rapidly but regularly in size as added, globular, somewhat appressed; sutures depressed, slightly curved, wall smooth, rather coarsely perforate; aperture a high arch at the base of the last septal face, with upper lip. Diameter of holotype 0.40 mm.; thickness of the last chamber, 0.16 mm. Rare.

This species differs from *G. aquilateralis* (Brady) (1884, Rep. Voy. Challenger, Zoology, vol. 9, p. 605, pl. 80, figs. 18-21) in being more evolute; in that species, the whorls barely touch. The large aperture, more coarsely perforate test, and more appressed chambers distinguish this species from *G. voluta* White (1928, Jour. Paleont., vol. 2, p. 197).

*Holotypic*. No. 4910, locality 15, Lisbon fm., Claiborne, Eocene.

Family **HETEROHELICIDÆ** Cushman, 1927Genus **GÜMBELINA** Egger, 1899**Gümbelina cubensis** Palmer

Plate 24, figs. 3a-b

*Gümbelina cubensis* Palmer, 1934, Mem. Soc. Cubana Hist. Nat., vol. 8, p. 74, text figs. 1-6 lower Oligocene, Cuba; Cushman, 1946, Cushman Lab. Res., Special Publ. 16, p. 22, pl. 4, fig. 28 upper Eocene, Ala.

Test minute, seven or eight pairs of chambers biserially arranged throughout; periphery moderately lobulate in side view; chambers inflated, increasing regularly but rapidly in width so that the later two pairs of chambers make up about half of the test length, maximum width at the apertural end; edges evenly rounded, sutures depressed, nearly straight and transverse; wall finely perforate, slightly roughened; aperture a very low arch at the base of the last apertural face, with lip. Length 0.31 mm.; width, 0.14 mm.; thickness, 0.15 mm. Common.

*Plesiotype*.—No. 4915, locality 59, Jackson, Eocene.

**Gümbelina cubensis heterostoma** Bermudez

Plate 24, figs. 7a-b

*Gümbelina cubensis heterostoma* Bermudez, 1937, Soc. Cubana Hist. Nat., Mem., vol. 2, p. 143, pl. 17, figs. 5-7 Eocene, Cuba; Bergquist, 1942, Mississippi State Geol. Surv., Bull. 49 (Fossils), p. 63 upper Eocene, Miss.

Test very small, about eight or nine pairs of chambers biserially arranged; periphery somewhat lobulate; chambers inflated, increasing regularly but rather rapidly in size so that the last two or three pairs of chambers make up half of the test length, maximum width at the apertural end; sutures very little depressed in the early portion, more so in the later part, nearly straight, somewhat oblique; wall finely perforate, somewhat roughened or apparently tending to be reticulate; aperture a distorted arch eccentrically located, with a faint lip or fringe. Length, 0.22 mm.; breadth, 0.13 mm.; thickness, 0.08 mm. Common.

The eccentric aperture of this variety and the comparatively thinner test are the distinguishing features.

*Plesiotype*.—No. 4916, locality 58, Jackson, Eocene.

Genus **GÜMBELITRIA** Cushman, 1933**Gümbelitria stavensis**, new species

Plate 24, figs. 5a-b

Test very small, elongate pyramidal in form; chambers globular, triserial, about twenty-one in number, increasing gradual-

ly in size; wall finely perforate; surface a little uneven; aperture a small, semicircular opening at the base of the last chamber, with an upper lip. Length, 0.21 mm.; diameter, 0.11 mm.

This species differs from *G. columbiana* Howe (1930, Louisiana Dept. Cons., Geol. Bull. 14) in having more chambers which increase much more gradually in size, resulting in a much longer and more slender test. Common.

*Holotype*. No. 4017, locality 10, Tallahatta fm., middle Eocene.

Genus **BOLIVINA** d'Orbigny, 1839

***Bolivina alazanensis*** Cushman

Plate 25, figs. 9a-b

*Bolivina alazanensis* Cushman, 1926, Contr. Cushman Lab. Forum. Res., vol. 1, pt. 4, p. 82, pl. 12, fig. 1 Alazan clay, Oligocene, Mex.; Cushman, 1937, Cushman Lab. Forum. Res., Special Publ. 9, p. 63, pl. 8, figs. 6, 7 upper Eocene Coastal Plain region, U. S. A.; Cushman, 1945, Contr. Cushman Lab. Forum. Res., vol. 21, p. 97, pl. 15, fig. 22 Oligocene, Mex., Venezuela, Cuba; Jackson, Eocene, southeastern U. S. A.

Test elongate, tapering, about  $2\frac{1}{2}$  times as long as broad, somewhat rhomboid in transverse section, very thick in middle then thinning rapidly toward the edges; periphery smooth in early portion, becoming slightly lobulate in the uppermost part, with thin keel in upper part; chambers distinct, curved, much broader than high in the early part but increasing in height toward the apertural end, in the adult developing a distinct angular lobe at the base near the center portion and slightly overlapping the previous chamber; sutures distinct, curved, limbate, in the early portion usually fused in the middle of the test to form a prominent, longitudinal median ridge, slightly broken up toward the apertural end; wall smooth, distinctly and finely perforate; aperture elongate, narrow, with a slight lip. Length, 0.43 mm.; breadth 0.19 mm.; thickness, 0.09 mm. Common.

*Plesiotype*.—No. 4801, locality 58, Jackson, Eocene.

***Bolivina dalli*** (Cushman)

Plate 24, figs. 6a-b

*Bifurina dalli* Cushman, 1926, Contr. Cushman Lab. Forum. Res., vol. 2, p. 31, pl. 4, fig. 5 Jackson, Eocene, Ala.

*Loxostomum dalli* Cushman, 1935, U. S. Geol. Sur., Prof. Paper 181, p. 38, pl. 15, fig. 3; Cushman, 1946, Cushman Lab. Forum. Res., Special Publ. 16, p. 27, pl. 5, fig. 13 upper Eocene, Ala., Panama and one reported occurrence from lower Oligocene Ala.

*Loxostoma dalli* Cushman, 1937, Cushman Lab. Forum. Res., Special Publ. 9, p. 175, pl. 20, figs. 25, 26, 27 upper Eocene Ala.

Test somewhat compressed, oval in section, much elongate with edges and sides nearly parallel, tapering gradually toward the initial end; edges round; apertural end rounded, apex abruptly rounded; chambers eight or nine pairs, increasing gradually in size, only slightly inflated near the apertural end; sutures slightly depressed, oblique; wall very finely perforate; surface ornamented with 10 to 12 small, longitudinal costæ, which are stronger in the first half of the test and extending forward different distances in different specimens; the costæ are lower or not developed along the biserial sutures; aperture an elongate, narrow slit, beginning at the base of the last septal face and extending upward onto the top of the last chamber, there becoming wider, with distinct lip. Length, 0.55 mm.; breadth, 0.18 mm.; thickness, 0.09 mm. Abundant.

In all of the apertural views given of this species and in all of the many specimens found at Little Stave Creek the aperture extends to the base of the septal face. For this reason this species is placed under *Bolivina*.

*Plesiotypic*.—No. 4805, locality 58, Jackson, Eocene.

***Bolivina denticulata*, new species**

Plate 25, figs. 3a-b

Test very small, three times longer than broad, ovate in apertural view, sides tapering very gradually from apertural end four-fifths of the way, then tapering abruptly to the initial end; periphery slightly lobulate or nearly smooth with spinose projections of the lower peripheral angle over the preceding chamber, most pronounced in the lower half of the test; chambers narrow, about nine pairs, increasing very gradually in height, as added, broader than high, very little if at all inflated; sutures distinct, not limbate, slightly depressed, oblique and gently curved; wall smooth, very finely perforate; aperture elongate, oval, with slight lip. Length, 0.26 mm.; breadth, 0.09 mm.; thickness, 0.04 mm. Common.

This species is apparently the ancestor of *B. beyrichi* Reuss (1851, Zeitscher. Deutsch. Geol. Gesell., vol. 3, p. 83, pl. 6, fig. 51) from which it differs in being much smaller with less prominent serrations along the periphery, sutures not limbate in the early part, and in being broader throughout its length.

*Holotype*.—No. 4806, locality 10, Tallahatta fm., Claiborne, Eocene.

***Bolivina hueri* Howe**

Plate 25, figs. 1a-b

*Bolivina hueri* Howe, 1939, Louisiana Dept. Cons., Geol. Bull. 11, p. 65, pl. 9, figs. 3, 4 Cook Mt., middle Eocene, La.

Test small, elongate, thickly elliptical in cross section, rapidly enlarging in the early part, slowly enlarging in the later three-fourths, so that the edges tend to be parallel; sides flat, nearly parallel; edge sharply rounded, sharper for the last few chambers; chambers not inflated, about 10 or 12 pairs, the last three pairs making up half of the test; sutures obscure, flush, arcuate, oblique at the edge; wall finely but conspicuously perforate, the pores enlarging in the secondary surface thickening; surface in general smooth, ornamented by a secondary deposit showing delicate irregularly imbricating or anastomosing striae which tend to be vertically arranged with enlarged pores between; last pair chambers unornamented; aperture a narrow, high slit, with thin lip. Length, 0.54 mm.; breadth, 0.23 mm.; thickness, 0.11 mm. Common.

*Plesiotype*.—No. 4807, locality 40, Yazoo clay, Jackson, Eocene.

***Bolivina jacksonensis* Cushman and Applin**

Plate 25, figs. 2a-b

*Bolivina jacksonensis* Cushman and Applin, 1926, Bull. Amer. Assoc. Petr. Geol., vol. 10, p. 167, pl. 7, figs. 3, 4 upper Eocene, Texas; Cushman, 1935, U. S. Geol. Surv., Prof. Paper 181, p. 37, pl. 14, figs. 11-13; Cushman and Todd, 1945, Contr. Cushman Lab. Forum. Res., vol. 21, p. 95, pl. 15, fig. 14 Moodys marl, Jackson, Eocene, Miss.

Test much compressed, thickest along the median line; periphery smooth, not lobulate; edge acute, not keeled; chambers in about 11 pairs, enlarging rapidly in the early portion, then very gradually in the later part; sutures arcuate, thickest at the top of the arc, slightly limbate in the early part, somewhat depressed in the later portion; wall of the early part with slightly coarser puncta, later portion with finer pores; aperture elongate, narrow, with a slight lip. Length, 0.54 mm.; breadth, 0.23 mm.; thickness, 0.10 mm. Not common.

*Plesiotype*.—No. 4808, locality 30, Lisbon fm., Claiborne, Eocene.

***Bolivina mississippiensis* Cushman**

Plate 25, figs. 4a-b

*Bolivina mississippiensis* Cushman, 1922, U. S. Geol. Surv., Prof. Paper 129 E, p. 92, pl. 15, fig. 5 Vicksburg, Oligocene, Miss.; Cushman and

Todd, 1946, Contr. Cushman Lab. Foram. Res., vol. 22, p. 92 pl. 15, fig. 30 Vicksburg Oligocene (Byram marl), Miss., Ala.

Test elongate, tapering, about  $2\frac{1}{2}$  times longer than broad, ovate in transverse section, greatest breadth near the apertural end; periphery smooth; edge subacute; chambers about 11 pairs broader than high, the base of the chambers in the adult with one or more small re-entrants; sutures distinct, limbate, crenulate, curved, strongly oblique; wall finely perforate, ornamented only with re-entrants; aperture a narrow, oval opening extending to the base of the septal face with a slight lip. Length, 0.52 mm.; breadth, 0.20 mm.; thickness, 0.11 mm. Common.

*Plesiotypic*.—No. 4809, locality 64, Mint Spring marl, Vicksburg, Oligocene.

***Bolivina regularis* Nuttall**

Plate 25, figs. 10a-b

*Bolivina regularis* Nuttall, 1928, Geol. Soc. London, Quart. Jour., vol. 84, p. 74, pl. 3, fig. 8 Oligocene, Trinidad.

Test small, elongate, about  $2\frac{1}{2}$  times longer than broad, flattened ovate in apertural view; edge sharply rounded; periphery smooth, noncarinate; chambers closely appressed, about 9 or 10 pairs, width greater than height, enlarging gradually; sutures slightly curved, oblique to edge, broadly limbate and raised medially, becoming narrower and less raised toward the periphery, somewhat fused along the median portion of the test forming a low ridge, particularly in the early part; wall very finely perforate surface smooth excepting for the marked sutural limbations; aperture elongate with lip. Length, 0.31 mm.; breadth, 0.11 mm.; thickness, 0.04 mm. Common.

The specimens from Little Stave Creek seem to be slightly broader and with somewhat less curvature to the sutures.

*Plesiotypic*.—No. 4812, locality 10, Tallahatta fm., Claiborne, Eocene.

***Bolivina retifera*, new species**

Plate 24, figs. 10a-b

Test subcuneiform in side view, strongly compressed, about  $1\frac{1}{2}$  to 2 times longer than broad; edge acute, carinate; periphery lobulate in later part; chambers 10 to 12, gradually enlarging; wall finely perforate; surface highly ornamented by raised arcuate sutures which fuse along the median line to form a zigzag ridge or costa; the outside of each chamber slopes inward and upward, and excepting for the last one or two pairs, is ornamented by

coarse puncta surrounded by raised rims, making a finely reticulate pattern; apical end most thickened and irregularly reticulate; aperture an oval slit, extending from the base of the last septal face upwards a short distance, bordered by a strong lip. Length, 0.72 mm.; breadth, 0.33 mm.; thickness of compressed adult chambers, 0.08 mm. Common.

This species slightly resembles *B. byramensis* Cushman (1923, U. S. Geol. Sur., Prof. Paper 133, p. 19, pl. 1, fig. 9) but differs from it in the carinate edge, more elongate form, finer reticulation, and the median ridge formed by the fusion of the sutures.

*Holotype*.—No. 4804, locality 59, Jackson, Eocene.

***Bolivina salebrosa*, new species**

Plate 25, figs. 6a-b

Test small, ovate in end view, very elongate, narrow, about three times longer than broad; periphery smooth; edge acute, not keeled; chambers about 11 or 12 pairs, enlarging gradually; sutures slightly limbate, flush; wall of lower two-thirds of test characterized by roughened thickening with rather coarse perforations, surface of last few chambers smooth with moderate perforations; aperture elongate, narrow, with a slight lip. Length, 0.52 mm.; breadth, 0.18 mm.; thickness, 0.09 mm. Not common.

This species is readily distinguished from *B. jacksonensis* Cushman and Applin by its relatively much narrower and thicker test and from *B. hueri* Howe by the lanceolate form and less surface ornamentation.

*Holotype*.—No. 4810, locality 43, Moodys marl, Jackson, Eocene.

***Bolivina striatellata*, new name**

Plate 24, figs. 8a-b, 9a-b

*Bolivina jacksonensis striatella* Cushman and Applin, 1926, Bull. Amer. Assoc. Petr. Geol., vol. 10, p. 167, pl. 7, figs. 5, 6 upper Eocene Tex.; Cushman, 1935, U. S. Geol. Sur., Prof. Paper 181, pl. 14, figs. 14-18 upper Eocene, S. C., Ala., Miss.; Cushman, 1937, Cushman Lab. Forum. Res., Special Publ. 9, p. 58, pl. 7, figs. 19-21; Cushman and Todd, 1945, Contr. Cushman Lab. Forum. Res., vol. 21, p. 96, pl. 15, fig. 15 Moodys marl, upper Eocene Miss.

Test elongate, much compressed, thickest along the median line, about  $2\frac{1}{3}$  times as long as broad; periphery with thickened keel, most prominent in upper half of test, apical end bluntly rounded; edge sharply rounded; chambers about 20, closely



appressed, increasing gradually in size, peripheral portions extending strongly backward, median portion slightly curved back; sutures distinct, limbate and raised on the upper portion of the test, flush and covered over in the early part, curved strongly back near the periphery, raised and fused in the median line to form a longitudinal costa or ridge; wall finely perforate; surface ornamented with a few fine longitudinal costæ in the early part of the test; aperture elongate, extending from the base of the last chamber part of the way up the septal face. Length, 0.60 mm.; breadth, 0.28 mm.; thickness, 0.03 mm. Common.

The name *B. jacksonensis striatella* Cushman and Applin is preoccupied by *B. advena striatella* Cushman (1925, Contr. Cushman Lab. Forum. Res., vol. 1, p. 30, pl. 5, fig. 3) and is, therefore, not valid.

*Plesiotype*.—No. 4802 (figs. 8a-b); plesiotype, No. 4803 (figs. 9a-b), locality 58, Jackson, Eocene.

***Bolivina taylori* Howe**

Plate 25, figs. 5a-b

*Bolivina taylori* Howe, 1939, Louisiana Dept. Cons., Geol. Bull. 14, p. 67, pl. 9, figs. 9, 10 Cook Mt., Eocene, La.; Cushman and Applin, 1943, Contr. Cushman Lab. Forum. Res., vol. 19, p. 39, pl. 7, fig. 27 Yegua, Eocene Tex.; Cushman and Todd, 1945, Contr. Cushman Lab. Forum. Res., vol. 21, p. 17, pl. 4, fig. 9 Lisbon fm., Claiborne, Eocene, Ala.

Test about  $2\frac{1}{2}$  times longer than broad, compressed ovate in end view; periphery smooth, not keeled; edge sharply rounded; chambers of uniform shape, increasing regularly in size as added, not inflated; sutures very distinct, limbate, strongly arched, oblique, not depressed, slightly raised at the intersection of sutures; wall smooth, finely perforate; aperture elongate, rather narrow. Length, 0.34 mm.; breadth, 0.13 mm.; thickness, 0.05 mm. Common.

The Little Stave Creek form seems to be very near, if not conspecific with, *B. taylori* Howe differing only, perhaps, in being slightly thicker. However, a comparison of measurements with those given by Dr. Howe indicates very little difference in this respect. Some variation in the relative breadth and taper of the test is apparent in the specimens from Little Stave Creek.

*Plesiotype*.—No. 4813, locality 15, Lisbon fm., Claiborne, Eocene.



Genus **LOXOSTOMUM** Ehrenberg, 1854**Loxostomum baculum**, new species

Plate 25, figs. 8a-b

Test small, fairly slender, oval in cross section, apertural end blunt, initial end rounded; chambers about eight pairs, slightly inflated; sutures oblique, somewhat depressed, especially in the later portion, earlier ones nearly straight, later ones arcuate; wall thick, coarsely perforate; aperture oval, terminal or sub-terminal, with a definite lip. Length, 0.38 mm.; breadth, 0.12 mm.; thickness, 0.08 mm. Common.

This form is similar to *Bolivina gracilis* Cushman and Applin (1926, Bull. Amer. Assoc. Petr. Geol., vol. 10), differing in the definite terminal aperture and more rounded apex. *L. claibornense* Cushman (1936, Cushman Lab. Foramin. Res., Special Publ. 6) has sigmoid sutures.

*Holotype*.—No. 4941, locality 58, Jackson, Eocene.

**Loxostomum serrula**, new species

Plate 25, figs. 11a-b

Test elongate, about four times longer than broad, slightly compressed, periphery slightly lobate, with spinelike projections downward from the lower peripheral edge of each chamber; chambers distinct, about eight pairs, increasing rapidly in height, especially in the adult, where they are fully twice as high as broad, very slightly inflated if at all; sutures distinct, not limbate, flush with the surface in the early part, slightly depressed in the later portion, slightly oblique in the early portion, strongly oblique in the adult portion, curved downward especially at the outer edge; wall smooth, finely perforate, unornamented excepting for the peripheral spines; aperture terminal, oval, with slight lip. Length, 0.45 mm.; breadth, 0.12 mm.; thickness, 0.07 mm. Rare.

*Bolivina beyrichi* Reuss (1851, Zeitschr. Deutsch. Geol. Gesell., vol. 3, p. 83, pl. 6, fig. 51) is broader, the cameral spines longer, and the aperture is bolivine.

*Holotype*.—No. 4811, locality 10, Tallahatta fm., Claiborne, Eocene.

Genus **BIFARINA** Parker and Jones, 1872**Bifarina vicksburgensis** (Cushman)

Plate 25, figs. 7a-b

*Bolivina vicksburgensis* Cushman, 1922, U. S. Geol. Sur., Prof. Paper 129-F, p. 126, pl. 29, fig. 2 Vicksburg, Oligocene, Miss.

*Bifarina vicksburgensis* Cushman, 1929, Contr. Cushman Lab. Foramin. Res., vol. 5, p. 45, pl. 8, figs. 3, 4 Oligocene, Miss.; 1937, Cushman Lab. Foramin. Res., Special Publ. No. 9, p. 198, pl. 22, figs. 29-33 Oligocene, Miss., Tex., and Mex.

Test very elongate, about five times as long as broad, little compressed, more so in the early biserial portion, adult portion staggered uniserial becoming uniserial; periphery in the young serrate, due to the projections of the basal angle of each chamber, in the adult somewhat lobate; chambers 10 to 11 pairs, in the early portion wider than high, in the adult height and breadth about equal, somewhat inflated in the later portion; sutures distinct, in the early portion slightly depressed and making an angle of about  $45^{\circ}$  with the horizontal, in the adult portion much depressed and approaching the horizontal; wall coarsely perforate, the perforations having a tendency to be arranged in longitudinal lines; aperture terminal, oval, with a distinct lip. Length, 0.50 mm.; breadth, 0.10 mm. Common.

This is apparently the lowest reported occurrence in the column of this distinctive little species. It is common in the sample from locality 58.

*Plesiotype*.—No. 4799, locality 58, Jackson, Eocene.

Genus **BITUBULOGENERINA** Howe, 1934

**Bitubulogenerina howei** Cushman

Plate 25, figs. 12a-b

*Gaudryina*, sp. Cushman, 1922, U. S. Geol. Sur., Prof. Paper 129-F, p. 127, pl. 29, fig. 6 Mint Spring marl, Oligocene.

*Bitubulogenerina*, sp. Howe, 1934, Jour. Paleont., vol. 8, pl. 51, fig. 4 Mint Spring marl, Oligocene.

*Bitubulogenerina howei* Cushman, 1935, Contr. Cushman Lab. Foramin. Res., vol. 11, pt. 1, p. 20, pl. 3, figs. 10-12 Mint Spring marl, Oligocene; Bergquist, 1942, Mississippi State Geol. Sur., Bull. 49 (Fossils), p. 72, pl. 7, fig. 25 Yazoo clay, Eocene.

Test elongate, early portion tapering, triserial, later adult portion biserial, with sides nearly parallel, very slightly compressed; periphery rounded and lobulate; chambers distinct, inflated, the early triserial chambers increasing rapidly in size, the biserial ones increasing gradually as added; sutures fairly distinct, strongly depressed; wall calcareous, coarsely perforate, with reticulate and finely spinose surface, with rough appearance; aperture in adult terminal, nearly median, large, rounded, with thick lip. Length, 0.31 mm.; breadth, 0.16 mm.; thickness, 0.13 mm. Not common.

*Plesiotype*.—No. 4800, locality 64, Mint Spring marl, Vicksburg, Oligocene.

Family **BULIMINIDÆ** Jones, 1876

Genus **REUSELLA** Galloway, 1933

**Reusella moodyensis**, new species

Plate 25, figs. 13a-b

Test elongate, trihedral, angles acute, sides slightly concave, in the adult form, widest slightly above the middle, triangular in transverse section; surface smooth; wall very finely perforate; sutures curved rather strongly downward toward the periphery, also deflected downward near the inner end of the chamber; chambers with small, thickened flaps developed at their lower inner margin overlapping the previous chamber slightly; aperture a small arched opening at the base of the last septal face, centrally located, with small upper lip. Length, 0.58 mm.; width of one side, 0.34 mm. Common.

The small inner thickened flaps, smooth surface, and sutural character distinguish this species from the other forms of this genus. *R. cocca* (Cushman) (1933, Contr. Cushman Lab. Foram. Res., vol. 9) has thickened angles in the adult. *R. moodyensis* does not exhibit such thickening in any of the growth stages. It is more slender and the sides are only slightly concave. The small thickened flaps are variable and in some individuals they are almost indistinguishable except when accentuated by staining methods.

*Holotype*.— No. 5002, locality 43, Moodys marl member, Jackson, Eocene

Genus **BULIMINA** d'Orbigny, 1826

**Bulimina byramensis** Cushman and Todd

Plate 25, figs. 14a-b

*Bulimina byramensis* Cushman and Todd, 1946, Contrib. Cushman Lab. Foram. Res., vol. 22, p. 91, pl. 15, figs. 25, 26 Byram marl, Vicksburg, Oligocene, Miss.

Test small, three-sided, straight or slightly twisted pyramidal or tapering at both ends, initial end subacute, greatest width above the middle, angles rounded, sides flat or slightly concave; chambers closely appressed, not inflated, six or seven whorls; sutures oblique, nearly flush, slightly curved; wall smooth, finely perforate; aperture small, virguline, not in a depression. Length, 0.34 mm.; diameter, 0.17 mm.

*Plesiotype*.— No. 4814, locality 64, Mint Spring marl, Vicksburg, Oligocene.

***Bulimina elongata* d'Orbigny**

Plate 25, fig. 15

*Bulimina elongata* d'Orbigny, 1846, Foraminifères fossiles du bassin tertiaire de Vienne, p. 187, pl. 11, figs. 19, 20 (not *Bulimina elongata* d'Orbigny, 1801, *nomen nudum*; Fornasini, 1901); Cushman and Parker, 1937, Contr. Cushman Lab. Foram. Res., vol. 13, p. 49, pl. 7, figs. 2, 3 Miocene, Vienna Basin; 1947, U. S. Geol. Sur., Prof. Paper 210-D, p. 108, pl. 25, figs. 15, 17 (not 14, 16) Miocene Austria.

Test elongate conical, twisted, enlarging from the subacute initial end to the greatest breadth at the last formed whorl, about  $2\frac{1}{2}$  times as long as broad, consisting of five or six whorls; chambers moderately inflated, twisted triserial, so that the chambers do not appear in vertical tiers, increasing rather uniformly in size as added; sutures curved, oblique, depressed; wall smooth, finely perforate; aperture virguline, oblique, in an oval depression in the septal face.

It would seem best to restrict this species to forms agreeing closely with the type figure from the Miocene as is the present practice for other species of Foraminifera.

*Plesiotype*.— No. 4819, locality 58, Jackson, Eocene.

***Bulimina jacksonensis* Cushman**

Plate 26, figs. 5a-b

*Bulimina jacksonensis* Cushman, 1925, Contr. Cushman Lab. Foram. Res., vol. 1, pt. 1, p. 6, pl. 1, figs. 6, 7 upper Eocene, Mex.; 1946, Cushman Lab. Foram. Res., Special Publ. 16, p. 23, pl. 5, fig. 1 Jackson Eocene, S. C., Fla., Ala., Miss., Tex., Venezuela, and Trinidad; Cushman and Parker, 1947, U. S. Geol. Sur., Prof. Paper 210-D, p. 97, pl. 22, figs. 14-16 upper Eocene, Ala., Mex.

Test large, elongate oval, tapering, initial end bluntly pointed or subacute, apertural end broadly rounded; chambers in seven to eight triserial whorls, in three regular tiers, the later ones slightly inflated; sutures flush in the early part and slightly depressed in the later part; surface smooth, ornamented by six to eight prominent, sharp, serrate, longitudinal costæ, much raised above the surface, continuous from base of test to last chamber; aperture virguline, nearly terminal or in a low, broad depression, with narrow lip. Length, 0.80 mm.; diameter, 0.43 mm. Abundant.

*Plesiotype*.— No. 4817, locality 58, Jackson, Eocene.

***Bulimina jacksonensis cuneata* Cushman**

Plate 26, fig. 4

*Bulimina jacksonensis cuneata* Cushman, 1926, Contr. Cushman Lab. Foram. Res., vol. 2, p. 35 upper Eocene, Ala.; Cushman, 1935, U. S. Geol. Sur., Prof. Paper 181, p. 35, pl. 13, figs. 10, 11 upper Eocene S. C., Ala.

This variety differs from the species in being more tapered, larger and with about 10 or 12 serrate costæ whereas the species

has only six or eight less serrate costæ. Length, 0.90 mm.; diameter, 0.48 mm. Common.

*Plesiotype*.—No. 4818, locality 58, Jackson, Eocene.

**Bulimina simplex** Terquem

Plate 26, figs. 3a-b

*Bulimina simplex* Terquem, 1882, Soc. Géol. France, Mém., ser. 3, vol. 2, p. 109, pl. 11 (19), figs. 23, 24 Eocene, Paris Basin; Cushman and Parker, 1937, Contr. Cushman Lab. Forum. Res., vol. 13, p. 67, pl. 9, fig. 4 (topotype); Cushman and Todd, 1945, Contr. Cushman Lab. Forum. Res., vol. 21, p. 17, pl. 4, fig. 5 Lisbon fm., middle Eocene, Ala.; Cushman and Parker, 1947, U. S. Geol. Sur., Prof. Paper 210-D, p. 89, pl. 21, fig. 9 Eocene, Paris Basin and Lisbon fm., Claiborne, Eocene, Ala.

Test small, elongate, tapering from the broad apertural end to the acute apex, about  $2\frac{1}{2}$  times as long as broad, consisting of five or six whorls; chambers moderately inflated, regularly triserial, appearing in vertical tiers, increasing rather uniformly in size as added; sutures straight, depressed; wall smooth, finely perforate; aperture small, virguline, in a shallow, oval depression, with neither tooth nor lip. Length, 0.39 mm.; diameter, 0.14 mm. Common.

*Plesiotype*.—No. 4821, locality 7, Tallahatta fm., Claiborne, Eocene.

**Bulimina simplex comis**, new variety

Plate 25, figs. 16a-b

Test small, fusiform, three-sided, with round edges, about  $2\frac{1}{2}$  times as long as broad; chambers in about five or six whorls, closely appressed, slightly inflated and in three vertical tiers sutures straight, transverse, depressed; wall smooth, finely perforate; aperture small, long, narrow, virguline, nearly terminal. Length, 0.26 mm.; diameter, 0.09 mm. Not common.

This variety differs from the species in the fusiform shape and the much smaller, narrow aperture. Several specimens were found at locality 7, all having the same character.

*Holotype*.—No. 4815, locality 7, Tallahatta fm., Claiborne, Eocene.

**Bulimina socialis** Borneman

Plate 26, figs. 1a-b

*Bulimina socialis* Bornemann, 1855, Zeitsch. Deutsch. Geol. Gesell., vol. 7, p. 342, pl. 16, fig. 10 middle Oligocene, Germany; Cushman, 1937, Contr. Cushman Lab. Forum. Res., vol. 13, p. 36, pl. 4, figs. 1 a-c middle Oligocene, Germany; Cushman and Parker, 1947, U. S. Geol. Sur., Prof. Paper 210-D, p. 102, pl. 24, fig. 3 middle Oligocene, Germany.

*Bulimina* sp., Cushman and Applin, 1926, Bull. Amer. Assoc. Petr. Geol., vol. 10, p. 169, pl. 7, figs. 10-11 upper Eocene, Tex.

*Bulimina ovata* Nuttall (not d'Orbigny), 1932, Jour. Paleont., vol. 6, p. 19, pl. 2, fig. 8 lower Oligocene, Mex.

Test oval in side view, about 1.6 times as long as broad, widest about midway between apical and apertural ends, both ends of test rounded; test roughly circular in end view; two whorls visible; chambers slightly inflated, the three chambers of the last whorl constituting three-fourths of the test; sutures curved, somewhat depressed; wall finely perforate, smooth; aperture virguline, without tooth or lip. Common.

*Plesiotype*.—No. 4820, locality 10, Tallahatta fm., Claiborne, Eocene.

***Bulimina trigona* Terquem**

Plate 25, figs. 17a-b, 18a-b

*Bulimina trigona* Terquem, 1882, Soc. Géol. France, Mém., ser. 3, vol. 2, p. 110, pl. 11 (19), figs. 28, 29 middle Eocene, Paris Basin; Cushman and Todd, 1945, Contr. Cushman Lab. Foran. Res., vol. 21, p. 17, pl. 4, fig. 6 Lisbon fm., middle Eocene, Ala.; Cushman and Parker, 1947, U. S. Geol. Sur., Prof. Paper 210-D, p. 91, pl. 21, fig. 18 middle Eocene, Paris Basin, Ala.

Test nearly twice as long as broad, flaring rapidly, widest at the last whorl, apertural end broadly rounded, initial end more sharply rounded; chambers moderately inflated, increasing rapidly in size and height as added, the last whorl making up about two-thirds of the test; sutures transverse, depressed; wall finely perforate, smooth; aperture virguline, in a deep oval depression; no tooth or lip observed. Length (fig. 18), 0.38 mm.; maximum diameter, 0.23 mm. Common.

The two figures display possible megaspheric and microspheric individuals. They are very similar in general. The dimensions of the specimen in figure 17 are: length, 0.39 mm.; maximum diameter, 0.19 mm.

*Plesiotype*.—No. 4822 (fig. 17, megaspheric specimen); plesiotype No. 4823 (fig. 18 microspheric specimen), locality 14, Lisbon fm., Claiborne, Eocene.

Genus **VIRGULINA** d'Orbigny, 1826

***Virgulina dibollensis* Cushman and Applin**

Plate 26, figs. 9a-b

*Virgulina dibollensis* Cushman and Applin, 1926, Bull. Amer. Assoc. Petr. Geol., vol. 10, p. 168, pl. 7, fig. 7 upper Eocene, Tex.; Cushman, 1932, Contr. Cushman Lab. Foran. Res., vol. 8, p. 21, pl. 3, fig. 14 upper Eocene, Gulf Coastal Plain; 1937, Cushman Lab. Foran. Res. Special Publ. 9, p. 7, pl. 1, fig. 20 (not 21, 22, see *V. dibollensis* sub-



*transversalis*, n. var.) Eocene, Tex.

Test elongate, slender, slightly twisted, somewhat compressed laterally,  $4$  or  $4\frac{1}{2}$  times as long as broad; edges rounded; early chambers vaguely triserial and spiral, later ones biserial, the last three or four making up the last half of the test; sutures indistinct, flush or very slightly depressed, curved and strongly oblique; periphery little lobulate; wall smooth, finely perforate; aperture elongate, narrow. Length, 0.50 mm.; breadth, 0.14 mm.; thickness, 0.08 mm.

*Plesiotype*.—No. 5068, locality 58, Jackson, Eocene.

*Virgulina dibollensis subtransversalis*, new variety Plate 26, figs. 10a-b  
*Virgulina dibollensis* Cushman, 1937, Cushman Lab. Foram. Res., Special Publ. 9, pl. 1, figs. 21, 22 (not 20) upper Eocene, Texas, La.

Test elongate, slender, about four times as long as broad, somewhat compressed laterally, twisting about  $90^\circ$ , broadest near the apertural end; early few chambers in a high triserial spire, quickly becoming biserial, the last four or five making up half of the test; edge round; sutures nearly transverse, usually flush; median sutures tending to be in a nearly vertical line; periphery smooth, very slightly lobulate; wall smooth, finely perforate; aperture elongate, extending well up on the last septal face. Length, 0.47 mm.; breadth, 0.14 mm.; thickness, 0.08 mm. Rare.

The more nearly transverse septa and the greater twisting of this form distinguish it from *V. dibollensis* Cushman and Applin.

*Holotype*.—No. 5069, locality 7, Tallahatta fm., Claiborne, Eocene.

*Virgulina polymorpbinoidea*, new species Plate 26, figs. 13a, b

Test elongate, compressed laterally, rather slender, sides and edges nearly parallel, about three times as long as broad; early chambers high-spired triserial, most of the test biserial, with six or seven pairs, little if at all inflated, broader than high, overlapping considerably; sutures moderately curved, slightly depressed, more so in the later part, strongly oblique to the periphery; wall smooth, finely perforate; aperture elongate, virguline, nearly vertical, extending from the base to the top of the last septal face, without definite lip. Length, 0.51 mm.; breadth, 0.15 mm.; thickness, 0.09 mm. Rare.

This species differs from *V. dibollensis* Cushman and Applin (1926, Bull. Amer. Assoc. Petr. Geol., vol. 10) in having parallel

sides throughout most of the length rather than tapering and in being relatively broader.

*Holotype*.—No. 5067, locality 14, Lisbon fm., Claiborne, Eocene.

Genus **BULIMINELLA** Cushman, 1911

***Buliminella biformata***, new species

Plate 26, figs. 2a-b

Test bifurmed, elongate, slender,  $2\frac{1}{2}$  or 3 times as long as broad, early part tightly coiled, with small and closely appressed chambers, later portion of about two or three whorls, abruptly and strongly inflated and enlarged; chambers in about five or six whorls, oblique to the axis; sutures flush with the surface in the early closely appressed portion, depressed in the later, inflated part; wall smooth, finely perforate; aperture large and virguline, with slight lip. Length, 0.51 mm.; maximum diameter, 0.19 mm. Common.

This species is distinguished by the bifurmed character.

*Holotype*.—No. 4816, locality 58, Jackson, Eocene.

***Buliminella longicamerata***, new species

Plate 26, figs. 8a-c

Test fairly large, subfusiform, greatest width somewhat above the middle; chambers elongate, inflated, about four to a whorl the chambers of the last whorl and one-half making up nearly the entire test; sutures oblique, curved, depressed; wall smooth, finely perforate; aperture rather small, virguline, extending from the base of the last septal face onto the summit of the last chamber. Length, 0.67 mm.; diameter, 0.26 mm. Rare.

The large, inflated, elongate chambers are distinctive of this species.

*Holotype*.—No. 4824, locality 58, Jackson, Eocene.

***Buliminella pulchra*** (Terquem)

Plate 26, figs. 6a-b

*Bulimina pulchra* Terquem, 1882, Soc. Géol. France, Mém., ser. 3, vol. 2, p. 114, pl. 12, figs. 8-12 Eocene, France.

*Buliminella pulchra* Cushman and Parker, (not Tolmachoff), 1937, Cushman Lab. Foram. Res. Contr., vol. 13, p. 69, pl. 10, figs. 1, 2 Eocene, France; 1947, U. S. Geol. Sur., Prof. Paper 210-D, p. 61, pl. 16, figs. 5, 6 Eocene, France, Germany and London clay, England.

Test small, about three times as long as broad, composed of about four whorls, the last forming about two-thirds the length of the test; chambers slightly inflated, about five in the adult whorl, increasing gradually in size as added; sutures slightly



curved, spiral suture depressed, others nearly flush; wall smooth, finely perforate; aperture virguline, nearly vertical, extending from the last suture up into the last septal face. Length, 0.27 mm.; diameter, 0.09 mm. Rare.

This form seems to be smaller and somewhat more slender than Terquem's species, but otherwise they are alike.

*Plesiotypic*.—No. 4825, locality 58, Jackson, Eocene.

Family CASSIDULINIDÆ d'Orbigny, 1839

Genus CASSIDULINA d'Orbigny, 1826

*Cassidulina alabamensis*, new species Plate 26, figs. 11a-b

Test equally biconvex, bumbonate, circular in side view; periphery smooth, keeled; chambers five pairs in adult, recurved around the central umbo with the inner ends club-shaped; sutures narrowly limbate, flush, meeting periphery at an angle; wall smooth, conspicuously perforate; aperture an elongate comma-shaped slit extending upward from the base of the last apertural face along the plane of coiling a short distance, with a slight lip. Diameter, 0.27 mm.; thickness, 0.12 mm. Not common.

This species most nearly resembles *C. reflexa* Galloway and Wissler (1927, Jour. Paleont., vol. 1), from which it is distinguished by its keel, more compressed character, and smaller aperture. The smooth keeled periphery also sets this form off from *C. carapitana* Hedberg (1937, Jour. Paleont., vol. 11).

*Holotype*.—No. 4829, locality 58, Jackson, Eocene.

*Cassidulina armosa*, new species Plate 26, figs. 12a-b

Test biconvex, bumbonate, subcircular in side view; periphery slightly lobulate, not carinate; edge sharply rounded or angled; chambers short and wide with nearly parallel edges in the last few chambers, about five pairs in the last whorl; sutures slightly curved, limbate, slightly depressed particularly near the periphery; wall smooth, finely perforate; aperture an elongate slit at the base of the last septal face with a projecting flap concealing most of it. Diameter, 0.34 mm.; thickness, 0.17 mm. Not common.

This species is similar to *C. galviniensis* Cushman and Frizzell (1940, Contr. Cushman Lab. Foram. Res., vol. 16) in general appearance. However, this form does not have the keel and has a distinctive aperture.

*Holotype*.—No. 4830, locality 58, Jackson, Eocene.

**Cassidulina subglobosa** Brady

Plate 26, figs. 7a-b

*Cassidulina subglobosa* Brady, 1881, Quart. Jour. Mier. Soc., vol. 21, p. 60; 1884, Rep. Voy. *Challenger* Zool., vol. 9, p. 430, pl. 54, figs. 17a-c Recent, Atlantic and Pacific Oceans; Galloway and Morrey, 1929, Bull. Am. Paleont., vol. 15 (55), p. 40, pl. 6, fig. 6 lower Oligocene, Ecuador; Galloway and Heminway, 1941, New York Acad. Sci. Sci. Survey Porto Rico and the Virgin Islands, vol. 3, pt. 4, p. 425, pl. 32, figs. 2a, b Oligocene, Porto Rico.

Test subglobular, only very slightly compressed on the sides; broadly oval in side and edge views; edge broadly rounded; chambers few, three pairs in the last whorl, little inflated; sutures little depressed; surface smooth, wall finely perforate; aperture a virguline opening extending up onto the last septal face, obliquely to the plane of coiling. Diameter, 0.34 mm.; thickness, 0.26 mm. Common.

*Plesiotyph.*—No. 4831, locality 58, Jackson, Eocene.

Family **UVIGERINIDÆ** Galloway and Wissler, 1927

Genus **UVIGERINA** d'Orbigny, 1826

**Uvigerina cocoaensis** Cushman

Plate 26, fig. 14

*Uvigerina cocoaensis* Cushman, 1925, Contr. Cushman Lab. Foram. Res., vol. 1, p. 68, pl. 10, fig. 12 upper Eocene, Ala.; 1935, U. S. Geol. Sur., Prof. Paper 181, p. 39, pl. 15, figs. 11-13 upper Eocene Ala., Miss.; 1946, Cushman Lab. Foram. Res., Special Publ. 16, p. 28, pl. 5, figs. 15-20 upper Eocene, Ala.

Test large, somewhat elongate conical, greatest width slightly above the middle; periphery moderately lobulate; chambers relatively few, evenly rounded; sutures slightly depressed, curved; wall ornamented with coarse longitudinal costæ, usually terminating at the suture lines, becoming lower and less conspicuous in later chambers, the last chamber in the adult usually smooth; about 12 to 16 costæ in the complete circumference in the widest region; wall finely perforate; aperture at the end of a short neck with a phialine lip. Length, 0.66 mm.; diameter, 0.35 mm. Very abundant.

*Plesiotyph.*—No. 5054, locality 58, Jackson, Eocene.

**Uvigerina curta** Cushman and Jarvis

Plate 27 figs. 1a-b

*Uvigerina curta* Cushman and Jarvis, 1929, Contr. Cushman Lab. Foram. Res., vol. 5, p. 13, pl. 3, figs. 13-15 Eocene, Trinidad; Cushman and Edwards, 1937, Contr. Cushman Lab. Foram. Res., vol. 13, p. 77 pl. 11, figs. 12, 13.

Test small, very short and stout, only slightly longer than broad; chambers few, inflated; sutures depressed, early ones somewhat obscured by ornamentation; wall of the early portion

with high, thin costæ, some independent on each chamber, others continuous, about 12 costæ in circumference, usually obsolete on the last chamber or two; aperture with a short cylindrical neck in a small depression on the apertural face, with a thin phialine lip, oblique to the axis of the test, aperture sometimes double. Length, 0.53 mm.; diameter, 0.35 mm. Common.

*Plesiotype*.—No. 5055, locality 58, Jackson, Eocene.

***Uvigerina danvillensis* Howe and Wallace** Plate 26, fig. 15

*Uvigerina danvillensis* Howe and Wallace, 1932, Louisiana Dept. Cons., Geol. Bull. 2, p. 62, pl. 12, fig. 5 upper Eocene, La.; Bergquist, 1942, Mississippi State Geol. Sur., Bull. 49 (Fossils), p. 76, pl. 8, fig. 1 upper Eocene, Miss.

Test short, subfusiform, greatest diameter near the midportion, about two times as long as wide, almost circular in transverse section; shoulders sloping to round; chambers inflated, regularly triserial; sutures mostly distinct, depressed, mostly transverse; wall ornamented with about 14 high platelike costæ, some extending across two or three chambers, strongest toward the initial end; wall finely perforate; aperture large, circular, eccentric, at the end of a moderately long neck with delicate phialine lip frequently broken. Length, 0.81 mm.; diameter, 0.45 mm. Common.

*Plesiotype*.—No. 5056, locality 59, Jackson, Eocene.

***Uvigerina dumblei* Cushman and Applin** Plate 27, figs. 6

*Uvigerina dumblei* Cushman and Applin, 1926, Bull. Amer. Assoc. Petr. Geol., vol. 10, p. 177, pl. 8, fig. 19 upper Eocene, Tex.; Cushman, 1946, Cushman Lab. Foram. Res., Special Publ. 16, p. 28, pl. 5, fig. 21 upper Eocene, Ala.

Test large, fusiform, sides nearly parallel for most of the length, about twice as long as broad; periphery lobulate; chambers inflated, regularly three to a whorl; sutures depressed; wall ornamented with numerous fine longitudinal costæ, often 10 to 12 to a single chamber, partly continuous across sutures, partly stopping at the sutures; aperture round, terminal, with short neck, usually lacking a lip. Length, 0.73 mm.; diameter, 0.33 mm. Common.

*Plesiotype*.—No. 5057, locality 58, Jackson, Eocene.

***Uvigerina gardneræ* Cushman** Plate 27, fig. 2

*Uvigerina gardneræ* Cushman, 1926, in Cushman and Applin, Bull. Amer. Assoc. Petr. Geol., vol. 10, p. 175, pl. 8, figs. 16, 17 upper Eocene, Tex.; Cushman, 1946, Cushman Lab. Foram. Res., Special Publ. 16, p. 29, pl. 6, figs. 3-5 upper Eocene, Ala.

Test of medium size, short fusiform, with sloping shoulders and blunt initial end; periphery lobulate; chambers inflated, in about seven regular whorls, early chambers with basal ends tending to overhang the preceding ones; sutures moderately deep; wall ornamented with longitudinal costae, about 20 around the greatest circumference, tending to break up into spines in the later portion, the last chambers with short, strong spines, not in line; aperture at the end of a slightly tapering neck, with phialine lip. Length, 0.61 mm.; diameter, 0.30 mm. Common.

*Plesiotypic*.—No. 5058, locality 58, Jackson, Eocene.

***Uvigerina glabrans* Cushman**

Plate 27, fig. 3

*Uvigerina glabrans* Cushman, 1933, Contr. Cushman Lab. Foram. Res., vol. 9, p. 13, pl. 1, fig. 28 upper Eocene, Ala.; 1946, Cushman Lab. Foram. Res., Special Publ. 16, p. 28, pl. 5, figs. 23-26 upper Eocene, Ala.

Test of medium size, short fusiform, greatest width about the middle; periphery very little lobulate; chambers in three or four whorls, somewhat inflated, evenly rounded; sutures little depressed; surface nearly smooth, vaguely costate in the earlier part; wall finely perforate; apertural end truncate, with a short thick, cylindrical neck and phialine lip. Length, 0.73 mm.; maximum diameter, 0.38 mm. Common.

The figured specimen is somewhat shorter than the average and lacks the traces of costae usually occurring near the apertural end. There is a gradation from the smooth to the slightly costate form in the various specimens.

*Plesiotypic*.—No. 5059, locality 58, Jackson, Eocene.

***Uvigerina microspinosa*, new species**

Plate 27, figs. 7a-b

Test elongate conical, sides subparallel, tapering gradually toward the subacute apex, rounded in transverse section; shoulders sloping; chambers regularly triserial, spiral, somewhat inflated, early chambers wider than high, later chambers higher than wide; wall finely perforate; surface finely spinose; aperture terminal, round, with a short neck, very slight lip. Length, 0.39 mm.; maximum diameter, 0.13 mm. Not common.

*Holotype*.—No. 5053, locality 58, Jackson Eocene.

***Uvigerina nuttalli* Cushman and Edwards**

Plate 27, fig. 4

*Uvigerina canariensis* d'Orbigny var. Nuttall, 1933, Jour. Paleont., vol. 6, p. 22, pl. 5, fig. 9 holotype, lower Oligocene, Mex.

*Uvigerina nuttalli* Cushman and Edwards, 1938, Contr. Cushman Lab. Foram. Res., vol. 14, p. 82, pl. 14, figs. 3-5 Oligocene, Mex.

Test 2 to 2½ times as long as broad, tapering, greatest breadth toward the apertural end which is usually somewhat truncate or rounded; chambers slightly inflated, regularly triserial, increasing rapidly in size as added; sutures little depressed; wall ornamented with very low, longitudinal costæ, in part continuous over the sutures, about 10 visible on one side of the test, variable in strength; aperture round, at the end of a short, tubular neck with a phialine lip, the neck fitted into a depression in the outer wall. Length, 0.68 mm.; diameter, 0.36 mm. Common.

The figured specimen may be a microspheric form of *U. vicksburgensis*. Figures 4 and 5 in Cushman and Edward's paper (cited above) are scarcely distinguishable from the type figure of *U. vicksburgensis* reproduced in the same publication (pl. 13, fig. 10). It seems possible that *U. nuttalli* may be a synonym of *U. vicksburgensis*.

*Plesiotype*.—No. 5060, locality 63, Red Bluff, lower Oligocene.

***Uvigerina topilensis* Cushman**

Plate 27, fig. 8

*Uvigerina topilensis* Cushman, 1925, Contr. Cushman Lab. Foram. Res., vol. 1, p. 5, pl. 1, figs. 5 a-b upper Eocene, Mex.; 1935, U. S. Geol. Sur., Prof. Paper 181, p. 41, pl. 16, fig. 4 upper Eocene Tex.; Bergquist, 1942, Mississippi State Geol. Sur., Bull. 49 (Fossils), p. 78, pl. 8, fig. 5 upper Eocene, Miss.

Test elongate fusiform, broadest near the middle, apex and apertural end rounded; chambers in the early part regularly triserial and spiral, in the later part staggered, triserial and inflated; sutures depressed; wall finely perforate; surface ornamented with about 10 costæ, progressively decreasing in height toward the apertural end of the test and not continuous from one chamber to another, the last few chambers smooth; the costæ in the early part sometimes projecting backward in platelike processes; aperture with a very narrow cylindrical neck, lip unknown. Length, 0.97 mm.; maximum diameter, 0.35 mm. Common.

*Plesiotype*.—No. 5061, locality 58, Jackson, Eocene.

***Uvigerina vicksburgensis* Cushman and Ellisor**

Plate 27, fig. 5

*Uvigerina vicksburgensis* Cushman and Ellisor, 1931, Contr. Cushman Lab. Foram. Res., vol. 7, p. 54, pl. 7, figs. 7 a, b Oligocene, Tex.; Ellisor, 1933, Bull. Amer. Assoc. Petr. Geol., vol. 17 pl. 3, figs. 10 a, b; Cushman and Edwards, 1938, Contr. Cushman Lab. Foram. Res., vol. 14, p. 76, pl. 13, figs. 10, 11 lower Oligocene, Gulf Coastal Plain and Alazan clay, Mex.; Cushman and Todd, 1948, Contr. Cushman Lab. Foram. Res., vol. 24, p. 7 (list), pl. 1, fig. 9 Red Bluff, Oligocene, Miss.

Test oval, about two times as long as broad, nearly circular in end view, shoulders round; chambers in about four whorls, regularly triserial, slightly inflated; sutures fairly distinct, little depressed; wall ornamented by about 24 low, narrow longitudinal costæ, usually broken at the sutures but some extending across the sutures; aperture with a short neck, in a depression. Length, 0.55 mm.; diameter, 0.33 mm. Common.

The figured specimen and others of *U. vicksburgensis* may be megaspheric, and *U. nuttalli* may be the microspheric form of the same species.

*Plcsiotype*.—No. 5062, locality 66, Marianna ls, middle Oligocene.

Genus **ANGULGERINA** Cushman, 1927

**Angulogerina byramensis** (Cushman) Plate 27, figs. 9a-b

*Uvigerina byramensis* Cushman, 1922, U. S. Geol. Sur., Prof. Paper 129, pp. 95, 133, pl. 18, fig. 5 Oligocene, Miss.

*Angulogerina byramensis* Ellisor, 1933, Bull. Amer. Assoc. Petr. Geol., vol. 17, pl. 3, fig. 16; Cushman and McGlamery, 1942, U. S. Geol. Sur., Prof. Paper 197-B, p. 72, pl. 6, figs. 4-10 Vicksburg, Oligocene, Ala.; Cushman and Todd, 1946, Contr. Cushman Lab. Foram. Res., vol. 22, p. 95 Byram marl, Vicksburg, Oligocene, Miss.

Test small, fusiform, conical in the early part, subtriangular in the later part, initial end pointed; chambers in about three whorls, moderately inflated; sutures depressed; surface ornamented by about 30 longitudinal costæ, excepting for the last chamber which is typically smooth, usually costate; costæ rather thin and sharp, not passing over the sutures; the final chamber larger than the rest, inner side concave, the other two sides slightly convex, resulting in a subtriangular transverse section; aperture oval, with a short oval neck and a slight lip. Length, 0.36 mm.; diameter, 0.15 mm. Common.

The variations of this form are well illustrated by Cushman and McGlamery (1942, see reference in synonymy).

*Holotype*.—No. 4784, locality 62, Red Bluff clay, lower Oligocene.

**Angulogerina danvillensis** Howe and Wallace Plate 27, figs. 10a-b

*Angulogerina danvillensis* Howe and Wallace, 1932, Louisiana Dept. Cons., Geol. Bull. 2, p. 56, pl. 12, fig. 2 Jackson, Eocene, La.; Bergquist, 1942, Mississippi State Geol. Sur., Bull. 49, (Fossils), p. 81, pl. 8, figs. 16, 17 Yazoo clay, upper Eocene Miss.

Test elongate, fusiform, the early part conical and trochoid, the adult portion evolute and composed of triangular chambers, tend-



ing to be uniserial; chambers in about five whorls; early chambers slightly inflated and covered with rather coarse, high, longitudinal costæ, which do not cross the sutures, the later chambers more loosely arranged with costæ on all chambers, though less conspicuous on the last one; sutures depressed; wall very finely perforate; aperture a circular opening at the end of a fairly long neck with phialine lip. Length, 0.45 mm.; width, 0.17 mm. Common.

*Plesiotype*.—No. 4785, locality 6I, Red Bluff, lower Oligocene.

*Angulogerina vicksburgensis* Cushman Plate 27, figs. 12a-b

*Angulogerina vicksburgensis* Cushman, 1935, Contr. Cushman Lab. Foram. Res., vol. 11, p. 33, pl. 5, figs. 3, 4 Vicksburg, Oligocene, Miss.; 1945, Contr. Cushman Lab. Foram. Res., vol. 21, p. 67, pl. 10, fig. 27 Oligocene, Ala., Miss., Oligocene and Eocene, Cuba.

Test small, elongate,  $2\frac{1}{2}$  to  $3\frac{1}{2}$  times as long as broad, subtriangular in end view, the earlier portion round; early portion rapidly enlarging, adult part with nearly parallel sides; chambers in about six whorls, closely appressed, triserial throughout, little inflated, increasing little in height in the adult; sutures transverse and curved, little if at all depressed; wall smooth, finely but distinctly perforate; aperture terminal, round, with flaring lip at the end of a long round neck. Total length, 0.45 mm.; diameter, 0.14 mm. Common.

*Plesiotype*.—No. 4786, locality 6I, Red Bluff, lower Oligocene.

Genus TRIFARINA Cushman, 1923

*Trifarina wilcoxensis* (Cushman and Ponton) Plate 27, figs. 11a-b

*Pseudourigera wilcoxensis* Cushman and Ponton, 1932, Contr. Cushman Lab. Foram. Res., vol. 8, p. 66, pl. 8, figs. 18 a-b Wilcox, Eocene, Ala.

*Angulogerina wilcoxensis* Cushman and Garrett, 1939, Contr. Cushman Lab. Foram. Res., vol. 15, p. 84, pl. 14, figs. 24, 25 Wilcox, Eocene, Ala.; Toulmin, 1941, Jour. Paleont., vol. 15, p. 599, pl. 80, fig. 30 Wilcox, Eocene, Ala.

Test small, elongate,  $1\frac{1}{2}$  to  $2\frac{1}{2}$  times as long as wide, trihedral, bluntly pointed at both ends, the sides nearly parallel and slightly concave; edge narrow, with two short keels with a narrow channel between, especially in the early part; chambers little inflated, triserial in first half, uniserial in the later half; sutures obscure excepting the later transverse ones which are slightly depressed and strongly curved; early sutures limbate, curved, arched upward and outward, with transverse lines or pores; wall finely perforate; aperture terminal, at the end of a short neck,

with slight lip. Length, 0.45 mm.; diameter, 0.17 mm. Common.

The specimens from Little Stave Creek appear to be identical with those figured from the Wilcox. In perfect specimens, the last two or three chambers are uniserial, hence this species is placed in *Trifarina*. The main difference between this species and *Trifarina bradyi* Cushman (1923, U. S. Nat. Mus., Bull. 104) is the canaliculate character of the edges of this form.

*Plesiotypic*.—No. 4787, locality 7, Tallahatta fm., middle Eocene.

Family PLEUROSATOMELLIDÆ Reuss, 1860

Genus NODOSARELLA Rzehak, 1895

*Nodosarella annulospinosa*, new species Plate 27, fig. 14a-b

Test elongate, nearly straight, with inflated chambers and depressed sutures, and with one row of short, spinose processes projecting backward from the lower part of each chamber; aperture at the end of a long, round neck, with lip and small tooth. Length, 0.64 mm.; diameter of last chamber, 0.13 mm. Rare.

This species somewhat resembles *Dentalina adolphina* d'Orbigny (1846, Foraminifères fossiles du bassin tertiaire de Vienne, p. 51, pl. 2, figs. 18-20) but differs in the less constricted sutures, one line of spines, as well as in the toothed aperture.

*Holotype*.—No. 4955, locality 58, Jackson, Eocene.

*Nodosarella cocoaensis* (Cushman) Plate 27, figs. 15a-b

*Nodosaria cocoaensis* Cushman, 1925, Contr. Cushman Lab. Foram. Res., vol. 1, p. 66, pl. 10, figs. 5, 6 upper Eocene, Ala.

*Dentalina cocoaensis* Cushman, 1927, Jour. Paleont., vol. 1, p. 153, pl. 24, fig. 14 Eocene, Mex.; 1935, U. S. Geol. Surv., Prof. Paper 181, p. 19, pl. 8, figs. 1, 2.

*Ellipsionodosaria cocoaensis* Cushman, 1939, Contr. Cushman Lab. Foram. Res., vol. 15, p. 68, pl. 11, figs. 27, 33 Eocene, (submarine core) off the eastern coast of N. A.; 1946, Cushman Lab. Foram. Res., Special Publ. 16, p. 30, pl. 6, fig. 10 upper Eocene, Ga., S. C., Ala., Miss., Tex.

Test elongate, very slender, slightly curved, gradually tapering to an apiculate apex; chambers in the early part closely appressed, not inflated, those in the later portion less appressed and somewhat inflated, 11 to 14 in the adult; chambers nearly as broad as long in the early part, becoming much longer than broad in the later portion; sutures distinct, of clear shell material, flush







in the early part and slightly depressed in the later portion; wall smooth, finely perforate; aperture an elliptical opening at the end of a short neck, with flaring lip. Length, 1.33 mm.; diameter of last chamber, 0.15 mm. Common.

Inasmuch as the genotype of both *Ellipsonodosaria* A. Silvestri, 1900, and *Nodosarella* Rzehak, 1895, are congeneric, this form is placed under the latter which has priority.

*Plesiotype*.—No. 4956, locality 58, Jackson, Eocene.

Genus **ELLIPSOLAGENA** Silvestri, 1923

***Ellipsolagena alabamensis***, new species Plate 27, figs. 16a-b

Test monothalamous, ovate in side and end views; wall smooth, rather finely perforate, with coarse scattered puncta around the aperture, probably due to parasitic organisms; aperture terminal, crescentic, higher on the convex side, with little if any lip. Length, 0.49 mm.; breadth, 0.46 mm.; thickness, 0.42 mm. Rare.

*Holotype*.—No. 4881, locality 60, Jackson, Eocene.

Family **NUMMULITIDÆ** Reuss, 1861

Genus **OPERCULINA** d'Orbigny, 1826

***Operculina cf. ocalana*** Cushman Plate 27, figs. 13a-b

*Operculina ocalana* Cushman, 1921, U. S. Geol. Sur., Prof. Paper 128, p. 129, pl. 19, figs. 4, 5 Ocala ls., upper Eocene, Ga., Fla.; 1935, U. S. Geol. Sur., Prof. Paper 181, p. 32.

Test planispiral, tending to be evolute, coils touching, much compressed, composed of about three coils, the last with about 16 to 18 chambers; sutures raised, rounded, the area between sutures concave and smooth; chambers three to four times longer than wide; central area of the test umbonate but not knobbed; periphery somewhat raised by a slight thickening in which the raised sutures terminate. Diameter, 1.78 mm.; thickness, 0.16 mm. Not common.

Very few specimens occur in the material from locality 58, and the figured specimen is the nearest entire individual found. The surface lacks the knobbed ornamentation of the type.

*Plesiotype*.—No. 4975, locality 58, Jackson, Eocene.

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All figured specimens are catalogued and deposited in the Paleontological  
Laboratory, Indiana University.

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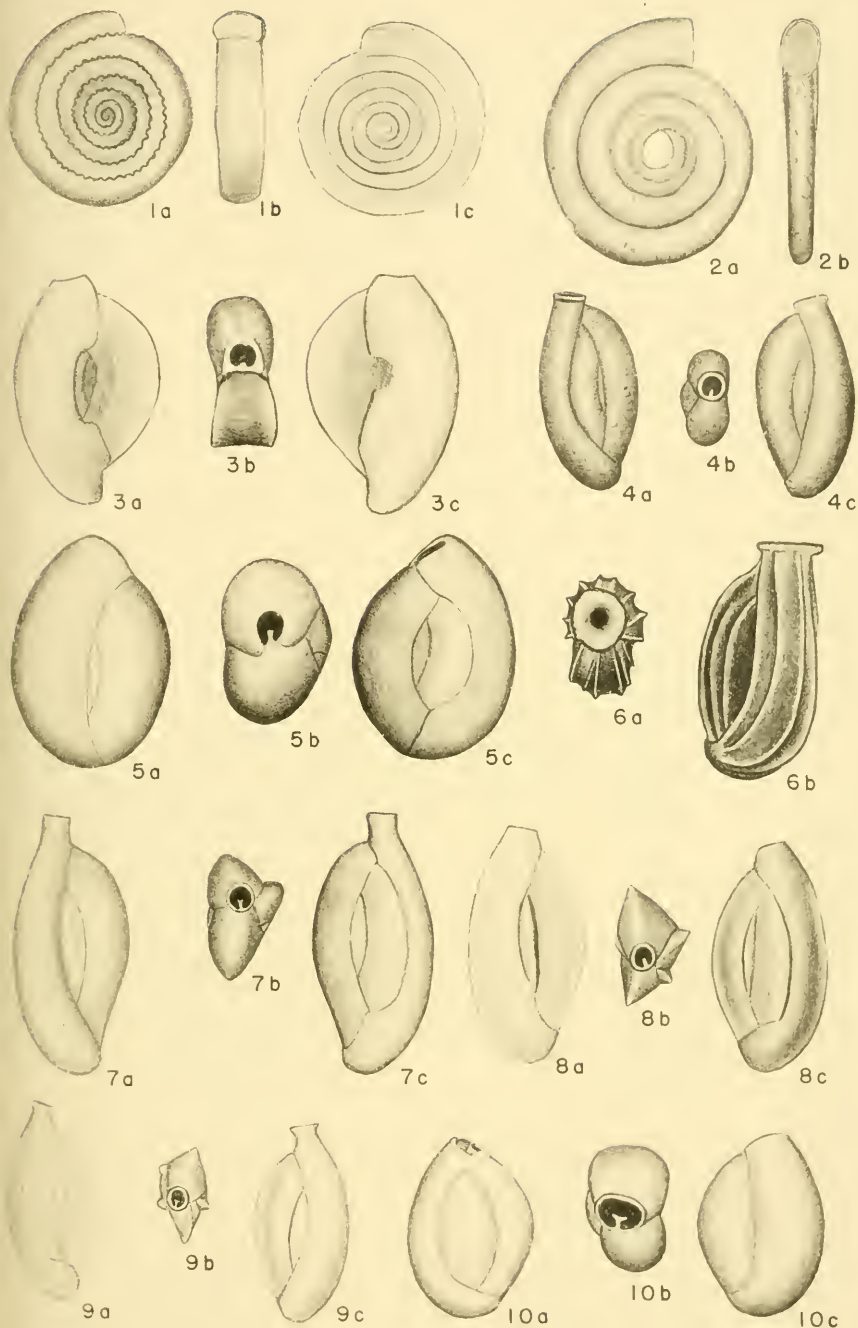




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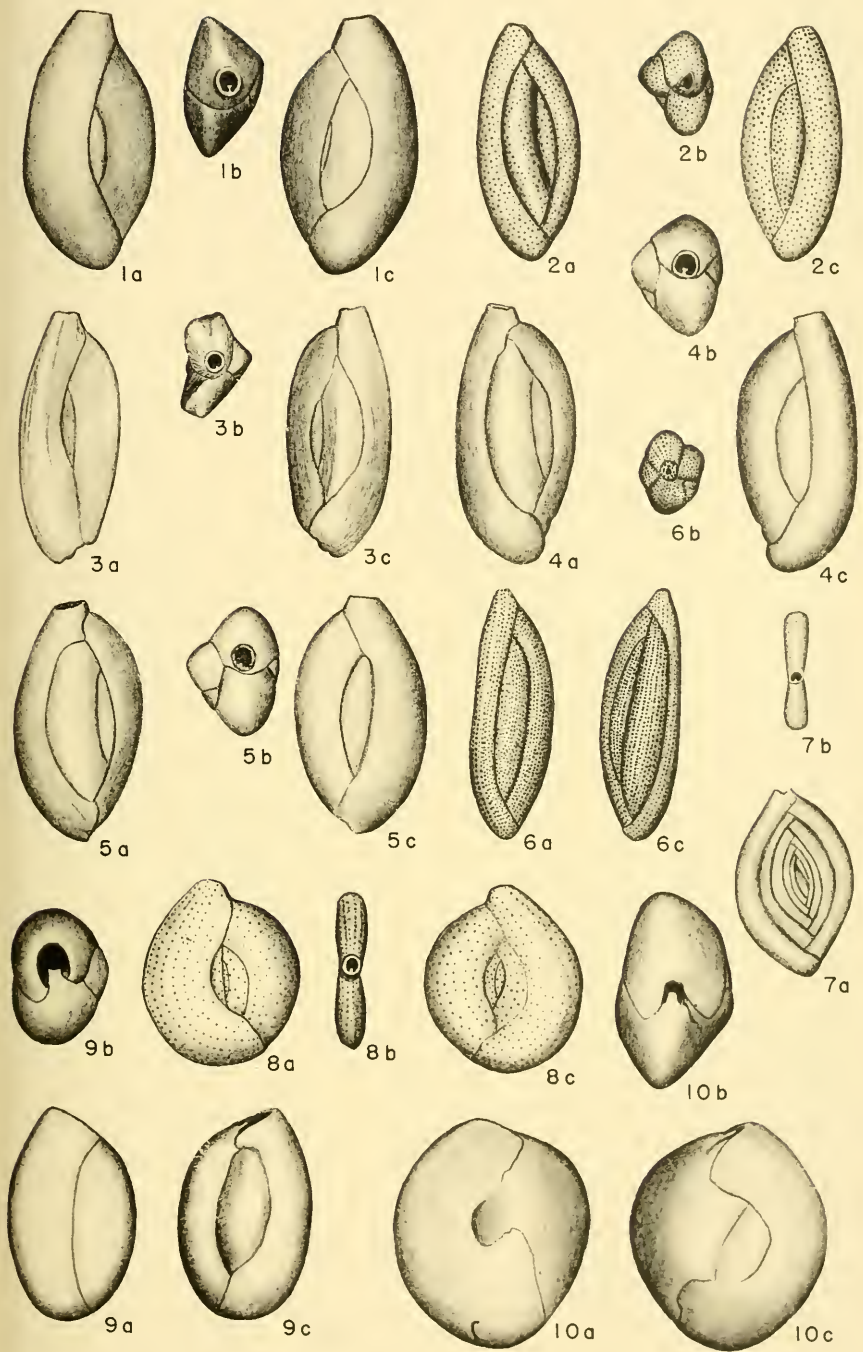




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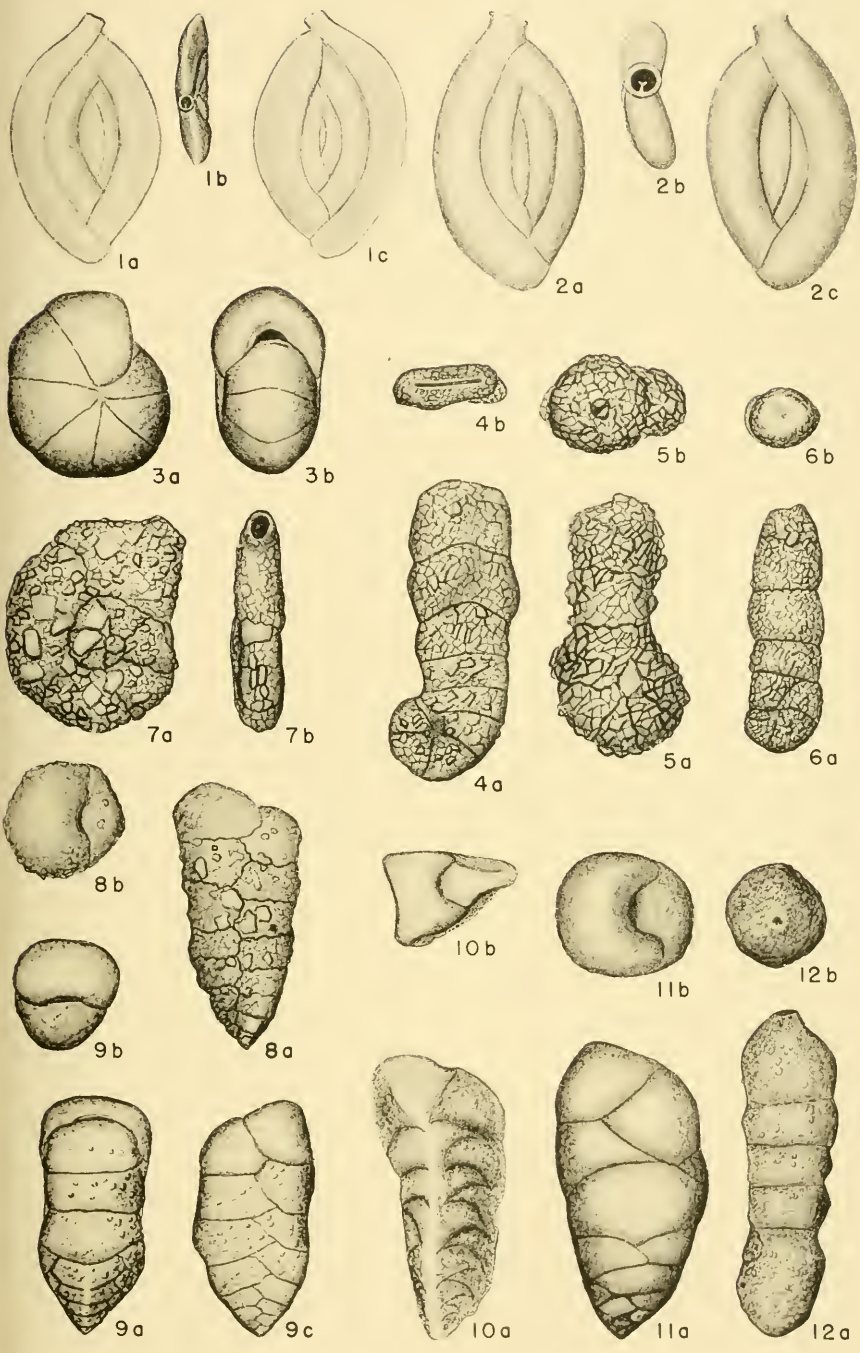




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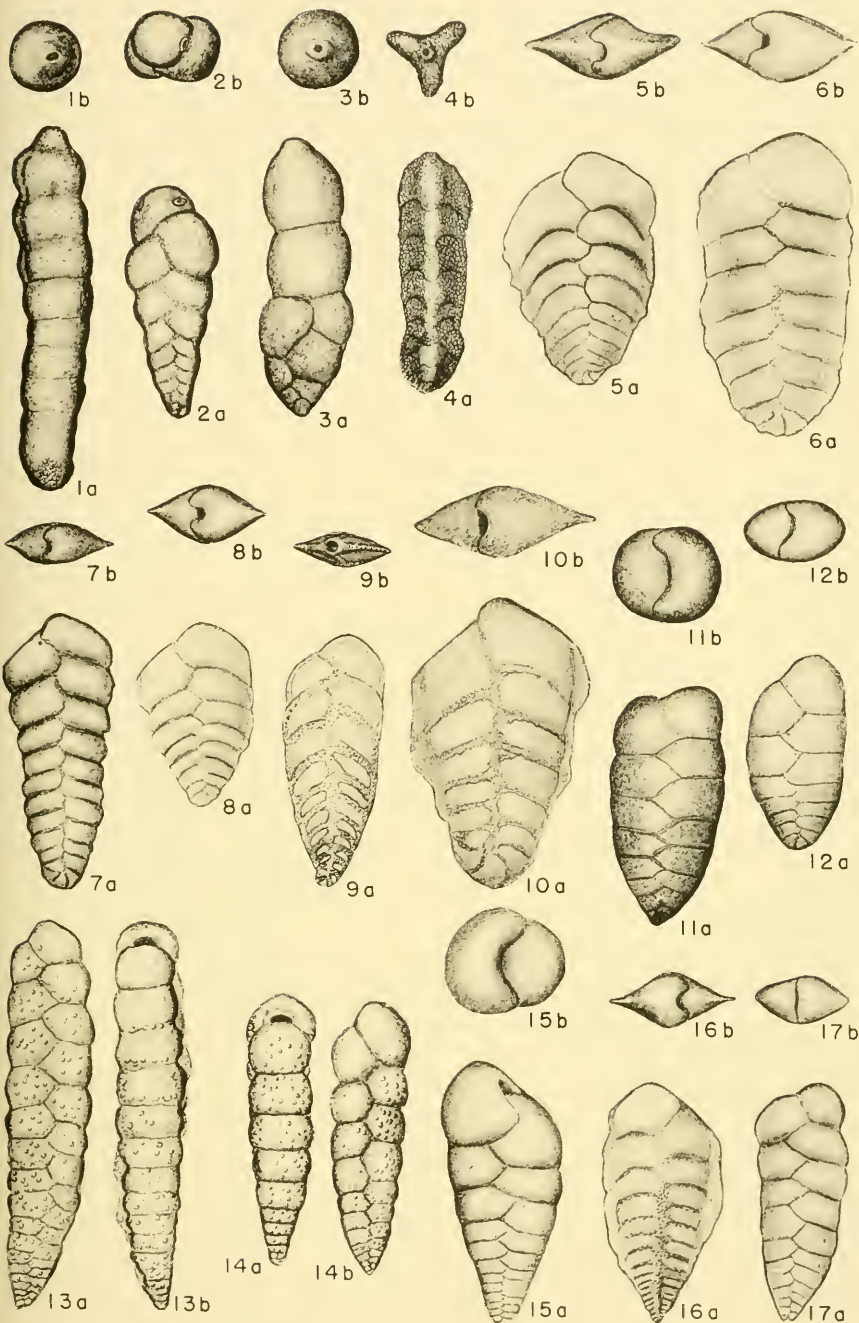




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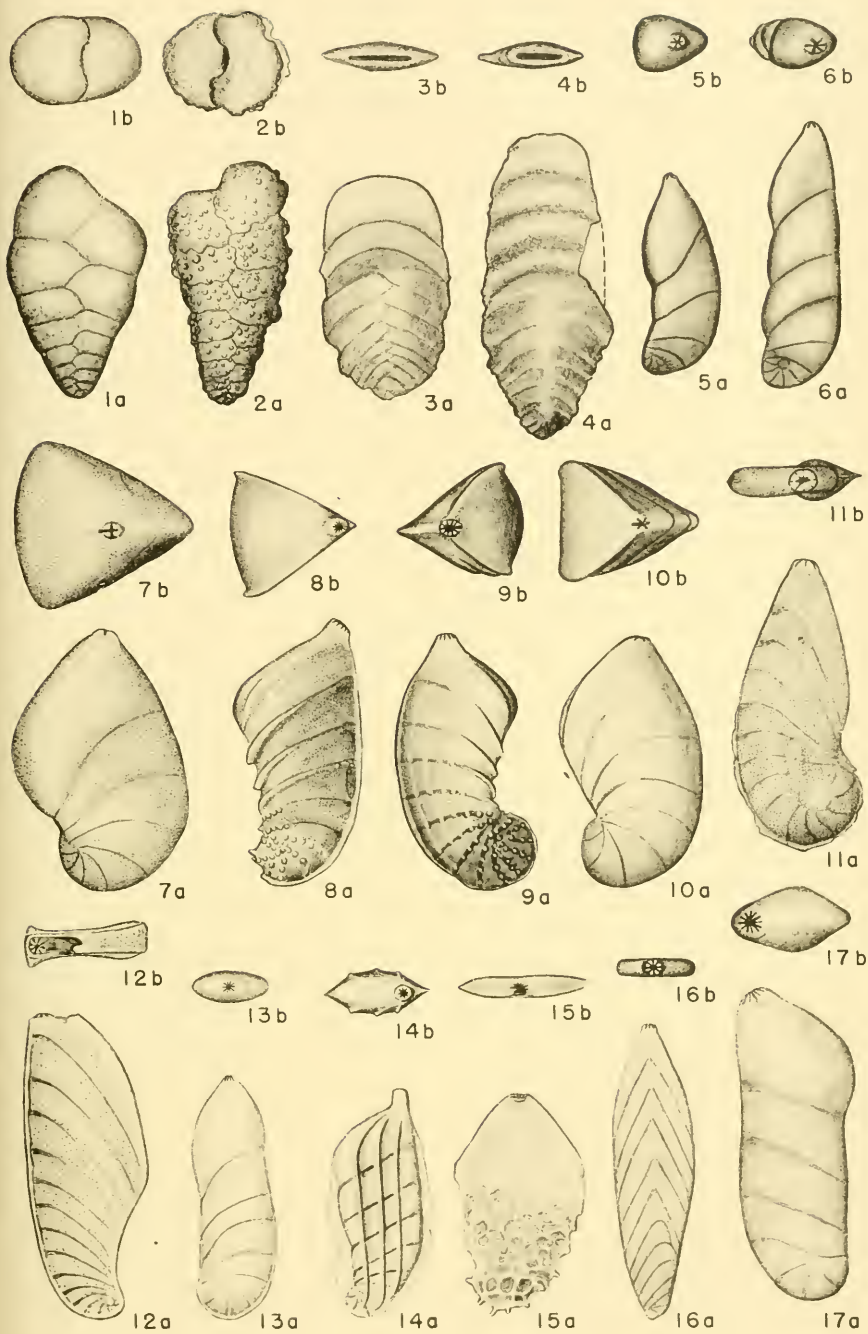






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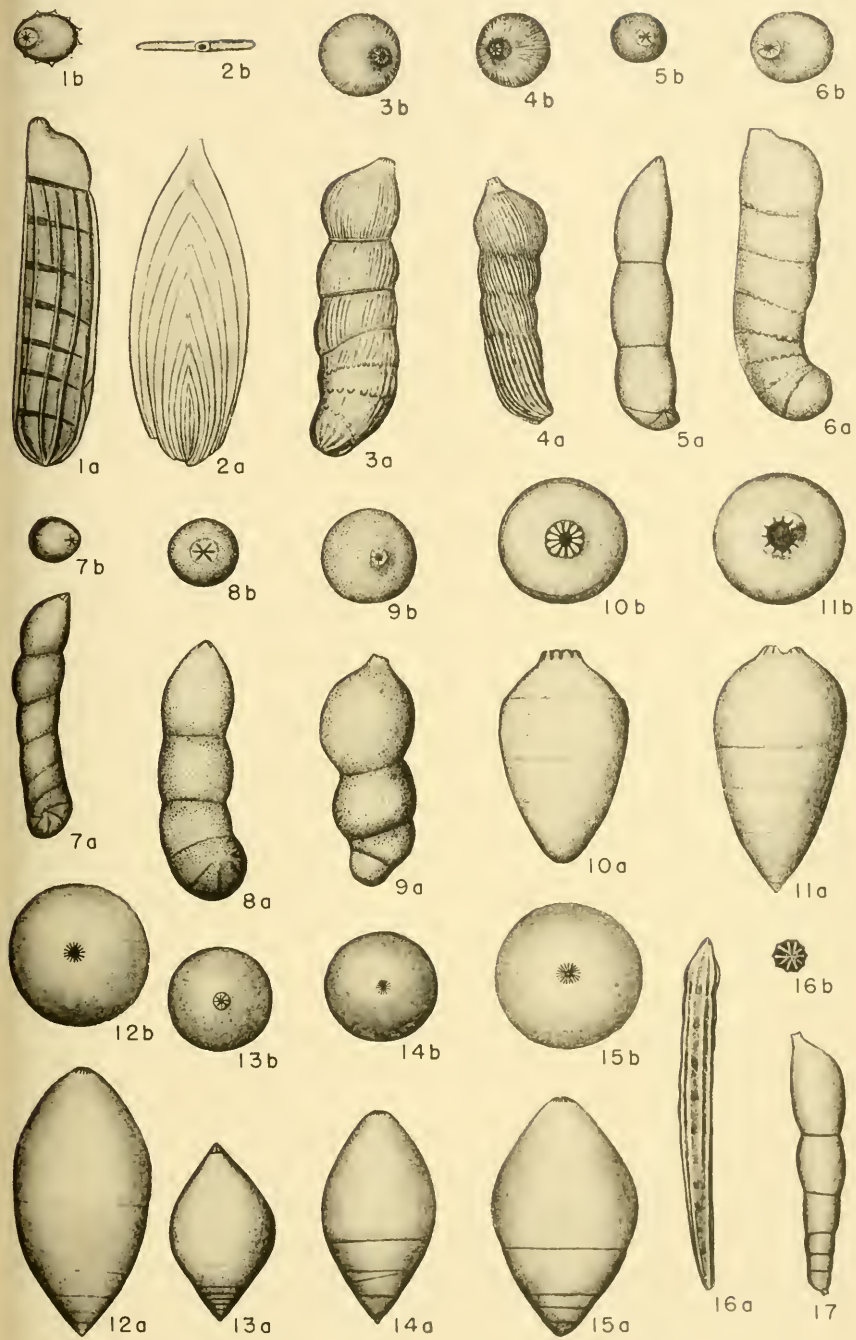




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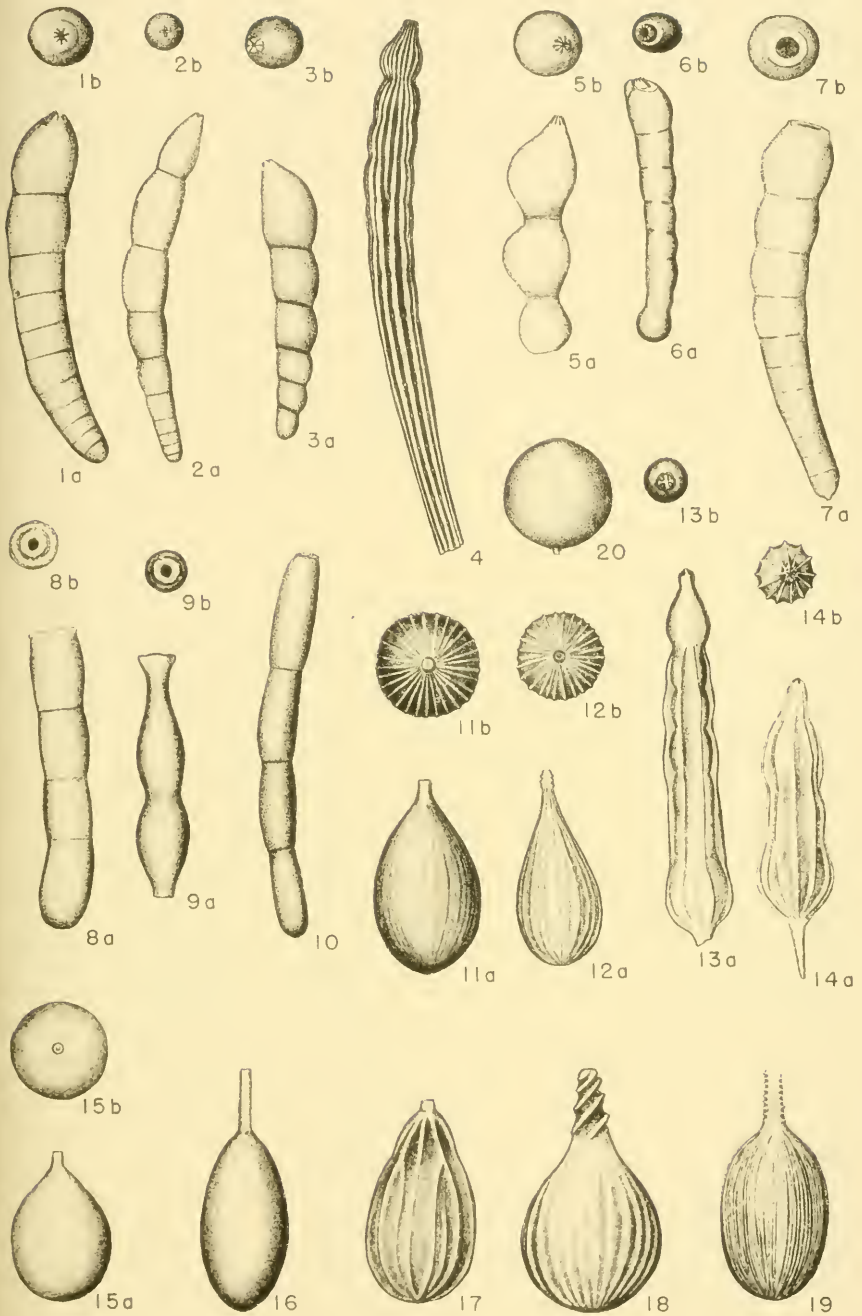






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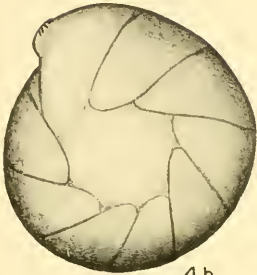
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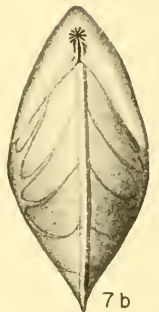
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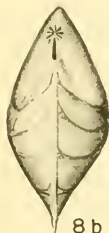
7a



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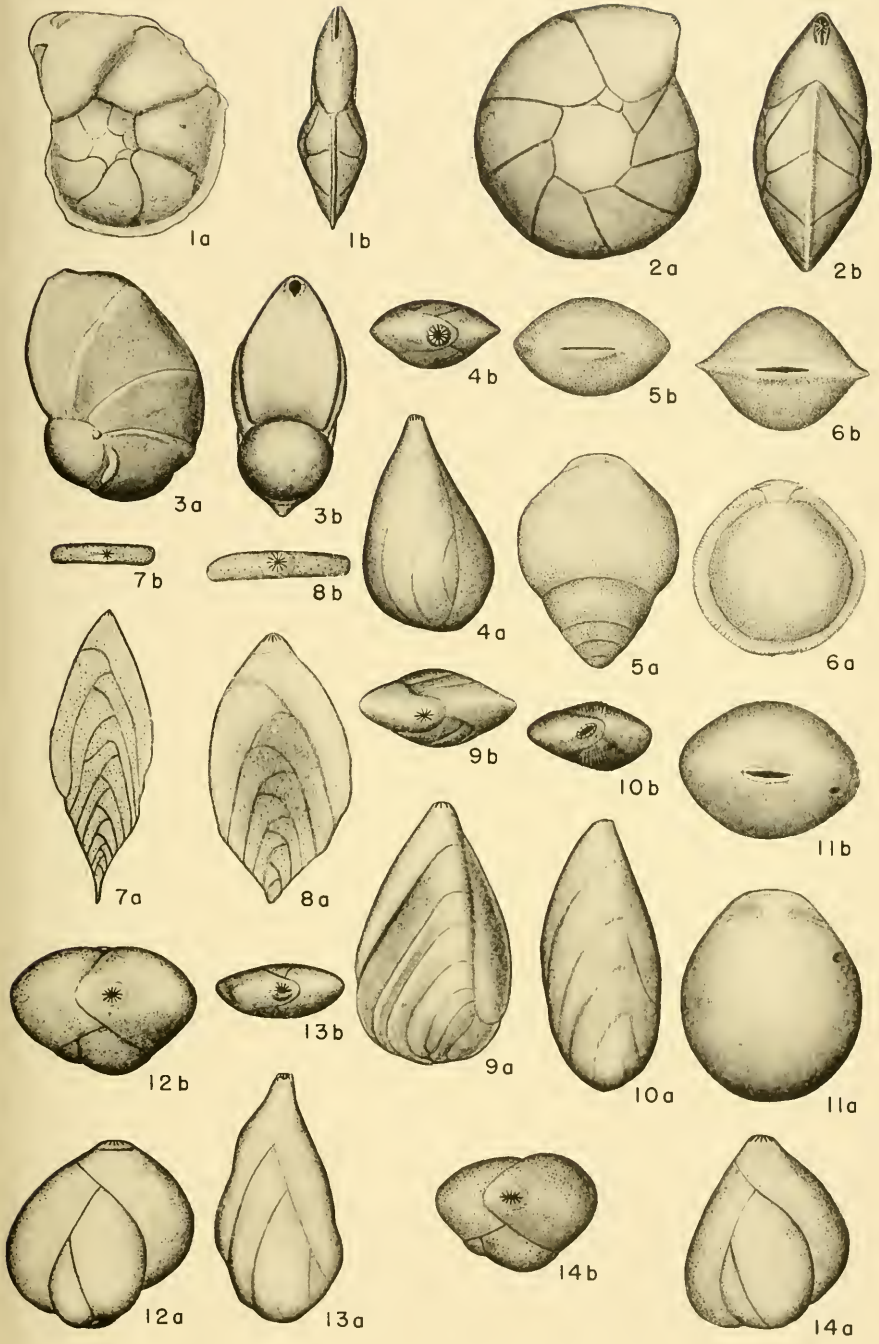




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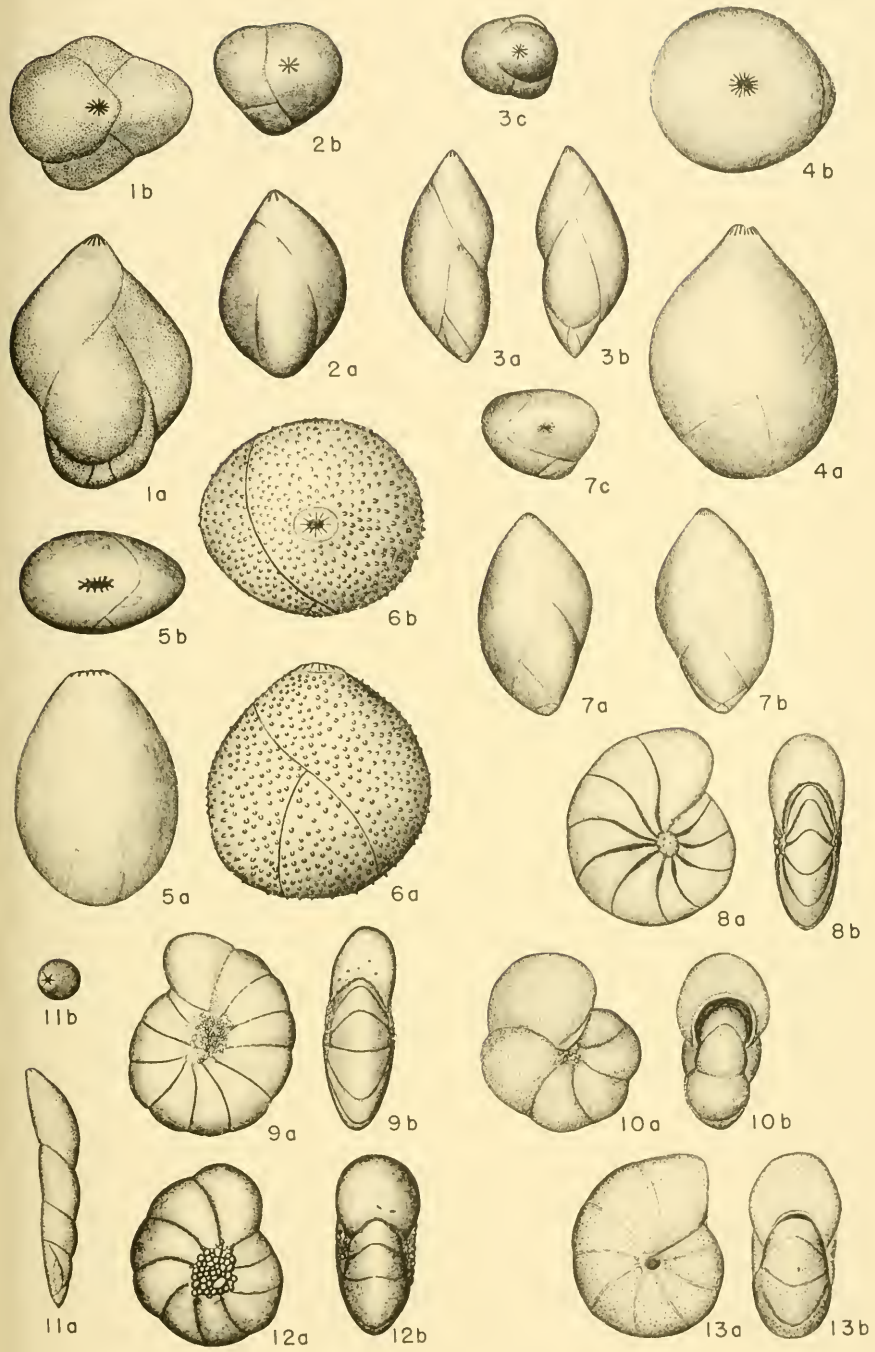




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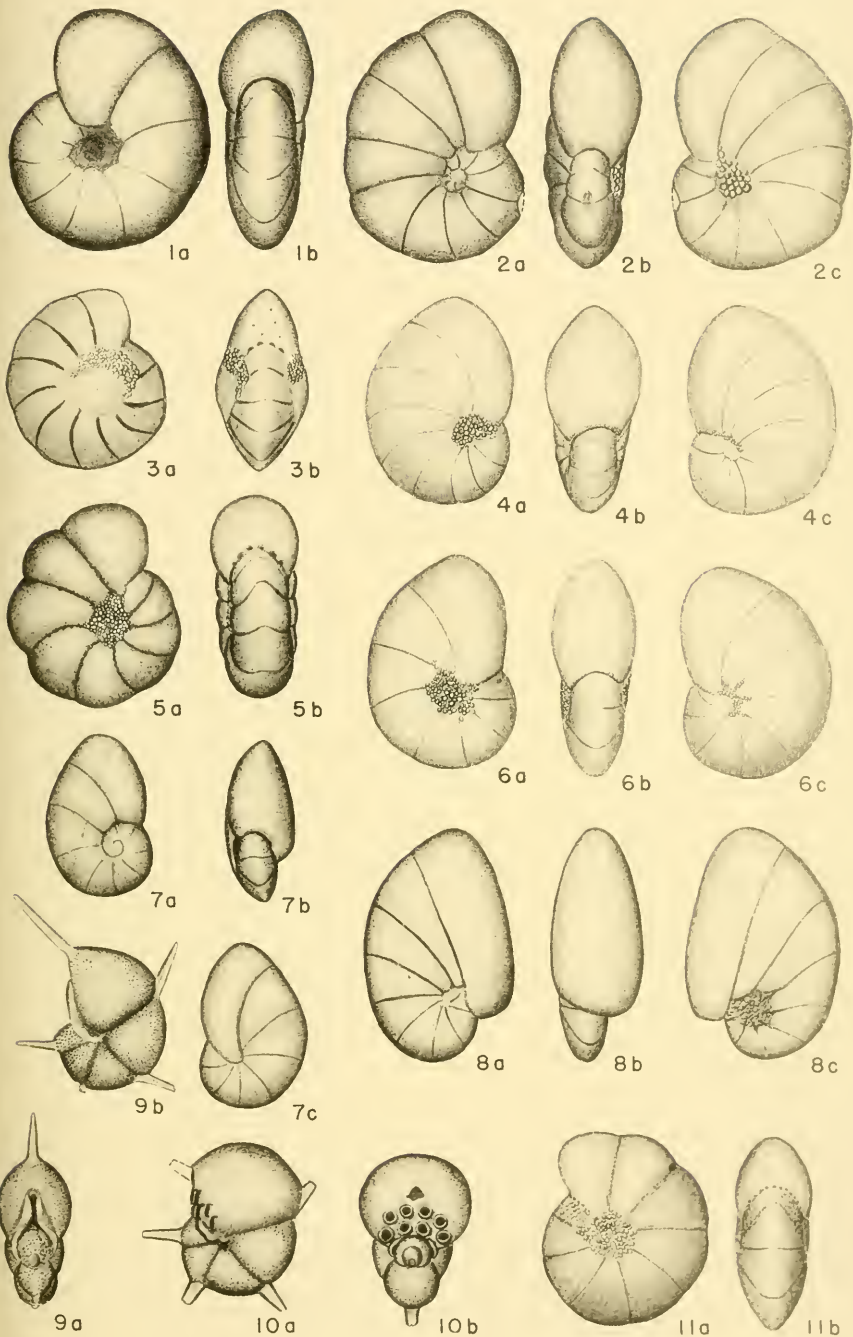
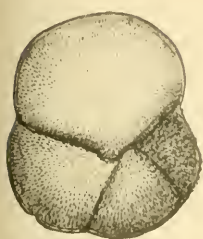




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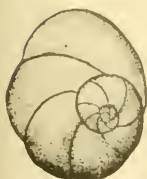
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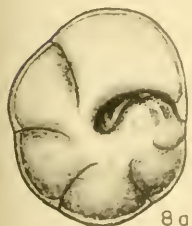
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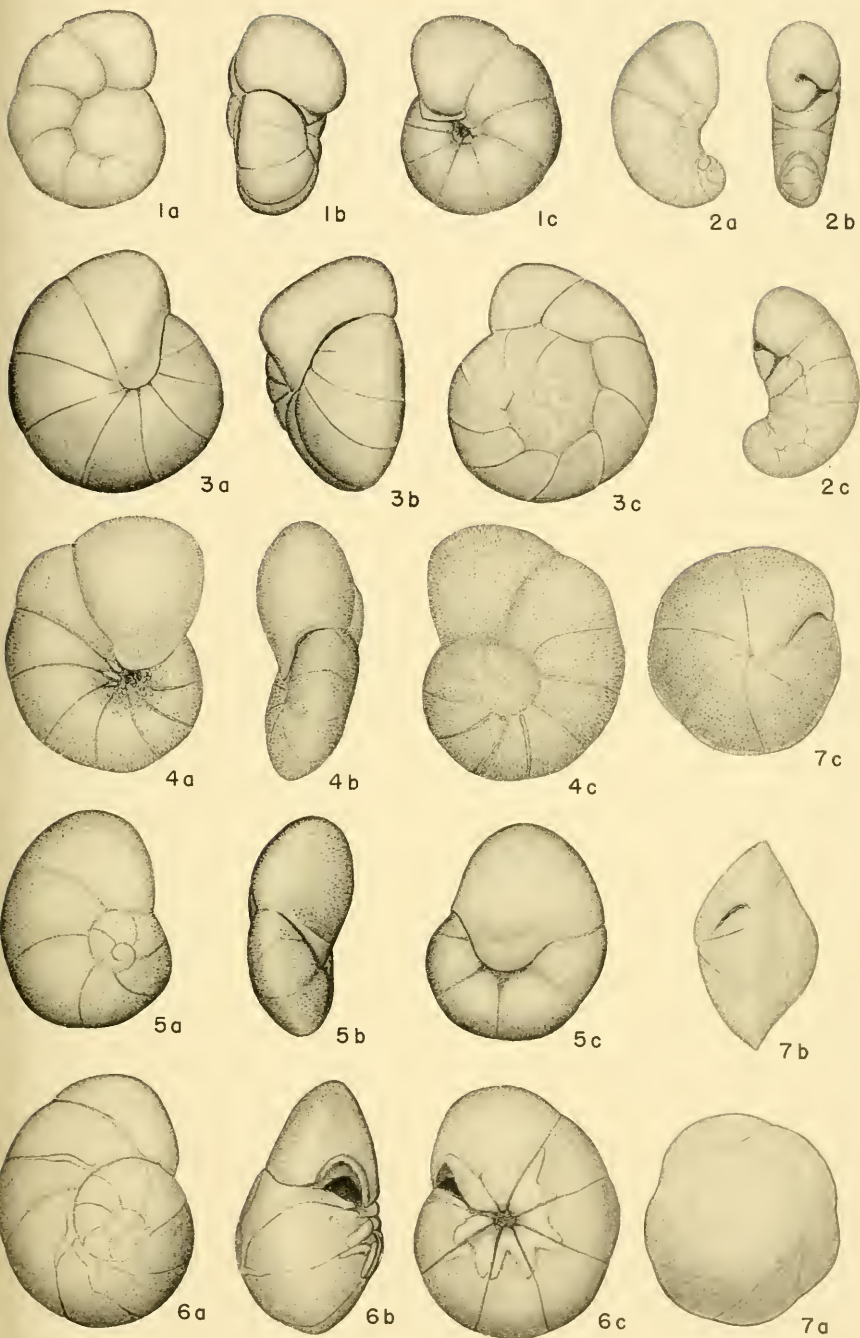




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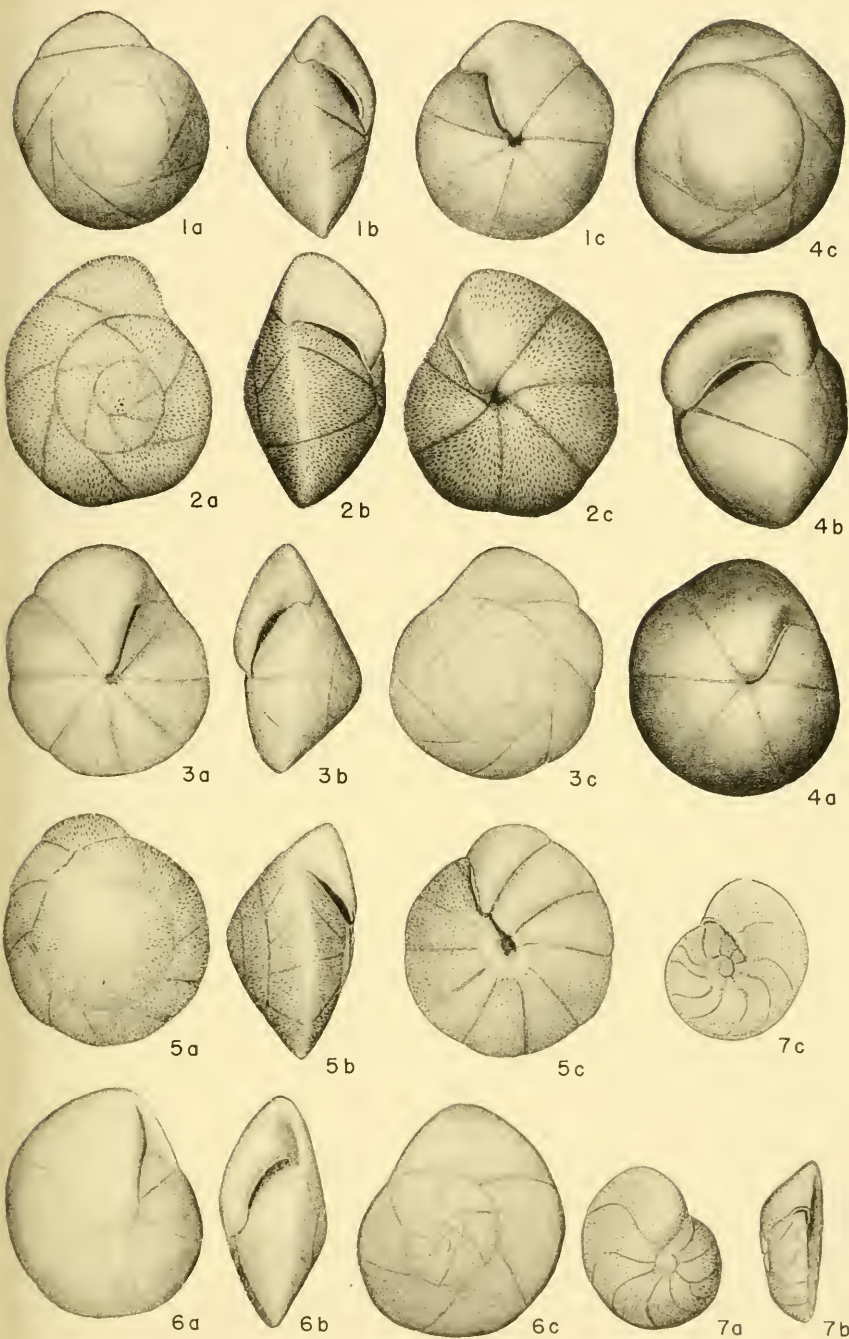






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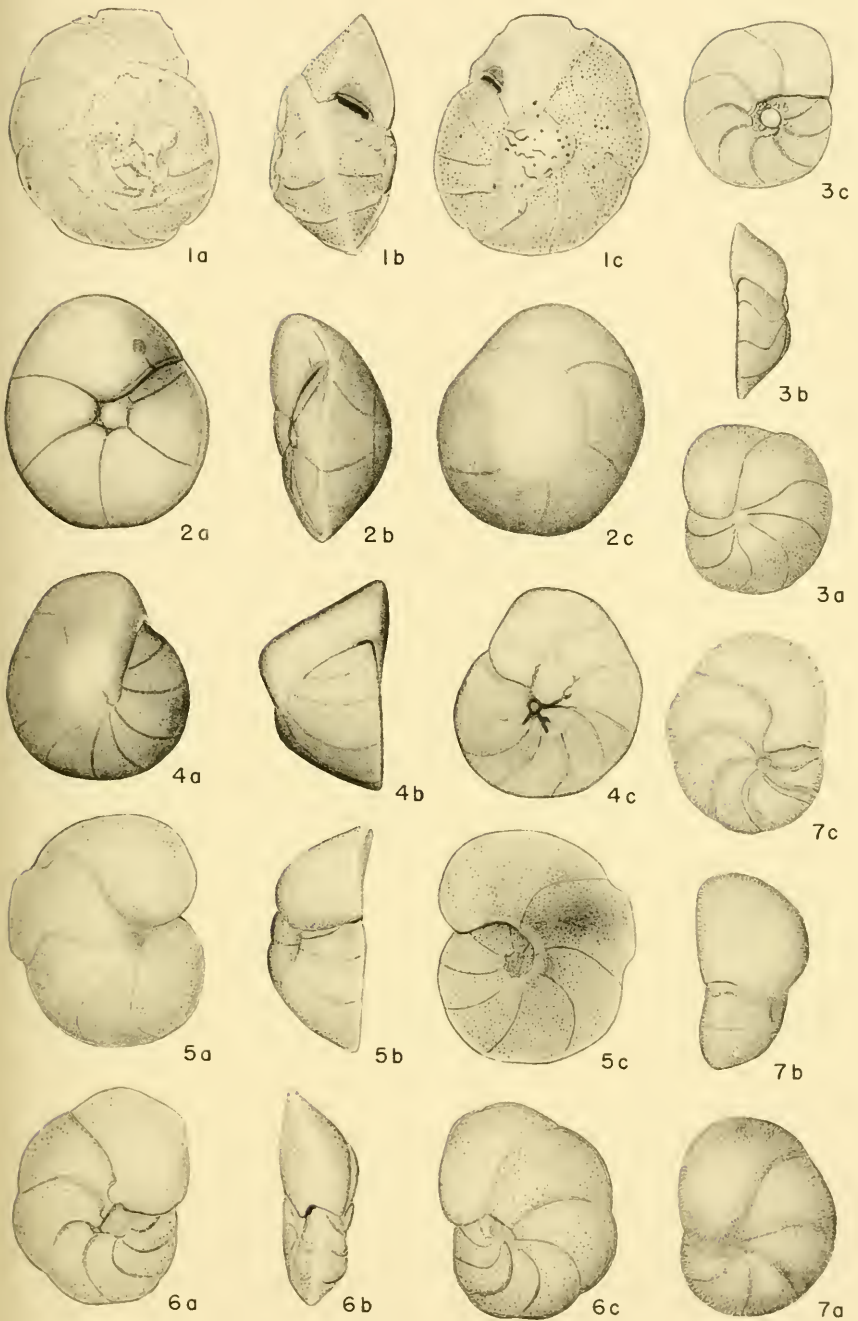




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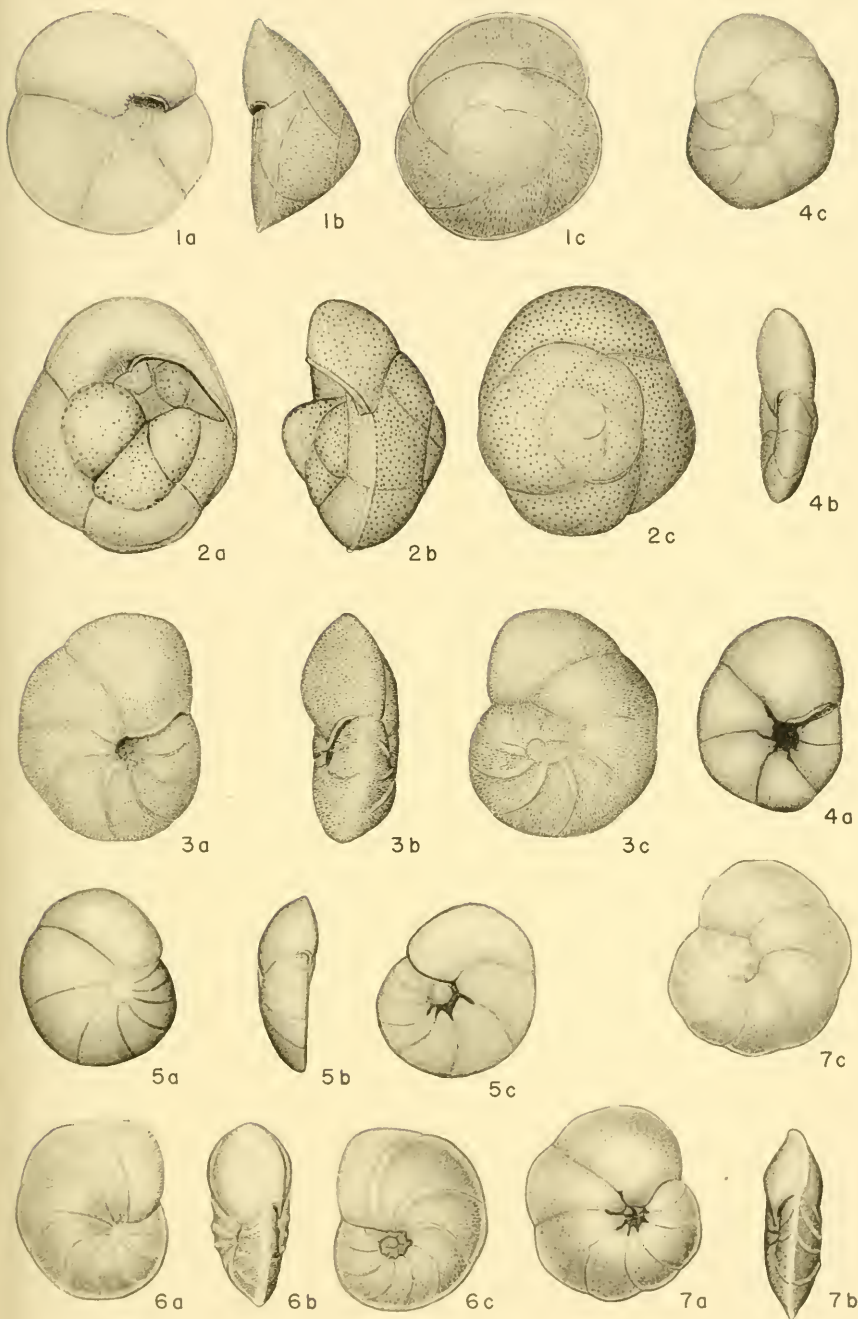






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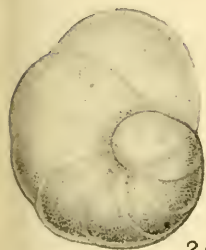
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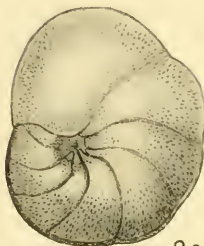
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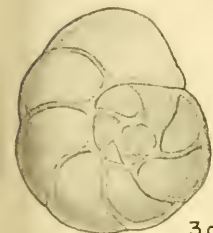
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3a



3b



3c



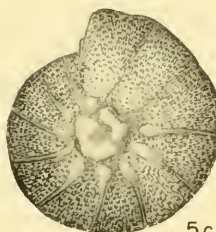
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6b



6c



7b



7a



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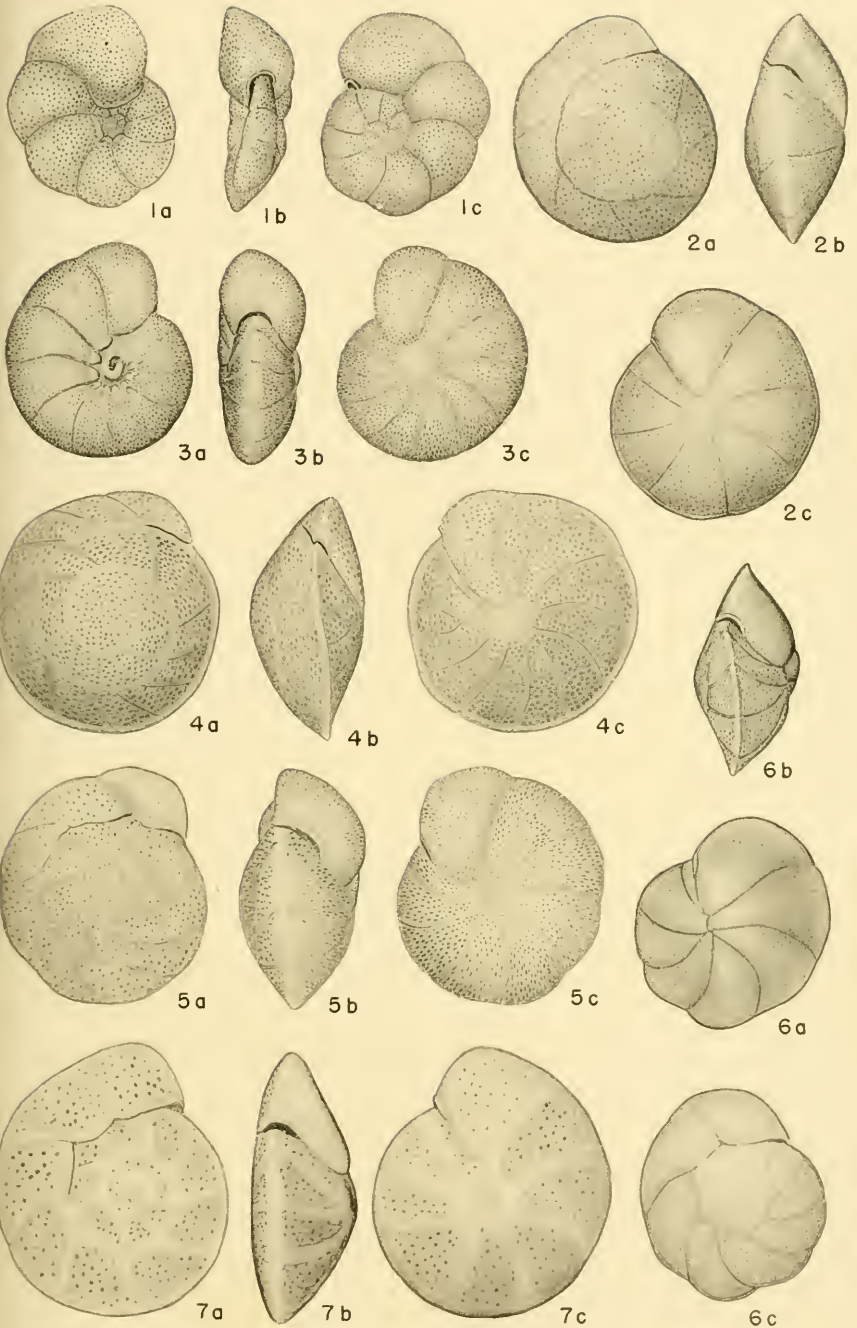






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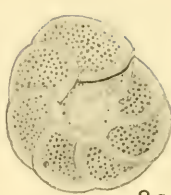
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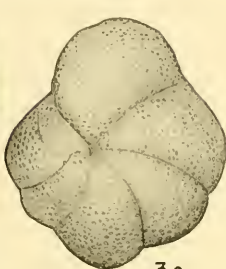
2b



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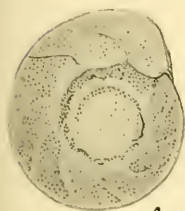
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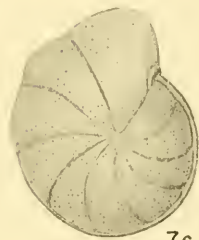
4a



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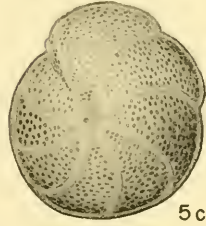
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7b



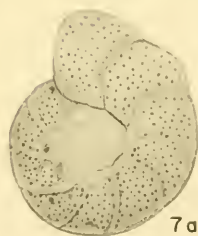
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PLATE 20 (21)

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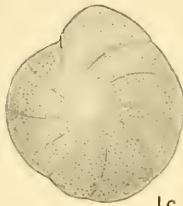
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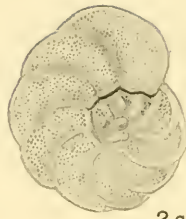
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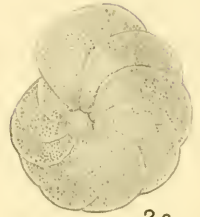
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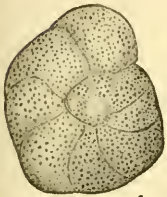
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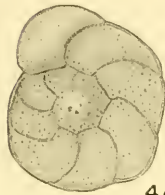
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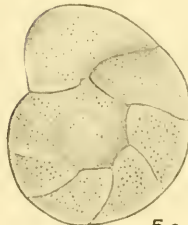
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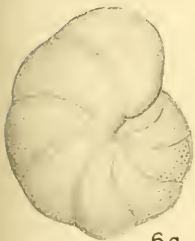
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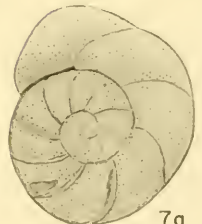
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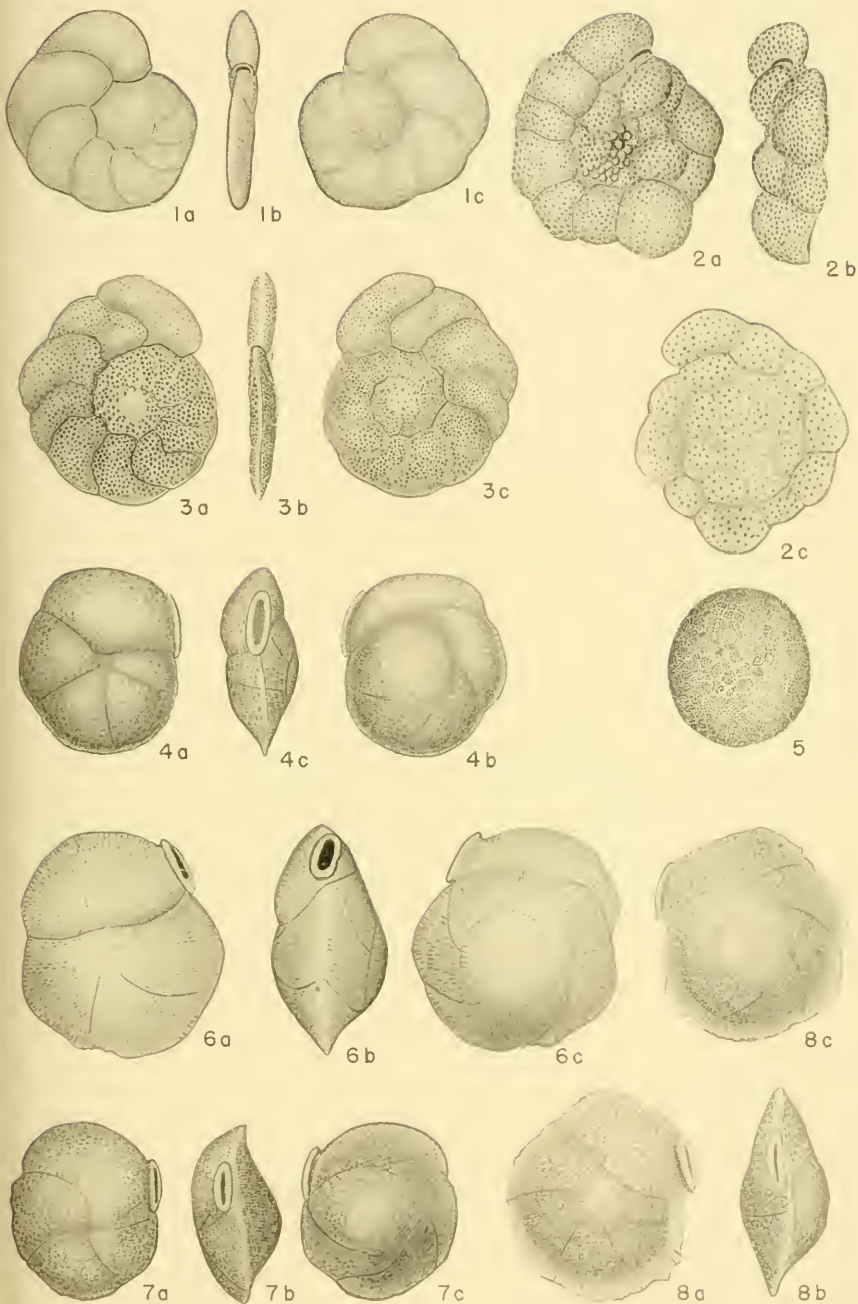
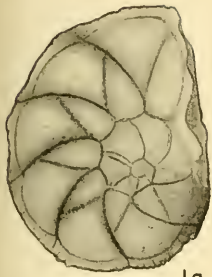




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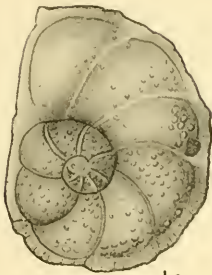
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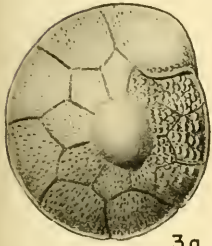
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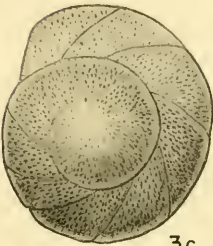
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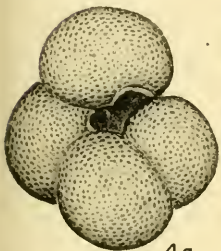
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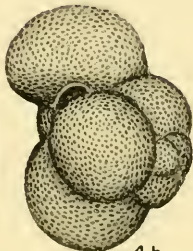
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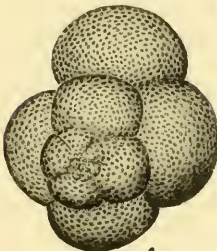
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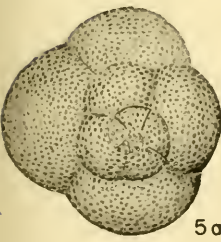
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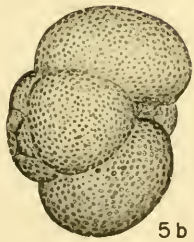
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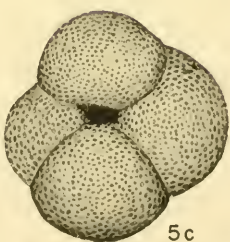
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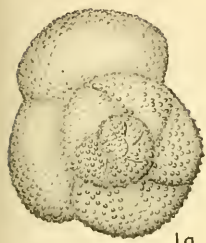




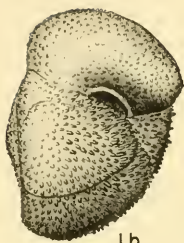
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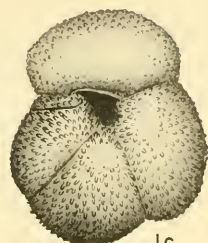
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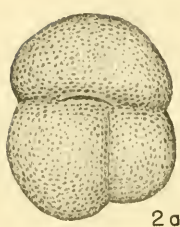
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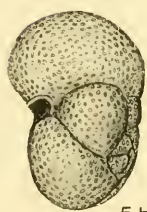
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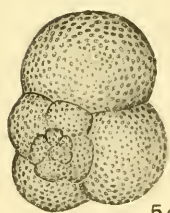
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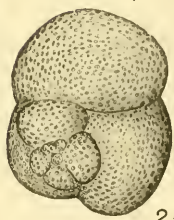
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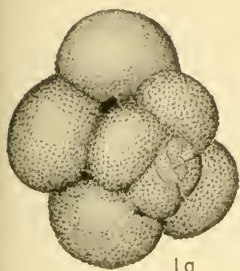
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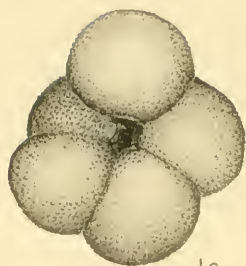
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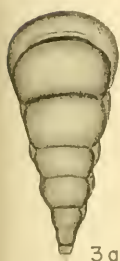
2b



2c



5b



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3b



4a



4b



5a



6b



7b



8b



9b



10b



6a



7a



8a



9a



10a





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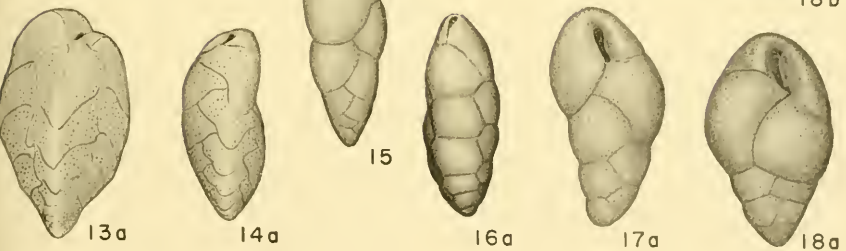
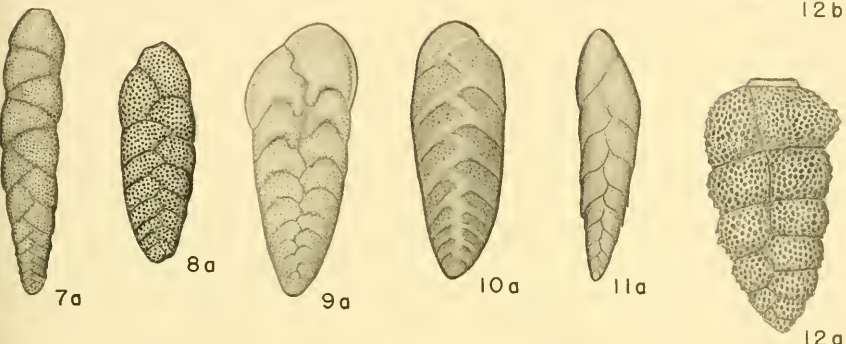
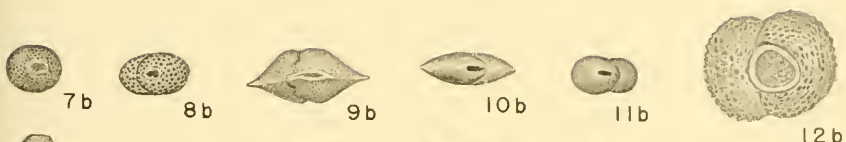
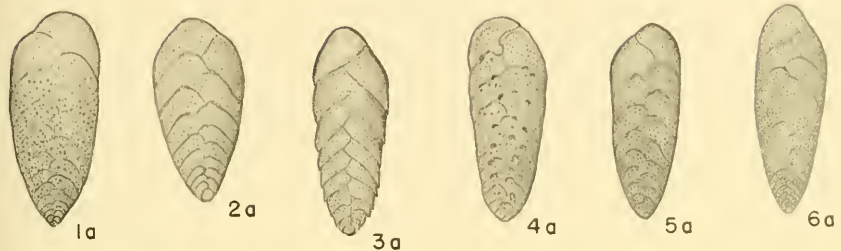
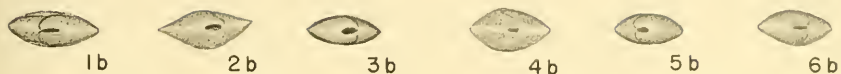




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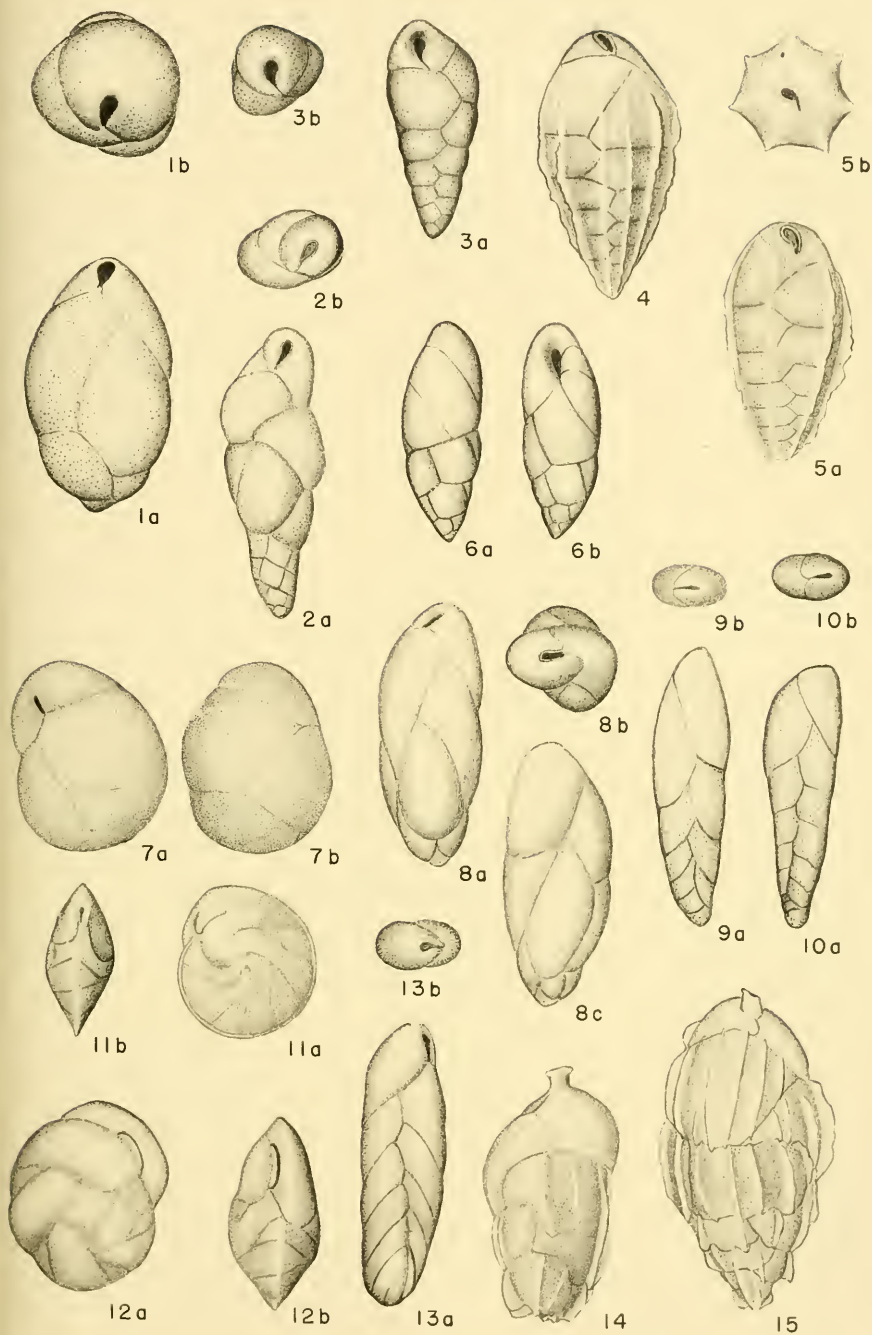


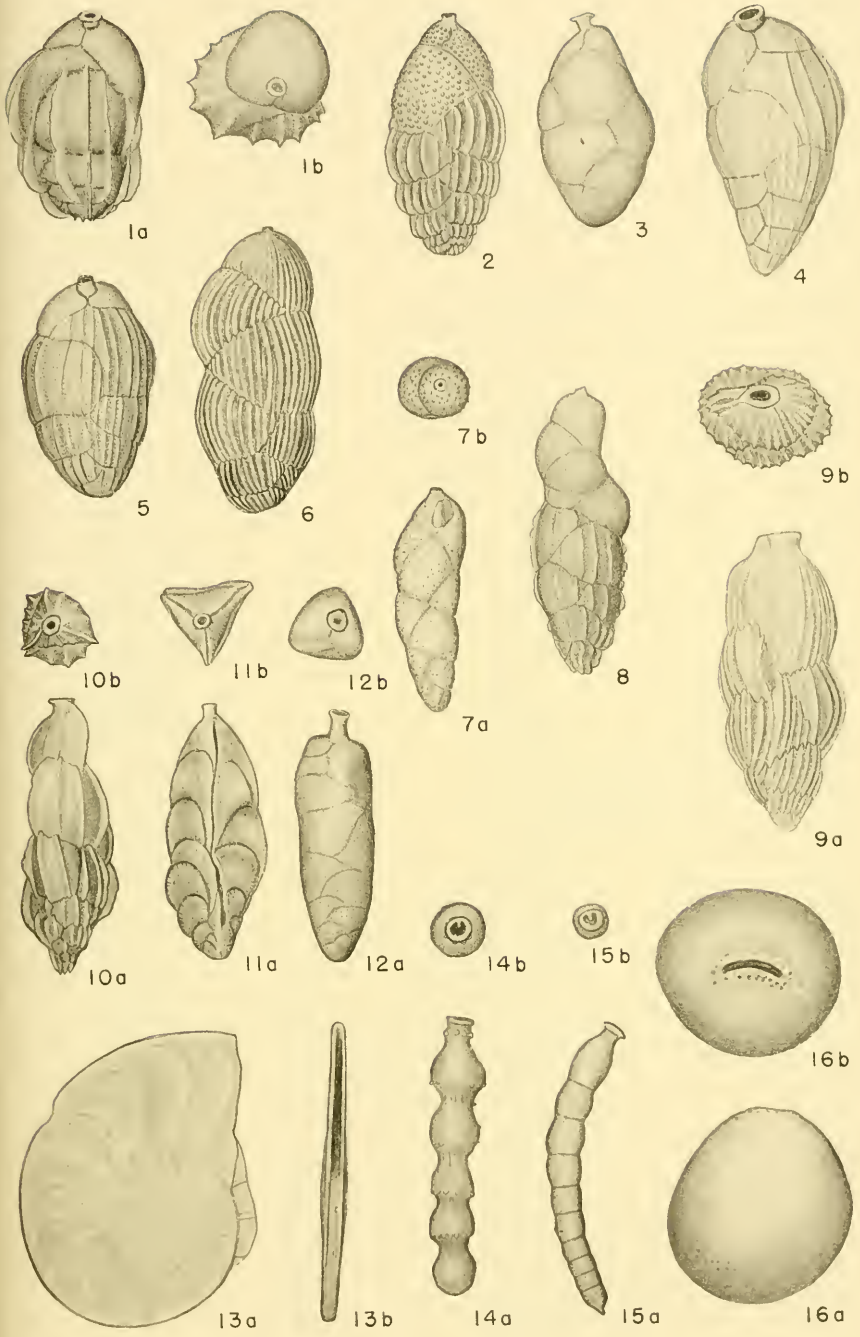




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## ERRATA

Page	Line	
7	16	For "William Moarn" read "William Morau."
13	31	For " <i>Lepidoeyclina ocalina</i> " read " <i>Lepidoeyclina ocalana</i> ."
17	6	For " <i>Hantkenina alabamaensis</i> " read " <i>Hantkenina alabamensis</i> ."
21	30	For "the last ultimate" read "the ultimate."
23	20	For "silicious cement" read "siliceous cement."
26	1	For "Cushman, 1944, Lab." read "Cushman, 1944, Cushman Lab."
50	9	For "portion of one of a chamber" read "portion of one side of a chamber."
90	14	For "common at Red Buff" read "common in the Red Buff."
109	19	For "Plate 20, figs. 3a-c" read "Plate 20, figs. 3a-e."
110	8	For "es." read "Res."
117	38	For ".034" read "0.34."
136	3	For "Nuttal" read "Nuttall."
148		For "Guadryina" read "Gaudryina."
160	36	For "diabollensis" read "dibollensis."
174	15	For "73" read "75."
174	33	For "73" read "75."

On headings of figures and charts for "vol. XXXI, No. 132" read "vol. XXXII, No. 131."

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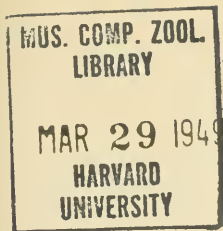


EZRA BABCOCK KNAPP. 1830-1908

From the painting by John Dodgson Barrow, Skaneateles Library Association, No. 2.

(Photograph by Ethel Ostrander Smith, 1948.)





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No. 132

HOLOTYPE OF MYTILARCA (PLETHOMYTILUS) KNAPPI HALL WITH  
A NOTE ON EZRA BABCOCK KNAPP

By

Burnett Smith

March 20, 1949

PALEONTOLOGICAL RESEARCH INSTITUTION  
ITHACA, NEW YORK  
U. S. A.



HOLOTYPE OF *MYTILARCA* (*PLETHOMYTILUS*)  
*KNAPPI* HALL WITH A NOTE ON  
EZRA BABCOCK KNAPP

By

BURNETT SMITH

INTRODUCTION

The holotype of *Mytilarca* (*Plethomytilus*) *knappi* Hall (Hall, 1884, p. 256, pl. 87, fig. 13) was found in 1948 during rearrangement and renovation of the geological collection of the Skaneateles Library Association of Skaneateles, New York. The President and Board of Trustees of this association, realizing the scientific importance of the find, presented the holotype to the Paleontological Research Institution, 126 Kelvin Place, Ithaca, New York, U. S. A. It now bears this repository's catalogue number 6051 and is there available for consultation by scientists throughout the world. No attempt is here made to redescribe Hall's species. The purposes of this note are (1) to acquaint paleontologists and students of mollusks with the location of the holotype, (2) to outline the specimen's probable history, (3) to tie definitely Ezra Babcock Knapp's name to the species, and (4) to give a brief sketch of the life and traits of an energetic local collector and remarkable personality. The present writer remembers Knapp well but any quoting of his words or anecdotes about him appearing here are based on recollections decades old and must therefore be accepted as approximations only.

ACKNOWLEDGMENTS

The compiler of these notes has been helped by so many persons that a complete list of them might rival the rest of the paper in length. The hope is here expressed that the many not mentioned will accept this blanket acknowledgment. First tribute must be paid to President L. Harris Hiscock, the Library Board of Trustees, and the officers and employees of the Skaneateles Library Association. Permission to reproduce the Knapp portrait in the Skaneateles Library is acknowledged with gratitude.

This painting by the late John Dodgson Barrow of Skaneateles, New York, gives an excellent and very characteristic picture of Knapp in his intellectual prime. Thanks are due to Doctor Remington Kellogg of the United States National Museum for an investigation of Knapp's Washington contacts. Of especial help in the preparation of the Knapp note have been Mrs. Annie C. Ackles and Mrs. Flora A. Burns Austin (Mrs. Anthony Austin) both of Skaneateles. The writer is also indebted to Doctor Katherine V. W. Palmer of the Paleontological Research Institution for the photograph of the holotype in its rock matrix and to Mrs. Ethel Ostrander Smith of Skaneateles for the photograph of the Barrow painting of Knapp.

#### THE HOLOTYPE, ITS LOCATION, AND PROBABLE HISTORY

The holotype of *Mytilarca (Plethomytilus) knappi* Hall (Hall, 1884, p. 256, pl. 87, fig. 13) as already stated is now in the Paleontological Research Institution, 126 Kelvin Place, Ithaca, New York, U. S. A. Its catalogue number is 6051. Hall's figure is of a right valve cast showing growth line and ligamental impressions. The specimen is, however, still in its rock matrix but there is no difficulty in recognizing a virtually complete agreement between the specimen and its figure. Even "imperfections" are faithfully depicted in the figure.

When found in 1948 the holotype was resting on, but not attached to, a wooden block. Pasted to the block was a label bearing the following: "Plethomytilus Knappi. n. sp. Hamilton Period. From near 10 mile Point. Skan. Lake, N. Y." Both block and attached label are similiar in design to those used for many other specimens in the Skaneateles Library collection, and it is, therefore, reasonable to conclude that block and label for the holotype were prepared either by the library or by Knapp. On the same side with the holotype there is attached to the rock matrix a faded label on which "Plethomytilus knappi" can be made out except perhaps for a few letters and also the word "specimen". On the same side there is also another faded label with the number 13 and a much fresher green label on which the number 2049 shows up distinctly.

On the "reverse" side of the specimen there is attached one label reading "E. B. Knapp, Skaneateles N. Y. to be returned" and another label with "Skan. Lake N. Y." upon it.

The writer has attempted to reproduce exactly the wording, punctuation, and abbreviations of these old labels for they form an important part of the history of this much-documented specimen.

The evidence, given largely by the labels, may be interpreted in this way. Knapp collected the specimen near Tennile Point on the east side of Skaneateles Lake and turned it over to Hall for identification with the understanding that the specimen was to be returned either to the Skaneateles Library or to Knapp. Hall, considering that he had before him something new, named the species after Ezra Babcock Knapp. Unfortunately Hall does not make this clear in his descriptive text (Hall, 1884, p. 256) but the labels unquestionably connect the specimen with Ezra Babcock Knapp. Many years ago Knapp told the present writer that *Mytilarca* (*Plethomytilus*) *knappi* had been named after him (Ezra Babcock Knapp). Apparently Knapp, in showing the specimen to Hall, acknowledged his inability to identify it. Hall's reply was something like this—"The species is *Mytilarca* (*Plethomytilus*) *knappi*." In that way Knapp learned that he had something hitherto unknown.

The holotype of *Mytilarca* (*Plethomytilus*) *knappi* Hall came from one of the harder and more resistant layers of the Hamilton shale. Virtually touching the holotype is the cast of a left valve fragment assignable to *Actinopteria*. The cast of a portion of the right valve of the same individual is also present. The valves were buried in the sediment with little or no separation from each other. The species is either *Actinopteria boydi* (Conrad) or *A. decussata* (Hall) (Hall, 1884, pl. 19, figs. 2-24, 26-30; pl. 18, figs. 1-15). A poorly preserved specimen probably of *Tropidoleptus carinatus* (Conrad), fragments of "crinoid" stems, and obscure "bryozoan" markings are also among the associates of the holotype.

It is now fitting to attempt to evaluate more closely the probable locality and geologic horizon of the holotype. The former,

according to the label, is near Tennile Point. Unfortunately which side of the point is not stated. Two of the labels at least suggest that the specimen came from rock outcropping along the shore. Hall (1884, p. 256) gives the "shores" of the lake. If collected in place the chances are that the specimen was found in the low but conspicuous cliffs which appear along the lake about one-half mile southeast of Tennile Point. This outcrop, assigned to the Centerfield member of the Hamilton, is exposed almost continuously along the shore until the bed dips below the lake level just south of Halls Landing (Smith, 1935, Geologic Map 1, fig. 18).

#### EZRA BABCOCK KNAPP

1830-1908

This brief sketch of the life and traits of Ezra Babcock Knapp is derived from a number of sources. An obituary notice is to be found in the Skaneateles Free Press for October 30, 1908 and a very like account of him, apparently prepared during his lifetime, occurs in Collins's history of Spafford (Collins, 1902 (?), 1917, p. 101). Personal recollections and anecdotes complete the list of sources.

Ezra Babcock Knapp was born in the Town of Scott, Cortland County, New York, on February 26, 1830. He was the son of Peter, Jr. and Sarah Babcock Knapp. When three years of age he moved with his parents to the adjoining Town of Spafford in Onondaga County. He grew up as a farmer boy on a farm near Spafford Corners. After his elementary schooling he attended the "Academy" at Homer, Cortland County. This "Academy" was then a famous school and Knapp was graduated from it in the later 1840's. From 1848 he taught school "for twenty-three terms." Three years followed in the book business in Syracuse, New York, where he was associated with E. P. Howe under the firm name of Knapp and Howe. After this for some twenty years he appears to have been a salesman for school book and school supply companies.

In 1857 Mr. Knapp married Loretta E. Wiltsie of Skaneateles, which village became his residence in 1870. He was elected

School Commissioner for the Second District of Onondaga County, New York, in 1884. Re-elected in 1887 he served three years more but declined the nomination for a third term. He is stated to have been an able school commissioner. For some six months in 1892 Mr. Knapp held the office of President of the Village of Skaneateles.

Knapp was undoubtedly a man well versed in the local geology and with a creditable record in education so one is not surprised to learn that in 1887 Colgate University conferred upon him an honorary degree of Master of Arts.

The following quotation from the obituary notice (Anonymous, 1908, p. 1) already mentioned adds other items of interest. "Mr. Knapp was one of the early and warm friends of Skaneateles Library, to which he donated a choice collection of geological specimens. He was for a time employed in the Smithsonian Institution at Washington in scientific duties."

The present writer has been unable to verify Knapp's possible employment at the Smithsonian. However, he was in touch with the United States National Museum which "Received (accession No. 14347) from Mr. E. B. Knapp, of Skaneateles, N. Y., a collection comprising 14 genera, 17 species, of Devonian fossils," etc. (See Walcott, 1885, p. 204.)

In addition to his "solid" qualities Knapp had another and very likeable side. He was an incorrigible joker. Mrs. Knapp was frequently referred to as his "bride." *Plethomytilus knappi* was his "stone baby." That Knapp's sense of humor could get him out of a tight place is illustrated by a story told the present writer by his father, the late Edmond Reuel Smith of Skaneateles. The incident occurred on a train between Skaneateles and Syracuse during the rage of spelling contests or spelling bees. The car was crowded and a disgruntled passenger, imagining that he had been jostled by Knapp, threatened to punch him in the "snoot." The unruffled Knapp turned upon the threatener with the following — "S-N-O-U-T, snout, Webster's unabridged." In this way an ugly situation was turned into a comic one to the delight and amusement of the weary passengers.

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**PLATE**

PLATE 1 (32)

## EXPLANATION OF PLATE I (32)

Figure	Page
1. <i>Mytilarca (Plethomytilus) knappi</i> Hall	4
Holotype in rock matrix. P. R. I., No. 6051. Long dimension of holotype about 48 mm. Probably from the Centerfield member of the Hamilton group. Near Tennile Point, shore of Skaneateles Lake, New York.	

(Photograph by Katherine V. W. Palmer, 1948.)



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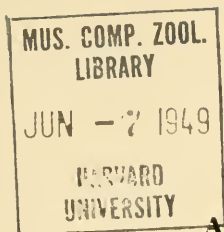
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No. 133

**CRINOID STUDIES**

PART III. APOGRAPHIOCRINUS ARCUATUS, NEW SPECIES FROM THE MISSOURI SERIES OF OKLAHOMA.

PART IV. ENOCRINUS, NEW GENUS FROM THE PENNSYLVANIAN OF OKLAHOMA.

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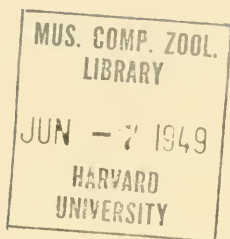
By

**HARRELL I. STRIMPLE**

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PALEONTOLOGICAL RESEARCH INSTITUTION  
ITHACA, NEW YORK  
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# CRINOID STUDIES

By

HARRELL L. STRIMPLE

## PART III

### APOGRAPHIOCRINUS ARCUATUS, NEW SPECIES FROM THE MISSOURI SERIES OF OKLAHOMA

#### INTRODUCTION

Ornamented apographiocrinids, other than the granular-appearing young forms, are rare in the Missouri series of north-eastern Oklahoma. However, they have been observed from time to time by the author in certain crinoidal zones of the Wann formation. Among the numerous crinoid specimens collected at the Mound (or hill) just west of the city limits of Bartlesville, Oklahoma, approximately one-tenth of one percent of the *Apographiocrinus* specimens shows evidence of a scarlike development below the articular facets of the RR. At a comparable horizon some three miles west of Ramona, Oklahoma, approximately thirty percent of the *Apographiocrinus* specimens have a scarlike development below the articular facets of the RR and, allowing some latitude for individual variants, appear in the main to belong to a single species which is described as *Apographiocrinus arcuatus*, new species. It is probable that additional species will eventually be presented from this zone.

The crinoidal horizons three miles west of Ramona (just west of the E.  $\frac{1}{4}$  cor. sec. 25, T. 24 N., R. 12 E.) occur as follows: 1.) Near the top of the shale that rests between the Iola limestone formation at the base of the hill and the next thin limestone layer; 2.) Just above the previously mentioned limestone layer; 3.) Just above the next higher thin limestone layer. Crinoid ossicles are common in the shale between the two thin limestones but complete specimens are almost nonexistent. It might be noted that crinoids are not prolific at this outcrop. However, *A. typicalis* Moore and Plummer, along with many other crinoid species, is found in all three horizons. *A. arcuatus* is restricted to the zones just above the two thin limestones.

## DESCRIPTION OF SPECIES

Genus **APOGRAPHIOCRINUS** Moore and Plummer**Apographiocrinus arcuatus**, n. sp.

Plate 1, figs. 1-10; text fig. 1

*Description.*—Dorsal cup is shallow and broad. Basal concavity is shallow. Five IBB are almost entirely covered by the comparatively stout column. Five BB are rather large plates and have a subhorizontal attitude. Five RR form the lateral sides of the cup and have a distinctive appearance due to the vertically developed, ornamented facets which appear below the arm articulating facets. Ornamentation is restricted to small nodelike projections which mark the lower perimeter of the arcuate facet which is itself entirely smooth. The outer surfaces of RR along the sutures project into the articulating areas as pronglike extensions and are more pronounced than normal for the genus. Only one anal plate is present in the dorsal cup and rests solidly on the truncated upper extremity of post. B. Upper extremity of anal X is considerably wider than the lower portion and is faceted for the reception of two tegmen plates.

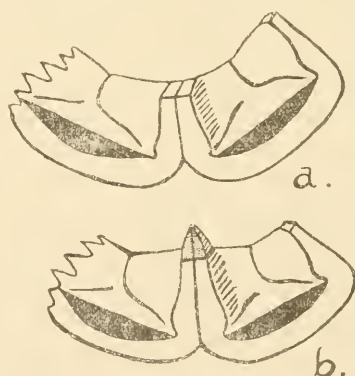


Figure 1. Diagrammatic sketches of articular facets of *Apographiocrinus* to show inward, pronglike extension of radials between articular facets: a. extensions ending with blunt inner edges, as normally preserved; b. stippled area representing two additional elements found in many well-preserved forms.

There are ten uniserial arms, bifurcating with the first PBrBr in all rays. Ant. PBr is longer than the others, 1. post. PBr and r. ant. PBr are elongate and of approximate equal length,

and r. post. PBr. and l. ant. PBr are short elements. In young specimens a faint keel-like ridge extends the length of each PBrBr. Small nodelike projections mark the upper edges of SBrBr.

The column is composed of round, alternating expanded ossicles and is pierced by a minute round lumen.

*Measurements*

	Holotype No. 857	Paratype No. 805a	Paratype No. 805b	Paratype No. 805c
Width of dorsal cup	10.8	9.5 <sup>1</sup>	10.5	8.2
Height of dorsal cup	3.7	3.4 <sup>1</sup>	2.9	3.8
Height of basal concavity	1.1	—	—	1.1
Width of proximal columnal	1.4	—	—	1.8
Length of ant. PBr	—	5.0	3.7	—
Length of crown	—	27.6	16.9 <sup>2</sup>	—

*Remarks.* *Apographiocrinis arcuatus* is more comparable to various ornamented apographiocrinids from the Missouri series of Texas than to those found in the Des Moines series of Oklahoma (see Strimple, 1948). In all other described species the entire surfaces of the arcuate facets of the PBr are ornamented by granular or nodular protuberances. The tendency toward granular development of these facets has been observed in Oklahoma forms from the Missouri series but is considered a divergent trend since almost all of the present specimens are entirely devoid of ornamentation except for the small nodes marking the lower edge of the facets.

Apparently this peculiar vertically developed facet served some function of the organism, for it would not have attained such wide distribution. In the opinion of the writer, the facets were in use when the arms were extended. The purpose of the pronglike extension between articular facets is apparent when the arms are closed, for the PPrBr are so constructed as to rest on them. If the extensions were not present, direct passage to the body cavity would be possible between the lower limits of the arms.

1. Approximate.

2. As preserved.

Close observation of innumerable specimens of *Apographiocrinus* has disclosed the presence of two elongate, sliverlike ossicles at the inner edge of the interfacetal projections. Normally the projections of the RR end in a blunt edge, and these additional plates are only found with nearly perfect preservation. The small elements provide an unusual problem in taxonomic designation among the inadunates. The presence of partitions between rami is best demonstrated among the camerates by *Eucalyptocrinites*.

*Occurrence and horizon.*—Road cut just west of the E.  $\frac{1}{4}$  cor. sec. 25, T. 24 N., R. 12 E., some three miles west of Ramona, Oklahoma, and the Mound (or hill) just west of the city limits of Bartlesville, Oklahoma; Wann formation, Ochelata group, Missouri series, Pennsylvanian.

*Types.*—Figured types, Nos. 895, 895a, 895b and 895c, Strimple Collection.

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## CRINOID STUDIES

### PART IV

#### EXOCRINUS, NEW GENUS FROM THE PENNSYLVANIAN OF OKLAHOMA

#### ABSTRACT

*Exocrinus*, new genus, is proposed to accommodate an assemblage of well over 100 specimens representing five new species of a unique Pennsylvanian crinoid group. Three major stratigraphic divisions of the Pennsylvanian are represented, *i. e.*, Des Moines, Missouri, and Virgil series.



## INTRODUCTION

A distinctive crinoid genus, rather common to some Pennsylvanian strata, has been known to the author for several years. However, the specimens are all so small when compared with those of most genera that there has been some doubt as to their maturity. Over 100 specimens assignable to the genus have now been observed, and there is no question that the larger forms are mature. The largest observed specimen is the holotype of *Exocrinus virgilensis*, n. sp., and the largest complete crown is the holotype of *Exocrinus multirami*, n. g., n. sp.

All specimens were collected by Mr. and Mrs. H. L. Strimple of Bartlesville, Oklahoma. The author is grateful to Dr. Raymond C. Moore, State Geologist, State of Kansas, and to Mr. James Wright, the eminent Scottish crinoid authority, for valuable suggestions in the study of the group.

## DESCRIPTION OF SPECIES

Genus **EXOCRINUS**, new genus

Genotype.—*Exocrinus multirami*, new species

The crown is compact and of medium length. Dorsal cup is shallow, truncate cone-shaped, with slightly invaginated base. BB five, small elements, of subhorizontal to downflared attitude, confined to the depressed basal area, and not visible in side view of dorsal cup. BB relatively small and largely in the basal plane. Anal series essentially a single plate (RA) in posterior position, followed normally by two smaller elements. In the younger species, *E. virgilensis*, RA is elongate and extends above the upper limits of the dorsal cup. It is apparently followed by a single plate.

The arms are rather stout, pinnular and short, with first bifurcation taking place on the first PBrBr. As reflected by the genotype, there is a second endotomous bifurcation and a third division in many rays. Twenty-four arms are shown by the holotype of *E. multirami*, but all rami are not preserved to their termination. A minimum of thirty arms is indicated. Some outer rays do not appear to have the third bifurcation which would

constitute a sporadic exotomousity in the distad portion of the arms.

A few proximal columnals have been observed. So far as preserved the stem is annulated, circular in outline, and non-cirriforous. The lumen is small and round.

This genus has a known distribution in the Des Moines, Missouri, and Virgil series (Pennsylvanian) of Oklahoma and southern Kansas.

Although the genus is placed under the Ampelocrinidæ, it is to the Mississippian representatives, rather than Pennsylvanian forms, that we must look for close affinities. *Cymbiocrinus* Kirk and *Ampelocrinus* Kirk are both small forms, as represented in the literature, and could have evolved to the present genus through fusion of the two PBrBr. All described Pennsylvanian ampelocrinids are rather large, have two PBrBr to each ramus, and have pentagonal-shaped stems.

*Stellarocrinus* Strimple has an arrangement of the post. IR similar to *Erocrinus* and a round column, and it is entirely possible there might be some relationship. However, the articular facets of the former genus are markedly different from those of *Exocrinus*.

*Exocrinus multirami*, n. sp.

Plate 2, figs. 5-7; Plate 3, figs. 4, 5

*Description*.—Dorsal cup is truncate cone-shaped, with base mildly depressed. IBB disk is subhorizontal, confined to the invaginated base, diameter slightly greater than the proximal columnal, and is composed of five equal elements. BB are five medium-sized elements, proximal portions participating in basal invagination. Post. B supports the single anal plate (RA). RA supports two almost equal elements above, the proximal portions of which are within the upper limits of the dorsal cup. That to the left (anal X) is slightly larger, and the upper facet forms a continuous face with the plate (RX) to the right. RR are five large elements with articular facets almost filling the full width of the plates. Articular facets slope very slightly outward and have shallow muscle areas. Intermuscular notch is narrow, denticles are absent, and the only sharply defined feature is the ligamental pit.

The number of arms varies with the stage of development. First bifurcation takes place with PBrBr in all rays. In very young specimens only ten arms are found, a strong keel-like ridge marks the median section, and most PBrBr are extremely elongate. Anterior PBr is considerably the longest, the two posterior PBrBr next in length, and the right and left anterior PBrBr are of moderate length. In full maturity, this inequality in length is still present though the unusual length is somewhat modified. All axillary BrBr are considerably longer than normal brachials, and the median keel splits at the apex of each axillary element to form two small spinelike protuberances. Twenty-four arms are preserved in the nearly complete crown figured as the holotype. Second bifurcation takes place with either the third or fourth secundibrach. Next branching is apparently mainly confined to the inner rays and takes place with the third or fourth tertibrach. This would be exotomous branching except that endotomous structure is found in some of the outer rays where axillary TBrBr have been observed.

Only proximal columnals have been observed. They are circular in outline, alternately expanded, with the larger ossicles having an almost beadlike outline. There is a minute, round lumen.

Under magnification, the entire crown is delicately granular. Tegmen is unknown.

*Measurements.*—

	Holotype	Young Paratype
Height of dorsal cup	1.8 mm.	1.7 mm.
Width of dorsal cup	7.1 mm.	4.1 mm.
Length of crown	16.6 mm.	14.0 mm.
Length of anterior primibrach	3.8 mm.	4.0 mm.

*Remarks.*—The rapidly expanding dorsal cup, arm structure, and arrangement of the elements in the post. IR serve to readily distinguish this from other described species. It is of some interest to note that dorsal cups without arms are seldom observed for this species, but small crowns are rather common at the type locality.

*Occurrence and horizon.*—Unnamed shale some 30 feet above the Torpedo sandstone formation, Ochelata group, Missouri series, Pennsylvanian; 2½ miles northeast of Copan, Oklahoma.

*Types.*—Strimple Collection, No. 536

*Exocrinus desmoinesensis*, n. sp.

Plate 2, figs. 3, 4, 8

*Description.*—Dorsal cup is shallow, more or less bowl-shaped, with the base invaginated. The basal depression is rather narrow and, with the proximal columnals in place, it is not possible to observe the small IBB disk. BB are five small elements, with the lower portions curving evenly into the basal invagination. Post. B is considerably longer than the other BB. RR are five rather large elements. A small, narrow RA rests squarely on the upper extremity of post. B. RA is followed by two small nearly equalized elements (anal X and RX). The latter plates are barely within the upper limits of the dorsal cup and their upper extremities form a confluent shelf.

Proximal columnals are circular in outline and are pierced by a minute, round lumen.

Arms and tegmen are unknown.

*Measurements.*—

	Holotype
Height of dorsal cup	2.0 mm.
Width of dorsal cup	6.0 mm.

*Remarks.*—The dorsal cup of *E. desmoinesensis* has an unusually rounded contour as compared to other species assigned to the genus. The stem is larger than normal, and the small, narrow RA is distinctive.

*Occurrence and horizon.* Altamont limestone formation, Des Moines series, Pennsylvanian; road cut near the end of 31st Street at the eastern edge of Tulsa, Tulsa County, Oklahoma.

*Holotype.*—Strimple Collection, No. 541.

*Exocrinus wanni*, n. sp.

Plate 2, figs. 1, 2; Plate 3, figs. 1-3

*Description.*—The dorsal cup is truncate cone-shaped, expanding rapidly from the basal plane. The basal area is invaginated. IBB disk is small and composed of five elements. BB are small, the proximal portions comprising the walls of the

basal invagination but curving sharply outward to participate slightly in the outer sides of the dorsal cup. RR are five large plates. There are three anal plates in the post. IR. RA rests on the slightly oblique upper facet of post. B, so that the right lateral side is longer than the left. Two smaller, almost identical ossicles rest on the truncated upper face of RA. They are designated as anal X to the left and RX to the right, and their upper extremities form an even, horizontal shelf.

In the largest observed specimen, only the lower portions of the arms are preserved. The largest PBr is anterior in position, the PBr of the right and left posterior are slightly shorter and of approximate equal length, and the PBr of the right and left anterior are no longer than wide. In some rays the first and second secundibrachs are preserved. There is a raised keel-like ridge extending the length of the arms, with some tendency for the keel to form a splayed effect at the apices of PBr, but no decided spines are developed.

Immature crowns are known, but they are at the stage where only ten arms are present and are of no value in determining the eventual number of arms carried by the species. Fragmentary specimens disclose a third bifurcation in some rays.

*Measurements.*—

	Holotype	Paratype
Height of dorsal cup	2.5 mm.	2.2 mm.*
Width of dorsal cup	7.1 mm.	8.2 mm.*
Length of ant. PBr	—	5.2 mm.

*Remarks.*—*E. wanni* is very similar in many respects to *E. multirami*. The calyx of *E. wanni* is more erect, and RA has an oblique placement on the post. B.

*Occurrence and horizon.*—Unnamed weak, sandy, limestone layer in the upper portion of the Wann formation, Ochelata group, Missouri series, Pennsylvanian; road cut in the S.  $\frac{1}{2}$  sec. 15, T. 25 N., Osage County, Oklahoma.

*Types.*—Strimple Collection, No. 537.

*Exocrinus virgilensis*, n. sp.

Plate 3, figs. 9, 10

*Description.*—Dorsal cup is shallow, truncate cone-shaped, with

\* Approximately (specimen is flattened).

the base invaginated. IBB are very small, almost entirely concealed by the proximal columnal, and are confined to the depressed basal area. BB are five, the proximal portions curved to participate in basal invagination. RR are five large elements. One elongate anal plate, RA, is present within the dorsal cup, lower extremity is very narrow and rests squarely on the truncated post. B, and the upper extremity extends above the calyx with a facet for the reception of only one plate above.

All of the PBrBr are present and several SBrBr in some rays. The PBrBr are elongate axillary elements with a keel-like ridge extending the length of the arms.

Proximal columnals are circular in outline. Tegmen has not been observed.

*Measurements.*—

	Holotype
Width of dorsal cup	9.3 mm.
Height of dorsal cup	2.5 mm.
Length of ant. PBr	5.5 mm.

*Remarks.*—*E. virgilensis* may be distinguished from other species referred to the genus because of the single anal plate within the dorsal cup. It is the largest form of the genus known at this time.

*Occurrence and horizon.*—Nelagoney formation, Virgil series, Pennsylvanian; SW.  $\frac{1}{4}$  sec. 21, T. 22 N., R. 10 E., approximately 15 miles west of Skiatook, Osage County, Oklahoma.

*Holotype.*—Strimple Collection, No. 893.

*Exocrinus pallium*, n. sp.

Plate 3, figs. 6-8

*Description.*—Dorsal cup broad and shallow. IBB five, small elements, confined to basal invagination. BB five, slightly tumid plates, curving rapidly out of basal depression. RR five, large elements, having an almost horizontal attitude. Articular facets slope slightly outward. Outer ligamental area is pronounced and denticles are present along the furrow. RA is broad, rests obliquely on the truncated posterior B and supports two smaller anal plates (anal X and RX) above.

Columnar cicatrix is round and pierced by a minute round lumen. Arms and tegmen are unknown,

*Measurements.*—

	Holotype
Width of dorsal cup	8.8 mm.
Height of dorsal cup	2.1 mm.

*Remarks.*—The broad, flattened appearance of the dorsal cup and mild tumidity of BB plates distinguish *E. pallium* from other known species referred to the genus.

*Occurrence and horizon.*—Just above the first limestone layer of the Wann formation, Ochelata group, Missouri series, Pennsylvanian (Upper Carboniferous); road cut west of Ramona, in center E.  $\frac{1}{2}$  sec. 25, T. 25 N., R. 12 E., Osage County, Oklahoma.

*Holotype.*—Strimple Collection, No. 540.

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## CRINOID STUDIES

## PART V

ALLOSOCRINUS, A NEW CRINOID GENUS FROM THE  
PENNSYLVANIAN OF OKLAHOMA

## ABSTRACT

A new genus, *Allosocrinus*, is proposed for the reception of an unusual Pennsylvanian crinoid described as *Allosocrinus brendaughii*, n. sp. Description of *Ampelocrinus erectus*, n. sp. from the Chester group is also undertaken.

## INTRODUCTION

Transition of known small Chester representatives of the *Ampelocrinidae* to the robust forms of Pennsylvanian age has



been somewhat difficult to visualize from available literature. For this reason the rather robust *Ampelocrinus erectus* of Chester age is presented here in conjunction with the description of *Allesocrinus bronoughi*, n. g., n. sp. which is of Pennsylvanian age.

It should be noted that all specimens used in this study were collected by two amateur paleontologists. Many years ago Mr. Claude Bronough, of Afton, Oklahoma, discovered the presence of the magnificent crinoid fauna in the Fayetteville formation outcrops lying between Vinita and Afton, Oklahoma, and has always been more than co-operative in placing materials into scientific channels. Like most amateurs, Mr. Bronough originally collected fossils simply because he enjoyed doing so, and, with encouragement and guidance, he has since acquired a scientific approach. It has been the observation of the author that this is not an exception but the normal transition of uninitiated amateur to useful and worthwhile (amateur) paleontologist.

## DESCRIPTION OF SPECIES

### Genus *AMPELOCRINUS* Kirk

*Ampelocrinus erectus*, n. sp.

Plate 4, figs. 5, 6

*Description.*—The crown of the holotype is slightly distorted due to compression; however, structure is readily determinable. Five IBB are modest-sized elements and are erect in posture. IB are five hexagonal-shaped plates of medium size, and that of the posterior is larger than the others with the upper surface obliquely truncated for the reception of the rather large RA. Two smaller plates are supported above the RA, that to the left being the anal X, and the one to the right RX. Five RR are rather large, pentagonal-shaped elements and have relatively narrow articular facets with strong ligamental pits in shallow ligamental furrows.

Ten uniserial arms are indicated, first bifurcation taking place with PBrBr<sub>2</sub> in all rays. PBrBr<sub>1</sub> are rather large, quadrangular-shaped plates. The articulating facets of BrBr are similar to those of the RR.

Columnar scar is pentagonal-shaped and is crenulated. All plates of the crown are strongly granular appearing.



*Measurements.*—

	Holotype Mm.
Height of dorsal cup	10.0*
Width of dorsal cup	15.0*
Diameter of stem impression	3.0*
Width of l. ant. B	5.0
Length of l. ant. B	5.1
Width of r. ant. R	6.8
Length of r. ant. R	4.1
Width of r. post. PBr <sub>1</sub>	5.9
Length of r. post. PBr <sub>1</sub>	3.1

*Remarks.*—*Ampelocrinus erectus* has all of the characters ascribed to the genus. All previously described species are from slightly older strata and are of considerably lesser stature. The present species demonstrates increase in size which culminates in Pennsylvanian forms assigned to the family. In addition to its robust nature, the pronounced ornamentation serves to readily distinguish *A. erectus* from other known species.

*Occurrence and horizon.*—Six miles SW. of Afton, Craig County, Oklahoma; Fayetteville formation, Chester group, upper Mississippian.

*Type.*—Holotype collected by Mr. Claude Bronaugh. To be deposited in the U. S. National Museum.

Genus **ALLOSOCRINUS**, new genus

Genotype.—*Allosocrinus bronoughi*, new species

*Generic diagnosis.*—Dorsal cup broad, bowl-shaped; infra-basals (IBB) form broad disk, confined to shallow basal concavity; basals (BB) large, six-sided plates except for post. B which is truncated for a single, long anal plate (RA); radials (RR) wider than high, five-sided plates. All calyx plates are thick with joint surfaces crenulated. Ornamentation of cup and arms composed of coarse, numerous granules. Primi-brachs (PBrBr) seven or more; brachials (BrBr) thin, regularly spaced to cuneate, fine striations from front to back on joint surfaces. Column round in outline, alternating expanded, strongly crenulated with crenulations visible in side view of stem.

\* Computed.

*Horizon and distribution.*—Missouri series, Pennsylvanian (Upper Carboniferous); North America.

*Remarks.*—Specimens of this unusual crinoid have been known to the author for several years from rocks of Missouri (Pennsylvanian) age. The single anal plate, general outline of dorsal cup, and nature of the radial articular facets, have indicated close relationship to *Aesiocrinus* Miller and Gurley (1890), to *Moundocrinus* Strimple (1939), or *Oklahomacrinus* Moore (1939). Both *Moundocrinus* and *Oklahomacrinus* appear to be direct derivatives of *Aesiocrinus*. However, the former genus has been considered by most authors as synonymous with *Aesiocrinus*, yet the later genus is accepted as valid. Such considerations only lead to confusion, and, since the evidence does indicate need for generic division between these forms, this author accepts *Oklahomacrinus* as a valid genus and reiterates the validity of *Moundocrinus*. Two factors serve to readily distinguish *Moundocrinus* from *Aesiocrinus*, *i. e.*, the single anal plate (RA) is followed by a single tegmen plate (in *Aesiocrinus* two plates are present\* which may be identified as anal X to the left and RX to the right), and the articular facets of RR are quite narrow as compared to the shelflike facets of *Aesiocrinus*.

In general calyx structure *Allosocrinus* is closer to *Moundocrinus* than any other described form. However, the later genus is known to have ten arms which bifurcate with the second PBrBr and has a column with a pentagonal outline. Articulation between BrBr of *Allosocrinus* is not comparable to any known Pennsylvanian form but is found in *Poteriocrinites* and *Rhabdocrinus* Wright (1944), both of Lower Carboniferous (Mississippian) age.

*Allosocrinus bronoughi*, n. sp.

Plate 4, figs. 1-4

*Material.*—Nine dorsal cups including several specimens with arm ossicles attached and numerous dissociated plates.

*Remarks.*—The generic characteristics previously given are based on *A. bronoughi* and are not repeated here. It might be noted that a plicated border is found between IBB and BB. First

\*See, Strimple (1948), Jour. Paleont., vol. 22, No. 4, for discussion of this type of developmental trend in the post. IR.

primibrach almost covers the entire width of radial and the under facet has a cross ridge almost identical to that of the radial articulating facet. However, the upper face of each PBrBr is considerably restricted in width and has a pattern of fine striations which converge toward the center of the inner edge. Some striations are seen to bifurcate. The five arms taper rapidly.

*Occurrence and horizon.*—Wann formation, Ochelata group, Missouri series, Pennsylvanian (Upper Carboniferous); 3 miles west of Ramona;  $\frac{1}{4}$  miles west of Ochelata; the Mound just west of Bartlesville; road cut just west of Bartlesville Municipal Airport, all in Osage and Washington counties, Oklahoma.

*Types.*—Holotype, Strimple Collection, No. 884; paratypes, Strimple Collection, Nos. 885-892.

*Measurements.*—

	Holotype No. 884 Mm.	Paratype No. 885 Mm.
Width of dorsal cup	22.5 <sup>1</sup>	19.0 <sup>2</sup>
Width at dorsal cup	10.0	9.0 <sup>2</sup>
Width of arms at base	10.3	10.3
Width of arms at summit of PBr <sub>1</sub>	8.8	6.3
Width of arms at summit of PBr <sub>7</sub>	Not known	4.1
Width of IBB circlet	7.0	Not known
Diameter of proximal columnal	2.6	" "
Length of BB	10.2	8.0
Width of BB	10.3	9.0
Height of RR	7.5	7.5
Width of RR	14.0	10.8
Length of RA	7.0	Not known
Width of RA (Maximum)	4.7	" "

1. Average.

2. Estimated.

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## CRINOID STUDIES

## PART VI

ALLAGECRINUS COPANI, NEW SPECIES FROM THE  
PENNSYLVANIAN OF OKLAHOMA

## ABSTRACT

Description of *Allagecrinus copani*, n. sp. provides us with exciting new material which should assist considerably in the eventual understanding of the allagecrinids.

## INTRODUCTION

A magnificent crown found by the author in the spring of 1948 provided the desired holotype for description of *Allagecrinus copani*, new species which is now supported by some 14 crowns and 12 calices. The species will be most valuable in the eventual

complete understanding of this unique group of crinoids, because it is considerably larger than any other previously described species of *Allagecrinus*. In fact, it is comparable in size to many catilloocrinids and has an appearance not greatly dissimilar to some synbathocrinids. A comprehensive study is not undertaken for considerable undescribed material is known to exist which might modify any conclusions arrived at on the basis of existing literature.

### DESCRIPTION OF SPECIES

Genus **ALLAGECRINUS** Carpenter and Etheridge

*Allagecrinus copani*, n. sp.

Plate 5, figs. 1-7

*Description.* Dorsal cup high, mildly lobate. Three BB form the base which is visible in side view of the dorsal cup. Five RR are large plates of unequal size and that of the posterior has a notch on the left shoulder which carries the brachial-like anal plate. The anal plate is elongate and supports a small triangular-shaped plate on its upper surface.

The arms are of extraordinary length and are composed of stout brachials of moderate length. L. post. R and l. ant. R carry two arms with those to the right more robust than those to the left. All other RR carry a single arm and the r. post. R and l. ant. R possess the most robust rami.

The dorsal cup is mildly granular appearing under magnification. All brachials are granular appearing. Proximal columnals are thin elements having a circular outline and a minute round lumen.

*Measurements.*—

	Holotype
	Mm.
Overall length of crown	45.9
Height of dorsal cup	3.7
Width of dorsal cup	5.3
Width of BB circlet	2.7

*Remarks.*—The robust, high calyx of *A. copani* and presence of only seven stout arms serve to readily distinguish the species from other described forms. Some paratypes possess the elong-

ate second brachial in the r. post. and l. ant. rays which is typical of *Allagecrinus bassleri* Strimple. However, that species has a broad low cup and carries more numerous rami. A small species, similar to *A. bassleri* in general structure, present in the same strata with *A. copani* has made a complete study of the growth stages impossible at this time.

*Occurrence and horizon.*—Two and one-fourth miles NE. of Copan, Washington County, Oklahoma; unnamed shale some 30 feet above the Torpedo sandstone formation, Ochelata group, Missouri series, Pennsylvanian.

*Types.*—Collected by Mr. and Mrs. H. L. Strimple. To be deposited in the U. S. National Museum.

#### REFERENCE

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### CRINOID STUDIES

#### PART VII

#### NEW SPECIES OF CRINIDS FROM SOUTHEASTERN KANSAS

#### ABSTRACT

Three new species of delocrinids are described as *Delocrinus extraneous*, n. sp., *D. separatus*, n. sp. and *Endelocrinus petalonus*, n. sp., all from the Stull shale, Virgil series. An interesting form from the Iola limestone, Missouri series, is described as *Ulocrinus caverna*, n. sp.

#### INTRODUCTION

Further studies of the unusually well-preserved crinoids collected by Allen Graffham from Pennsylvanian rocks of Kansas have disclosed the need for several additional new species. At this time three new delocrinids from the Stull shale formation are described as *Delocrinus extraneous*, n. sp., *Delocrinus separatus*, n. sp., and *Endelocrinus petalonus*, n. sp. Also described is *Ulocrinus caverna*, n. sp. from the Iola limestone formation.

The last named species is considered by the author to be a vital factor in comprehensive understanding of the ulocrinid-cromyocrinid group. Close relationship to *Ulocrinus blairi*

Miller and Gurley is obvious, and since that species was taken as the genotype for *Parulocrinus* Moore and Plummer which has been referred by this author\* to synonymy with *Ulocrinus*, the present form is of considerable interest. Close examination of *U. blairi* shows that the IBB are slightly upflared in attitude. In preservation the base of that species has the appearance of being flat. The main justification for establishment of *Parulocrinus* was the position of the IBB. It is recognized by the author that genera distinct from *Ulocrinus* do exist in the group as exemplified by such species as *Ethelocrinus marquisi* (Moore and Plummer) where the arm structure is different from that of *Ulocrinus*, and the basal area is distinct.

### SYSTEMATIC DESCRIPTIONS

Genus **ULOCRINUS** Miller and Gurley, 1890

*Ulocrinus caverna*, n. sp.

Plate 6, figs. 5-8

*Description.*—The dorsal cup is almost spherical in outline except for the protrusion of the post. IR, particularly in the area occupied by the RA, and a similar bulge of the area about the l. ant. B. Five IBB form a slightly upflared disk. Five large BB have hexagonal outlines except where affected by the two anal plates. RR are five pentagonal-shaped elements having horizontally developed articular facets. Anal X is large and rests solidly on post. B with the quadrangular-shaped RA lying obliquely to the right below. No RN is present.

Sutures between cup plates are not impressed but are outlined by fine continuous ridges. The calyx plates are smooth but under magnification are seen to be mildly granulose. Columnar scar is circular in outline, heavily crenulated, and is pierced by a pentalobate lumen. Arms have not been observed.

*Measurements.*—

	Holotype
	Mm.
Greatest width of dorsal cup	20.5
Greatest width of cup at summit	18.7
Height of dorsal cup	12.7
Width of IBB circlet	11.0

\*Strimple, Harrell L., Paleont. Amer., vol. III, No. 23 in press, 1949.



Width of l. post. B	10.7
Width of columnar scar	3.5
Length of l. post. B	9.1
Length of suture between BB	5.3
Width of l. ant. R	10.6
Length of l. ant. R	6.3
Length of suture between RR	5.1
Width of body opening (approximate)	10.4

*Remarks.*—This species is similar to *Ulocrinus blairi* Miller and Gurley but is readily separated by the smaller size and the swelling of the dorsal cup both in the region occupied by the RA and the opposite l. ant. B. Apparently the loop of the gut in this species exerted strong pressure on the dorsal cup at both of those points. The IBB are slightly raised about the columnar scar in *U. caverna*.

*Occurrence and horizon.*—Iola Cement Quarry, near Iola, Kansas; Iola limestone formation, Kansas City group, Missouri series, Pennsylvanian.

*Holotype.*—Collected by Allen Graffham. To be deposited in the U. S. National Museum.

Genus **ENDELOCRINUS** Moore and Plummer, 1940

*Endlocrinus petalosus*, n. sp.

Plate 6, figs. 1-4

*Description.*—Dorsal cup is low and wide, with basal area invaginated. Five small, downflared IBB form the greater part of the basal concavity. Five large, petal-like BB form a large disk having the appearance of a flower. Post. B is unusually long and is squarely truncated for the reception of the single robust anal plate. RR are broad pentagonal-shaped plates and are mildly bulged in midsection of the area below the outer ligamental processes. Articular facets are well-defined horizontal shelves. Anal X is broad and bulbous appearing with only a small portion extending above the upper limits of the cup.

Columnar scar is circular in outline and is rather large. There are minute but sharp inflections of the borders of RR and BB at the angles of meeting creating dimplelike depressions. Other than the swollen appearance of cup plates there is no pronounced ornamentation, though granulose appearance is detected under magnification. Arms are unknown.



*Measurements.*—

	Holotype Mm.
Greatest width of dorsal cup	18.5
Width of cup at summit	16.2
Height of cup	6.1
Height of basal concavity	2.5
Width of IBB circlet	4.5
Length of l. p. B	8.2
Width of l. p. B	6.1
Length of suture between BB	4.1
Length of l. a. R	5.7
Width of l. a. R	10.2
Length of suture between RR	2.4
Width of columnar scar	2.3

*Remarks.*—*E. texanus* (Weller) from lower Permian strata is the only described species closely approaching *E. petalosis*, and it has a larger basal concavity, lateral sides of the cup are steeper, and the narrow post. IR is quite different from the present species.

*Occurrence and horizon.*—NW.  $\frac{1}{4}$  sec. 33, T. 17 S. R. 16 E. 2 miles NW. of Melvern, Kansas; Stull shale formation, Shawnee group, Virgil series, upper Pennsylvanian.

*Holotype.*—Collected by Mr. Allen Graffham. To be deposited in the U. S. National Museum.

Genus **DELOCRINUS** Miller and Gurley, 1890

**Delocrinus extraneous**, n. sp.

Plate 7, figs. 1-3

*Description.*—The dorsal cup is robust appearing and high, with a relatively shallow basal invagination. IBB are five small elements forming a disk almost entirely obscured by the large proximal columnal. BB are five large plates that sweep out of the basal well. The median portion of each basal is mildly depressed so that only five points of the cup are actually in contact with the basal plane. Post. B is truncated for the reception of anal X. RR are five large pentagonal plates. Articular facets are broad, horizontal shelves showing very shallow muscle fosse and have narrow outer ligamental pits. Post. IR is mild-

ly depressed and is occupied by an elongate, pentagonal-shaped anal X. Sutures between calyx plates are not impressed. However, there is a shallow groove on each side of the sutures.

Cup plates are unornamented. Arms are unknown. Proximal columnals are large, circular in outline, and are pierced by a minute lumen.

*Measurements.*—

	Holotype
	Mm.
Maximum width of dorsal cup	22.9
Height of dorsal cup	10.3
Length of r. post. B	12.7
Width of r. post. B	12.0
Length of r. ant. R	9.8
Width of r. ant. R	15.7
Length of anal X	7.1
Maximum width of anal X	3.7
Diameter of proximal columnal	4.7
Height of basal concavity	1.9

*Remarks.*—The robust size and deep cup of *D. extrancous* are distinctive. Together with the large column and depressed median portion of each RR, these characters are sufficient to distinguish the species from other described representatives of the genus.

*Occurrence and horizon.*—Stull shale, Shawnee group, Virgil series, upper Pennsylvanian; near Melvern, Kansas.

*Holotype.*—Collected by Mr. Allen Graffham. To be deposited in the U. S. National Museum.

*Delocrinus separatus*, n. sp.

Plate 7, figs. 4-7

*Description.*—The dorsal cup is broad, shallow, and has only the hint of a basal concavity. IBB are five small plates forming a modest-sized pentagonal disk in the shallow, depressed basal area. Five large BB form a large star-shaped disk. Post. B is unusually elongate and is evenly truncated for the reception of anal X which plate is missing in the holotype. RR are

five widely appearing elements having rather distinctive articular facets. Outer ligamental slits are not readily visible in side view of the cup. The median portion of each facet is strongly depressed and muscle scars are hardly discernible.

Proximal columnal is small, round, and is pierced by a minute round lumen. All cup plates are delicately granular. Arms are not known.

*Measurements.*—

	Holotype
	Mm.
Maximum width of dorsal cup	26.0
Height of dorsal cup	8.2
Length of r. post. B	12.0
Width of r. post. B	10.0
Length of r. ant. R	8.8
Width of r. ant. R	16.1
Diameter of IBB circling	5.6
Diameter of proximal columnal	2.3
Height of basal concavity	0.8

*Remarks.*—*Delocrinus separatus* has ornamentation similar to that of *D. stullensis* Strimple. The present species has a broader base and lacks the well-like basal invagination found in *D. stullensis*.

*Occurrence and horizon.*—Stull shale, Shawnee group, Virgil series, upper Pennsylvanian; near Melvern, Kansas.

*Holotype.*—Collected by Mr. Allen Graffham. To be deposited in the U. S. National Museum.

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## ERRATUM

Bull. Amer. Paleont., vol. 31, No. 124, 1947; *Three New Crinoid Species from the Virgil series of Southeastern Kansas*, by Harrell L. Strimple, "Explanation of Plate 2, figs. 5 and 6,—natural size," should read "2/3 natural size."

# PLATES

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All figures enlarged approximately two times.

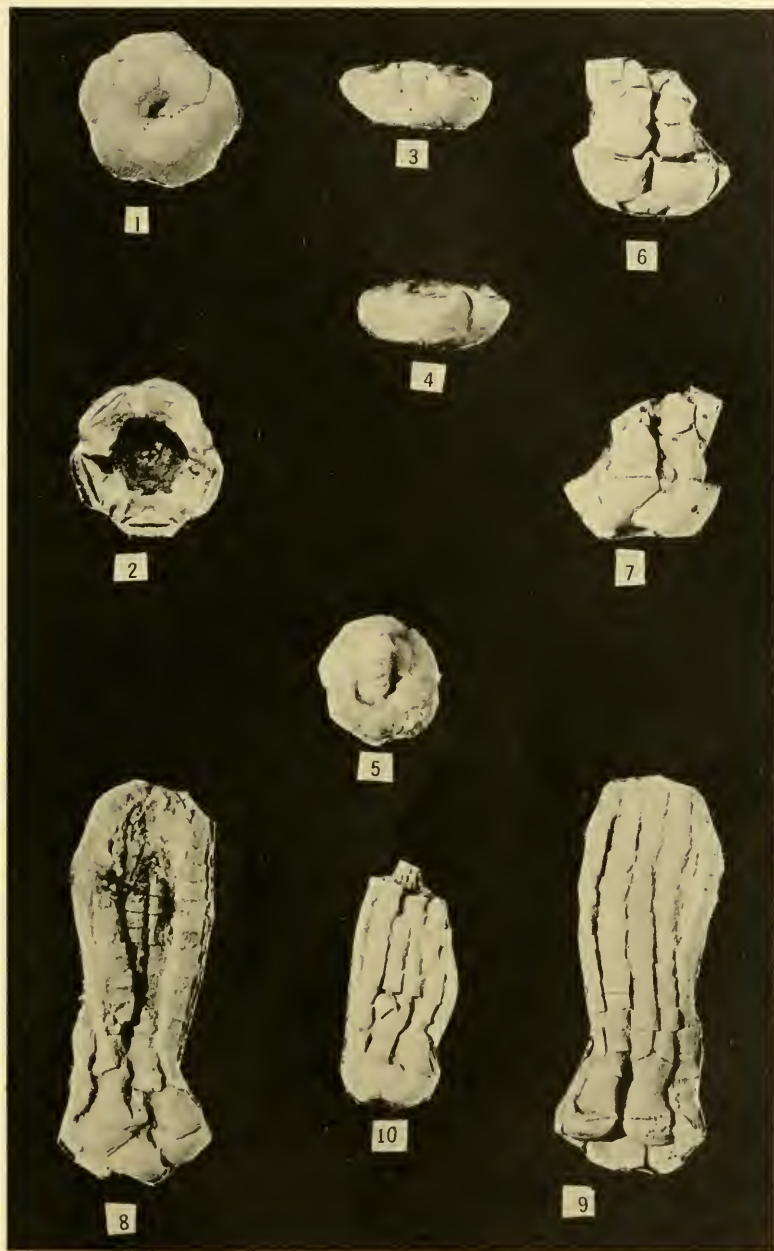






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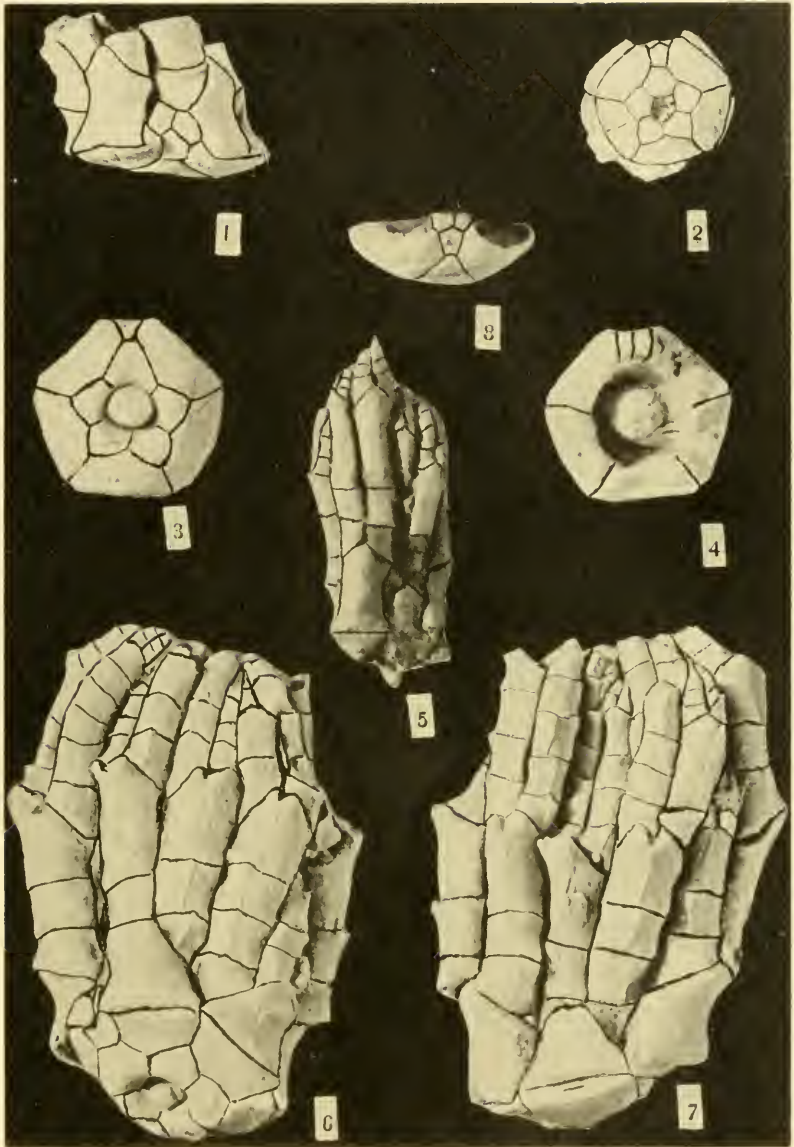




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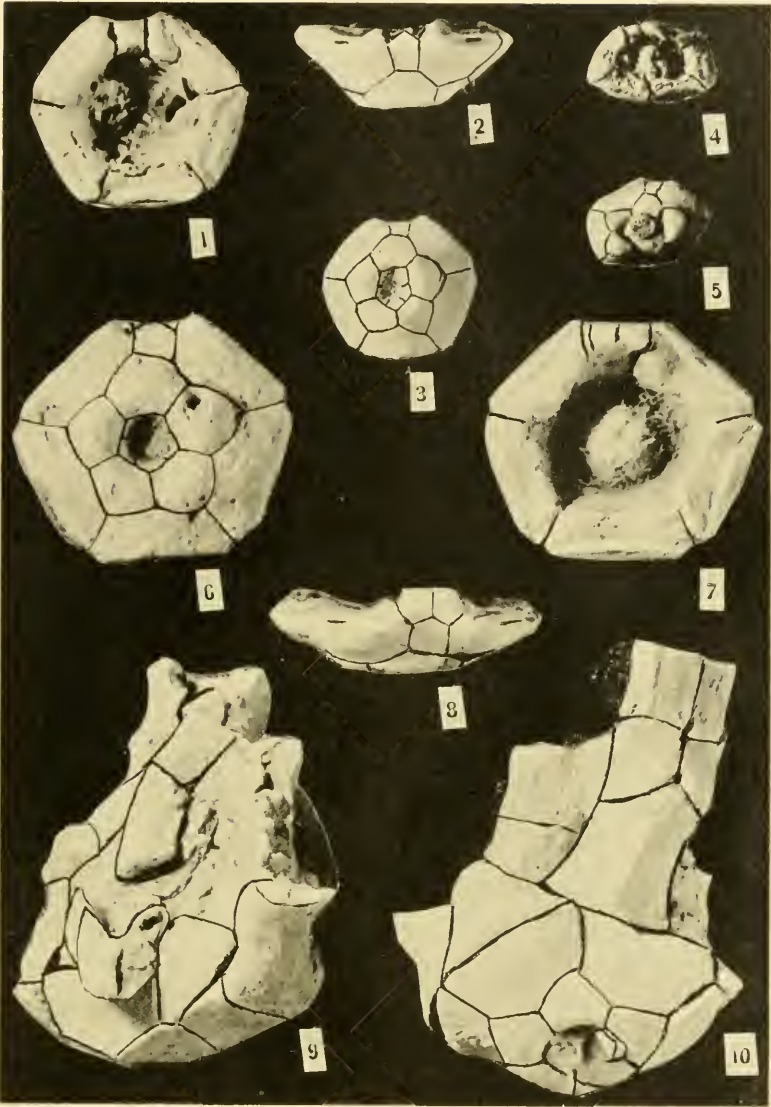






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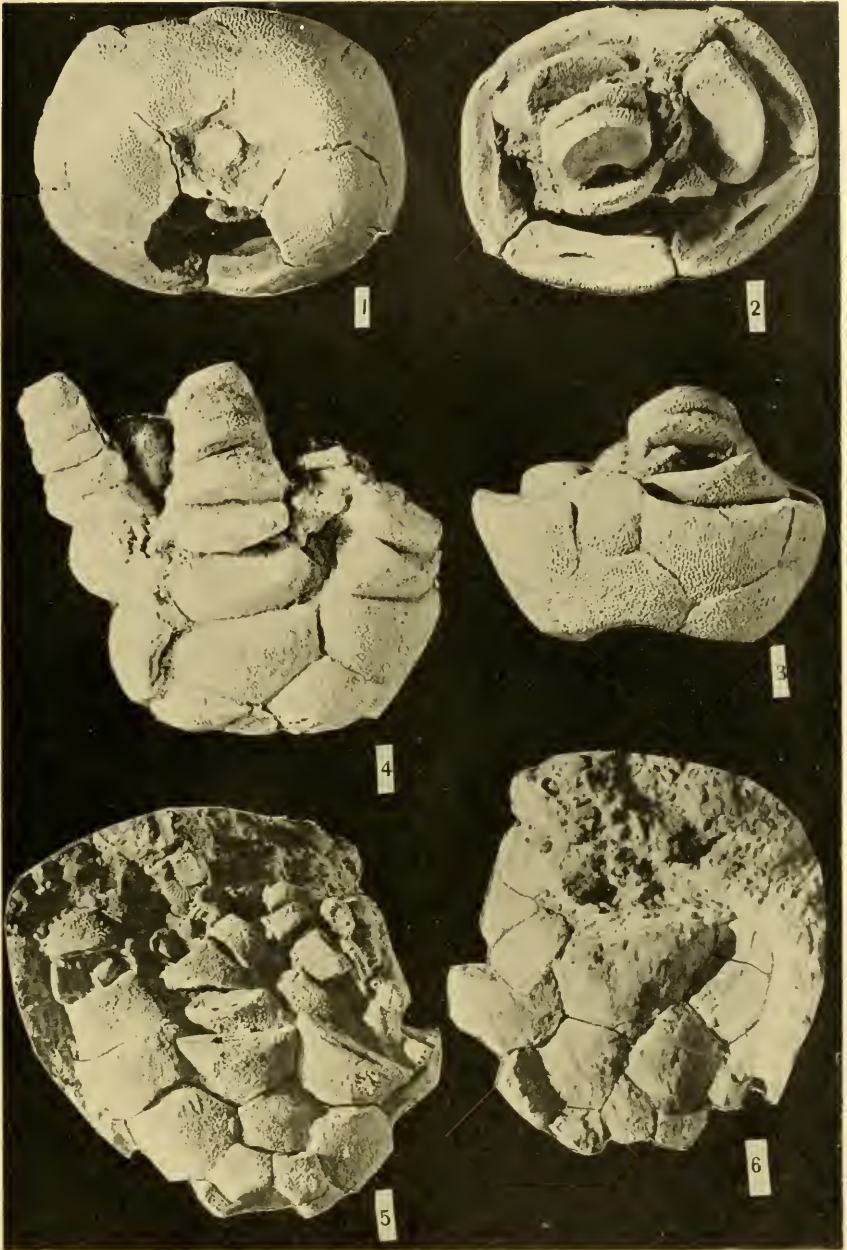




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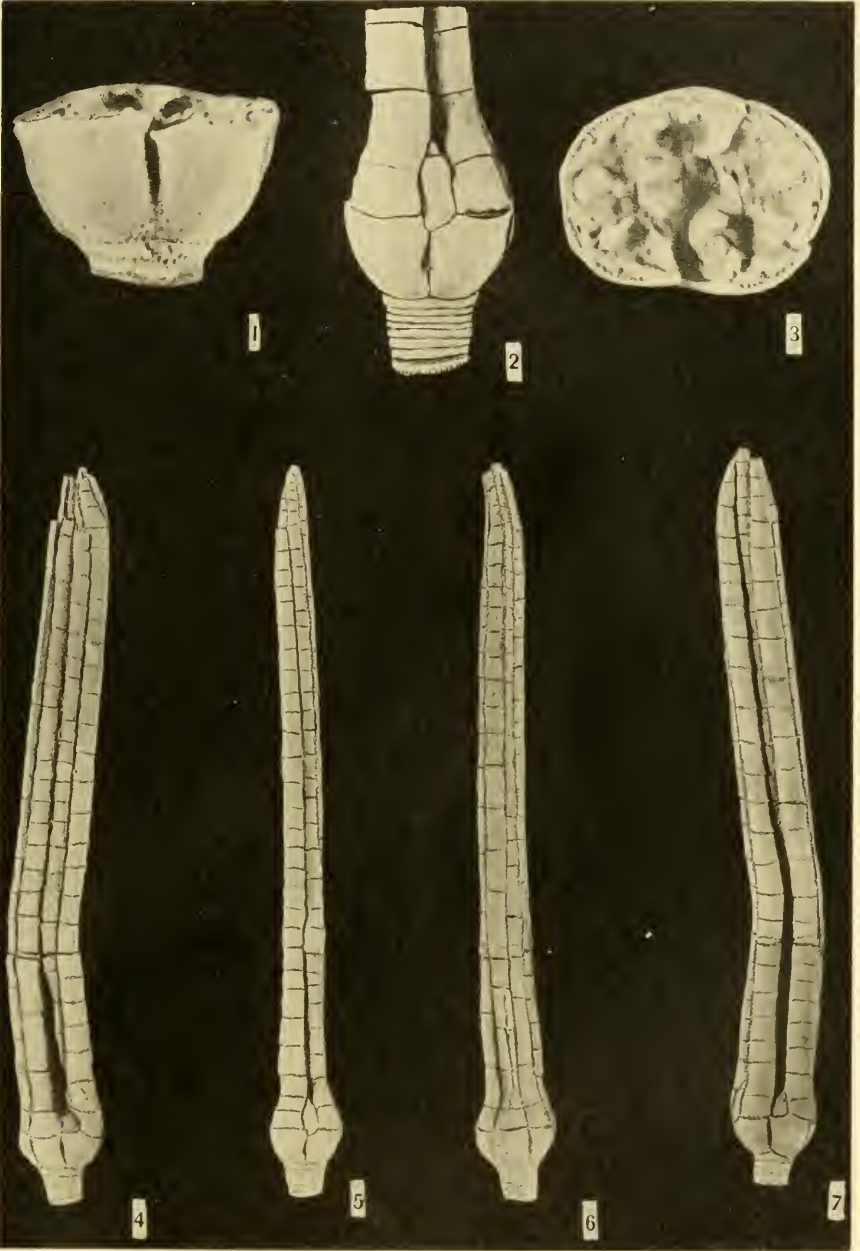






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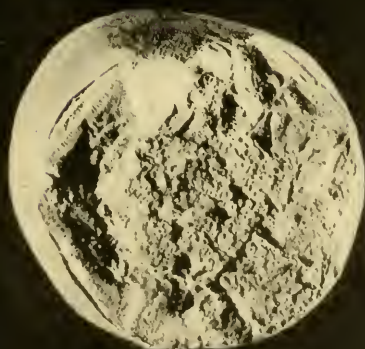
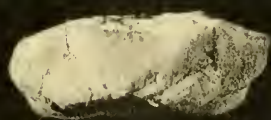
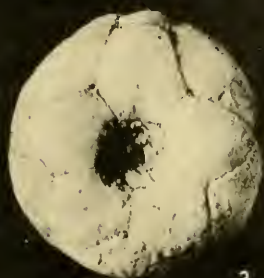




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