

FLORIDA STATE GEOLOGICAL SURVEY

HERMAN CUNTER, *State Geologist*

BULLETIN No. 6

THE PIOCENE AND PLEISTOCENE
FORAMINIFERA OF FLORIDA

By W. STOKES COLLIS,
Dallas, Texas.

TALLAHASSEE, FLORIDA
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LETTER OF TRANSMITTAL

*To His Excellency, Hon. Doyle E. Carlton,
Governor of Florida.*

SIR: I have the honor to submit herewith for publication the sixth scientific bulletin of this Department consisting of a detailed report or catalogue of the foraminifera contained in the formations of Florida of Pleistocene and Pliocene age. For comparative purposes conclusions resulting from studies of collections by Dr. Cole from formations of similar age occurring in other states within the Coastal Plain are included. Such comparisons have made this report much more inclusive and I feel sure that it will serve a very useful purpose. These minute fossils have been found very helpful in working out stratigraphic problems in the more precise identification of geological horizons and with the progression of such detailed work the fossils contained in the formations of Florida are gradually becoming better known.

Respectfully,

HERMAN GUNTER,
State Geologist.

Tallahassee, Florida,
April, 1931.

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THE PLIOCENE AND PLEISTOCENE FORAMINIFERA OF FLORIDA

By W. STORRS COLE,
Dallas, Texas.

ABSTRACT

The Pliocene and Pleistocene formations of Florida contain characteristic faunal groups of foraminifera by means of which the individual formations may be recognized. These organisms also supply valuable information with regard to the depositional history. The Caloosahatchee marl (Pliocene) contains the most varied and abundant fauna with many of the species found therein actually living at present in the West Indian region. It is indicative of shallow, warm water depositional conditions. The Charlton formation (Pliocene?) is represented by only one species and is evidently of brackish water type. Of the two Pleistocene formations discussed, the Fort Thompson has a fauna which is most closely related to the underlying Caloosahatchee marl. The fauna of the Anastasia formation is of shallow, relatively cool water type. The Florida Pliocene faunas are compared with those of the Waccamaw marl (North and South Carolina), while the Pleistocene faunas are compared with those of the Wadmalaw marl (South Carolina), the Chowan? formation (North Carolina) and the Talbot formation (Maryland).

During the summer of 1929, through the kindness of Mr. Herman Gunter, State Geologist of Florida, I was able to make a considerable collection of Pliocene and Pleistocene foraminiferal material from that state. Later, that same summer I supplemented this material by additional collections for comparison purposes as far north as Maryland. Additional Florida material has been sent me from time to time during the preparation of this paper by Mr. Gerald M. Ponton of the Florida State Geological Survey.

The Pliocene foraminifera from Florida were collected from the Caloosahatchee marl,¹ including deposits which were formerly called Nashua,² but are now included under the name Caloosahatchee. Material for comparison was collected from the Waccamaw³ formation of North and South Carolina. Samples were obtained also from the Charlton formation of Florida. This formation is of questioned Pliocene age.

¹For a detailed description of the stratigraphy of Florida see: Cooke, C. W., and Mosson, S., "Geology of Florida", Florida Geol. Survey, Twentieth Ann. Rept., 1929, pp. 31-227.

²Ibid: p. 152.

³Vaughan, T. W., Bull. Geol. Soc. Amer., 1924, p. 742.

The Pleistocene foraminifera were collected from the Fort Thompson and Anastasia formations. Comparative material was obtained from the Simmons Bluff, S. C., Pleistocene along the Neuse⁴ River and the Talbot⁵ formation of Maryland. Samples were obtained also from the "Miliolite limestone," Levy County, Florida, assigned by Cooke⁶ and Mossom to the Pleistocene.

NOTE:—Examination of the samples of the "Miliolite Limestone" collected by Cole and Ponton from near Ellzey and Otter Creek, Levy County, showed a more or less intimate mixture of Ocala limestone (Eocene) and Pleistocene material. The Eocene formation being represented by the echinoderms *Eupatagus floridanus* and *Laganum archerensis* and the foraminifera *Gypsina globulus*, *Coskinolina* probably *C. cookei*, and fragments of *Operculinella willcoxi* and *Lepidocyclus*, probably *L. ocalana*.

The Pleistocene is represented by *Chione cancellata* and fragments of *Mellita* cf. *pentaphora*. The numerous specimens of the family *Miliolidae* are too poorly preserved for specific identification. It is not surprising that such an admixture of formations exists in this area. The waves of the shallow Pleistocene sea could easily break up the soft Ocala limestone and mix it with the material being laid down at the time. It is known that the Miliolite limestone is comparatively thin as several borrow-pits operated for grading roads have penetrated the formation exposing the undisturbed Ocala limestone. In the pits referred to the greatest thickness noted was six feet.—G. M. PONTON.

The following is a list of localities at which collections were made. If time had permitted, many more localities could have been visited. However, it is felt that a sufficient number have been examined to give a representative cross-section of the fauna.

- Station 1. Pleistocene—Talbot formation. Wailes Bluff, 1 mile above Cornfield Point on the left bank of the Potomac River, St. Mary's County, Maryland.—Collector, W. S. Cole.
- Station 2. Pleistocene—Talbot formation. Langley's Bluff on the bay shore about 5½ miles south of Cedar Point, St. Mary's County, Maryland.—Collector, W. S. Cole.
- Station 3. Pleistocene—Chowan (?) formation. Neuse River, on the right bank about 10 miles below New Bern, Craven County, N. C., near the residence of W. B. Flanner.—Collector, W. S. Cole.
- Station 4. Pleistocene—Wadmalaw marl. Simmons Bluff, Yonge's Island, South Carolina.—Collector, W. S. Cole.
- Station 5. Pleistocene—Anastasia formation. Rose's Bluff, right bank of St. Mary's River, Nassau County, Florida.—Collector, W. S. Cole.

⁴Mansfield, W. C., U. S. Geol. Survey Prof. Paper 150-F, 1928, p. 136.

⁵Ibid: pp. 129-132; Maryland Geol. Survey, Pliocene and Pleistocene 1906, pp. 95-136.

⁶Cooke, C. W., and Mossom, S., "Geology of Florida," Florida Geol. Survey, Twentieth Ann. Rept., 1929, p. 216.

Table I.
Ranges of Species Specifically Found in Florida.

Stations 1 and 2 are in Maryland, 3, 13 and 14 in North Carolina, 4, 15 and 16 in South Carolina, and the rest in Florida. See list in text.

	F.S.G.S. Cat. Number	Pleistocene												Pliocene												
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Textularia floridana.....	S-2056													V	R	V	V		R	R	R		V			V
gramen.....	S-2057																V		VR							
mayori.....	S-2058																									
Quinqueloculina agglutinans.....	S-2060																		R							
contorta.....	S-2061														C				V							
fusca.....	S-2062																V	V	C							
lamarckiana.....	S-2063				C			V						V	V	V	V		C							
poeyana.....	S-2064																	V	C							
seminula.....	S-2065	V												V				V								
seminula var.....	S-2066																	V								
costata.....	S-2067																	V	V							
sp.....	S-2068																								V	
Articulina antillarum.....	S-2069																		V							
sp.....	S-2070																	V	V							
Vertebralina cassis.....	S-2071																	V	V	V	V					
Spiroloculina antillarum var. angulata.....	S-2072																	V	V		V					
glabrata.....	S-2073																	V	V	V	V					
reticulosa.....	S-2074																	V	V	V	V					
Triloculina bicarinata.....	S-2076																		V	V	V				V	
circularis.....	S-2077											V			V				V						V	
linneiana var.....																										
caloosahatcheensis n. var.....	S-2078														A		R	R	C	R						
oblonga.....	S-2079														V				V							
terquemiana.....	S-2080																		V							
tricarinata.....	S-2081																		V							
trigona.....	S-2082																		V							
Pyrgo subsphaerica.....	S-2083														V				R							
Flintia robusta.....	S-2084																		V						V	
Lenticulina sp.....	S-2085													V					V							
Lagena clavata.....	S-2086										V				V	V	V		R							
hexagona.....	S-2087				V																					
Guttulina caudata.....	S-2088														V	V	V		V						V	
pulchella.....	S-2089														V	V	V									
problema.....	S-2090				V						V				V	V		V							V	
Globulina gibba.....	S-2093																	V	V							
inaequalis var. caribaea.....	S-2094										V				R	V	V		R	V	V	V	V	V		
Pseudopolymorphina rutila.....	S-2095																		V							
Sigmomorphina undulosa.....	S-2154																		V		V					
Nonion glabrella.....	S-2096														V	V			V							
pompilioides.....	S-2097	V																	V							
grateloupi.....	S-2098				V						V								R						R	
Nonionella pseudo-auris n. sp.....	S-2099																		V		V					
Elphidium fimbriatulum.....	S-2100														V	V			C	R						
fimbriatulum var. advenum.....	S-2101				V	V	C				V								V							
discoidale.....	S-2102	R																	V							
gunteri n. sp.....	S-2103																									
incertum.....	S-2104	C	C	C	A	A	A	C	C	C	A	C	C	C				C	C	C	C	C	C	A	A	
lanieri.....	S-2105																		A	V						
poeyanum.....	S-2106				R	R	C				R	R	A	C	R	C	C		C						R	
sagrum.....	S-2107						V							V	V				C	C						
Peneroplis proteus.....	S-2108																	V	V							
Archaias angulatus.....	S-2109																		R							
Sorites marginalis.....	S-2110																	V	V							
Buliminella elegantissima.....	S-2111				C		C				A								V							
Bulimina marginata.....	S-2112																		V							
sp.....	S-2113																	V								
Entosolenia lucida.....	S-2114	R	R								V								V							
Virgulina punctata.....	S-2115																		V		V					
Bolivina doniezi.....	S-2116			V	V	V					A				V	V								VR		
plicatella.....	S-2117																		V							
pulchella var. primitiva.....	S-2118																		V							
striatula.....	S-2119						R				C															
rhomboidalis.....	S-2120																		V							
Loxostoma gunteri.....	S-2121																	V								
cf. mayori.....	S-2122																	VR								
Reussia spinulosa.....	S-2123														V											
Uvigerina peregrina var. bradyana.....	S-2124																									
Angulogerina occidentalis.....	S-2125				V	V	V								V	V	V		R	V						
Spirillina limbata.....	S-2126																		V							
Discorbis allomorphinoides.....	S-2128																		R						V	
floridana.....	S-2129				V										R	V			V						V	
mira.....	S-2130														R				V						V	
gladysae n. sp.....	S-2131				V		C				R								V						R	
subaraucana.....	S-2132														R											
subrugosa.....	S-2133																		V							
orbicularis (?).....	S-2134																		V						V	
Rotalia beccarii var. ornata.....	S-2136	A	A									A							C							
beccarii var. parkinsoniana.....	S-2137	C	C	R			A	R	R	R	A	A	C	R	C	R	V		A	C	R	A	C	C		
beccarii var. tepida.....	S-2138			A	A	C	A								A	R	V		C	C						
caloosahatcheensis n. sp.....	S-2139																		A	V						
Siphonina pulchra.....	S-2140																		V							
Cancris sagra.....	S-2141										V				V	C	V								V	
Amphistegina gibbosa.....	S-2142														R	C	V		C							
Cymbaloporetta squamosa.....	S-2143																		V							
Cassidulina crassa.....	S-2144										V					V										
laevigata var. carinata.....	S-2145														R	V			V							
Cassidulinoides braziliensis.....	S-2146																									
Globigerina bulloides.....	S-2147														V	V			V							
triloba.....	S-2148				V	V					V	V							V						R	
Orbulina universa.....	S-2149																		V							
Anomalina basiloba.....	S-2150										V				R	R			V						V	
Cibicides lobatulus.....	S-2151				V	V									V	R			V						V	
Dyocibicides biserialis.....	S-2152																								C	
Planorbulina mediterraneensis.....	S-2153																		V							

(A—abundant, C—common, R—rare, V—very rare), (not over three specimens to a sample)

- Station 6. Pleistocene—Anastasia formation. From shell bed exposed in a drainage canal just south of Bradenton, Manatee County, Florida.—Collectors, W. S. Cole and G. M. Ponton.
- Station 7. Pleistocene—Fort Thompson formation. Seven miles west of West Palm Beach, Palm Beach County, Florida.—Florida State Survey Collection.
- Station 8. Pleistocene—Fort Thompson formation. Canal bank along Highway No. 25 between Clewiston and West Palm Beach, 9.4 miles west of West Palm Beach, Palm Beach County, Florida.—Florida State Survey Collection.
- Station 9. Pleistocene—Anastasia formation. Ditch of St. Petersburg water pipe line, two miles west of Cosme, northwest corner of Hillsborough County, Florida, six feet below surface of the ground.—Florida State Survey Collection.
- Station 10. Pleistocene—Anastasia formation. On the south bank of the main Crane Creek Canal at its junction with a small canal entering it at right angles from the south, being $\frac{1}{2}$ mile north of a point on Highway No. 24 which is 4.7 miles west of depot at Melbourne, Brevard County, Florida.—Florida State Survey Collection.
- Station 11. Pleistocene—Anastasia formation. Marl pit, Port Orange, Volusia County, Florida.—Collector, G. M. Ponton.
- Station 12. Pleistocene—Type locality of the Fort Thompson formation. Goodno's Landing at old Fort Thompson on the left bank of the Caloosahatchee River above La Belle, Florida.—Collectors, W. S. Cole and G. M. Ponton.
- Station 13. Pliocene—Waccamaw formation. Walker's Bluff, Cape Fear River, Bladen County, North Carolina.—Collector, W. S. Cole.
- Station 14. Pliocene—Waccamaw formation. Neill's Eddy Landing, 28 miles above Wilmington, North Carolina, on the Cape Fear River.—Collector, W. S. Cole.
- Station 15. Pliocene—Waccamaw formation. Nixonville, Horry County, South Carolina, which is near Tilly's Lake, a tributary of the Waccamaw River.—Collector, W. S. Cole.
- Station 16. Pliocene—Waccamaw formation. Nixon's Landing, about 7.5 miles in a straight line upstream on the Waccamaw River from Conway, Horry County, South Carolina.—Collector, W. S. Cole.
- Station 17. Pliocene—Caloosahatchee marl. Left bank Shell Creek, about $3\frac{1}{2}$ miles upstream from Washington's place,

- which is 8 miles east of Cleveland, Charlotte County, Florida.—Collectors, W. S. Cole and G. M. Ponton.
- Station 18. Pliocene—Caloosahatchee marl. On left bank of the Caloosahatchee River, at Ayer's Landing, 5 miles down river from La Belle, Hendry County, Florida.—Collectors, W. S. Cole and G. M. Ponton.
- Station 19. Pliocene—Caloosahatchee marl. Left bank Caloosahatchee River, about $\frac{1}{2}$ mile below Crawford's Run, a small tributary, approximately $4\frac{1}{2}$ miles below La Belle, Florida.—Collectors, W. S. Cole and G. M. Ponton.
- Station 20. Pliocene—Caloosahatchee marl. Right bank, 3 miles downstream along the Caloosahatchee River from La Belle, Florida.—Collectors, W. S. Cole and G. M. Ponton.
- Station 21. Pliocene—Caloosahatchee marl (formerly Nashua). City marl pit, Orange City, Florida.—Collectors, W. S. Cole and G. M. Ponton.
- Station 22. Pliocene—Caloosahatchee marl (formerly Nashua). City marl pit just south of DeLand, Florida.—Collectors, W. S. Cole and G. M. Ponton.
- Station 23. Pliocene—Caloosahatchee marl (formerly Nashua). DeLeon Springs, Volusia County, Florida, on the golf links about a mile south of the spring.—Collectors, W. S. Cole and G. M. Ponton.
- Station 24. Pliocene (?)—Charlton formation. St. Mary's River at the Florida end of the Atlantic Coast Line railroad bridge, 3 miles southeast of Folkston, Georgia.—Collectors, W. S. Cole and G. M. Ponton.
- Station 25. Pliocene (?)—Caloosahatchee marl (?). Five feet below surface along Tamiami Trail, 42 miles west of Miami, Dade County, Florida.—Collector, G. M. Ponton.

While the main emphasis in this paper will be placed on the Florida material, Mr. Gunter has very kindly allowed the writer to introduce as much comparative material from other states as is necessary in order to completely show the relationships of the foraminifera occurring in the Florida formations with those of the other Pliocene and Pleistocene formations of the Atlantic coastal plain.

While foraminifera do not form a considerable portion of the material examined from any of the localities, by concentrating the material after washing, a sufficient number of specimens can usually be obtained. Even though the fauna of the Pliocene formations is much more varied than that of the Pleistocene, the Pleistocene samples generally contain more individuals of a given species. Most of the

species recorded have their counterpart in the recent faunas, particularly that of the West Indian region. A few, however, have not as yet been described in either the recent or the fossil faunas.

Previous workers have not examined the Atlantic coastal plain Pliocene and Pleistocene deposits in much detail for fossil foraminifera. The first notes on Pleistocene foraminifera are given by Bagg⁷ in his report on "The Tertiary and Pleistocene Foraminifera of the middle Atlantic Slope." Later Clark⁸ utilized Bagg's observations on the Pleistocene foraminifera of Maryland, listing four species. The most extensive and comprehensive work is that of Cushman⁹ on the "Pliocene Foraminifera of the Coastal Plain of the United States." Cushman has also published some short notes on Pleistocene foraminifera faunules from Panama.¹⁰⁻¹¹ Recently, Cushman and Cole¹² have published some short notes on the Pleistocene foraminifera of Maryland.

⁷Bagg, R. M., Bull. Amer. Pal., vol. 2, No. 10, 1898, pp. 1-54 (295-348), pls. 131-133).

⁸Clark, W. B., Maryland Geol. Survey, Pliocene and Pleistocene, 1906, pp. 214-216, pl. 66.

⁹Cushman, J. A., U. S. Geol. Survey, Bull. 676, 1918, pp. 1-45, pls. 1-8.

¹⁰Cushman, J. A., Amer. Geol., vol. 33, 1904, p. 266.

¹¹Cushman, J. A., U. S. Nat. Mus., Bull. 103, 1918, pp. 45-87, pls. 19-33.

¹²Cushman, J. A., and Cole, W. S., Contr. Cushman Lab. Foramin. Res., vol. 6, pt. 4, 1930, pp. 94-100, pl. 13.

THE PLIOCENE FORAMINIFERA

The Pliocene faunas are much more varied than those of the overlying Pleistocene, and seem to indicate much warmer conditions of deposition. The occurrence in the Caloosahatchee marl of such genera as *Amphistegina*, *Archaias*, *Cymbaloporella*, *Peneroplis*, *Sorites*, and *Vertebralina* are evidence of warm shallow waters like those of the present West Indian region. As will be pointed out later, the Pliocene Caloosahatchee fauna is very similar to the present West Indian fauna. These genera just mentioned do not occur in the overlying Pleistocene, although many of the more hardy and adaptable forms like *Elphidium incertum* (Williamson) are found in both the Pliocene and Pleistocene.

From a study recently published by Norton¹³ on the "Ecological Relations of Some Foraminifera" in which most of the samples used were from recent Florida or West Indian deposits, it is apparent that the typical Caloosahatchee and Waccamaw formations fall in his zones A and B (0-60 fathoms) with a temperature range of about 20°-32° C. As will be pointed out in more detail later, the Waccamaw deposition took place under temperatures nearer the lower end of this range, while that of the Caloosahatchee was at least above 22° C. The depth was probably not over 16 fathoms, if the relationships as shown by Norton are correct. It is highly probable that without the climatic disturbances which accompanied the Continental ice sheet, the fauna of the Pleistocene of Florida would have been about the same as both the West Indian recent faunas and the Pliocene. It is apparent on studying these faunas, that the more tropical elements of the Pliocene fauna were forced farther south during Pleistocene time, while the more adaptable forms of the Pliocene remained, and comprise the fauna of the Pleistocene deposits in Florida.

The species in the Pleistocene of Panama are more nearly like the Pliocene fauna than the Pleistocene of Florida. Cushman¹⁴ reports such forms as *Sorites marginalis* and *Peneroplis pertusus* in the Panama Pleistocene. These are present in the Pliocene, but not the Pleistocene of Florida.

The difference then between the Pliocene and the Pleistocene faunas of Florida becomes one of temperature and adaptability of species rather than the dying out and replacement by new species.

This differentiation and adaptation was emphasized by the fact that the faunas in all cases were those of shallow water. This habitat would reflect climatic changes much more rapidly than the deeper,

¹³Norton, R. D., Bull. Scripps Inst. Oceanography, Tech. Ser., vol. 2, No. 9, 1930, pp. 331-383.

¹⁴Cushman, J. A., Amer. Geol., vol. 33, 1904, p. 266.

more uniform waters of the outer continental shelf. Deeper-water genera and species are generally lacking or represented at the best by one or two individuals.

In a comparison between the Pliocene faunas from the various localities studied, it is apparent that the fauna from the typical Caloosahatchee represents the warmest waters and is most like the present West Indian fauna. However, the differences between the Caloosahatchee and Waccamaw are not as strongly marked as believed by Cushman.¹⁵

While *Archaias angulatus*, *Peneroplis proteus*, *Sorites marginalis* and *Vertebralina cassis* are apparently confined to the typical Caloosahatchee, *Amphistegina gibbosa*, *Cymbaloporella squamosa*, *Planorbulinella larvata*, together with typical tropical Miliolidae, occur in the Waccamaw formation.

The fauna of the "Nashua" apparently differs from both the typical Caloosahatchee and the Waccamaw. In the case of the Mollusca, the "Nashua" fauna more nearly resembles the Waccamaw than the Caloosahatchee, according to Mansfield.¹⁶ Miliolidae are absent in all the samples from the "Nashua" examined by me. The most characteristic species occurring is *Elphidium gunteri* n. sp. *Rotalias* comprise nearly all the remaining individuals from these localities, except for a few specimens of *Reussia spinulosa*, *Lagena clavata*, and others as noted in Table I. It is surprising that more genera and species do not occur.

The sample from Station 25 is different from other samples examined. In the majority of its species, it resembles the Caloosahatchee fauna, but some of the species indicate Miocene age. It contains *Dyocibicides biserialis* as its most abundant species, and this form was not found in any other samples. As it is impossible to absolutely determine the age of this sample from the foraminifera, I am including it with the Pliocene material, although a study of the molluscan fauna may establish its age to be Miocene.

The only foraminifer found in the samples from the Charlton formation was *Rotalia beccarii* var. *tepida*. As this species is not diagnostic, it is impossible to state from foraminiferal evidence what the age of that deposit is. It was probably deposited under very brackish water conditions which were entirely unsuited for foraminiferal life.

¹⁵Cushman, J. A., U. S. Geol. Survey, Bull. 676, 1918, pp. 5-6.

¹⁶Mansfield, W. C., Florida Geol. Survey, Fifteenth Ann. Rept., 1924, p. 30.

The following 44 species are common to both the Caloosahatchee marl and the recent West Indian faunas:

<i>Amphistegina gibbosa</i>	<i>Peneroplis proteus</i>
<i>Angulogerina occidentalis</i>	<i>Planorbulina mediterraneensis</i>
<i>Archaias angulatus</i>	<i>Pyrgo subsphaerica</i>
<i>Articulina antillarum</i>	<i>Quinqueloculina agglutinans</i>
<i>Bolivina rhomboidalis</i>	<i>costata</i>
<i>Canceris sagra</i>	<i>lamarckiana</i>
<i>Cymbaloporeta squamosa</i>	<i>poeyana</i>
<i>Discorbis floridana</i>	<i>Reussia spinulosa</i>
<i>mira</i>	<i>Rotalia beccarii</i>
<i>orbicularis</i>	var. <i>parkinsoniana</i>
<i>subaraucana</i>	var. <i>tepida</i>
<i>Elphidium fimbriatulum</i>	<i>Sigmomorphina undulosa</i>
var. <i>advenum</i>	<i>Siphonina pulchra</i>
<i>discoideale</i>	<i>Spiroloculina antillarum</i>
<i>poeyanum</i>	var. <i>angulata</i>
<i>sagrum</i>	<i>Textularia candeiana</i>
<i>Globigerina bulloides</i>	<i>floridana</i>
<i>triloba</i>	<i>mayori</i>
<i>Globulina inaequalis</i>	<i>Triloculina bicarinata</i>
var. <i>caribaea</i>	<i>circularis</i>
<i>Guttulina pulchella</i>	<i>oblonga</i>
<i>Loxostoma</i> cf. <i>mayori</i>	<i>tricarinata</i>
<i>Nonion grateloupi</i>	<i>Vertebralina cassis</i>
<i>Orbulina universa</i>	<i>Virgulina punctata</i>

Certain species occur in the Waccamaw which have not been found in the Florida material. These are:

<i>Anomalina ammonoides</i> (?)	<i>Planulina ariminensis</i>
<i>Eponides repanda</i>	<i>Quinqueloculina</i> cf. <i>funafutiensis</i>
<i>Faujasina carinata</i>	<i>Sigmomorphina semitecta</i>
<i>Guttulina costatula</i>	var. <i>terquemiana</i>
<i>lactea</i>	<i>Spirillina decorata</i>
<i>Planorbulinella larvata</i>	<i>Spiroloculina planulata</i>

Cushman records the following species from the Caloosahatchee marl which have not been found by me. This difference is to be expected in view of the scarcity of certain species.

<i>Discorbis globularis</i>	<i>Peneroplis discoideus</i>
<i>Hauerina ornatissima</i>	<i>Spiroloculina excavata</i>
<i>Lagena semistriata</i>	<i>Truncatulina ungeriana</i>

THE PLEISTOCENE FORAMINIFERA

As has been pointed out before in this paper, and can readily be seen on consulting the range table, the Pleistocene fauna is comparatively limited in number of species, but often these are very prolific in numbers of individuals at a given locality.

Of the two marine Pleistocene formations of Florida studied in this paper, the Anastasia has a much more varied and prolific fauna than that of the Fort Thompson formation.

The foraminifera from the Fort Thompson are exceedingly scarce, but seem to indicate a close connection with the underlying Pliocene. *Elphidium incertum*, *Elphidium sagrum* and *Rotalia beccarii* var. *ornata* are the commonest forms found. It is of interest to note that *Rotalia beccarii* var. *ornata*, which is one of the commonest fossils in the Pliocene and Fort Thompson beds (Pleistocene) of Florida, is also found in the Talbot formation of Maryland, where it is exceedingly well developed and abundant.

The species which especially characterize the Anastasia formation are *Angulogerina occidentalis*, *Bolivina doniezi*, *Buliminella elegantissima*, *Elphidium incertum*, *Elphidium fimbriatulum* var. *advenum*, *Elphidium poeyanum* and *Rotalia beccarii* var. *tepida*. Rarer species are *Bolivina striatula*, *Cassidulina crassa*, *Elphidium sagrum*, *Lagena clavata* and *Nonion grateloupi*.

Norton¹⁷ points out that the genus *Buliminella* seems to be more or less confined to deep cool waters in temperatures from about 2° to 8° C. This is the commonest genus observed in samples from the Anastasia formation. As the other forms associated with it are typically of shallow water type, it may be assumed that the temperature conditions were the controlling factor in its abundance. It is probable that the temperature during the deposition of the Anastasia was higher than 8° C, but lower than 20°. The depth is indicated as being about the same as in the Caloosahatchee and Waccamaw deposition.

The fauna of Simmons Bluff, South Carolina, is very similar to that of the Anastasia formation of Florida, as it contains *Buliminella elegantissima*, *Elphidium incertum*, *Elphidium fimbriatulum* var. *advenum* and *Rotalia beccarii* var. *tepida*. *Quinqueloculina lamarchiana* is also found in some numbers. The occurrence of *Elphidium incertum* var. *clavatum* and *Nonion* cf. *sloanii* with the above, however, begins to suggest a connection between the Simmons Bluff fauna and the more temperate fauna of Flanner's Bluff (Neuse River, N. C.) and of the Talbot formation of Maryland. The fauna of Flanner's Bluff,

¹⁷Norton, R. D., Bull. Scripps Inst. Oceanography, Tech. Ser., vol. 2, 1930, p. 348.

while comparatively poor in number of species and individuals, is closely related to that of Maryland.

The Maryland fauna is decidedly distinct.¹⁸ *Elphidium incertum* var. *clavatum* and *Rotalia beccarii* var. *ornata* are its commonest and most abundant species. *Elphidium fimbriatulum* var. *margaretaceum*, *Elphidium discoideale*, *Eponides frigida* var. *calida*, *Elphidium incertum*, *Entosolenia lucida*, *Nonion pompilioides*, *Nonion sloanii*, *Quinqueloculina seminula*, *Rotalia beccarii* var. *parkinsoniana* and *Triloculina rotunda* are rarer appearing species.

Table II.

Ranges of Species Not Found at the Florida Localities.

Stations 1 and 2 are in Maryland. 3, 13 and 14 in North Carolina and 4, 15 and 16 in South Carolina. See list in text.

	Pleistocene				Pliocene			
	1	2	3	4	13	14	15	16
<i>Textularia candeiana</i>						R		R
<i>Quinqueloculina flexuosa</i>	V			V				
cf. <i>funa-</i> <i>futiensis</i>						R	V	
<i>Spiroloculina planulata</i>						C	R	V
<i>Triloculina rotunda</i>	V							
<i>Guttulina costatula</i>								V
<i>lactea</i>					V	R		
<i>Sigmomorphina semitecta</i> var. <i>terquemiana</i>					V	V		
<i>Nonion sloanii</i>		V	V	V				
<i>Elphidium fimbriatulum</i> var. <i>margaretaceum</i>	V							
<i>incertum</i> var. <i>clavatum</i>	A	A	A	C	V			
<i>Faujasina carinata</i>					V			
<i>Spirillina decorata</i>						V	V	
<i>Eponides frigida</i> var. <i>calida</i> ..	C	C						
<i>repanda</i>						V	V	V
<i>Anomalina ammonoides</i> (?).....					V	V		
<i>Planulina ariminensis</i>						V		
<i>Planorbulinella larvata</i>					V	V		

(A—abundant, C—common, R—rare, V—very rare)
(not over three specimens to a sample)

The species in the table are not listed in the catalogue below, but are tabulated here to make the lists of foraminifera from these localities as complete as possible.

¹⁸Cushman, J. A., and Cole, W. S., Contr. Cushman Lab. Foram. Res., vol. 6, pt. 4, 1930, pp. 94-100, pl. 13.

As Mansfield¹⁹ has already pointed out by means of the molluscan faunas, the Talbot formation of Maryland, the Neuse River Pleistocene and the fauna at Rose's Bluff, Florida (Anastasia formation) are nearly equivalent in age. He considers the Simmons Bluff, South Carolina, fauna slightly older than these. The molluscan fauna indicates that the Neuse River and Maryland fauna are much more temperate in aspect than the Simmons Bluff and Rose Bluff faunas. The foraminifera indicate similar conditions and age relationships.

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All of the holotypes as well as specimens of all the species discussed in this paper are filed in the Florida State Geological Museum at Tallahassee.

¹⁹Mansfield, W. C., U. S. Geol. Survey Prof. Paper 150-F, 1928, pp. 138-140.

DESCRIPTIONS OF SPECIES

Family TEXTULARIIDAE

Subfamily Textulariinae

Genus TEXTULARIA DeFrance, 1824

TEXTULARIA FLORIDANA Cushman

Textularia transversaria Flint (not H. B. Brady), Rept. U. S. Nat. Mus., 1897 (1899), p. 283, pl. 28, fig. 4.*Textularia floridana* Cushman, Carnegie Inst. Washington, Publ. 311, 1922, p. 24, pl. 1, fig. 7; U. S. Nat. Mus., Bull. 104, pt. 3, 1922, p. 18, pl. 2, figs. 11, 12; Florida Geol. Survey, Bull. 4, 1930, p. 18, pl. 1, figs. 9a, b.

Numerous specimens from the Caloosahatchee marl of Florida seem to fit the description given by Cushman for this species. The sutures are nearly at right angles to the edge of the test, and give the chambers a very square appearance. Specimens referable to this species occur also in the Waccamaw formation.

There are other specimens in the Waccamaw which are referable to *T. candeiana* d'Orbigny, a species which was not noted in the Florida deposits. It is easily recognized by its highly inflated chambers, particularly the final ones.

Textularia gramen (Pl. 2, fig. 1 [not Pl. 1, fig. 1], U. S. Geol. Survey, Bull. 676) as reported by Cushman from the Pliocene is probably *T. floridana*. His figure shows a rounded periphery and straight sutures rather than the subacute periphery and sloped sutures of *T. gramen*.

Localities: Pliocene stations 13, 14, 15, 18, 19, 20, 22, 25.

Florida Geol. Survey Cat. No. S-2056.

TEXTULARIA GRAMEN d'Orbigny

Textularia gramen d'Orbigny, Foram. Foss. Vienne, 1846, p. 248, pl. 15, figs. 4, 6.*Textularia gramen* Cushman, U. S. Geol. Survey, Bull. 676, 1918, p. 8, pl. 1, fig. 1.*Textularia gramen* Cushman and Valentine, Contr. Dep. Geol. Stanford University, vol. 1, No. 1, 1930, p. 8, pl. 1, figs. 2a, b.

A few specimens from the Caloosahatchee marl of Florida seem to fit d'Orbigny's species from the Vienna basin very closely. It is a relatively small form with high chambers, subacute periphery and rather compressed test. Specimens referable to this species also occur in the Waccamaw formation.

Localities: Pliocene stations 16, 18, 19.

Florida Geol. Survey Cat. No. S-2057.

TEXTULARIA MAYORI Cushman

Plate 2, figure 12; Plate 7, figure 1

Textularia mayori Cushman, Carnegie Inst. Washington, Publ. 311, 1922, p. 23, pl. 2, fig. 3; U. S. Nat. Mus., Bull. 104, 1922, pt. 3, p. 7; Florida Geol. Survey, Bull. 4, 1930, p. 17, pl. 1, figs. 6-8.

Test compressed, increasing rather rapidly in breadth from the bluntly rounded initial end; apertural end obliquely truncate; cham-

bers indistinct initially, becoming more distinct aperturally with slightly depressed sutures separating these final chambers from each other; periphery rather regular, rounded with the exception of the final chambers which develop a short conical peripheral spine; wall arenaceous with much cement so that the test has a very smooth appearance; aperture low, small, at the base of the last formed chamber.

Length 0.38 to 0.86 millimeter.

The type specimen of this species has many more peripheral spines than are found on the fossil specimens. Cushman has pointed out in his study of the Florida Miocene specimens assigned by him to this species that, while the Miocene specimens are very similar to the living ones, they are less accelerated, the early chambers usually being without spines. This is also true of the Pliocene specimens.

This species occurs only rarely in the Caloosahatchee marl.

Locality: Pliocene station 18.

Florida Geol. Survey Cat. No. S-2058.

Family MILIOLIDAE

Genus QUINQUELOCULINA d'Orbigny, 1826

QUINQUELOCULINA AGGLUTINANS d'Orbigny

Plate 1, figure 12

Quinqueloculina agglutinans d'Orbigny, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, Forams., 1839, p. 195, pl. 12, figs. 11-13.

Quinqueloculina agglutinans Cushman, U. S. Geol. Survey, Bull. 676, 1918, pp. 22, 23, pl. 7, fig. 6; U. S. Nat. Mus., Bull. 104, 1929, p. 22, pl. 1, figs. 1a-c.

Test broader than long, the periphery broadly rounded; sutures fairly distinct; wall composed of rather large, agglutinated sand grains which give it a very rugose appearance; aperture slightly extended, teeth not observed.

Length 0.58 millimeter.

This species was observed only from localities along the Caloosahatchee River. In recent deposits, it is characteristic of warm, shallow waters of the West Indian region. Associated with it is *Q. fusca* H. B. Brady, another arenaceous form, from which it differs by its more rugose appearance and broadly rounded periphery.

Locality: Pliocene station 18.

Florida Geol. Survey Cat. No. S-2060.

QUINQUELOCULINA CONTORTA d'Orbigny

Quinqueloculina contorta d'Orbigny, Foram. Foss. Vienne, 1846, p. 298, pl. 20, figs. 4-6.

Quinqueloculina contorta Cushman, U. S. Nat. Mus., Bull. 104, pt. 7, 1930, p. 29, pl. 3, figs. 6a-c; Florida Geol. Survey, Bull. 4, 1930, p. 20, pl. 2, figs. 6a-c.

Test slightly longer than broad; chambers polygonal in transverse section, with both the periphery and sides flat, or slightly concave; angles acute with very slightly raised ridges; sutures distinct, but

slightly depressed; wall smooth, porcellanous; aperture tending to be rectangular, somewhat like the cross-section of the final chamber, slightly projecting, tooth large, weakly bifid.

Length 0.72 millimeter. Breadth 0.46 millimeter.

This interesting species is common at some localities of the Waccamaw formation, and appears only rarely in the Caloosahatchee. Its abundance may be of some practical use in serving to distinguish samples from these formations.

Cushman reports this species from the Miocene of Florida. It apparently does not occur in the recent West Indian fauna.

Localities: Pliocene stations 14 and 18.

Florida Geol. Survey Cat. No. S-2061.

QUINQUELOCULINA FUSCA H. B. Brady

Plate 1, figure 13

Quinqueloculina agglutinans H. B. Brady (not d'Orbigny) Nat. Hist. Trans. Northumberland and Durham, vol. 1, 1865, pp. 87, 95.

Quinqueloculina fusca H. B. Brady, Ann. Mag. Nat. Hist., ser. 4, vol. 6, 1870, p. 286, pl. 11, fig. 2.

Quinqueloculina bidentata Cushman (not d'Orbigny), U. S. Geol. Survey, Bull. 676, 1918, pp. 23, 24, pl. 7, fig. 5.

Quinqueloculina fusca Cushman, U. S. Nat. Mus., Bull. 104, pt. 7, 1930, pp. 23-24, pl. 1, figs. 4a-c; Florida Geol. Survey, Bull. 4, 1930, p. 19, pl. 1, figs. 11-12.

Test elongate, nearly twice as long as wide, subtriangular in end view; chambers distinct, sutures slightly depressed; periphery bluntly angulate; surface of test composed of sand grains, some of which are rather large and project above the general surface; aperture large, circular; tooth not observed.

Length 0.40 millimeter. Width 0.28 millimeter.

The Florida specimens seem identical with the figures given by Brady. This is evidently the species reported by Cushman as *Q. bidentata*; but that form has a considerably different shape, as can readily be seen on a comparison of figures of it with the Florida specimens of *Q. fusca*.

This is a rather common form in the Caloosahatchee marl on the Caloosahatchee River.

Localities: Pliocene stations 17 and 18.

Florida Geological Survey Cat. No. S-2062.

QUINQUELOCULINA LAMARCKIANA d'Orbigny

Plate 1, figures 9, 10

Quinqueloculina lamarckiana d'Orbigny, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, Forams., 1839, p. 189, pl. 11, figs. 14, 15.

Quinqueloculina auberiana d'Orbigny, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, Forams., 1839, p. 193, pl. 12, figs. 1-3.

Quinqueloculina auberiana Cushman, U. S. Geol. Survey, Bull. 676, 1918, p. 23, pl. 5, fig. 3.

Quinqueloculina lamarckiana Cushman, Carnegie Inst. Washington, Publ. 311, 1922, p. 64; U. S. Nat. Mus., Bull. 104, pt. 6, 1929, pp. 26, 27, pl. 2, figs. 6a-c; Florida Geol. Survey, Bull. 4, 1930, p. 20, pl. 2, figs. 3-5.

Test nearly as broad as long; sutures distinct, slightly depressed; chambers triangular in tranverse section, margins acute, but not carinate; wall smooth, unornamented, tending to be rather dull; apertural end but slightly extended, forming a short elliptical neck without a definite lip; tooth long, narrow, bifid.

Length 0.64 millimeter. Width 0.49 millimeter. Thickness 0.38 millimeter.

This species is well distributed in the West Indian region. It is one of the common species in the Caloosahatchee deposits along the Caloosahatchee River. It is also common in the Pleistocene of Simmons Bluff, S. C. The specimens from Simmons Bluff are smaller and the surface of the test is smoother and more polished.

Localities: Pleistocene stations 4 and 7; Pliocene stations 13, 14, 15, 16, 18, 19.

Florida Geol. Survey Cat. No. S-2063.

QUINQUELOCULINA POEYANA d'Orbigny

Plate 6, figure 10

Quinqueloculina poeyana d'Orbigny, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, Forams., 1839, p. 191, pl. 11, figs. 25-27.

Quinqueloculina poeyana Cushman, U. S. Geol. Survey, Bull. 676, 1918, p. 24, pl. 6, fig. 2; U. S. Nat. Mus., Bull. 104, pt. 7, 1930, p. 31, pl. 5, figs. 2a-c.

There are a few specimens from the Caloosahatchee marl along the Caloosahatchee River and on Shell Creek which agree with figures given of this species. The costae on the fossil specimens are somewhat finer than those illustrated on recent specimens.

Locality: Pliocene station 18.

Florida Geol. Survey Cat. No. S-2064.

QUINQUELOCULINA SEMINULA (Linnaeus)

Serpula seminulum Linnaeus, Syst. Nat., ed. 12, 1767, p. 1264.

Quinqueloculina seminulum Cushman, U. S. Nat. Mus., Bull. 104, pt. 7, 1930, pp. 24, 25, pl. 2, figs. 1, 2.

Quinqueloculina seminulum Cushman and Cole, Contr. Cushman Lab. Foram. Res., vol. 6, pt. 4, 1930, p. 95, pl. 13, figs. 1a-c.

This species was reported by Cushman from the Waccamaw formation and the Caloosahatchee marl on Shell Creek. I have a doubtful specimen referable to it from Shell Creek. The Waccamaw formation had several typical specimens evidently belonging under this species. It also occurs in the Talbot formation of Maryland.

In the recent faunas the typical *Q. seminula* seems to be confined to cool, shallow waters. It is therefore not surprising that it is not found in the typical Caloosahatchee and is a rare species in the Waccamaw.

Localities: Pleistocene station 1; Pliocene stations 13 and 17.

Florida Geol. Survey Cat. No. S-2065.

QUINQUELOCULINA SEMINULA (Linnaeus) var.

Plate 7, figure 13

The form figured may be considered a variety of this species. It is very similar to the variety figured by Cushman from the Miocene of Florida. (Florida Geol. Survey, Bull. 4, 1930, pl. 2, figs. 2a-c).

A few specimens were found in the typical Caloosahatchee.

Locality: Pliocene station 18.

Florida Geol. Survey Cat. No. S-2066.

QUINQUELOCULINA COSTATA d'Orbigny

Plate 2, figure 1

Quinqueloculina costata d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 301, No. 3.

Quinqueloculina costata Cushman, Carnegie Inst., Washington, Publ. 311, 1922, pp. 66, 67, pl. 11, fig. 5; U. S. Nat. Mus., Bull. 104, pt. 6, 1929, p. 31, figs. 7a-c.

A few specimens from the typical Caloosahatchee may be referred to this species. It is characteristic of warm water and has been reported by Cushman from the Tortugas region.

Except for being of slightly larger size, the Florida specimens agree very well with figures given of the Tortugas specimens.

Localities: Pliocene stations 17 and 18.

Florida Geol. Survey Cat. No. S-2067.

QUINQUELOCULINA sp.

Plate 1, figure 1

A single specimen which is figured for future reference was found in the sample from the Tamiami Trail locality (Sta. 25). It is very similar to *Q. candeiana* d'Orbigny and with more specimens for comparison may prove to be that species or a variety of it.

Locality: Pliocene station 25.

Florida Geol. Survey Cat. No. S-2068.

Genus ARTICULINA d'Orbigny, 1826

ARTICULINA ANTILLARUM Cushman

Plate 2, figure 11

Articulina antillarum Cushman, Carnegie Inst. Washington, Publ. 311, 1922, p. 71, pl. 12, fig. 4; U. S. Nat. Mus., Bull. 104, pt. 6, 1929, pp. 52-53, pl. 12, fig. 4.

A single broken specimen from the Caloosahatchee (Sta. 18) is referred doubtfully to this species. It represents the final chamber and seems to be characteristic.

Locality: Pliocene station 18.

Florida Geol. Survey Cat. No. S-2069.

ARTICULINA sp.

Plate 7, figure 9

A single specimen from the Caloosahatchee is figured for future reference. It is near *Articulina mexicana* Cushman, and may be a young specimen of that species.

Locality: Pliocene station 18.

Florida Geol. Survey Cat. No. S-2070.

Family OPHTHALMIDIIDAE

Subfamily Ophthalmidiinae

Genus VERTEBRALINA d'Orbigny, 1826

VERTEBRALINA CASSIS d'Orbigny

Plate 5, figure 8

Vertebralina cassis d'Orbigny, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, Forams., 1839, p. 51, pl. 7, figs. 14, 15.

Vertebralina cassis Cushman, U. S. Geol. Survey, Bull. 676, 1918, p. 25; Carnegie Inst., Washington, Publ. 311, 1922, p. 262; U. S. Nat. Mus., Bull. 104, pt. 7, 1930, p. 96, pl. 22, figs. 4a, b.

"Test compressed, for the most part planispiral; periphery of each chamber with a broad, thin keel, two to three chambers in the last formed coil, the main body of each chamber with numerous, somewhat oblique costae, the last formed chamber often projecting beyond the periphery of the preceding coil, but carinate, like the earlier ones; aperture elongate, with a distinct, everted lip; early chambers, where visible, spiroloculine."—Cushman.

Length 1.01 millimeters. Breadth 0.75 millimeter.

This species is confined to the Caloosahatchee marl, occurring at stations on Shell Creek and the Caloosahatchee River. In the recent faunas, it is largely limited to warm, shallow waters of the West Indian region. It is absolutely typical with the type as described by d'Orbigny.

Localities: Pliocene stations 17-20.

Florida Geol. Survey Cat. No. S-2071.

Genus SPIROLOCULINA d'Orbigny, 1826

SPIROLOCULINA ANTILLARUM d'Orbigny var. ANGULATA Cushman

Plate 2, figure 14

Spiroloculina grata H. B. Brady (part) (not Terquem) Rept. Voy. Challenger, Zoo., vol. 9, 1884, pl. 10, figs. 22, 23.

Spiroloculina antillarum var. *angulata* Cushman, U. S. Nat. Mus., Bull. 100, vol. 4, 1921, p. 408, pl. 81, figs. 5a, b; Carnegie Inst., Washington, Publ. 311, 1922, p. 62; U. S. Nat. Mus., Bull. 104, pt. 6, 1930, pp. 43-44, pl. 9, figs. 4a, b.

A few specimens from the Caloosahatchee marl along the Caloosahatchee River are referred to this variety. The angulate edges, together with the costae which extend the length of the periphery, are identical with figures of recent specimens from Tortugas given by Cushman. My specimens appear to be the same as that figured by Cushman as *S. antillarum* (U. S. Geol. Survey, Bull. 676, 1918, pl. 8, fig. 2).

Length 0.58 millimeter.

Locality: Pliocene station 18.

Florida Geol. Survey Cat. No. S-2072.

SPIROLOCULINA GLABRATA Cushman

Plate 1, figure 2

Spiroloculina glabrata Cushman, U. S. Geol. Survey, Bull. 676, 1918, p. 22, pl. 6, fig. 3.

A few very small specimens which I am referring to Cushman's species were found in the typical Caloosahatchee material. The orig-

inal description is rather meager and the figure poor. The specimens in my collection are entirely smooth, with the exception of the final chamber which has a few slightly raised ridges, more pronounced near the aperture, which is strongly compressed, quadrangular, with a distinct lip.

Length 0.23 millimeter. Width 0.17 millimeter.

Localities: Pliocene stations 18 and 19.

Florida Geol. Survey Cat. No. S-2073.

SPIROLOCULINA RETICULOSA Cushman

Plate 1, figure 11

Spiroloculina reticulosa Cushman, U. S. Geol. Survey, Bull. 676, 1918, p. 21, pl. 6, fig. 4.

Test large, elongate, elliptical; periphery rounded; sutures fairly distinct; center of the test slightly excavated; wall ornamented by a series of relatively coarse costae which anastomose freely; aperture circular at the end of a slightly produced neck; tooth small, weak, bifid.

Length 0.93 millimeter.

An easily recognized, but rare species found only in the Caloosahatchee marl on the Caloosahatchee River and Shell Creek, Florida.

This is one of the few species which to date has not been reported in the recent faunas and is evidently confined to the Pliocene.

Localities: Pliocene stations 17 and 18.

Florida Geol. Survey Cat. No. S-2074.

Genus TRILOCULINA d'Orbigny, 1826

TRILOCULINA BICARINATA d'Orbigny

Plate 1, figure 7

Triloculina bicarinata d'Orbigny, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, Forams., 1839, p. 158, pl. 10, figs. 18-20.

Triloculina bicarinata Cushman, Carnegie Inst., Washington, Publ. 311, 1922, p. 76, pl. 12, fig. 7; U. S. Nat. Mus., Bull. 104, pt. 7, 1930, p. 66, pl. 17, fig. 5.

Test slightly longer than broad, chambers with a truncate periphery, the angles of which are slightly ridged or extended like a small keel; chambers relatively distinct; sutures, but slightly depressed; surface ornamented by more or less rectangular reticulations which give the test a rather rugose appearance; aperture elongate, rectangular, with definite thin lips, slightly everted, tooth elongate, narrow extending slightly above the general outline of the test.

Length 0.58 millimeter.

This species is found in the Caloosahatchee marl, occurring at the Caloosahatchee River localities. A few specimens were also found at the Tamiami Trail locality (Sta. 25). It is very distinctive and easily recognized.

Localities: Pliocene stations 18 and 25.

Florida Geol. Survey Cat. No. S-2076.

TRILOCULINA CIRCULARIS Bornemann

Triloculina circularis Bornemann, Zeitschr. deutsch. geol. Ges., vol. 7, 1855, p. 349.

Triloculina circularis Cushman, Carnegie Inst., Washington, Publ. 311, 1922, p. 73;
U. S. Nat. Mus., Bull. 104, pt. 7, 1930, p. 58, pl. 13, figs. 6, 7; pl. 14, figs. 1, 2.

Test of three visible chambers, rounded, inflated, slightly compressed laterally, the last formed chamber the largest, embracing the other chambers rather strongly; sutures distinct, depressed; wall smooth, highly polished; aperture a narrow crescentiform slit with a large, flattened semicircular tooth.

Length 0.56 millimeter. Breadth 0.40 millimeter.

This species occurs in both the Pleistocene and Pliocene, although it is very rare. All the specimens are very typical.

Localities: Pleistocene station 11; Pliocene stations 14, 18, 25.

Florida Geol. Survey Cat. No. S-2077.

TRILOCULINA LINNEIANA d'Orbigny var. CALOOSAHATCHEENSIS n. var.

Plate 1, figures 4, 5, 6

Triloculina linneiana Cushman (not d'Orbigny), U. S. Geol. Survey, Bull. 676, 1918, pp. 24-25, pl. 7, fig. 1.

Variety very near the typical, but differing in having more and not as strongly raised ridges; in being more compressed, with a slightly truncated periphery; the tooth very small and not so well developed as in the typical.

Length 0.90 millimeter. Breadth 0.49 millimeter. Thickness 0.29 millimeter.

Types from station 18, Ayres Landing on the Caloosahatchee (Pliocene).

Florida Geol. Survey Cat. No. S-2078.

This variety occurs in some numbers in both the Waccamaw and Caloosahatchee formations. While it is very close to the typical form, there seems to be enough variation to warrant the erection of a varietal name. Some specimens approach the typical rather closely, but the number of costae seem to be more in all cases.

Localities: Pliocene stations 14, 16-19.

TRILOCULINA OBLONGA (Montagu)

Vermiculum oblongum Montagu, Test. Brit., 1803, p. 522, pl. 14, fig. 9.

Triloculina oblonga d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 300, No. 16.

Triloculina oblonga Cushman, Carnegie Inst., Washington, Publ. 311, 1922, p. 73;
U. S. Nat. Mus., Bull. 104, pt. 6, 1930, p. 57, pl. 13, figs. 4, 5.

This widely distributed species occurs in both the typical Caloosahatchee and Waccamaw formations. It is very rare, only three or four specimens being noted to a sample. Its elongate, smooth shining test makes it an easily recognized form.

Localities: Pliocene stations 14 and 18.

Florida Geol. Survey Cat. No. S-2079.

TRILOCULINA TERQUEMIANA (H. B. Brady)

Plate 1, figure 8

Miliolina terquemiana Brady, Rept. Voy. Challenger, Zoo., 1881, p. 166, pl. 64, fig. 1.

There are a few specimens from the Caloosahatchee marl on the Caloosahatchee River which seem referable to this species. The angles of the test are not quite as sharp as in some of the figures given. (See Millett, Jour. Roy. Micros. Soc., 1898, p. 503, pl. 11, figs. 10, 11). The number, arrangement and size of the costae, together with the type of aperture, however, make it seem desirable to refer the Florida specimens to this species.

Length 0.44 millimeter. Width 0.32 millimeter.

Locality: Pliocene station 18.

Florida Geol. Survey Cat. No. S-2080.

TRILOCULINA TRICARINATA d'Orbigny

Plate 1, figure 3

Triloculina tricarinata d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 299, No. 7: Modèles, 1826, No. 94.*Triloculina tricarinata* Cushman, U. S. Nat. Mus., Bull. 104, pt. 7, 1930, pp. 56-57, pl. 13, figs. 3a-c.

A few specimens evidently referable to this species are recorded from the Caloosahatchee marl on the Caloosahatchee River. It has the angles of the chambers very sharply angled with almost the suggestion of a slight keel. As Cushman has already pointed out, a great number of forms have been referred to this species. Our specimen agrees rather closely with the figures given by Cushman of a recent specimen from Tortugas referred to this species.

Length 0.35 millimeter. Width 0.29 millimeter.

Locality: Pliocene station 18.

Florida Geol. Survey Cat. No. S-2081.

TRILOCULINA TRIGONULA (Lamarck)

Miliola trigonula Lamarck, Ann. Mus., vol. 5, 1804, p. 351, No. 3; vol. 9, 1807, pl. 17, fig. 4.*Triloculina trigonula* Cushman, U. S. Nat. Mus., Bull. 104, pt. 7, 1930, p. 56, pl. 12, figs. 10, 11, pl. 13, figs. 1, 2.

Test with three visible chambers, test somewhat longer than broad, angles rounded, the periphery broadly convex; triangular in end view; sutures depressed, distinct; wall smooth; aperture round with a bifid tooth occupying the greater part of the aperture.

Length 0.35 millimeter. Width 0.26 millimeter.

A few specimens from the Caloosahatchee marl along the Caloosahatchee River are referred to this species.

Locality: Pliocene station 18.

Florida Geol. Survey Cat. No. S-2082.

Genus PYRGO Defrance, 1824

PYRGO SUBSPHAERICA (d'Orbigny)

Biloculina subsphaerica d'Orbigny, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, Forams., 1839, p. 162, pl. 8, figs. 25-27.

Biloculina laevis Cushman (not Defrance), U. S. Geol. Survey, Bull. 676, 1918, p. 25, pl. 7, figs. 3, 4.

Pyrgo subsphaerica Cushman, U. S. Nat. Mus., Bull. 104, pt. 7, 1930, p. 68, pl. 18, figs. 1, 2; Florida Geol. Survey, Bull. 4, 1930, p. 23, pl. 3, figs. 5a-c.

Test small, rotund, inflated, slightly broader than long, about as broad as thick, chambers rounded, periphery broadly rounded; suture distinct, depressed, in side view having an undulating curved appearance; wall smooth, shiny, polished; aperture broadly oval with a flattened bifid tooth which only partially fills the apertural opening.

Length 0.38 millimeter. Breadth 0.29 millimeter. Thickness 0.32 millimeter.

This species occurs in both the Waccamaw and Caloosahatchee formations, but is rather rare. It is a common form in the recent West Indian fauna.

Localities: Pliocene stations 14, 18, 19.

Florida Geol. Survey Cat. No. S-2083.

Genus FLINTIA Schubert, 1911

FLINTIA ROBUSTA (H. B. Brady)

Plate 2, figure 13

Spiroloculina robusta H. B. Brady, Rept. Voy. Challenger, Zoo., vol. 9, 1884, p. 150, pl. 9, figs. 7, 8.

Flintia robusta Schubert, Abhandl. K. K. Geol. Reichs., vol. 20, pt. 4, 1911, p. 124.

Flintia robusta Cushman, U. S. Nat. Mus., Bull. 104, pt. 6, 1929, p. 75, pl. 20, figs. 1, 2.

There are several specimens from the Caloosahatchee marl along the Caloosahatchee River and two specimens from the Tamiami Trail locality (Sta. 25) which are referred to this species.

In the recent faunas, this species is characteristic of deep water. This would account for its rarity in the Pliocene deposits, as they are of shallow-water type.

Length 0.47 millimeter.

Localities: Pliocene stations 18 and 25.

Florida Geol. Survey Cat. No. S-2084.

Family LAGENIDAE

Subfamily Nodosariinae

Genus LENTICULINA Lamarck, 1804

LENTICULINA sp.

Plate 6, figure 1

The specimen from the Caloosahatchee marl, station 18, which I am figuring for future reference, is the only one of this genus found in either the Pleistocene or Pliocene of Florida. It is very small, with the final chamber broken, so that a specific determination is impossible.

It resembles slightly a form figured by Cushman in his Tortugas report. (Carnegie Inst., Washington, Publ. 311, 1922, p. 32, pl. 4, fig. 3). It evidently belongs in the general group represented by *L. convergens*. This form is also represented by a single specimen from the Waccamaw formation (Sta. 13).

Localities: Pliocene stations 13 and 18.

Florida Geol. Survey Cat. No. S-2085.

Subfamily Lageninae

Genus LAGENA Walker and Jacob, 1798

LAGENA CLAVATA (d'Orbigny)

Plate 6, figure 6

Oolina clavata d'Orbigny, Foram. Foss. Vienne, 1846, p. 24, pl. 1, fig. 2.

Lagena clavata Cushman, Contr. Cushman Lab. Foram. Res., vol. 5, pt. 3, 1929, p. 68, pl. 11, fig. 3; Florida Geol. Survey, Bull. 4, 1930, pp. 29, 30, pl. 5, figs. 6a, b.

Test form variable, elongate, clavate or fusiform, with a long slim neck at the apertural end, and a relatively short but somewhat variable prolongation at the base; surface smooth, unornamented; wall thin; aperture circular at the end of the long neck, with a small phialine lip.

Length 0.32 millimeter.

This species is rather small and easily overlooked. It has been found in both the Pleistocene and Pliocene of Florida. It also occurs in the Waccamaw formation.

Cushman reports *Lagena semistriata* Williamson from his Shell Creek locality, but it has not been found by me.

Localities: Pleistocene station 10; Pliocene stations 14, 15, 16, 18, 19, 20, and 21.

Florida Geol. Survey Cat. No. S-2086.

LAGENA HEXAGONA (Williamson)

Plate 6, figure 7

Entosolenia squamosa Montagu var. *hexagona* Williamson, Ann. Mag. Nat. Hist., ser. 2, vol. 1, 1848, p. 20, pl. 2, fig. 23; Rec. Foram. Great Britain, 1858, p. 13, pl. 1, fig. 31.

Lagena hexagona Siddal, Cat. Brit. Rec. Forams., 1879, p. 6.

Lagena hexagona Cushman, Florida Geol. Survey, Bull. 4, 1930, p. 30, pl. 5, figs. 11a, b.

A single specimen referable to this species was found at Rose's Bluff, Florida.

In the comparison material from Simmons Bluff, another typical specimen was found. It was not noted in the Pliocene material.

The hexagonal, reticulated surface makes this species both distinctive and easily recognized. It can scarcely be confused with other species of *Lagena*.

Locality: Pleistocene station 4.

Florida Geol. Survey Cat. No. S-2087.

Family POLYMORPHINIDAE

Subfamily Polymorphininae

Genus GUTTULINA d'Orbigny, 1826

GUTTULINA CAUDATA d'Orbigny

Plate 4, figure 11

Guttulina caudata d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 266, No. 16.

Guttulina caudata Fornasini, Boll. Soc. Geol. Ital., vol. 19, 1900, p. 137, fig. 2 (in text).

Guttulina caudata Cushman and Ozawa, U. S. Nat. Mus. Proc., vol. 77, Art. 6, 1930, p. 36, pl. 6, figs. 4, 5.

A few specimens of this species were found in the typical Caloosahatchee and the Waccamaw formation of the Carolinas.

Localities: Pliocene stations 13, 14, 15, 18, 19, 23, 25.

Florida Geol. Survey Cat. No. S-2088.

GUTTULINA PULCHELLA d'Orbigny

Plate 4, figure 12

Guttulina pulchella d'Orbigny, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, Forams., 1839, p. 129, pl. 2, figs. 4-6.

Polymorphina pulchella Cushman, Carnegie Inst., Washington, Publ. 311, 1922, p. 33, pl. 4, figs. 7, 8.

Guttulina pulchella Cushman, U. S. Nat. Mus. Proc., vol. 77, Art. 6, 1930, p. 33, pl. 5, figs. 7a-c.

Test elongate, fusiform, somewhat compressed, both ends acute, initial end occasionally having a short spine; sutures distinct, only slightly depressed; chambers few, ornamented by distinct longitudinal costae which run unbroken the entire length of the test; aperture produced, radiate.

Length 0.78 millimeter.

This species was originally described by d'Orbigny and later reported by Cushman from the Tortugas region. It is one of the prettiest foraminifera occurring in the Pliocene. It is apparently characteristic of the warm, shallow waters of the West Indian region. Its occurrence in the Pliocene extends its vertical range considerably, and further indicates the close connection between the Pliocene and recent faunas of these regions. It is very rare.

Localities: Pliocene stations 18 and 20.

Florida Geol. Survey Cat. No. S-2089.

GUTTULINA PROBLEMA d'Orbigny

Polymorphina (Guttulina) problema d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 266, No. 14.

Specimens which seem to be identical with d'Orbigny's figures occur very rarely in both the Pleistocene and Pliocene of Florida.

Localities: Pleistocene stations 4 and 10; Pliocene stations 13, 14, 17, 18 and 25.

Florida Geol. Survey Cat. No. S-2090.

Genus GLOBULINA d'Orbigny, 1826

GLOBULINA GIBBA d'Orbigny

Globulina gibba, Ann. Sci. Nat., vol. 7, 1826, p. 266, No. 10; Modèles No. 63.

Globulina gibba Cushman and Ozawa, U. S. Nat. Mus. Proc., vol. 77, Art. 6, 1930, p. 60, pl. 16, figs. 1-4.

Polymorphina gibba Cushman, U. S. Geol. Survey, Bull. 676, 1918, p. 10, pl. 2, fig. 4.

There are only a few, rather large, smooth, globular forms from the typical Caloosahatchee which may be referred to this species. They are easily distinguished from the following species by the smooth polished surface of the test.

Locality: Pliocene station 18.

Florida Geol. Survey Cat. No. S-2093.

GLOBULINA INAEQUALIS REUSS var. CARIBAEA d'Orbigny

Plate 7, figure 12

Globulina caribaea d'Orbigny, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, Forams., vol. 6, 1840, p. 130, pl. 2, figs. 7, 8.

Polymorphina lactea Cushman, Carnegie Inst., Washington, Publ. 311, 1922, p. 34, pl. 4, figs. 10, 11.

Globulina inaequalis Reuss var. *caribaea* Cushman and Ozawa, U. S. Nat. Mus. Proc., vol. 77, Art. 6, 1930, p. 75, pl. 18, figs. 5, 6.

This is one of the most persistent species, occurring in the typical Caloosahatchee, the "Nashua" equivalent of the Caloosahatchee, and the Waccamaw formation. It also occurs at certain of the Pleistocene localities. It is readily recognized by its sub-globular, slightly compressed shape and roughened test wall.

Length 0.58 millimeter.

Localities: Pleistocene station 10; Pliocene stations 13, 14, 15, 18-23.

Florida Geol. Survey Cat. No. S-2094.

Genus PSEUDOPOLYMORPHINA Cushman and Ozawa, 1928

PSEUDOPOLYMORPHINA RUTILA (Cushman)

Plate 4, figure 13

Polymorphina regina H. B. Brady, Parker and Jones, var. *rutila* Cushman, U. S. Geol. Survey Prof. Paper 133, 1923, p. 34, pl. 5, figs. 7, 8.

Pseudopolymorphina rutila Cushman and Ozawa, U. S. Nat. Mus. Proc., vol. 77, Art. 6, 1930, p. 100, pl. 26, figs. 3a, b.

Test elongate, somewhat fusiform, flattened; chambers somewhat inflated; sutures distinct, but slightly depressed; wall ornamented by few, rather heavy costae which are continuous the length of the test; the initial portion of the test often with a short spine; aperture somewhat produced, radiate.

Length 0.96 millimeter.

A few specimens were found in the Pliocene deposits along the Caloosahatchee River. With it occur forms which are assigned to *Guttulina pulchella* (d'Orbigny). *P. rutila* is more compressed and has fewer but more prominent longitudinal costae than *G. pulchella*.

Localities: Pliocene stations 18 and 20.

Florida Geol. Survey Cat. No. S-2095.

Genus SIGMOMORPHINA Cushman and Ozawa, 1928

SIGMOMORPHINA UNDULOSA (Terquem)

Text figures 1-3

Polymorphina amygdaloides Terquem (not Reuss) Mém. Soc. Géol. France, ser. 3, vol. 1, 1878, p. 39, pl. 3 (8), figs. 22, 25 (not 23, 24, 26-30).

Polymorphina undulosa Terquem, Mém. Soc. Géol. France, ser. 3, vol. 1, 1878, p. 41, pl. 3 (8), figs. 35 a, b, (not 36).

Sigmomorphina undulosa Cushman and Ozawa, Proc., U. S. Nat. Mus., vol. 77, Art. 6, 1930, p. 131, pl. 34, fig. 4, 5.

One specimen referred to this species was found in the Caloosahatchee marl at the Shell Creek locality. It is very near *S. semitecta* (Reuss) var. *terquemiana* (Fornasini) reported from the Waccamaw formation. It differs from that species however, in that each preceding chamber is much further removed from the base and does not extend down to the base as in that species.

It is not surprising to find this fossil in the Caloosahatchee marl as Cushman and Ozawa report it in recent deposits from the Dry Tortugas, Fla. (in 18 fathoms).

Locality: Pliocene station 18.

Florida Geol. Survey Cat. No. S-2154.

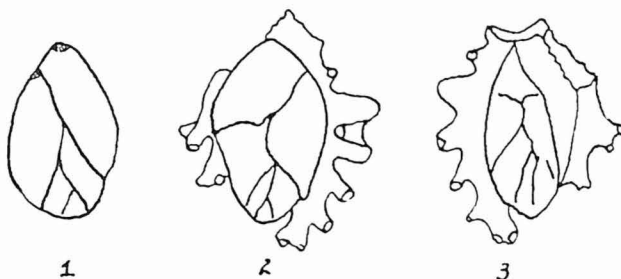


FIG. 1. *Sigmomorphina semitecta* (Reuss) var. *terquemiana* (Fornasini) from Waccamaw formation.

FIGS. 2, 3. *Sigmomorphina undulosa* (Terquem) from Caloosahatchee marl, showing general plan and fistulose tubes (opposite sides of same specimen) $\times 35$.

Family NONIONIDAE

Genus NONION Montfort, 1808

NONION GLABRELLA Cushman

Nonion glabrella Cushman, Florida Geol. Survey, Bull. 4, 1930, p. 38, pl. 6, figs. 6a, b.

A single specimen from the Caloosahatchee marl along the Caloosahatchee River, seems identical with this species described by Cushman from the Miocene of Florida. The highly polished surface of the test is the same as noted by Cushman in the Miocene specimens.

A very few specimens were also recorded from the Waccamaw formation.

Localities: Pliocene stations 13, 14 and 18.

Florida Geol. Survey Cat. No. S-2096.

NONION POMPILOIDES (Fichtel and Moll)

Plate 6, figure 2

"*Nautilus melo*" Soldani, Testaceographia, vol. 2, 1798, p. 38, pl. 8, figs. zz, A, B, C.
Nautilus pompilioides Fichtel and Moll, Test. Micr., 1798, p. 31, pl. 2, figs. a-c.
Nonionina depressula Cushman, U. S. Geol. Survey, Bull. 676, 1918, p. 19, pl. 1, fig. 6.
Nonion pompilioides Cushman, U. S. Nat. Mus., Bull. 101, pt. 7, 1930, p. 4, pl. 1, figs. 7-11; pl. 2, figs. 1-2.

The Florida specimens are very near figures given for *N. pompilioides* in the recent faunas. It occurs only sparingly in the Pliocene of Florida and also in the Talbot formation of Maryland.

Localities: Pleistocene station 1; Pliocene stations 18 and 19.

Florida Geol. Survey Cat. No. S-2097.

NONION GRATELOUPI (d'Orbigny)

Plate 7, figures 7, 8

Nonionina grateloupi d'Orbigny, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, Forams., 1839, p. 46, pl. 6, figs. 6, 7.
Nonionina grateloupi Cushman, Carnegie Inst., Washington, Publ. 311, 1922, p. 55, pl. 9, figs. 7, 8.
Nonion grateloupi Cushman, Florida Geol. Survey, Bull. 4, 1930, pps. 36, 37, pl. 6, figs. 1-3.

Test small, nearly bilaterally symmetrical, in front view the sides of the chambers nearly parallel, 9-12 chambers in the last formed coil, gradually increasing in length as added; periphery broadly rounded; sutures slightly depressed, distinct; wall smooth, finely punctate; chambers of the initial coils partly visible; aperture small, at the base of the last formed chamber.

Length 0.29 millimeter (Pleistocene) to 0.58 millimeter (Pliocene).

N. grateloupi occurs in both the Pleistocene and Pliocene of Florida. The specimens from the Pliocene are much larger and better developed than those of the Pleistocene. However, the major features are the same.

Some of the larger specimens from the Pliocene approach *N. pizarrensis* Berry. The roughness about the umbilicus which seems characteristic of this species was not observed. As these larger specimens grade through others into the typical *N. grateloupi*, all are assigned to this species.

Localities: Pleistocene stations 4, 6, 10; Pliocene stations 18, 19, 20, 23 and 25.

Florida Geol. Survey Cat. No. S-2098.

Genus NONIONELLA Cushman, 1926

NONIONELLA PSEUDO-AURIS n. sp.

Plate 5, figures 4, 5

Test small, subtrochoid, the final volution composed of 7-8 chambers; periphery rounded; sutures rather indistinct between the initial chambers of the final whorl, becoming more pronounced between the final chambers in this whorl, very slightly recurved; the last chamber

produced into a distinct lobe on the ventral side which completely fills the umbilicus; wall finely perforate aperture low, elongate.

Length 0.32 millimeter. Width 0.22 millimeter.

Type from Station 21, Florida Geol. Survey Cat. No. S-2099.

While very near *N. auris* d'Orbigny, this species differs in having fewer chambers, slightly different form and less distinct sutures. It is very near the form figured by Cushman from Queen Charlotte Sound, British Columbia, as *N. auris*.

It is a very rare species in the Caloosahatchee marl.

Locality: Pliocene station 21.

Florida Geol. Survey Cat. No. S-2099.

Genus ELPHIDIUM Montfort, 1808
ELPHIDIUM FIMBRIATULUM (Cushman)

Plate 4, figure 7

Elphidium fimbriatulum Cushman, U. S. Geol. Survey, Bull. 676, 1918, p. 20, pl. 8, fig. 5.

Elphidium advenum Cushman, Florida Geol. Survey, Bull. 4, 1930, pps. 40-41, pl. 7, figs. 7a, b. (not *Elphidium advenum* Cushman, 1922).

Test of medium size for the genus, strongly compressed, periphery acute, with a narrow carina in most specimens, but apparently lacking in a few, slightly lobate initially, but becoming more so in the final chambers; umbilical region depressed, with generally a central small boss of clear shell material which however does not project out beyond the general contour of the test; chambers distinct, very narrow at the umbilicus, gradually increasing in size as they approach the periphery, slightly recurved, about 12 in the final volution; sutures markedly depressed so that the chambers stand up as raised equally sloped ridges in between, retral processes, short, about as wide as the initial portion of the chamber, distinct, 12 to 15 in number; wall smooth, opaque, very finely perforate; aperture composed of a series of small rounded pores at the base of the apertural face.

Diameter 0.44 millimeter. Thickness 0.12 millimeter.

This is one of the most common and characteristic species of the Caloosahatchee. It is rarer in the Waccamaw. Its range in Florida is from Miocene to Pliocene; in the Pleistocene it is replaced by the variety *advenum* described below.

Localities: Pliocene stations 13, 14, 18 and 19.

Florida Geol. Survey Cat. No. S-2100.

ELPHIDIUM FIMBRIATULUM (Cushman) var. ADVENUM (Cushman)

Plate 4, figure 6

Polystomella advena Cushman, Carnegie Inst., Washington, Publ. 311, 1922, p. 56, pl. 9, figs. 11, 12; Publ. 342, 1924, p. 48; Publ. 344, 1926, p. 80.

Elphidium advenum Cushman, U. S. Nat. Mus., Bull. 101, pt. 7, 1930, p. 25, pl. 10, figs. 1-2.

The variety differing from the typical mainly in the shape of the chambers which are more flaring as they approach the periphery and not as distinctly ridged as in the typical; the retral processes are also of slightly different shape.

Diameter 0.41 millimeter.

It is apparent on detailed study that the *E. advenum* of Cushman from the recent deposits of the West Indian area should be made a variety of the Florida Pliocene *E. fimbriatulum*. The general similarity between the Miocene, Pliocene, Pleistocene and recent forms referred to these two types is striking, and at first it was believed they should be referred to only one species; but the chamber shape serves to differentiate them into two types: *E. fimbriatulum*, slightly small in size, with ridged, about equally sloped almost costae-like shaped chambers confined to the Miocene and Pliocene, and *E. fimbriatulum* var. *advenum*, ranging from Pleistocene to recent, with much more flaring, rather flat or gently rounded chambers, which are generally more greatly recurved on the anterior side than on the posterior.

Localities: Pleistocene stations 4, 5, 6 and 10.

Florida Geol. Survey Cat. No. S-2101.

ELPHIDIUM DISCOIDALE (d'Orbigny)

Polystomella discoidalis d'Orbigny, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, Forams., 1839, p. 56, pl. 6, figs. 23, 24.

Polystomella discoidalis Cushman, Carnegie Inst. Washington, Publ. 311, 1922, p. 56, pl. 10, figs. 3, 4.

Elphidium discoidale Cushman, U. S. Nat. Mus., Bull. 104, pt. 7, 1930, pp. 22, 23, pl. 8, figs. 8., 9.

Elphidium discoidale Cushman and Cole, Contr. Cushman Lab. Foram. Res., vol. 6, pt. 4, 1930, p. 97, pl. 13, figs. 10a, b.

Test of medium size for the genus, periphery subacute, sides convex in peripheral view rising to a high point at the umbilicus; margin slightly lobate; umbilical regions with a large rounded boss which projects rather strongly beyond the general outline of the test; chambers rather numerous, about 14 in the last formed whorl, distinct; sutures slightly depressed, marked by rather short retral processes about 12 in number; wall smooth, transparent, distinctly perforate; umbos with rather coarse tubules; aperture composed of small, rounded pores at the base of the apertural face.

Diameter 0.44 millimeter. Thickness 0.35 millimeter.

Localities: Pleistocene station 1; Pliocene stations 18 and 21.

Florida Geol. Survey Cat. No. S-2102.

ELPHIDIUM GUNTERI, n. sp.

Plate 4, figures 9, 10

Test of medium size for the genus, margin entire, broadly rounded, sides slightly convex in peripheral view, umbilical region with a group

of irregular, slightly raised areas of clear shell material; chambers distinct, not inflated, averaging about 14 in the last volution; sutures not depressed, marked by slightly raised, rectangular shaped retral processes which at the base of the chambers tend to fuse together; wall smooth, shiny, distinctly and rather coarsely perforate; aperture composed of several rounded openings at the base of the apertural face.

Diameter 0.44 millimeter. Thickness 0.26 millimeter.

Type from Station 21, Orange City, Florida (Pliocene).

Florida Geol. Survey Cat. No. S-2103.

This is probably the same form that Cushman referred to *Polystomella craticulata* var. in his Pliocene paper. It is very common in the "Nashua" equivalent of the Caloosahatchee marl in Florida. It is found rarely in the typical Caloosahatchee marl and in the Waccamaw formation of the Carolinas.

This form is evidently closely related to several of the recent species of *Elphidium*. From *E. lanieri*, it differs in its lesser number of chambers, more broadly rounded periphery, and the irregular raised areas of shell material instead of a single umbilical knob; from *E. craticulatum* in its smaller number of chambers, smaller umbilical area and different arrangement of the bridgings. *E. discoideale* differs from *E. gunteri* by its slightly lobate margin, its sub-acute periphery and different shaped retral processes.

This species is named in honor of Mr. Herman Gunter, State Geologist of Florida, whose help made the publication of this paper possible.

Localities: Pliocene stations 14, 21, 22, and 23.

Florida Geol. Survey Cat. No. S-2103.

ELPHIDIUM INCERTUM (Williamson)

Plate 4, figure 8

Polystomella umbilicatulata var. *incerta* Williamson, Rec. Foram. Great Britain, 1858, p. 44, pl. 3, figs. 82, 82a.

Polystomella striatopunctata Cushman (not Fichtel and Moll), U. S. Geol. Survey, Bull. 676, 1918, p. 19, pl. 8, fig. 4.

Elphidium incertum Cushman, U. S. Nat. Mus., Bull. 104, 1930, pp. 18-20, pl. 7, figs. 4-9; Florida Geol. Survey, Bull. 4, 1930, pps. 39, 40, pl. 7, figs. 2a, b.

Test nautiloid, compressed, the sides nearly parallel in end view, periphery broadly rounded, lobate, especially in the final 3 or 4 chambers (the degree of lobation often depending on the age and size of the specimen), umbilical region slightly depressed, sometimes with a slight knob or irregularities due to the ending of the slit-like sutures; about 9-10 chambers comprising the last volution; sutures distinct, plainly marked by the openings which are in a single row, retral processes few, distinct, the inner ends of the sutures slit-like; shell wall opaque, aperture a series of pores at the base of the apertural face with occasionally secondary pores scattered over the entire face.

Diameter 0.61 millimeter. Thickness 0.20 millimeter.

Cushman records this species as only occurring in the deeper, colder waters of the Atlantic, north of Hatteras. It occurs in the Pliocene, however, associated with a shallow, warm-water fauna. It is also an abundant species in the Pleistocene as far north as the Simmons Bluff locality. It can scarcely be mistaken, because of the character of the inner ends of the sutures to form slit-like depressions. Since Pleistocene times, it has evidently adapted itself to a different mode of environment. This change was taking place during Pleistocene time, as this species is one of the prolific forms in the Pleistocene deposits which were evidently deposited in much cooler water than that of the Pliocene period.

Localities: Pleistocene stations 1 to 12; Pliocene stations 13, 16 to 23 and 25.

Florida Geol. Survey Cat. No. S-2104.

ELPHIDIUM LANIERI (d'Orbigny)

Polystomella lanieri d'Orbigny, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, Forams., 1839, p. 54, pl. 7, figs. 12, 13.

Elphidium lanieri Cushman, U. S. Nat. Mus., Bull. 104, pt. 7, 1930, p. 23, pl. 9, fig. 7.

A few individuals referred to this species, occur in the typical Calcoosahatchee and the "Nashua" equivalent.

Locality: Pliocene station 18.

Florida Geol. Survey Cat. No. S-2105.

ELPHIDIUM POEYANUM (d'Orbigny)

Polystomella poeyana d'Orbigny, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, Forams., 1839, p. 55, pl. 6, figs. 25, 26.

Polystomella poeyana Cushman, Carnegie Inst., Washington, Publ. 311, 1922, p. 55, pl. 9, figs. 9, 10.

Elphidium poeyanum Cushman, U. S. Nat. Mus., Bull. 104, pt. 7, 1930, pp. 25-26, pl. 10, figs. 4, 5; Florida Geol. Survey, Bull. 4, 1930, p. 39, pl. 7, figs. 3, 4.

Test of small size for the genus, composed of 10-12 chambers in the final volution, compressed, slightly umbilicate, periphery broadly rounded; peripheral margin only slightly lobate; sutures distinct, slightly depressed, retral processes short, broad, about 15 in number; wall thin, smooth, translucent, finely perforate; aperture a series of round small pores at the base of the apertural face.

This species, with *E. incertum*, is one of the commonest forms in both the Pliocene and Pleistocene of Florida. It can easily be recognized from that species by its smaller size, more rounded outline and different arrangement of retral processes.

Localities: Pleistocene stations 4, 5, 6, 10, and 11; Pliocene stations 13, 14, 15, 16, 18, 21, 22, 23 and 25.

Florida Geol. Survey Cat. No. S-2106.

ELPHIDIUM SAGRUM (d'Orbigny)

Plate 4, figure 5

Polystomella sagra d'Orbigny, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, Forams., 1839, p. 55, pl. 6, figs. 19, 20.

Elphidium sagrum Cushman, U. S. Nat. Mus., Bull. 104, 1930, p. 24, pl. 9, figs. 5-6; Florida Geol. Survey, Bull. 4, 1930, p. 40, pl. 7, figs. 6a, b.

Test of medium size for the genus, periphery broadly rounded, not lobate, except some specimens have the final chamber slightly inflated; sides convex, the test often appearing roughly spherical; umbilical region flattened rather than depressed; chambers fairly distinct, except in adults where the retral processes form such heavy ridges that the initial chambers are concealed; sutures only depressed in the final 2 or 3 chambers; marked by retral processes which form distinct ridges or welts; apertural face very narrow, apertures a row of small pores at the base of the apertural face.

Diameter 0.48 millimeter.

This is a very characteristic species, which occurs rather commonly in the Caloosahatchee and Fort Thompson formations, and much more sparingly in the Pleistocene deposits. A few specimens also have been found in the Waccamaw. It is easily recognized by its raised retral processes.

Localities: Pleistocene stations 6, 11 and 12; Pliocene stations 13, 14, 15, 18, 21 and 22.

Florida Geol. Survey Cat. No. S-2107.

Family PENEROPLIDAE

Subfamily Spirolininae

Genus PENEROPLIS Montfort, 1808

PENEROPLIS PROTEUS d'Orbigny

Peneroplis protea d'Orbigny, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, Forams., 1839, p. 60, pl. 7, figs. 7-11.

Peneroplis pertusus Cushman (not Forskal), U. S. Geol. Survey, Bull. 676, 1918, p. 26, pl. 8, fig. 1.

Peneroplis proteus Cushman, U. S. Nat. Mus., Bull. 104, pt. 7, 1930, p. 37, pl. 13, figs. 1-17.

Test plano-spirally coiled, the earlier portion closely coiled and complete involute, later portion not entirely embracing, rather flaring; about 12 chambers comprise the final coils; sutures distinct, depressed; wall smooth, thick, rather shiny; apertures a row of pores along the median line of the apertural face.

Length 0.41 millimeter. Width 0.29 millimeter.

This common West Indian species occurs but rarely in deposits of Caloosahatchee age at Shell Creek and along the Caloosahatchee River. The Florida specimens resemble figures given by Cushman

of specimens from Bermuda and from San Juan Harbor, Porto Rico. (See U. S. Nat. Mus., Bull. 104, pt. 7, 1930, pl. 13, figs. 7, 8).

Localities: Pliocene stations 17 and 18.

Florida Geol. Survey Cat. No. S-2108.

Subfamily Archaiasinae

Genus ARCHAIAS Montfort, 1808

ARCHAIAS ANGULATUS (Fichtel and Moll)

Plate 5, figures 2, 3

Nautilus angulatus Fichtel and Moll, Test. Micr., 1803, p. 112, pl. 21.

Orbiculina adunca Cushman, U. S. Geol. Survey, Bull. 676, 1918, p. 27, pl. 7, fig. 2.

Archaias angulatus Cushman, U. S. Nat. Mus., Bull. 104, pt. 7, 1930, pp. 46-47, pl. 16, figs. 1-3; pl. 17, figs. 3-5.

"Test compressed, the early portion closely coiled, later becoming more or less complanate or even circular, periphery truncate; early chambers simple, later ones divided into a series of chamberlets by partitions generally at right angles to the periphery, distinct, elongate, low; sutures distinct, depressed; wall imperforate; aperture in the early stages, as in *Peneroplis*, a narrow slit, then a series of pores, one to each chamberlet, in a slight depression in the median line of the peripheral face."

Diameter 0.67 to 1.16 millimeters.

This is one of the restricted species apparently confined to the Caloosahatchee marl along the Caloosahatchee River and Shell Creek. It is exactly like recent specimens from the south coast of Florida in my collection, and fits Cushman's recent description so well that we have quoted the largest part of it.

Localities: Pliocene stations 17 and 18.

Florida Geol. Survey Cat. No. S-2109.

Subfamily Orbitolitinae

Genus SORITES Ehrenberg, 1838

SORITES MARGINALIS (Lamarck)

Plate 5, figure 10

Orbulites marginalis (Lamarck), Syst. Anim. sans Vert., vol. 2, 1816, p. 196, No. 1.
Orbitolites marginalis H. B. Brady, Rept. Voy. Challenger, Zool., vol. 9, 1884, p. 214, pl. 15, figs. 1-5.

Orbitolites marginalis Cushman, U. S. Geol. Survey, Bull. 676, 1918, p. 27.

Sorites marginalis Cushman, U. S. Nat. Mus., Bull. 104, pt. 7, 1930, pp. 49-50, pl. 18, figs. 1-4.

Test relatively large, thin, very compressed, flat, circular in outline in the adult, the entire test composed of a single layer of chambers, each with a single layer of chamberlets throughout, early chambers in a spiral, later extending back, finally meeting and in most of the chambers forming annuli; aperture a single row of pores along the periphery of the test.

Adult diameter 2.18 millimeters.

A few specimens were found in the Caloosahatchee marl from the Shell Creek and Caloosahatchee River localities. It is comparatively rare, probably because of its relatively fragile test which could easily be broken and destroyed.

In the recent faunas this species is characteristic of warm, shallow water. It is a rather common species in the recent West Indian fauna, where it occurs in an average water depth of about 42 feet with a fine sand as bottom material.

Localities: Pliocene stations 17, 18 and 19.

Florida Geol. Survey Cat. No. S-2110.

Family BULIMINIDAE

Subfamily Turrilinae

Genus BULIMINELLA Cushman, 1911

BULIMINELLA ELEGANTISSIMA (d'Orbigny)

Plate 2, figure 8

Bulimina elegantissima d'Orbigny, Voy. Amér. Mérid. Forams., vol. 5, No. 5, 1839, p. 51, pl. 7, figs. 13, 14.

Buliminella elegantissima Cushman, Florida Geol. Survey, Bull. 4, 1930, p. 42, pl. 8, figs. 2, 3.

This species is relatively abundant in the Pleistocene of Florida and rare in the Pliocene except in the "Nashua" where it is relatively abundant. It is easily overlooked on account of its small size. It seems to be typical in every way with recent specimens referred to this species.

Localities: Pleistocene stations 4, 6 and 10; Pliocene stations 18, 19, 21, 22 and 23.

Florida Geol. Survey Cat. No. S-2111.

Genus BULIMINA d'Orbigny, 1826

BULIMINA MARGINATA d'Orbigny

Bulimina marginata d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 269, No. 4, pl. 12, figs. 10-12.

Bulimina marginata Cushman, U. S. Nat. Mus., Bull. 104, pt. 3, 1922, pp. 91-93, pl. 21, figs. 4, 5.

A very few specimens of this beautiful species were found at Sta. 21. The distinct chambers, which are cut deeply under the base, with the basal margin broken into small teeth, make it easily recognized.

Locality: Pliocene station 21.

Florida Geol. Survey Cat. No. S-2112.

BULIMINA sp.

Plate 5, figure 13

This form is somewhat similar to *B. affinis* d'Orbigny. Only one specimen was found in the Caloosahatchee marl on the Caloosahatchee

River. A single specimen of this same species was found in the Waccamaw formation.

Length 0.29 millimeter.

Localities: Pliocene stations 16 and 18.

Florida Geol. Survey Cat. No. S-2113.

Genus ENTOSOLENIA Ehrenberg, 1848

ENTOSOLENIA LUCIDA (Williamson)

Plate 7, figures 5, 6

Entosolenia marginata Walker and Boys, var. *lucida* Williamson, Rec. Foram. Great Britain, 1858, p. 10, pl. 1, figs. 22, 23.

Test small, compressed slightly, shape variable, generally somewhat pyriform, marginal portion and central area clear and translucent, an opaque band between; wall smooth; aperture fissurine.

Length 0.25 millimeter.

This species has been found in both the Pliocene and Pleistocene of Florida. It occurs also in the Talbot formation of Maryland. It is a very rare species and hard to distinguish on account of its small size.

Localities: Pleistocene stations 1, 2, 6, and 10; Pliocene station 20.

Florida Geol. Survey Cat. No. S-2114.

Genus VIRGULINA d'Orbigny, 1826

VIRGULINA PUNCTATA d'Orbigny

Plate 6, figure 14

Virgulina punctata d'Orbigny, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, Forams., 1839, p. 139, pl. 1, figs. 35, 36.

Virgulina punctata Cushman, Carnegie Inst., Washington, Publ. 311, 1922, p. 31, pl. 3, fig. 9; Florida Geol. Survey, Bull. 4, 1930, pp. 44-45, pl. 8, figs. 7a, b.

Test minute, elongate, widest just below the apertural end, apertural end less pointed than the initial end; axis of test slightly twisted; sutures oblique, but slightly depressed; triserial portion small; biserial chambers slightly inflated, rather numerous; wall finely punctate, smooth; aperture elongate.

Length 0.44 millimeter.

This small form occurs in both the Waccamaw and Caloosahatchee marl. It is very small and easily overlooked.

Localities: Pliocene stations 15, 16, 18, 19, and 20.

Florida Geol. Survey Cat. No. S-2115.

Genus BOLIVINA d'Orbigny, 1839

BOLIVINA DONIEZI Cushman and Wickenden

Plate 6, figures 3, 4

Bolivina doniezi Cushman and Wickenden, U. S. Nat. Mus. Proc., vol. 75, 1929, p. 9, pl. 4, figs. 3a, b.

Numerous specimens which seem to agree with the species described by Cushman and Wickenden from the West coast of South America are found in the Pleistocene of Florida.

Localities: Pleistocene stations 3, 4, 5 and 10; Pliocene stations 14 and 23.

Florida Geol. Survey Cat. No. S-2116.

BOLIVINA PLICATELLA Cushman

Bolivina plicatella Cushman, Florida Geol. Survey, Bull. 4, 1930, p. 46, pl. 8, figs. 10a, b.

A very few specimens from the typical Caloosahatchee along the Caloosahatchee River and from the Waccamaw seem to be identical with the form described by Cushman from the Miocene of Florida.

The surface ornamentation of the test seems characteristic. The last two chambers are not covered. The two main longitudinal ridges, with the connecting, secondary, transverse ribs are nicely developed on the Pliocene specimens.

Localities: Pliocene stations 14 and 18.

Florida Geol. Survey Cat. No. S-2117.

BOLIVINA PULCHELLA d'Orbigny var. *PRIMITIVA* Cushman

Plate 2, figure 10

Bolivina pulchella d'Orbigny var. *primitiva* Cushman, Florida Geol. Survey, Bull. 4, 1930, p. 47, pl. 8, figs. 12a, b.

The variety differs from the typical in having fewer biserial chambers, averaging two to four, the major portion of the test made of triserial chambers; wall coarsely perforate.

Length 0.47 millimeter.

Very rare in the typical Caloosahatchee marl.

Locality: Pliocene station 18.

Florida Geol. Survey Cat. No. S-2118.

BOLIVINA STRIATULA Cushman

Plate 2, figure 9

Bolivina striatula Cushman, Carnegie Inst., Washington, Publ. 311, 1922, pp. 27-28, pl. 3, fig. 10.

Original description:

"Test elongate, gradually tapering from the somewhat rounded initial end to the broad apertural end; chambers numerous distinct, slightly inflated; sutures very slightly depressed; early portion of the test less compressed than the adult, the peripheral margin rounded in the young, sharply angled in the adult, early portion of the test with numerous longitudinal striations occupying about half the length of the test, following the chambers with a very fine reticulate pattern, the final chambers being smooth, punctate."

Length 0.38 millimeter.

As Cushman has already pointed out, this species is rather easily distinguished by its peculiar ornamentation. It is rather rare in the Pleistocene, and apparently does not occur in the Pliocene deposits.

Localities: Pleistocene stations 6 and 10.

Florida Geol. Survey Cat. No. S-2119.

BOLIVINA RHOMBOIDALIS (Millett)

Textularia rhomboidalis Millett, Jour. Roy. Micros. Soc., 1899, p. 559, pl. 7, fig. 4.

Bolivina rhomboidalis Cushman, Carnegie Inst., Washington, Publ. 311, 1922, p. 28.

Only one specimen of this characteristic species was found, that from the typical Caloosahatchee at Station 18. It is readily recognized by its triangular shape in front view and rhomboid shape in end view. It is identical with the excellent figure given by Millett.

Cushman records this species in his Tortugas report; so it is not surprising to find it in the fossil condition.

Locality: Pliocene station 18.

Florida Geol. Survey Cat. No. S-2120.

Genus LOXOSTOMA Ehrenberg, 1854

LOXOSTOMA GUNTERI Cushman

Plate 2, figures 2, 3, 4

Bolivina karreriana Cushman (not Brady), U. S. Geol. Survey, Bull. 676, 1918, p. 8, pl. 2, fig. 5.

Loxostoma gunteri Cushman, Florida Geol. Survey, Bull. 4, 1930, p. 47, pl. 3, figs. 11a, b.

Test elongate, compressed, periphery rounded, apical and apertural ends broadly rounded; chambers numerous, more distinct initially than aperturally; sutures, where showing, slightly depressed, but not affecting the ornamentation, limbate; test ornamented by numerous raised costae which run the length of the test, joining and branching freely, particularly towards the aperture; aperture terminal, rather large, elliptical and bordered by raised slightly recurved lips.

Length 0.46 millimeter. Width 0.20 millimeter.

This species differs from *L. karreriana* in having the initial end rounded whereas that species typically has a rather sharply pointed initial end with a strong apical spine. The costae on *L. gunteri* are finer and more numerous.

It is evidently a shallow-water tropical species and seems to be confined to the Caloosahatchee marl on the Caloosahatchee River and Shell Creek in the Pliocene deposits. Cushman described this species from the Florida Miocene.

Localities: Pliocene stations 17 and 18.

Florida Geol. Survey Cat. No. S-2121.

LOXOSTOMA cf. MAYORI (Cushman)

Plate 6, figure 5

Bolivina mayori Cushman, Carnegie Inst., Washington, Publ. 311, 1922, p. 27, pl. 3, figs. 5, 6.

Only one specimen was found which can be assigned to this species. It is evidently an adult specimen with the final chamber contracted, as has been noted by Cushman in his original description of the species. The depressed sutures and coarse punctations are also very characteristic.

This species occurred in the Caloosahatchee marl along the Caloosahatchee River.

Length 0.55 millimeter.

Locality: Pliocene station 18.

Florida Geol. Survey Cat. No. S-2122.

Subfamily Reussiinae

Genus REUSSIA Schwager, 1877

REUSSIA SPINULOSA (Reuss)

Plate 2, figure 6

Verneuilina spinulosa Reuss, Denkschr. Wiss. Wien, vol. 1, 1850, p. 374, pl. 47, fig. 12.
Verneuilina spinulosa Cushman, Carnegie Inst., Washington, Publ. 311, 1922, p. 28, pl. 3, fig. 11.

The figured specimen was obtained from the Caloosahatchee marl along the Caloosahatchee River. It is apparently this species, although the spines are not as strongly developed as in some figures given of this species. Cushman described a specimen from the Waccamaw formation as *R. glabrata*, because while it resembled *R. spinulosa*, it apparently had a more tapering form and was non-spinose. It is probable that the specimen in his possession was merely a variation of *R. spinulosa*.

It was observed rarely in the typical Caloosahatchee, but occurred in some numbers in the "Nashua" equivalent.

Localities: Pliocene stations 13, 19, 22 and 23.

Florida Geol. Survey Cat. No. S-2123.

Subfamily Uvigerininae

Genus UVIGERINA d'Orbigny, 1826

UVIGERINA PEREGRINA Cushman var. BRADYANA Cushman

Plate 6, figure 13

Uvigerina peregrina var. *bradyana* Cushman, U. S. Nat. Mus., Bull. 104, pt. 4, 1925, p. 168, pl. 42, fig. 12.

Test elongate, about 3 times as long as wide, widest just above the middle, ends rounded, initial end slightly more pointed than the apertural; chambers numerous, slightly inflated; sutures distinct depressed; wall ornamented by numerous longitudinal costae, which

under low power appear almost continuous, but under higher power are apparently slightly offset, the costae low, rounded, the costae toward the apertural end, tending to break up into spines on some specimens, on others continuous up to the neck; wall between the costae perforate; aperture circular at the end of a short cylindrical neck.

Length 0.41 millimeter.

The recent type of this species is from relatively deep water off the northeastern coast of the United States. The Florida specimens assigned to this variety agree very closely with Cushman's figure of the recent form. It is very rare, a few specimens were found from Station 21 only.

This is a different form from that which was referred to *U. tenuistriata* Reuss by Cushman from the Waccamaw marl. His figure indicates that the Waccamaw specimen is different from the Florida specimens, as it is much shorter and the costae are missing on the final chamber.

It is interesting to record this variety in a relatively shallow-water fossil deposit. Because of its rarity and absence at other stations, it is probable that it was washed in from the more open ocean.

Locality: Pliocene station 21.

Florida Geol. Survey Cat. No. S-2124.

Genus ANGULOGERINA Cushman, 1927
ANGULOGERINA OCCIDENTALIS (Cushman)

Plate 2, figure 5

Uvigerina angulosa Cushman (not Williamson), U. S. Geol. Survey, Bull. 676, 1918, p. 11, pl. 2, fig. 2.

Uvigerina angulosa Cushman (not Williamson), Carnegie Inst. Washington, Publ. 311, 1922, p. 34, pl. 5, figs. 3, 4.

Uvigerina occidentalis Cushman, U. S. Nat. Mus., Bull. 104, pt. 4, 1923, pp. 169-170.
Angulogerina occidentalis Cushman, Florida Geol. Survey, Bull. 4, 1930, p. 50, pl. 9, figs. 8, 9.

Test, minute, of different lengths, some being rather short, others rather elongate; in general, triangular in cross-section, although in the initial chambers little triangularity is shown, but the final chambers decidedly triangular; chambers distinct, sutures depressed; the final chambers tending to be added uniserially; wall ornamented with comparatively large, high costae, which do not appear to be continuous; final chamber unornamented; aperture on the end of a tubular neck with a slight phialine lip.

Length 0.32 to 0.38 millimeter.

The type specimens of the species are from the Tortugas region. The specimens from Florida and the Carolinas agree exactly with Cushman's figures. His figured specimen in the Pliocene report from the Waccamaw River, South Carolina, is evidently generalized. It shows the final chamber costate. The specimens in my collection from

Florida and the Carolinas do not exhibit this feature. Some of my specimens, particularly those from the Caloosahatchee River, are rather elongate, appearing the same as the one illustrated on Plate 5, figure 4 of the Tortugas report. It is undoubtedly only a form of *A. occidentalis* and this variation should be attributed to senescence as already noted by Cushman.

This form is easily overlooked on account of its small size. Its occurrence indicates the close relationship between the Waccamaw and Caloosahatchee formations and the recent deposits of the Tortugas region. It also occurs in the Pleistocene deposits of Florida, so that its range is complete from Miocene to recent.

This species is easily distinguished from *A. angulosa* (Williamson) by its rather coarse costae, the nudity of its final chamber and further that it does not show the regularity of triangular cross-section as the typical *angulosa* does.

Localities: Pleistocene stations 4, 5 and 6; Pliocene stations 13, 14, 15, 18, 19, 21 and 23.

Florida Geol. Survey Cat. No. S-2125.

Family ROTALIIDAE

Subfamily Spirillininae

Genus SPIRILLINA Ehrenberg, 1841

SPIRILLINA LIMBATA H. B. Brady

Spirillina limbata H. B. Brady, Quart. Jour. Roy. Micr. Sci., vol. 19, 1879, p. 278, pl. 8, fig. 26a, b; Rept. Voy. Challenger. Zoo., vol. 9, 1884, p. 632, pl. 85, figs. 18-21.

Spirillina limbata Cushman, U. S. Nat. Mus., Bull. 71, pt. 5, 1915, p. 5, pl. 2, figs. 1, 2.

A few specimens referred to this species were found in the typical Caloosahatchee. It differs from *S. decorata*, which occurs in the Waccamaw formation, in having a square peripheral border and lacking the characteristic ornamentation of that species.

Locality: Pliocene station 18.

Florida Geol. Survey Cat. No. S-2126.

Subfamily Discorbisinae

Genus DISCORBIS Lamarck, 1804

DISCORBIS ALLOMORPHINOIDES (Reuss)

Plate 6, figures 8, 9

Valvulina allomorphinoides Reuss, Sitz. Akad. Wiss. Wien., vol. 40, 1860, p. 223, pl. 11, fig. 6.

Discorbis allomorphinoides Cushman, U. S. Nat. Mus., Bull. 71, pt. 5, 1915, pp. 21, 22, pl. 9, fig. 1.

There are a few specimens from one locality in Florida (Sta. 25) which are evidently closely related to Reuss' species. As can be seen

by referring to my figure of the Florida form, there is some difference in shape of the final chamber between this and that of the typical.

Length 0.31 millimeter.

Locality: Pliocene station 25.

Florida Geol. Survey Cat. No. S-2128.

DISCORBIS FLORIDANA Cushman

Plate 3, figures 11, 12

Discorbis floridana Cushman, Carnegie Inst., Washington, Publ. 311, 1922, pp. 39, 40, pl. 5, figs. 11, 12.

Test rotaliform, plano-convex, the dorsal side strongly convex, the ventral side slightly concave, umbilicate; periphery slightly lobate, rounded; last whorl composed of 5-6 chambers, which gradually increase in size; sutures of the earlier whorls limbate, those of the outer whorl slightly depressed dorsally, more strongly so ventrally, not limbate on the outer whorl; wall coarsely punctate dorsally, finely punctate ventrally with the coarser punctations near the outer border; aperture an elongate, arched opening at the base of the last formed chamber, extending in to the umbilical area, sometimes with a thin lip.

Diameter 0.29 millimeter. Height 0.17 millimeter.

This species occurs in both the Caloosahatchee and Waccamaw formations. It is exactly like the specimens figured by Cushman from the West Indian region.

Localities: Pleistocene station 4; Pliocene stations 13, 14, 18 and 25.

Florida Geol. Survey Cat. No. S-2129.

DISCORBIS MIRA Cushman

Plate 3, figures 7, 8

Discorbis mira Cushman, Carnegie Inst. Washington, Publ. 311, 1922, p. 39, pl. 6, figs. 10, 11; Florida Geol. Survey, Bull. 4, 1930, p. 52, pl. 10, figs. 2a-c.

Test conical, trochoid, plano-convex, the dorsal side forming a low cone, the ventral side generally slightly concave, periphery acute, about five chambers in the last formed whorl; sutures on the dorsal side limbate, flush with the surface, oblique, slightly recurved, ventrally slightly depressed, nearly radial; wall smooth, rather coarsely perforate; aperture an elongate, slightly arched slit at the ventral margin.

Diameter 0.32 millimeter.

This species is common to both the Caloosahatchee marl of Florida and the Waccamaw formation of the Carolinas. While never very abundant, it appears in most of the samples examined from these formations. The finding of this subtropical species in the Waccamaw helps to indicate the similarity in conditions of deposition in both the Caloosahatchee and Waccamaw formations.

Localities: Pliocene stations 13, 18, 19, 22 and 25.

Florida Geol. Survey Cat. No. S-2130.

DISCORBIS GLADYSÆ, n. sp.

Plate 3, figures 9, 10

Test biconvex, dorsal side more strongly so than the ventral which is slightly concave; periphery lobate, rounded; 6 chambers comprise the last formed coil, final chamber very large; sutures curved, depressed, more strongly so ventrally than dorsally; dorsally, a marked, depressed line separating the outer whorl of chambers from the inner whorls; wall rather coarsely perforate; aperture a curved slit at the base of the last formed chamber, extending into the umbilicus; generally covered by a slight lip.

Diameter 0.32 millimeter.

Type from Station 6, Bradenton, Florida (Pleistocene).

Florida Geol. Survey Cat. No. S-2131.

This species is similar in general outline to *Discorbis obtusa* (d'Orbigny) from the Miocene of the Vienna Basin. It lacks the marked tuberculate area shown on the ventral side of that species and the final chamber is not so extended into the umbilicus.

This species occurs with slight variation in both the Pleistocene and Pliocene of Florida. It was found in greatest numbers of individuals in the Pleistocene deposits south of Bradenton. A few specimens referable to this species were found in the Waccamaw formation. It is easily recognized by the depressed area which separates the final whorl from the initial whorls.

This species is named in honor of my wife, Gladys W. Cole, to whom most of the credit for organizing the material for this paper must go.

Localities: Pleistocene stations 4, 6 and 10; Pliocene stations 14, 18, 19 and 21.

DISCORBIS SUBARAUCANA Cushman

Plate 6, figures 11, 12

Discorbis subaraucana Cushman, Carnegie Inst. Washington, Publ. 311, 1922, p. 41, pl. 7, figs. 1, 2; Florida Geol. Survey, Bull. 4, 1930, p. 52, pl. 10, figs. 1a-c.

Test unequally biconvex, dorsal side somewhat arched, the ventral side flat or slightly concave; periphery not lobate initially, but the final two or three chambers slightly lobate, not keeled, bluntly rounded; sutures oblique, curved, depressed, limbate both dorsally and ventrally except the final 2-3 chambers which do not have limbate sutures; test composed of about 2.5 to 3 coils with generally 6 chambers in the final volution, the final chamber occupying about one-fourth the area of the test; walls with numerous rather coarse punctæ; aperture a narrow slit at the base of the last formed chamber extending from the periphery well into the umbilicus, covered by a slight projecting lip.

Diameter 0.44 millimeter.

This is a very pretty species, which is found in both the Waccamaw

and Caloosahatchee formations. While it is generally rather rare, enough specimens were obtained from most localities to give a complete suite. Upon comparison of the fossil material with recent material at the Cushman laboratory, they were found to be identical. This species furnishes a further connection with the Pliocene of Florida and the recent West Indian fauna. Cushman also records it from the Miocene of Florida.

Localities: Pliocene stations 13, 16, 18 and 25.

Florida Geol. Survey Cat. No. S-2132.

DISCORBIS SUBRUGOSA Cushman

Plate 5, figures 6, 7

Discorbis subrugosa Cushman, U. S. Geol. Survey, Bull. 676, 1918, p. 14, pl. 5, figs. 4a, b.

Test small, plano-convex, the ventral side flat or slightly concave, the dorsal side strongly concave; 6 chambers comprising the last volution; sutures distinct, depressed, more strongly so dorsally than ventrally; chambers extend into the center ventrally so that there is no marked umbilicus; wall deeply and coarsely punctate dorsally, giving a very rugose appearance, ventrally finely punctate, smooth; periphery subacute; aperture a narrow slit on the ventral side of the final chamber extending from the periphery into the small umbilical area.

Length 0.24 millimeter. Width 0.20 millimeter.

This species was described by Cushman from the Caloosahatchee marl on the Caloosahatchee River. It is very rare, and is represented by only two specimens in the present collection.

It is easily recognized by the coarse punctations on the dorsal side.

Locality: Pliocene station 18.

Florida Geol. Survey Cat. No. S-2133.

DISCORBIS ORBICULARIS (Terquem) (?)

Rosalina orbicularis Terquem, Anim. sur la Plage de Dunkerque, 1876, p. 75, pl. 9, figs. 4a, b.

Discorbis orbicularis Cushman, U. S. Geol. Survey, Bull. 676, 1918, p. 13, pl. 3, fig. 4.

Test conical, trochoid, convex dorsally, concave ventrally, peripheral margin angular; 3 to 5 chambers showing in the last volution, chambers elongate; narrow; sutures indicated by extremely fine lines nearly flush with the surface of the test; strongly oblique; recurved; wall smooth, very finely perforate; aperture a small slit at the base of the last chamber, opening into the umbilicus.

Diameter 0.28 millimeter.

This species was found in both the Caloosahatchee marl and the Waccamaw formation. Cushman reports it only from the Caloosahatchee.

It is somewhat similar to *D. mira* Cushman, but differs from that species in its smaller size and very oblique sutures.

Localities: Pliocene stations 14, 15, 18, 22 and 25.

Florida Geol. Survey Cat. No. S-2134.

Subfamily Rotaliinae

Genus ROTALIA Lamarck, 1804

ROTALIA BECCARII (Linné) var. ORNATA Cushman

Plate 5, figure 9

Rotalia beccarii var. *ornata* Cushman, U. S. Geol. Survey, Bull. 676, 1918, p. 18, pl. 8, fig. 7.

Rotalia beccarii var. *ornata* Cushman and Cole, Contr. Cushman Lab. Foram. Res., vol. 6, pt. 4, 1930, p. 100, pl. 13, figs. 15a-c.

Test biconvex, the dorsal side generally more convex than the ventral which has a tendency to be slightly flattened, 10-12 chambers comprising the final whorl; sutures covered by a raised ridge of clear shell material, both dorsally and ventrally; umbilicus distinct, generally filled with a plug of clear shell material which projects slightly beyond the general surface of the test; aperture a small arched opening at the base of the final chamber, extending into the umbilicus.

Diameter 0.48 millimeter (Pliocene, Fla.) to 0.67 millimeter (Pleistocene, Md.)

This variety may be deserving of specific rank, as it has features which make it very distinctive. It is a rather common fossil in the Caloosahatchee and Fort Thompson formations. It reaches its best development in the Talbot formation of Maryland (Pleistocene). Cushman, in his Pliocene paper, considers it a tropical variety of *R. beccarii*, but it may be that other environmental conditions as well as warm water give rise to such modifications. The Maryland deposit must have been laid down under much more temperate conditions than either the Caloosahatchee or Fort Thompson formations. It is surprising that this form is very rare or lacking in the other Pleistocene deposits of Florida. It tends to show how much a form may be affected and the localization and migrations which may take place in faunas and individual species.

Localities: Pleistocene stations 1, 2 and 12; Pliocene stations 17, 18, 19 and 20.

Florida Geol. Survey Cat. No. S-2136.

ROTALIA BECCARII (Linné) var. PARKINSONIANA (d'Orbigny)

Plate 3, figures 5, 6

Rosalina parkinsoniana d'Orbigny, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, Forams., 1839, p. 99, pl. 4, figs. 25-27.

Rotalia beccarii var. *parkinsoniana* Cushman, Florida Geol. Survey, Bull. 4, 1930, p. 56, pl. 11, figs. 3a-c.

As Cushman has pointed out the "variety differs from the typical in the number of chambers which in the variety rarely have more than

ten in full grown specimens, the shorter broader chambers on the ventral side, the almost entire lack of beading at the sides of the chambers, and the lack of thickening of the sutures on the dorsal side.”

Diameter 0.52 millimeter.

While this variety is evidently distinct, specimens referred to it approach the type species from Rimini on the Adriatic. Fig. 5, given by Cushman (Contr. Cushman Lab. Foram. Res., vol. 4, pt. 4, 1928, p. 106, pl. 15) in the series of type material of *R. beccarii*, is very close to the Florida specimens referred to this variety.

This is rather a common form in the Pliocene and rare in the Pleistocene of Florida.

Localities: Pleistocene stations 1, 2, 3, 11 and 12; Pliocene stations 13, 14, 15, 16, 18, 19, 20, 21, 22 and 23.

Florida Geol. Survey Cat. No. S-2137.

ROTALIA BECCARII (Linné) var. TEPIDA Cushman

Plate 3, figures 3, 4

Rotalia beccarii Cushman (not Linné), Carnegie Inst. Washington, Publ. 311, 1922, pp. 52-53, pl. 8, figs. 7-9.

Rotalia beccarii var. *tepida* Cushman, Carnegie Inst. Washington, Publ. 344, 1926, p. 79, pl. 1.

Test small, trochoid, almost equally biconvex, 6-8 chambers comprising the final whorl; periphery broadly rounded; sutures of the final coil depressed both dorsally and ventrally, more strongly so ventrally, limbate on the inner whorls dorsally; umbilicus open, pronounced, the ends of the chambers of the final whorl produced into a point which projects slightly into the open umbilicus; wall smooth, finely punctate; aperture a narrow slit beneath the inner angle of the last formed chamber.

Diameter 0.46 millimeter.

This is a common species in both the Pliocene and Pleistocene of Florida. It is identical with the recent variety described by Cushman from the West Indian region. It is quite similar to young megalospheric forms from Rimini (Cushman, Contr. Cushman Lab. Forams. Res., vol. 4, pt. 4, 1928, p. 107) when compared with type material which Dr. Cushman kindly supplied me. As no typical *R. beccarii* are found associated with this form which is evidently an adult, the varietal distinction is warranted. It shows very little change throughout either its vertical or horizontal range in the material examined by me.

Localities: Pleistocene stations 3, 4, 5, 6, 7, 8, 9, 10 and 11; Pliocene stations 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24 and 25.

Florida Geol. Survey Cat. No. S-2138.

ROTALIA CALOOSAHATCHEENSIS, n. sp.

Plate 3, figures 1, 2

Test small, biconvex, strongly so on the dorsal side, ventral side very slightly convex; umbilical area with a distinct but small plug of shell material; periphery acute, thickened to form a narrow carina; six chambers comprise the last formed whorl, indistinct on the dorsal side, but plainly marked ventrally; sutures deeply depressed ventrally, straight radial, indistinct dorsally, not depressed, slightly curved; wall coarsely perforate, the perforations more plain ventrally; aperture a narrow slit at the base of the last formed chamber extending toward the umbilicus.

Diameter 0.40 millimeter.

Type from Station 18, Ayer's Landing on the Caloosahatchee (Pliocene).

Florida Geol. Survey Cat. No. S-2139.

This species is somewhat similar to *Rotalia turbinata* Cushman and Valentine, but differs in having a much smaller umbilical plug and a much more pointed dorsal spire. The ventral sutures are also more nearly radial.

This is a rare form only found at Sta. 18. It is remarkably like the figure given by Cushman for *Discorbis vilardeboana*, in his Pliocene paper, although his description would not fit *R. caloosahatcheensis*. The figure given by Cushman of his Pliocene form is considerably different from d'Orbigny's figure of *D. vilardeboana*.²⁰

Subfamily Siphonininae

Genus SIPHONINA Reuss, 1849

SIPHONINA PULCHRA Cushman²¹

Plate 4, figure 2

A young specimen evidently referable to this species, was found at one station in the Caloosahatchee marl along the Caloosahatchee River. This species is still living in the recent West Indian fauna.

Diameter 0.26 millimeter.

Locality: Pliocene station 18.

Florida Geol. Survey Cat. No. S-2140.

²⁰D'Orbigny's *Rosalina* (*Discorbis* of later authors) *vilardeboana*, is now referred to the genus *Valvulineria*.

²¹For details regarding this genus and its species see J. A. Cushman, Proc. U. S. Nat. Mus., vol. 72. Art. 20, (1927), pp. 1-15, pls. 1-4.

Subfamily Baggininae

Genus CANCRIS Montfort, 1808

CANCRIS SAGRA (d'Orbigny)

Rotalina sagra d'Orbigny, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, Forams., 1839, p. 77, pl. 5, figs. 13-15.*Pulvinulina sagra* Cushman, U. S. Geol. Survey, Bull. 676, 1918, p. 65, pl. 22, fig. 3; pl. 23, fig. 1.*Cancris sagra* Cushman, Florida Geol. Survey, Bull. 4, 1930, p. 56, pl. 11, figs. 4a-c.*Cancris sagra*, Cole and Ponton, Florida Geol. Survey, Bull. 5, 1930, pp. 43-44, pl. 5, fig. 6; pl. 11, fig. 1.

Test biconvex, longer than broad, the ventral side generally the most convex, about 6-7 chambers forming the last coil, these chambers increasing in size so that the final one occupies at least a fourth of the area of the test; sutures distinct, nearly flush with the surface dorsally, ventrally markedly depressed; peripheral margin of the test sharp, angulate, in some specimens bearing a slight keel, lobate; wall smooth, very finely perforate; aperture a narrow slit at the base of the final chamber in the umbilicus concealed by a thin plate of clear shell material which extends out over the umbilicus from the last chamber.

Length 0.49 millimeter. Width 0.38 millimeter.

This is a rather rare species but has been found both in the Waccamaw and Caloosahatchee formations. Specimens referred to this species from the Marianna limestone are found to be identical with our Pliocene specimens. Cushman has also reported this species from the Miocene of Florida. Thus with the exception of the Pleistocene strata of Florida, this species has a continuous range from Oligocene to recent in Florida.

That this species occurs in both the Caloosahatchee and Waccamaw formations, is considered additional proof that the two were deposited under nearly like conditions.

Localities: Pleistocene station 10; Pliocene stations 13, 14, 15, 16, 19, 23 and 25.

Florida Geol. Survey Cat. No. S-2141.

Family AMPHISTEGINIDAE

Genus AMPHISTEGINA d'Orbigny, 1826

AMPHISTEGINA GIBBOSA d'Orbigny

Plate 5, figure 14

Amphistegina gibbosa d'Orbigny, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, Forams., 1839, p. 120, pl. 8, figs. 1-3.*Amphistegina gibbosa* Cushman, Proc. U. S. Nat. Mus., vol. 59, No. 2360, 1921, p. 62.

Test unequally biconvex, the dorsal side strongly convex, composed of from 12-14 chambers in the final volution; sutures of clear shell material, radiating outward on the dorsal side from a small knob of clear shell material, but strongly recurved and angulate near the border; ventrally divided into two lobes; surface of test smooth except

near the aperture where it is strongly papillate; margin of test subangular; aperture simple, rotaliform.

Diameter 1.19 millimeters.

This form appears to be a valid species rather than a form of *A. lessonii*, which is generally figured as being nearly biconvex with about 25 chambers in final volution. While the sutures are angled near the periphery, they are not represented as being so much so as in *A. gibbosa*. The margin of *A. lessonii* is also more bluntly rounded than is the case in our specimens.

This is a characteristic form in both the Caloosahatchee and Waccamaw formations, but it has not been found in the Pleistocene deposits. This fact of its occurrence in the Pliocene and not in the Pleistocene is one of the points on which is based the conclusion that the Pliocene deposition occurred under more tropical conditions than the latter deposits.

Localities: Pliocene stations 13, 14, 17, 18 and 19.

Florida Geol. Survey Cat. No. S-2142.

Family CYMBALOPORETTIDAE

Genus CYMBALOPORETTA Cushman, 1928

CYMBALOPORETTA SQUAMMOSA (d'Orbigny)

Plate 4, figure 1

Rotalia squamosa d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 272, No. 8.

Rosalina squamosa d'Orbigny, in De La Sagra, Hist. Fis. Pol. Nat. Cuba, Forams., 1839, p. 91, pl. 3, figs. 12-14.

Cymbalopora squamosa Cushman, Carnegie Inst., Washington, Publ. 311, 1922, pp. 41-42, pl. 6, figs. 4-6.

Test subconical, trochoid, dorsal side forming a cone of various heights, ventral side concave, consisting of 5-7 chambers widest at the periphery, bluntly pointed in the umbilicus, constricted very slightly in the center; umbilical area marked; dorsal chambers rather irregular, smallest at the top of the cone; margin of the test irregularly lobate; sutures depressed, distinct; wall rather coarsely perforate; aperture consisting of rounded pores along the ventral sides of the chamber.

Diameter 0.40 millimeter.

This species was found in the Pliocene deposits of Florida and the Waccamaw formation. It is a characteristic species in recent deposits of warm, shallow-water type.

The apertures are apparently of two types: one, the rounded pores leading through the ventral surface from one chamber to the next and second, a larger aperture opening directly into the umbilicus, observed only in the final chambers.

Localities: Pliocene stations 13, 14, 18, 19 and 25.

Florida Geol. Survey Cat. No. S-2143.

Family CASSIDULINIDAE

Subfamily Cassidulininae

Genus CASSIDULINA d'Orbigny, 1826

CASSIDULINA CRASSA d'Orbigny

Plate 7, figure 2

Cassidulina crassa d'Orbigny, Voy. Amér. Mérid. Foranis., vol. 5, No. 5, 1839, p. 56, pl. 7, figs. 18-20.

Test small, biconvex, oval in outline, periphery broadly rounded; chambers comparatively few, inflated; sutures slightly depressed; wall smooth, very finely perforate; aperture a long narrow slit just below and nearly parallel with the periphery of the test.

Length 0.17 millimeter.

This species occurs in some numbers at several stations in the Caloosahatchee formation. It also occurs sparingly at some stations in the Waccamaw formation of North and South Carolina and the Pleistocene of Florida.

With it occur specimens which are referable to *Cassidulina laevigata* d'Orbigny var. *carinata* Cushman. This form has a sharply angulate periphery with a slight carina while *C. crassa* has a broadly rounded periphery. These two species may be easily separated on that character.

Localities: Pleistocene station 10; Pliocene stations 14, 21 and 22. Florida Geol. Survey Cat. No. S-2144.

CASSIDULINA LAEVIKATA d'Orbigny var. CARINATA Cushman

Plate 4, figure 4

Cassidulina laevigata d'Orbigny var. *carinata* Cushman, U. S. Nat. Mus. Bull. 104, pt. 3, 1922, p. 124, pl. 25, figs. 6, 7; Florida Geol. Survey, Bull. 4, 1930, p. 58, pl. 11, figs. 7a, b.

Cassidulina laevigata Cushman (not d'Orbigny), U. S. Geol. Survey, Bull. 676, 1918, p. 9, pl. 1, fig. 5.

A very few specimens which are referred to this variety are found in samples from the typical Caloosahatchee and in the Waccamaw formation. Cushman reports it only from the Waccamaw formation. It is easily overlooked on account of its small size.

The variety differs from the typical in the thinner more compressed test, with a small distinct carina bordering the periphery.

Localities: Pliocene stations 13, 14 and 18.

Florida Geol. Survey Cat. No. S-2145.

Genus CASSIDULINOIDES Cushman, 1927

CASSIDULINOIDES BRAZILIENSIS (Cushman)

Plate 2, figure 7

Cassidulina braziliensis Cushman, U. S. Nat. Mus., Bull. 104, pt. 3, 1922, p. 130, pl. 25, figs. 4, 5.

Test elongate, slightly compressed, initial portion closely coiled, later portion uncoiled; axis of test curved; chambers relatively few,

distinct; sutures distinct, slightly depressed; wall thin, finely perforate; aperture in slight depression, elongate, comma-shaped.

Length 0.20 millimeter. Width 0.14 millimeter.

This is a rare species. While it agrees in general with Cushman's description and figures, there are some points of difference. The Florida specimens from the Caloosahatchee marl appear to be slightly less compressed, and the arrangement of the final chambers is slightly different. It is felt best to refer it to this species for the present, however, on account of the general agreement with this species.

Locality: Pliocene station 21.

Florida Geol. Survey Cat. No. S-2146.

Family GLOBIGERINIDAE

Subfamily Globigerininae

Genus GLOBIGERINA d'Orbigny, 1826

GLOBIGERINA BULLOIDES d'Orbigny

A few specimens which can be considered under this species have been found in both the Pliocene and Pleistocene. They probably drifted in from the more open ocean and are not indigenous to these faunas.

As the *Globigerinidae* are at present in a very chaotic condition with regard to classification, it is difficult to assign species definitely in this family. However, as noted above, the Florida specimens agree with recent forms generally assigned to this type.

Localities: Pliocene stations 13, 14, 19-23.

Florida Geol. Survey Cat. No. S-2147.

GLOBIGERINA TRILOBA Reuss

Plate 7, figures 10, 11

Several individuals of a three-chambered *Globigerina* occur at the Tamiami Trail locality and rarely at several other localities of both the Pliocene and Pleistocene. They appear very similar to figures given of this species in papers on the recent faunas.

Length 0.46 millimeter.

Localities: Pleistocene stations 4, 5, 10 and 11; Pliocene stations 18, 23 and 25.

Florida Geol. Survey Cat. No. S-2148.

Subfamily Orbulininae

Genus ORBULINA d'Orbigny, 1826

ORBULINA UNIVERSA d'Orbigny

Orbulina universa d'Orbigny, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, Forams., 1839, p. 3, pl. 1, fig. 1.

Orbulina universa Cushman, U. S. Geol. Survey, Bull. 676, 1918, p. 12, pl. 3, fig. 3.

While not abundant, specimens of this species have been found in both the Waccamaw and Caloosahatchee formations. As this is a

pelagic species, it probably drifted into the shallower waters. This would account for its comparative rarity.

Diameter 0.32 millimeter.

Localities: Pliocene stations 14, 17, 18, 19 and 23.

Florida Geol. Survey Cat. No. S-2149.

Family ANOMALINIDAE

Subfamily Anomaliniinae

Genus ANOMALINA d'Orbigny, 1826

ANOMALINA BASILOBA (Cushman)

Plate 4, figure 3; Plate 7, figures 3, 4

Truncatulina basiloba Cushman, U. S. Geol. Survey, Bull. 676, 1918, p. 64, pl. 21, fig. 2.

Test relatively large, plano-convex, the dorsal side flat, the ventral side strongly convex, periphery subangular, 7 to 8 chambers in the last formed whorl; sutures slightly depressed initially, strongly depressed between the last formed chambers, limbate in the initial portion of test; a definite umbilicus on the dorsal side, a smaller umbilical area on the ventral side; a definite backward projection or lip on each chamber which projects into and over the umbilicus, these projections slightly overlapping; surface smooth, finely punctate; aperture peripheral, a rather large curved opening, with a definite lip and extending ventrally as a narrow slit.

Diameter 0.52 millimeter (Florida) to 0.96 millimeter (South Carolina).

This species raises the question as to generic classification. It is of intermediate type similar to *Cibicides americanus*. The type of aperture in *A. basiloba* seems to warrant placing it under *Anomalina* rather than *Cibicides*.

This striking, easily recognized species occurs in both the Waccamaw and Caloosahatchee formations. It was described by Cushman from the Miocene, and is one of the connecting species ranging from the Miocene to the Pliocene in Florida.

Localities: Pleistocene station 10; Pliocene stations 14, 15, 18, 21, 22, 23 and 25.

Florida Geol. Survey Cat. No. S-2150.

Subfamily Cibicidinae

Genus CIBICIDES Montfort, 1808

CIBICIDES LOBATULUS (Walker and Jacob)

Nautilus lobatulus Walker and Jacob, Adam's Essays on the Microscope, Kanmacher's ed., 1798, p. 642, pl. 14, fig. 36.

Truncatulina lobatula Cushman, U. S. Geol. Survey, Bull. 676, 1918, p. 16, pl. 1, fig. 10.

Test typically plano-convex, dorsal face flat, ventral moderately convex; peripheral margin rather sharp, often slightly lobate with the

suggestion of a narrow keel; chambers few about 7 in the last coil; sutures distinct, slightly limbate; wall punctate; aperture a slit which extends over on the dorsal face.

Length 0.46 millimeter. Width 0.35 millimeter.

Some of the Florida specimens from both the Pleistocene and Pliocene evidently belong under this species. The specimens which I have from the Waccamaw formation (Sta. 14) apparently should be placed under *C. advenus* (d'Orbigny) rather than *C. lobatulus*. The sutures of *C. advenus* are not limbate, they are markedly depressed and the peripheral margin is decidedly rounding.

Localities: Pleistocene stations 4 and 5; Pliocene stations 13, 14, 18, 19, 20, 22, 23 and 25.

Florida Geol. Survey Cat. No. S-2151.

Genus DYOCIBICIDES Cushman and Valentine, 1930

DYOCIBICIDES BISERIALIS Cushman and Valentine

Plate 5, figures 11, 12

Dyocibicides biserialis Cushman and Valentine, Contr. Dep. Geol. Stanford University, vol. 1, No. 1, 1930, p. 31, pl. 10, figs. 1, 2a, 2b.

Dyocibicides biserialis Cushman, Florida Geol. Survey, Bull. 4, 1930, p. 62, pl. 12, figs. 6a, b.

Test fairly large, in adults composed of two distinct portions, the early portion coiled appearing like *Cibicides*, the latter portion made up of spreading, biserial plano-convex chambers, the dorsal, attached side flattened; 6-8 chambers show in the initial coil, these chambers not inflated, sutures depressed ventrally, dorsally flush with the surface, limbate; chambers of the biserial portion large, inflated, sutures markedly depressed ventrally, about flush with the surface dorsally; wall coarsely perforate; aperture in the uncoiled portion peripheral or slightly dorsal, in the uncoiled portion an elongate slit at the outer edge of the chamber at the line of attachment.

Length 0.75 millimeter.

Cushman and Valentine described this new genus and two species, *D. biserialis* and *D. perforata*, from the recent fauna of the Channel Islands of Southern California. Most of our specimens appear more nearly like *D. biserialis*, although some resemble the other species. In our material there seems to be some graduation of forms and we believe that these two species are only different stages of one form.

This interesting form is recorded from only one locality (Sta. 25), but it occurred in some numbers. It suggests some relationship between the Pliocene fauna of Florida and the recent fauna of the west coast. Dr. Cushman informs me that this genus occurs also in the recent fauna of the Southern Atlantic Coast.

It has been reported previously by Cushman from the Miocene of

Florida. Locality 25, as indicated in the introduction, is the only station from which I have this form. It may prove later to be Miocene in age, but the assumption now is that it is early Pliocene.

Locality: Pliocene station 25.

Florida Geol. Survey Cat. No. S-2152.

Family PLANORBULINIDAE

Genus PLANORBULINA d'Orbigny, 1826

PLANORBULINA MEDITERRANENSIS d'Orbigny

Plate 5, figure 1

Planorbulina mediterraneensis d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, pl. 14, figs. 4-6; Modèles, 1826, No. 79.

Planorbulina mediterraneensis Cushman, Carnegie Inst., Washington, Publ. 311, 1922, pp. 45, 46, pl. 6, figs. 1, 2.

Test adherent in life, at least in the young, plano-convex, dorsal side flattened, ventral side slightly convex; early chambers distinct spiral, later ones irregularly annular in arrangement, inflated in ventral view; ventral sutures markedly depressed, particularly between the last formed chambers; wall rather coarsely perforate; apertures simple with a slightly raised lip.

Diameter 1.02 millimeters.

This is a very rare species and is represented by only a few specimens from the typical Caloosahatchee.

Planorbulinella larvata was noted in the Waccamaw formation. It is easily differentiated from *Planorbulina mediterraneensis* by the development of the tubercles over the central area of the test which makes the sutures indistinct. *Planorbulinella larvata*, like *Planorbulina mediterraneensis*, is essentially a shallow warm water type and serves to indicate the similarity in deposition between the Waccamaw and Caloosahatchee formations.

Locality: Pliocene station 18.

Florida Geol. Survey Cat. No. S-2153.

PLATES 1-7

PLATE 1.

- FIG. 1. *Quinqueloculina* sp.; front view; $\times 85$; locality 25. Page 22.
- FIG. 2. *Spiroloculina glabrata* Cushman; front view; $\times 120$; locality 18. Page 23.
- FIG. 3. *Triloculina tricarinata* d'Orbigny; front view; $\times 85$; locality 18. Page 26.
- FIGS. 4, 5, 6. *Triloculina linneiana* d'Orbigny var. *caloosahatcheensis* n. var.; 4, apertural view; 5, 6, opposite sides; $\times 45$; locality 18. Page 25.
- FIG. 7. *Triloculina bicarinata* d'Orbigny; front view; $\times 50$; locality 18. Page 24.
- FIG. 8. *Triloculina terquemiana* (H. B. Brady); front view; $\times 75$; locality 18. Page 26.
- FIGS. 9, 10. *Quinqueloculina lamarckiana* d'Orbigny; 9, apertural view; 10, front view; $\times 85$; locality 18. Page 20.
- FIG. 11. *Spiroloculina reticulosa* Cushman; front view; $\times 40$; locality 18. Page 24.
- FIG. 12. *Quinqueloculina agglutinans* d'Orbigny; front view; $\times 85$; locality 18. Page 19.
- FIG. 13. *Quinqueloculina fusca* H. B. Brady; front view; $\times 85$; locality 18. Page 20.

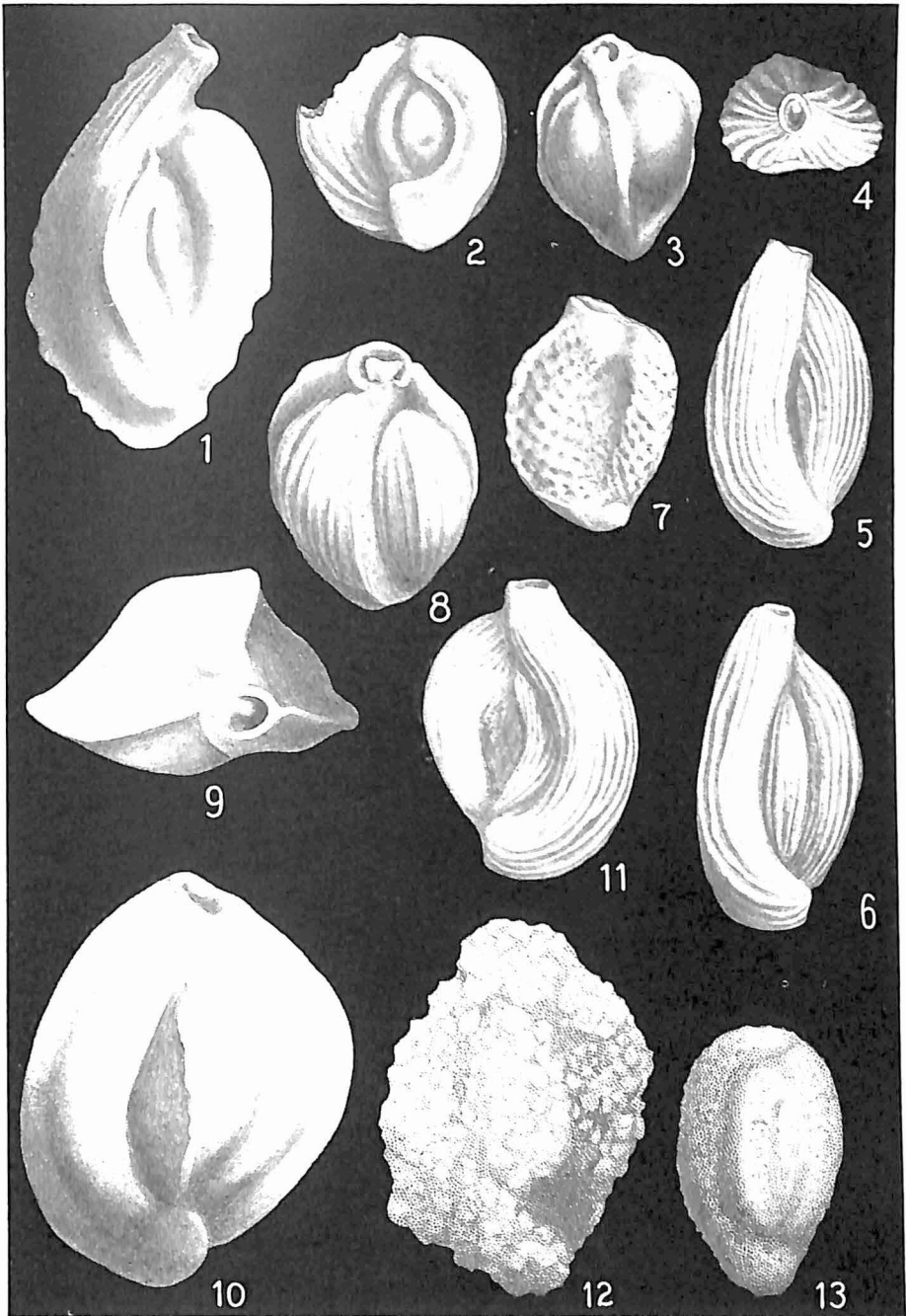


PLATE 2.

- FIG. 1. *Quinqueloculina costata* d'Orbigny; front view; $\times$ 45; locality 18. Page 22.
- FIG. 2. *Loxostoma gunteri* Cushman; side view of a mature specimen; $\times$ 85; locality 18. Page 42.
- FIG. 3. *Loxostoma gunteri* Cushman; side view of a younger specimen; $\times$ 85; locality 18. Page 42.
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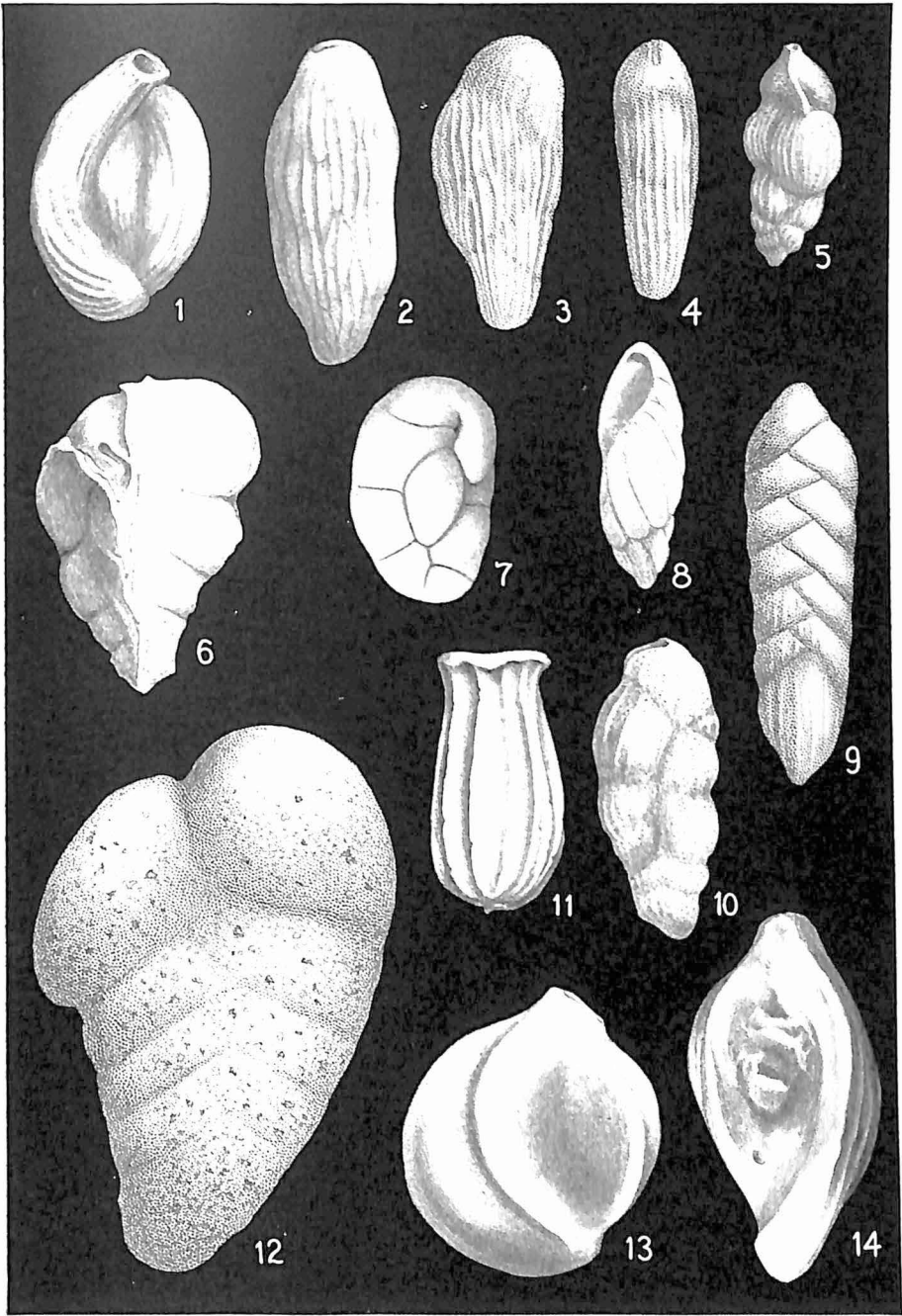


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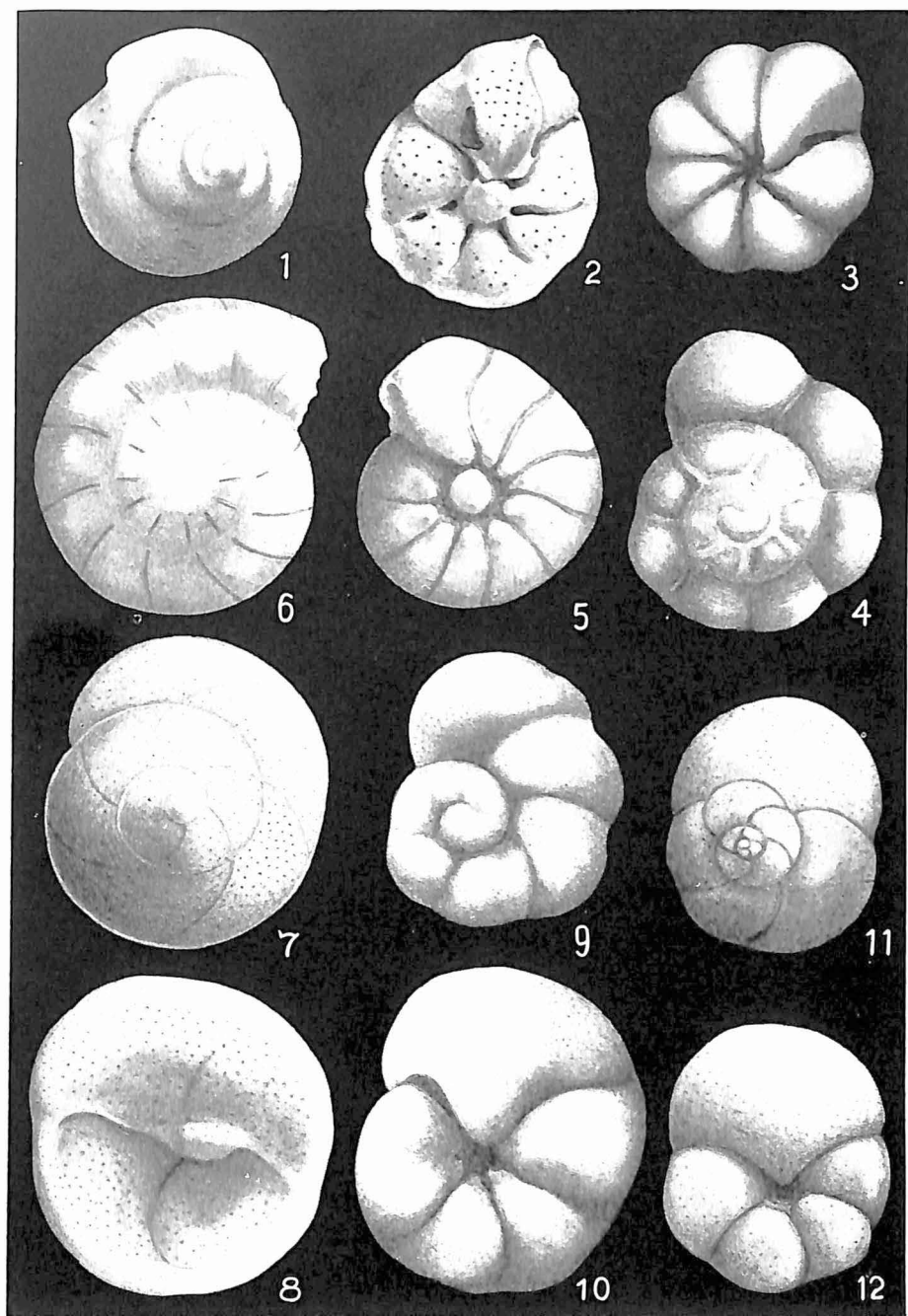


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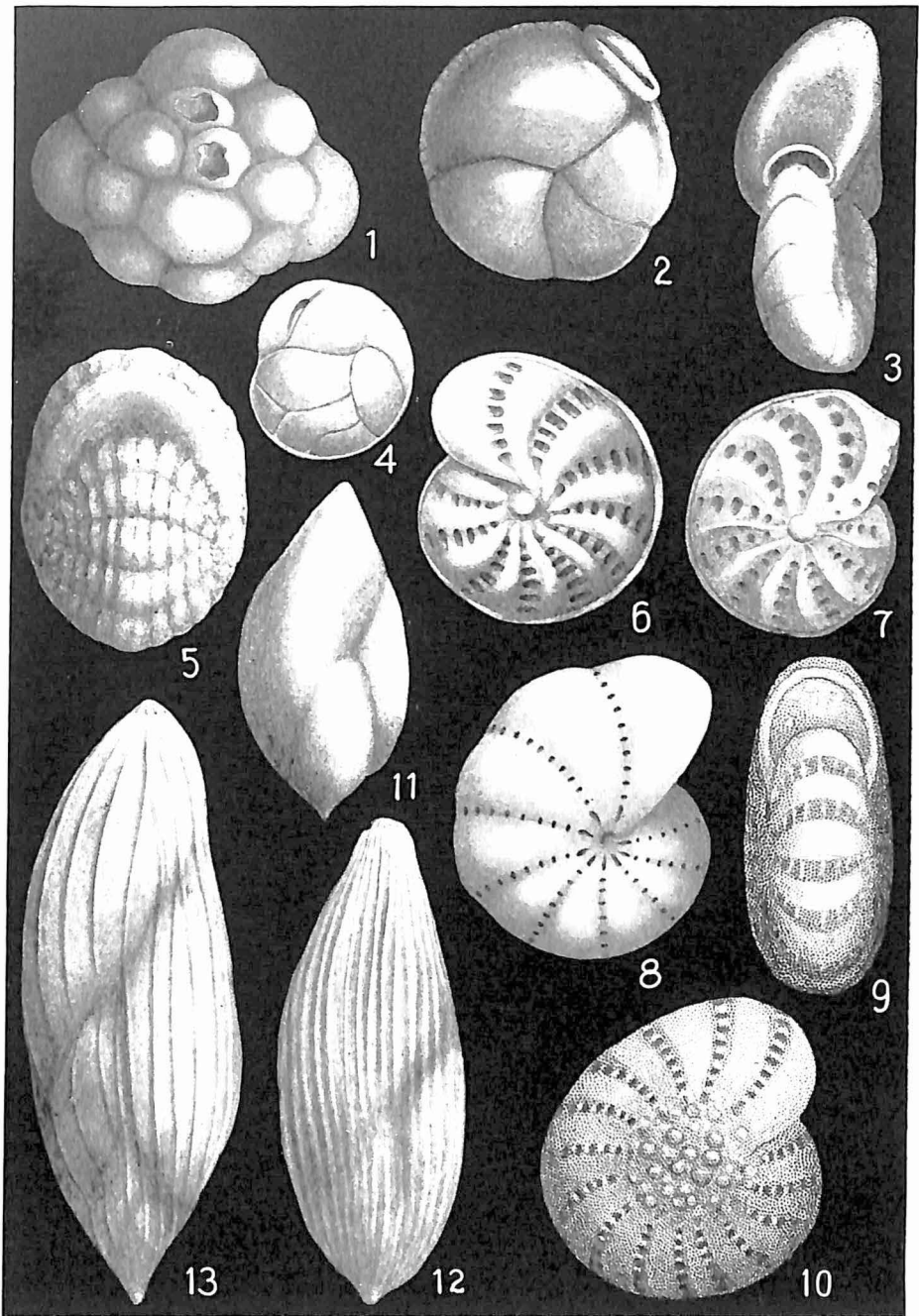


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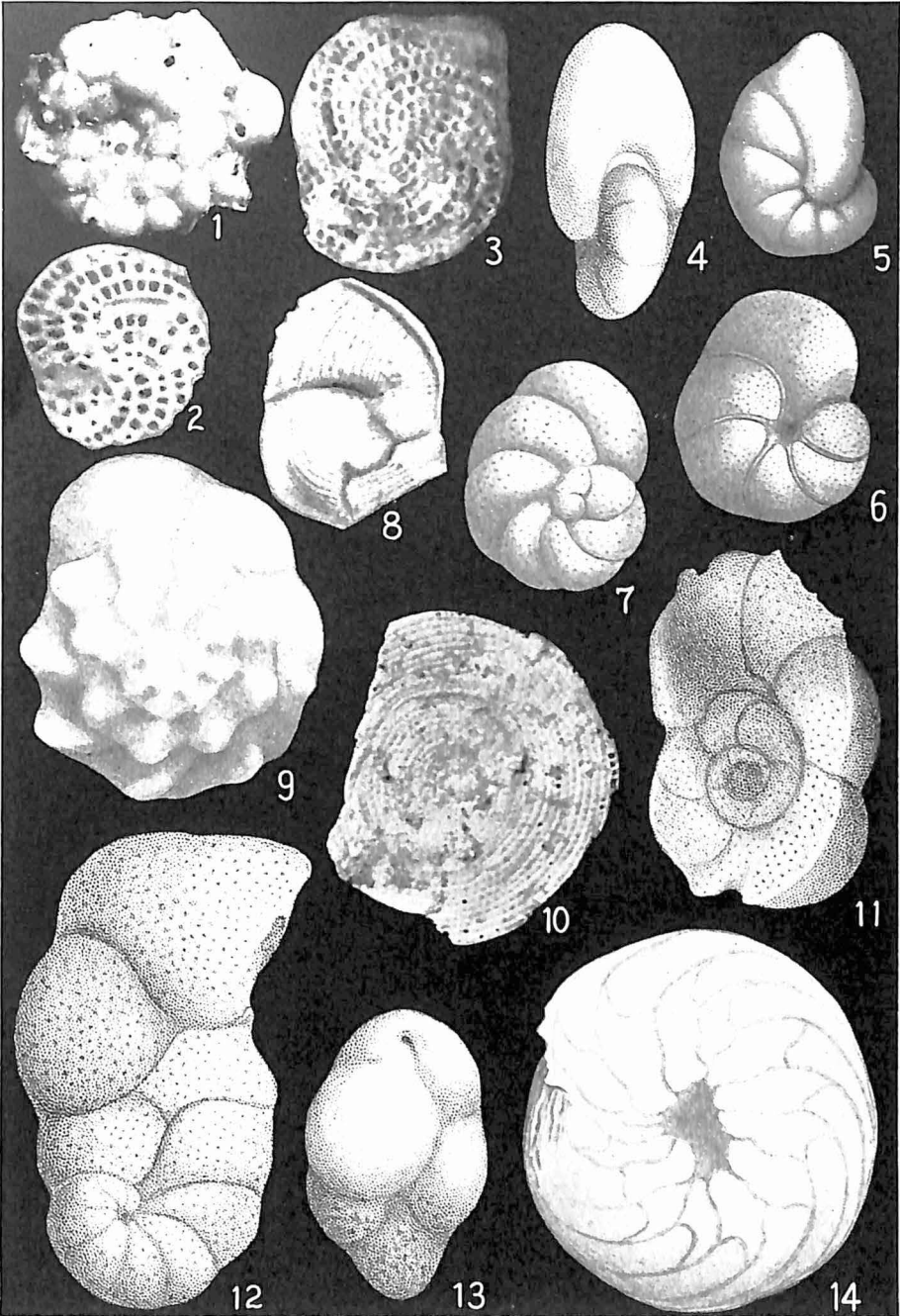


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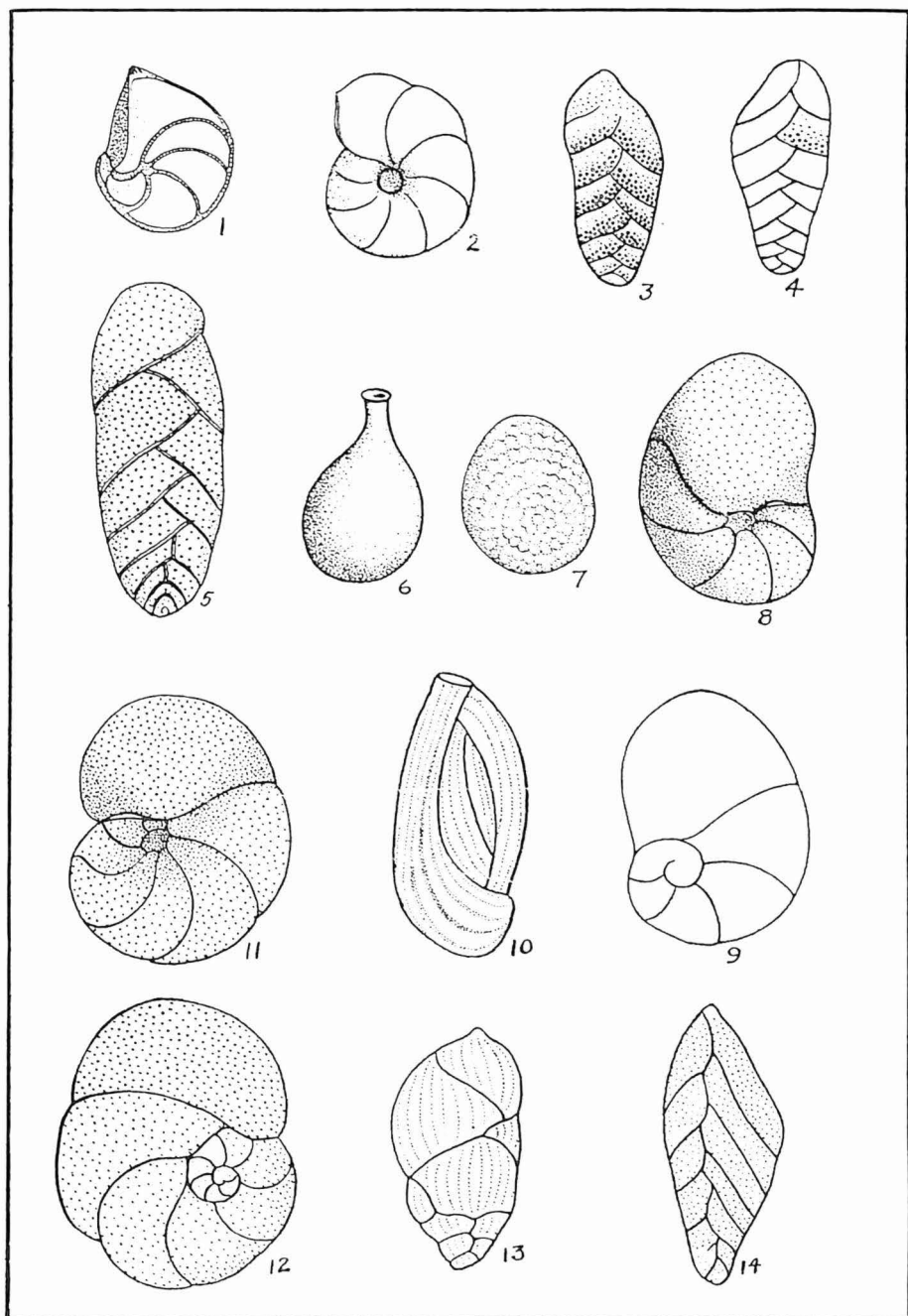
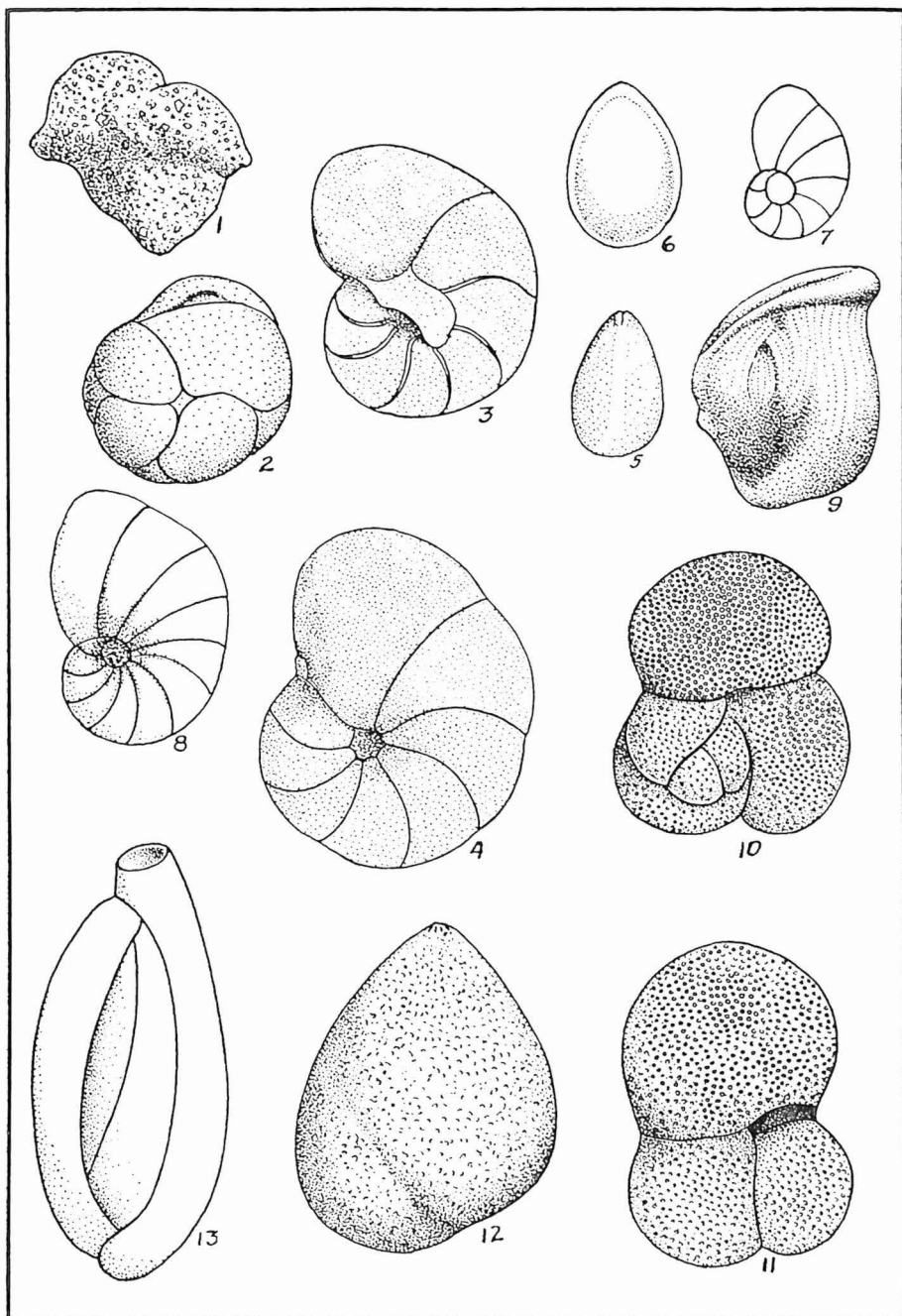


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