

FLORIDA STATE GEOLOGICAL SURVEY

HERMAN GUNTER, *State Geologist*

BULLETIN No. 9

THE FORAMINIFERA OF THE UPPER, MIDDLE AND PART OF THE LOWER MIOCENE OF FLORIDA

JOSEPH A. CUSHMAN AND GERALD M. PONTON

TALLAHASSEE, FLORIDA

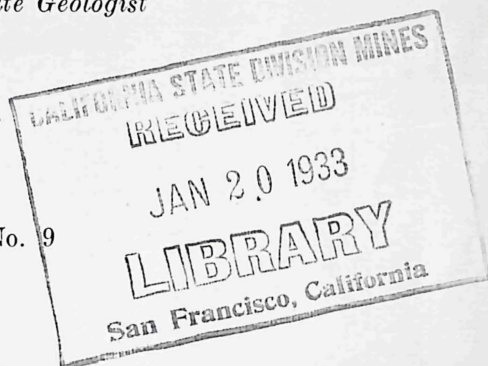
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LETTER OF TRANSMITTAL

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

Sir:

I have the honor to submit herewith for publication as Bulletin No. 9 of the Florida State Geological Survey, a report entitled "The Foraminifera of the Upper, Middle and Part of the Lower Miocene of Florida" by Dr. Joseph A. Cushman, of Sharon, Mass., and Gerald M. Ponton, Assistant Geologist, Florida Geological Survey, which has been prepared in cooperation with the United States Geological Survey without expense to the Florida Survey other than the cost of illustrations and of publication. This is the most complete report on these microscopic fossils contained in the Miocene formations of Florida yet published and will do much to further our knowledge of the rich fauna of these formations. More and more interest is being exhibited in these minute organisms, especially by oil geologists engaged in structural studies.

Respectfully,

HERMAN GUNTER,

State Geologist.

Tallahassee, Florida.

October 13, 1932.

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THE FORAMINIFERA OF THE UPPER, MIDDLE AND PART OF THE LOWER MIOCENE OF FLORIDA

JOSEPH A. CUSHMAN AND GERALD M. PONTON

INTRODUCTION

In 1930 the Florida Geological Survey published as Bulletin number 4, "The Foraminifera of the Choctawhatchee Formation of Florida" by Dr. Cushman, which bulletin included that formation from the top of the *Cancellaria* zone to the *Arca* zone as exposed at its type locality near Red Bay, Walton County.

Dr. W. C. Mansfield and G. M. Ponton in 1930 discovered several new exposures of the Choctawhatchee in west Florida and determined that these represented lower divisions of the Choctawhatchee than had heretofore been examined.

Later the junior author made collections at many localities of the upper zones of the Choctawhatchee and extended the range of some of the species as reported by Dr. Cushman with also some additions to the list of species.

Although originally to cover only the foraminifera of the Alum Bluff Group of the Miocene of Florida, the scope of the report now includes a revision of the upper zones of the Choctawhatchee, the foraminiferal fauna of the lower zones of the Choctawhatchee, and of the Shoal River formation, the Oak Grove sand and the Chipola formation of the Alum Bluff Group.

In the collection of samples of the Chipola formation we were extremely successful. Owing to the drought of 1931 the typical *Orthaulax gabbi* zone of the Chipola at Alum Bluff appeared above water-level for the first time in years; we found within a half mile of the type locality of the Chipola, with uninterrupted exposure of the marl intervening, a bed which was unoxidized (the Chipola at the type locality on McClelland's farm and at Alum Bluff are so highly oxidized that the fossils are comparatively poorly preserved). Unoxidized typical Chipola was also found on Tenmile Creek; the exposure in the bed of Econfina River on Bryant Scott's farm in Bay County has presented interesting information in that the fauna shows the gradually changing conditions from the warm Chipola to the colder water conditions in the formations above.

PREVIOUS FORAMINIFERAL LITERATURE

The most important papers that have been published describing the foraminiferal fauna of the Florida Miocene are as follows: "Some Pliocene and Miocene Foraminifera of the Coastal Plain of the United States," United States Geological Survey, Bulletin 676, 1918; "Lower Miocene Foraminifera of Florida," United States Geological Survey, Professional Paper 128-B, 1920; and "The Foraminifera of the Choctawhatchee Formation of Florida," Florida State Geological Survey Bulletin 4, 1930. All were authored by Dr. Cushman.

The second paper mentioned dealt with the fauna of the Alum Bluff Group. The scarcity of specimens (only 18 species were recorded) in the samples used for that report can only be explained by the assumption that they were procured from the matrix washed from specimens of mollusks, and in the washing most of the foraminifera were floated off.

In addition to the main papers mentioned above there are a number of random records of species from the Florida Miocene, and efforts have been made to cover these fully in the synonymies. Perhaps the most important sources of these random records are the Contributions from the Cushman Laboratory for Foraminiferal Research. A number of records occur in the Proceedings of the United States National Museum, vol. 77, 1930, Art. 6 dealing with the *Polymorphinidae*.

LIST OF STATIONS AND DISTRIBUTION OF SPECIES

A list of the localities sampled with full details and a table (Table No. 1 in envelope inside back cover) showing the distribution of species and including those records from Bulletin 4, which are added to those of the newer collections are given. These have been restudied in the light of our increased knowledge of this group and also of the recent faunas from the same general region. Those species which are new or were not adequately figured in Bulletin 4 are here figured for the use of students working with this fauna. A reference is given to the figures in Bulletin 4 for the other species so that the two bulletins together will give illustrations of practically all the species of the Florida Miocene from and including the Chipola formation to the *Cancellaria* zone of the Choctawhatchee formation, the uppermost Miocene.

A map showing the location of the stations will be found on page 11.

LIST OF STATIONS

Sample No. 1.—U. S. G. S. locality No. 1/954.—Dripping Spring on Four-mile Creek, $\frac{1}{2}$ mile northwest of Clarksville, Calhoun County. Here six feet

or more of highly fossiliferous shell marl is exposed with the shells more numerous towards the base. At the base of the bed is an erosional unconformity separating it from, presumably, the "Alum Bluff sands" of Dall, now the Chipola formation. At the unconformity are fragmentary bones of *Sirenia* and teeth of shark, likely *Carcharodon megalodon*. Mansfield placed this station in the *Ecphora* zone of the Choctawhatchee formation and this correlation was confirmed in April 1932 by the finding of a specimen of *Ecphora quadricostata* var. *umbilicata* by Mansfield and Ponton. This locality is easily accessible and the molluscan fauna is well preserved and quite numerous especially in respect to the Pelecypoda. Collected by G. M. Ponton and J. C. Simpson, November, 1930.

Sample No. 2.—U. S. G. S. localities 1/706 and 1/955.—Gully Sink at the northwest end of Gully Pond, about $3\frac{1}{2}$ miles east of Greenhead, in "The Deadens," Washington County, and $1\frac{1}{2}$ miles west of the Hamlin Pond locality (See sample No. 26 below). Mansfield in F. S. G. S. Bull. No. 3, p. 19 placed this station in the *Cancellaria* zone of the Choctawhatchee formation. This locality is most difficult to find except with a guide familiar with the maze of wood-roads of "The Deadens." The molluscan fauna is quite large especially as to the Pelecypoda, but as the marl is oxidized and indurated, the preservation of the fossils has suffered considerably. Almost 3 feet of marl is exposed. Collected by G. M. Ponton and J. C. Simpson, October 8, 1930.

Sample No. 3.—U. S. G. S. locality No. 1/946.—Harveys Creek in SW $\frac{1}{4}$ Sec. 9, T. 1 S., R. 3 W., about $1\frac{1}{2}$ miles east of Florida Road No. 19, Leon County. This is the type locality of the *Cancellaria* zone of the Choctawhatchee formation. This locality is easily accessible on Florida Road No. 19 from Tallahassee, and the molluscan fauna is especially well balanced between Pelecypoda and Gastropoda and the preservation is excellent. (See note after Sample No. 6). Collected by H. Gunter and G. M. Ponton, September 9, 1929.

Sample No. 4a.—U. S. G. S. locality No. 12718.—The upper eight to ten feet of the section exposed on the Chester Spence farm at a small dripping spring in the NE $\frac{1}{4}$ of the NE $\frac{1}{4}$ of Sec. 17, T. 2 N., R. 19 W., Walton County. (See discussion below). Collected by W. C. Mansfield and G. M. Ponton, April 13, 1932.

Sample No. 4b.—U. S. G. S. locality No. 10612.—The lower four feet or more of the section exposed on the Chester Spence farm at a small dripping spring in the NE $\frac{1}{4}$ of the NE $\frac{1}{4}$ of Sec. 17, T. 2 N., R. 19 W., Walton County. (See discussion below). Collected by W. C. Mansfield and G. M. Ponton, April 13, 1932.

DISCUSSION:—Dr. Julia A. Gardner reported U. S. G. S. locality No. 10612 on the Chester Spence farm as Shoal River formation in Professional Paper No. 142-A, p. 4, 1926. In the spring of 1930 and again in 1931 Mansfield and Ponton made collections at this locality and decided that it represented a transitional zone between the Shoal River and Choctawhatchee formations but the finding of the large *Yoldia*, *Yoldia waltonensis*, here made it questionable as to whether it

did not represent a portion of the *Yoldia* zone of the Choctawhatchee.¹ In April 1932 Mansfield and Ponton revisited the locality, and by very careful collecting found that the large *Yoldia* was restricted to the upper eight to ten feet of the section together with other species of mollusks which had been found to be confined to the Choctawhatchee formation, and the lower part of the section had a distinct Shoal River fauna. Miss Gardner apparently obtained her collection from the lower portion. Owing to the small molluscan fauna at the type locality of the *Yoldia* zone on the Frazier farm (see Sample No. 9) it is possible that the upper part of the section at this locality (Chester Spence farm) represents the lower part of the *Yoldia* zone and on the other hand the molluscan fauna of the lowest part of the section not presenting as large a fauna as at the typical exposure of the *Cardium* beds of the Shoal River, it is possible that it represents the top part of the *Cardium* beds. The two beds are separated by a thin oxidized seam, but apparently are conformable. The matrix in the upper bed is less sandy than in the lower. The locality is easily accessible by taking the Steele Church Road from DeFuniak Springs. The molluscan fauna is a beautiful representation of transitional faunas, and while the shells are well preserved they are somewhat soft while wet, but harden on drying.

The foraminiferal fauna of the *Yoldia* zone in general is one of mostly comparatively deep water, widely ranging forms. Perhaps the two most striking species of the zone are *Plectofrondicularia mansfieldi* and *Virgulina* (*Virgulinella*) *miocenica*. The former shows decided relationship with the Shoal River, and the latter ranges from the lower part of the *Arca* zone of the Choctawhatchee to the Oak Grove sand. The species *Nodogenerina advena* and *Bulimina buchiana* have been recorded from the *Yoldia* zone and nowhere else in the Florida Miocene.

Although a study of the individual species represented in the two beds at the Chester Spence farm is somewhat unsatisfactory we find a considerable difference in the fauna as a whole, as the list below will readily show.

¹ Mansfield, W. C. and Ponton, G. M., Faunal zones in the Miocene Choctawhatchee formation of Florida. Washington Acad. of Sci. Journal, vol. 22, No. 4, p. 85, 1932.

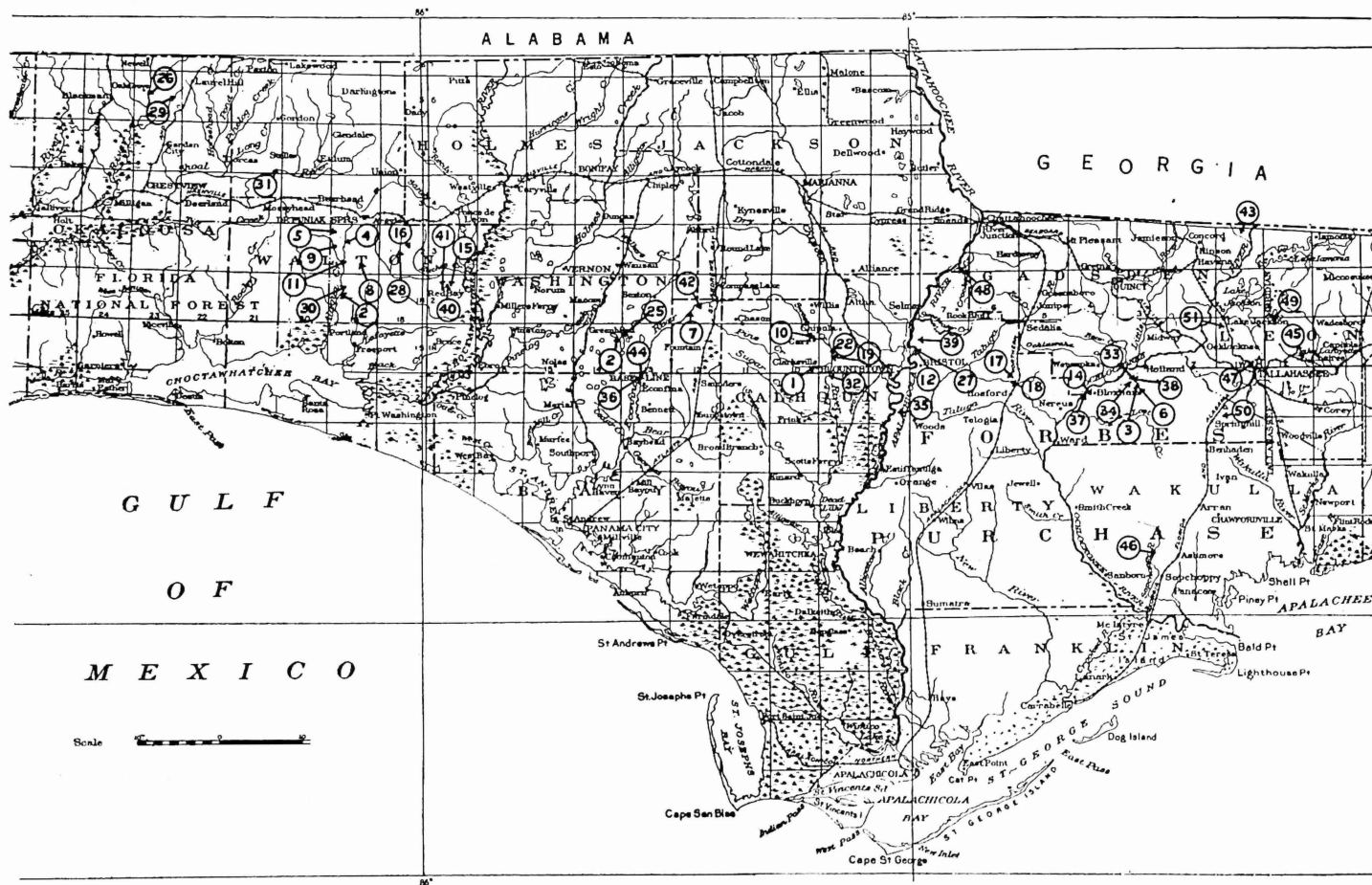


Fig. 1. Map of a portion of western Florida showing fossil localities. The numbers in circles refer to sample numbers used in this report. (See pages 8 to 18 and 21 to 22.)

DISTRIBUTION OF SPECIES IN THE UPPER (*YOLDIA* ZONE OF THE
CHOCTAWHATCHEE) AND LOWER (*CARDIUM* BED OF THE
SHOAL RIVER) BEDS ON THE CHESTER SPENCE FARM

SPECIES	UPPER BED	LOWER BED
<i>Textularia majori</i>	Common	Common
<i>Textularia articulata</i>		Few
<i>Sigmoilina tenuis</i>		Few
<i>Robulus americanus</i>	1 specimen	Quite numerous
<i>Robulus americanus spinosus</i>	Rare	Quite numerous
<i>Robulus iotus</i>	Rare	Rare
<i>Robulus vauhani</i>	3 specimens	Very numerous
<i>Saracenaria acutauricularis</i>	Rare	Numerous
<i>Dentalina communis</i>	1 fragment	Common
<i>Nodosaria longiscata</i>		Few
<i>Lagena marginato-perforata</i>		Quite common
<i>Lagena gracilis</i>		Few
<i>Globulina inaequalis</i>		Few
<i>Nonion grateloupi</i>	Common	Numerous
<i>Nonion pizarrensis</i>	Few	Few
<i>Nonionella auris</i>	Common	Common
<i>Elphidium poeyanum</i>	Fairly common	Fairly common
<i>Plectofrondicularia mansfieldi</i>	Fairly common	Rare
<i>Amphimorphina</i> sp.?	Rare	
<i>Nodogenerina advena</i>	3 specimens	
<i>Buliminella elegantissima</i>	Common	Common
<i>Buliminella curta</i>	Common	Common
<i>Bulimina buchiana</i>	Fairly common	
<i>Virgulina gunteri</i>	Few	Rare
<i>Virgulina miocenica</i>	Numerous	Numerous
<i>Virgulina pontoni</i>		Rare
<i>Bolivina marginata</i>	Common	Common
<i>Bolivina marginata multicostata</i>	Common	Common
<i>Bolivina floridana</i>	Few	Rare
<i>Chrysalidinaella pulchella</i>		Few
<i>Uvigerina peregrina</i>	Quite numerous	Numerous
<i>Eponides mansfieldi</i>	Few	Few
<i>Valvulineria floridana</i>		Common
<i>Rotalia beccarii parkinsoniana</i>	Occasional	Occasional
<i>Cancris sagra</i>	Few	Common
<i>Pulvinulinella pontoni</i>	Numerous	Numerous
<i>Cassidulina laevigata carinata</i>		Few
<i>Globorotalia menardii</i>	Few	Few
<i>Cibicides concentricus</i>	Numerous	Numerous
<i>Cibicides floridanus</i>	Few	Few
<i>Dyocibicides biserialis</i>	Rare	Few
<i>Globigerinidae</i>	75% of specimens	Comparatively few
<i>Orbulina universa</i>	Very numerous	Few

Sample No. 5.—U. S. G. S. locality No. 9959.—One-quarter mile west of Alaqua School or Pleasant Ridge Church, in small gorge cut by the run of a dripping spring on the Stafford farm in Sec. 6, T. 2 N., R. 19 W., Walton County. Typical of the *Cardium* bed of the Shoal River formation. This locality is easily reached by the Alaqua School road out of DeFuniak Springs. The molluscan fauna is well preserved and species are quite numerous. Collected by W. C. Mansfield and G. M. Ponton, March 11, 1930.

DISCUSSION:—An exposure with a similar molluscan fauna occurs at a dripping spring on Langley's old farm in Sec. 9, T. 2 N., R. 19

W., Walton County. By an accident the foraminifera from this locality were contaminated in the laboratory. This locality is reached by the Steele Church road out of DeFuniak Springs, and the molluscan fauna is excellently preserved and species are quite numerous.

Sample No. 6.—Harveys Creek at abandoned settlement called Yankeetown, in Sec. 16, T. 1 S., R. 3 W., Leon County. *Cancellaria* zone of the Choctawhatchee formation. This locality can be reached by walking upstream from the locality on Harveys Creek listed under Sample No. 3. The molluscan fauna here is represented almost exclusively by numerous specimens of the genus *Turritella*. About 2 feet of marl is exposed on the banks. Collected by J. H. C. Martens, 1928.

DISCUSSION:—This last station proved of importance as being the type locality of the new genus *Rectocibicides* represented by *R. miocenicus*. Here this species occurs abundantly. The only other record for the form rests on a few specimens from the type locality of the *Cancellaria* zone of Harveys Creek (See sample No. 3), at which locality our samples were taken from the bed of the creek from the unaltered marl with no especial care being taken to eliminate the chance admixture with the oxidized marl in the banks. Recently the junior author sampled carefully both the marl in the bed of the creek and the indurated material some 4 to 5 feet higher in the banks, with the result that no *Rectocibicides* were found in the former, while the latter had quite numerous specimens somewhat poorly preserved but showing all the characteristics. From this it would appear that *Rectocibicides* is restricted to a part of the *Cancellaria* zone and near the top.

Sample No. 7.—U. S. G. S. locality No. 12268.—Bed of Econfinia River, Bryant Scott's farm, Sec. 28, T. 2 N., R. 12 W., Bay County. Placed by Gardner at the top of the Chipola formation (See page 22 of this report). This locality is not easily accessible without the services of a local guide. The molluscan fauna is large and well preserved, but the specimens are somewhat scattered in a tough marl. Collected by W. C. Mansfield and G. M. Ponton, March 1931.

Sample No. 8.—U. S. G. S. locality No. 12046.—100 feet below small falls near head of Vaughan Creek (locally known as Blounts Creek), in Sec. 27, T. 2 N., R. 19 W., Walton County. Placed in the lower part of the *Arca* zone of the Choctawhatchee formation. The molluscan fauna at this locality is especially well preserved and numerous as to species. The locality is easily accessible from DeFuniak Springs on Florida State Road No. 40. Six feet of marl is exposed here. The exposures along Vaughan Creek to our knowledge form the most extensive continuous outcrop of the Choctawhatchee in Florida. Collected by G. M. Ponton and J. C. Simpson, October 11, 1930.

Sample No. 9.—U. S. G. S. locality No. 12060.—Frazier's old farm (formerly the Spencer farm) in the SE $\frac{1}{4}$ Sec. 18, T. 2 N., R. 19 W., Walton County. Mansfield and Ponton choose this locality as the type for the *Yoldia* zone of the Choctawhatchee formation. The molluscan fauna here is represented by the large species, *Yoldia waltonensis*, almost exclusively.

The locality is reached by a road leading from Alauqua School (See sample No. 5) to the Steele Church. Six feet of marl is exposed here. Collected by W. C. Mansfield and G. M. Ponton, March 1930.

Sample No. 10.—Tenmile Creek, from bridge to $\frac{1}{2}$ mile below bridge on the Marianna-Clarksville road, 22 miles south of Marianna, Calhoun County. This locality represents typical Chipola formation, and the molluscan fauna is beautifully preserved and carries large numbers of both species and specimens. This is perhaps the best locality at which to collect the Chipola fauna. About 4 feet of the marl is exposed. Collected by G. M. Ponton, November 1929.

Sample No. 11.—U. S. G. S. locality No. 12044.—Bell's farm in the NE $\frac{1}{4}$ of Sec. 29, T. 2 N., R. 19 W., Walton County. The exposures here are at the heads of small branches flowing into Sconiers Mill Creek. This locality is placed in the lower part of the *Arca* zone of the Choctawhatchee formation. The molluscan fauna here is fairly large and fairly well preserved. The Steele Church road out of DeFuniak Springs takes one within three-quarters of a mile of the locality. Ten to fifteen feet of marl is exposed. Collected by W. C. Mansfield and G. M. Ponton, March 12, 1930.

DISCUSSION:—In the paper on the faunal zones of the Choctawhatchee, Mansfield on the basis of the mollusks placed this locality in the *Arca* zone but below the beds at Red Bay (See samples 15, 40 and 41) but in the same stratigraphic position as the beds on Vaughan Creek (See sample No. 8), but Ponton on the basis of the foraminifera believed that the position of the Bell farm beds was higher in the section than the Vaughan Creek beds. Further study of the foraminiferal fauna has inclined the junior author to agree with Mansfield's correlation.

Sample No. 12.—U. S. G. S. locality Nos. 1/670 and 1/956.—Upper shell beds at Alum Bluff on the east bank of the Apalachicola River about 4 miles north of Bristol, Liberty County. This is the type locality of the *Ecphora* zone of the Choctawhatchee formation. (See Table No. 2 for sections at Alum Bluff). The molluscan fauna here is only fairly well preserved, the shells being soft. However, a fairly large fauna is present but somewhat obscured by masses of *Mulinia congesta* which occur. The species from which the *Ecphora* zone is named, *Ecphora quadricostata* var. *umbilicata* is very rare. The locality is easily accessible. Collected by G. M. Ponton, November 1929.

Sample No. 13.—Same as sample No. 6 above, and the foraminiferal fauna has been grouped with it.

Sample No. 14.—U. S. G. S. locality No. 11732.—Borrow-pit just east of the power dam at Jackson Bluff on Ocklocknee River, Leon County. *Cancellaria* zone of the Choctawhatchee formation. Reached by Florida Road No. 19 twenty-five miles southwest of Tallahassee. An excellently preserved, numerous (both as to species and specimens) and well balanced molluscan fauna is present. Some care must be taken not to include specimens from the *Ecphora* zone which has been entered in the lower parts of the pit. Collected by J. H. C. Martens and G. M. Ponton, 1927.

Sample No. 15.—U. S. G. S. locality Nos. 1/671 and 1/947. Jim Kennedy Branch, one mile east of Red Bay, Walton County. Typical of the latest

fauna of the *Arca* zone of the Choctawhatchee formation. The locality is easily reached by the main road east from Red Bay. The molluscan fauna is not well preserved being generally broken and worn, but a worthwhile fauna can be collected if time is taken. About 21 feet of the *Arca* zone is exposed. (The upper bed, nearly unfossiliferous, at this locality has been placed in the *Ecphora* zone.) Collected by W. C. Mansfield and G. M. Ponton, March 6, 1930.

Sample No. 16.—Bottom of old flourspar prospect shaft at a depth of 50 to 55 feet, about 4½ miles south of Argyle, Walton County. The molluscan fauna is very similar to that at White's Creek (See sample No. 28) and thus is placed somewhat higher in the section than that at Shell Bluff (See sample No. 31). The shaft is abandoned and cannot be sampled. Collected by J. H. C. Martens, November 1928.

Sample No. 17.—U. S. G. S. No. 3672.—Robinson's Mill (abandoned) on Robinson's Mill Creek about three-quarter miles (airline) northwest of Hosford's Mill (See sample No. 18), Liberty County. The molluscan fauna here is well preserved and quite numerous and represents the earliest fauna of the *Cancellaria* zone of the Choctawhatchee formation. The marl lies in the bed of the creek. Collected by H. Gunter and G. M. Ponton, June 17, 1931.

Sample No. 18.—U. S. G. S. locality Nos. 3671 and 1/958.—Hosford's Mill (Old Coe's Mill) on Big Creek about 2 miles northeast of the town of Hosford, Liberty County. Three to four feet of marl is exposed in the mill race. The molluscan fauna is well preserved and specimens and species quite numerous. The fossils represent the earliest fauna of the *Cancellaria* zone of the Choctawhatchee formation. The locality is easily accessible. Collected by H. Gunter and G. M. Ponton, June 17, 1931.

Sample No. 19.—At mouth of Senterfeit Branch, a small branch entering the Chipola River ½ mile below the type locality of the Chipola formation on McClelland's farm (See sample No. 22) Calhoun County. Sample represents the light yellow highly oxidized marl from the surface of the deposit. The exposure of Chipola formation is continuous from McClelland's farm to Senterfeit Branch. The molluscan fauna is numerous but not well preserved, and represents typical Chipola formation. Collected by G. M. Ponton, October 1931.

Sample No. 20.—Same as sample No. 19 except that it represents the unoxidized greenish-gray marl about three feet in from the surface of the deposit. The molluscan fauna here is well preserved.

The foraminiferal fauna from Samples Nos. 19 and 20 have been grouped.

Sample No. 21.—U. S. G. S. locality No. 12048.—Permenter's old farm in Sec. 17, T. 1 N., R. 19 W., Walton County. The exposure of shell marl occurs in a road cut leading to an abandoned bridge on the east bank of Alaqua Creek. The molluscan fauna is not numerous and not well preserved, and is placed in the *Ecphora* zone of the Choctawhatchee formation. The locality is most difficult to find unless accompanied by a local guide. Collected by G. M. Ponton and J. C. Simpson, October 11, 1930.

DISCUSSION:—Mansfield from the study of the mollusks believed this bed to be in the *Ecphora* zone. This correlation is confirmed to a large extent by the occurrence here of the foraminifer, *Virgulina*

(*Virgulinella*) *gunteri*, var. *curtata*, a species apparently confined to that zone.

Sample No. 22.—U. S. G. S. locality No. 994.—The J. P. M. McClelland farm on the right bank of the Chipola River about 2½ miles east of the village of Carr, Calhoun County. This is the type locality of the Chipola formation. The molluscan fauna is not very well preserved as the marl is oxidized, but a large fauna can be collected by handling much material. The locality is easily accessible from Marianna on the Marianna-Clarksville road and turning off at Carr. Collected by G. M. Ponton, October 1931.

Sample No. 25.—U. S. G. S. locality No. 1/422.—East end of Hamlin Pond in small sinks in Sec. 7 (?), T. 1 N., R. 13 W., Washington County, about 5 miles east of Greenhead. The condition of the molluscan fauna and the accessibility of the locality is the same as that described under Sample No. 2. Collected by G. M. Ponton and J. C. Simpson, October 8, 1930.

Sample No. 26.—U. S. G. S. locality No. 7054.—At old saw-mill near Oak Grove on right bank of Yellow River about 100 yards below bridge on Laurel Hill-Oak Grove road, Okaloosa County. This is the type locality of the Oak Grove sands. The molluscan fauna is well preserved and numerous as to species and specimens. The marl lies in the bed of the river and is only exposed at low stages of the river. Collected by G. M. Ponton and J. C. Simpson, October 12, 1930.

Sample No. 27.—U. S. G. S. locality No. 10660.—Lowermost shell bed toward lower end of Alum Bluff on the east bank of the Apalachicola River about 4 miles north of Bristol, Liberty County. The sample was taken from the four feet of highly fossiliferous marl appearing about water-level at a very low stage of the river. The molluscan fauna is well preserved and numerous. (See table No. 2 for sections at Alum Bluff.) The sands overlying this very fossiliferous bed were sampled with result that very few foraminifera were found. In the lower one-half of the sand a few specimens of *Elphidium chipolensis* and *Sorites?* sp.? were noted. This bed is typical Chipola formation. Collected by H. Gunter and G. M. Ponton, October 6, 1931.

Sample No. 28.—U. S. G. S. locality No. 10608.—Small gully, 50 feet south of road and 150 feet east of bridge over White's Creek on Eucheeanna-Knox Hill road, 1 mile west of Valley Church, Walton County. This locality presents perhaps the best preserved and most numerous molluscan fauna of the Shoal River formation. It would appear that perhaps the fossils show a somewhat later fauna than that at the type locality of the formation at Shell Bluff (See sample No. 31). The locality is easily accessible by taking the Red Bay road south from Argyle and turning west at Valley Church. Collected by G. M. Ponton, November 1929.

Sample No. 29.—U. S. G. S. locality No. 10659.—Senterfiet's or Tanner's Mill (abandoned), four miles southwest of Laurel Hill, Okaloosa County. This locality was placed by Gardner in the Oak Grove sands although the molluscan fauna showed a higher percentage of Shoal River forms than at the type locality of the Oak Grove. A recent visit to this locality disclosed that the exposure has been sanded over by the flooding of the Creek. Collected by Miss Julia A. Gardner, 1923.

Sample No. 30.—U. S. G. S. locality No. 12527.—On Alice Creek, a tributary of Alaqua Creek, near the NE corner of the SE¼ Sec. 8, T. 1 N., R. 19 W., Walton County, and about 1 mile northeast of the locality on

Permenter's old farm (See sample No. 21). The molluscan fauna here is not well preserved, the shells being soft, nor are the species numerous. The locality has been placed in the *Arca* zone of the Choctawhatchee formation. The locality is not easily found without the services of a local guide. Collected by G. M. Ponton and J. C. Simpson, October 11, 1930.

Sample No. 31.—U. S. G. S. locality No. 10658.—Toward upper end of Shell Bluff on right bank of Shoal River, 5 miles north of Mossyhead, Walton County. This is the type locality of the Shoal River formation. A large and well preserved molluscan fauna is present and the locality is easily reached from Mossyhead. Collected by G. M. Ponton, November 1929.

Sample No. 32.—U. S. G. S. locality No. 1/960.—Darling Slide, an old log slide at a bluff on the east bank of the Chipola River about $2\frac{1}{2}$ miles southeast of Clarksville. The molluscan fauna here is not well preserved nor large as to species, but much of the fauna is obscured by the large number of *Mulinia congesta* present, as at Alum Bluff (See sample No. 12). Collected by G. M. Ponton, October 1931.

Sample No. 33.—U. S. G. S. locality No. 1/964.—Sec. 8, T. 1 S., R. 3 W., Leon County, highest bed exposed in a small stream entering Harveys Creek at an abandoned mill. It belongs to the *Cancellaria* zone of the Choctawhatchee formation. Recently visited, the exposure was found to be almost entirely covered with sand, and considerable work would have to be done to make a representative collection of the molluscan fauna. Collected by W. C. Mansfield November 16, 1925 and further sampled by G. M. Ponton February 1932.

Sample No. 34.—U. S. G. S. locality No. 1/966.—Just above bridge across Double Branch on Florida Road No. 19 in Sec. 8, T. 1 S., R. 3 W., Leon County. *Cancellaria* zone of the Choctawhatchee formation. Collected by W. C. Mansfield, October 17, 1925.

Sample No. 35.—U. S. G. S. locality No. 1/961.—On S. D. Johnson's farm near Woods in Sec. 26, T. 1 S., R. 8 W., Liberty County. *Cancellaria* zone of the Choctawhatchee formation. Collected by W. C. Mansfield, November 7, 1925.

Sample No. 36.—U. S. G. S. locality No. 1/953.—On R. L. Gainer's farm on the Econfinia River in Sec. 4, T. 1 S., R. 13 W., Bay County. Loose shells representing the *Cancellaria* zone of the Choctawhatchee formation are found lying on the hard indurated Chipola formation (See sample No. 44) along the river and have been turned up by the plow in the fields. No exposure of the marl was seen in place. The locality is reached over poor roads from Youngstown on Florida Road No. 20. Collected by W. C. Mansfield October 30, 1925 and further sampled by W. C. Mansfield and G. M. Ponton April 15, 1932.

Sample No. 37.—Lowest shell bed lying directly on top of the Hawthorn formation at Jackson Bluff, left bank of Ocklocknee River just above highway bridge, Leon County. This bed is indurated and thus the shells are not very well preserved. The fauna represents the latest fauna of the *Eophora* zone of the Choctawhatchee formation. A power house has been built at this locality but the same bed outcrops below the bridge. Collected by W. C. Mansfield October 16, 1925, and further sampled by G. M. Ponton, March 1931.

Sample No. 38.—U. S. G. S. locality No. 1/965.—On Harvey's Creek at abandoned mill about $\frac{1}{2}$ mile above Florida Road No. 19, in Sec. 8, T. 1 S.,

R. 3 W., Leon County. The mollusks represent the latest fauna of the *Ecphora* zone of the Choctawhatchee formation. Collected by W. C. Mansfield November 15, 1925. Recently visited, it was found that this bed was completely sanded over.

Sample No. 39.—U. S. G. S. locality No. 1/962.—Cut in road leading to Watson's Landing, Liberty County, about two miles north of Alum Bluff and about the same distance from the Apalachicola River. Base of the bed about 40 feet above the river terrace. *Ecphora* zone of the Choctawhatchee formation. Collected by W. C. Mansfield, November 10, 1925.

Sample No. 40.—U. S. G. S. locality No. 1/948.—John Anderson's farm $\frac{3}{4}$ mile east of Red Bay, Walton County. This locality is regarded as the type locality of the Choctawhatchee formation and also of the *Arca* zone of that formation. Collected by W. C. Mansfield, October 20, 1925. The beds exposed on Jim Kennedy Branch (See sample No. 15) and on Gomillion's farm (See sample No. 41) present much better exposures of the same bed.

Sample No. 41.—U. S. G. S. locality Nos. 1/673 and 1/950.—At small spring head in E. Gomillion's field at Red Bay, Walton County. This is typical of the *Arca* zone of the Choctawhatchee formation. This is perhaps the best locality for obtaining a representative sample showing the latest fauna of the zone. Collected by W. C. Mansfield October 20, 1925 and further sampled by W. C. Mansfield and G. M. Ponton March 1931.

Sample No. 42.—U. S. G. S. locality No. 1/682.—Bryant Scott's farm, $\frac{1}{4}$ mile above mouth of small branch (likely Taylor Branch) entering Econfinia River near bridge in Sec. 22, T. 2 N., R. 12 W., Bay County. This represents the *Arca* zone of the Choctawhatchee formation. The molluscan fauna is small and not well preserved. Collected by Julia A. Gardner, November 14, 1923.

For other localities sampled but not included in distribution table see page 21.

CORRELATIONS OF THE FLORIDA MIOCENE

The molluscan fauna of the Choctawhatchee formation and of the Alum Bluff Group have been studied intensively, respectively by Dr. W. C. Mansfield² and Dr. Julia A. Gardner³ of the United States Geological Survey and the result of their work is to a large extent the basis for the zonal divisions as used in this paper.

The first definite identification of Miocene rocks in Florida was that by the late Dr. Eugene A. Smith⁴ in 1881. A low bluff of indurated shell marl at Rock Springs, Orange County, was so desig-

² Mansfield, W. C., Miocene Gastropods and Scaphopods of the Choctawhatchee Formation of Florida: Florida Geol. Survey, Bull. 3, 1930; Miocene Pelecypods of the Choctawhatchee Formation of Florida: Florida Geol. Survey, Bull. 8, 1932.

³ Gardner, Julia A., The Molluscan Fauna of the Alum Bluff Group of Florida: U. S. Geol. Survey, Prof. Paper 142 (A to E), 1926.

Note: The five papers, above, include the Pelecypoda. The papers covering the Gastropoda are now in press.

⁴ Smith, Eugene A., Geology of Florida: Amer. Journ. of Sci., vol. 21, 3rd Ser., No. 124, pp. 302 and 303, Apr. 1881.

TABLE NO. 2—VARIOUS SECTIONS AND CORRELATIONS OF THE BEDS AT ALUM BLUFF.

Langdon's section 1887, published 1889. ¹	Langdon's Correlation 1891. ²	Burns and Johnson's section 1890, published 1892. ³	Dall and Stanley-Brown's section, pub- lished 1894. ⁴	Dall's Correlation 1892 ⁵ and 1894. ⁴	Dall's Correlation 1896. ⁵	Matson's & Clapp's Correlation 1909. ⁶	Condensed section based on those made by Sellards & Gunter 1909, Cooke 1914, & Berry 1916. ⁷	Present Correlation
1. White sand, evi- dently marine but of recent forma- tion. 30 ft.		Yellow unfossil- iferous sand 70 ft.	1. Superficial sands. 8½ ft.	Pleistocene	Pleistocene	Pleistocene	9. Light colored ferruginous unconsolidated sand. 9 ft.	Pleistocene and Recent
			2. Red Clay 2½ ft. 3. Reddish and yellowish streaked sands. 66 ft.	Pliocene Lafayette	Pliocene Lafayette	Pliocene Lafayette	8. Hard reddish clay. 2 ft. 7. Variegated reddish and yellowish ferruginous sand. 65 ft.	Pliocene Citronelle formation
2. Black lignitic sand very pyritous, and from efflorescence of ferrous sulphate arises the name Alum Bluff. 10 to 15 ft.	Miocene Alum Bluff Series.	Lignitic sand 10 ft.	4. Aluminous clays 24 ft.	Upper Miocene Chesapeake (Pasca- goula?)	Upper Miocene Chesapeake (Pasca- goula?)	Miocene Choctaw- hatchee formation Aluminous clays	6. Brown, sandy, micaceous pyritiferous clay tasting like alum; casts of mul- luskus abundant near bottom, rare above; fine slightly coherent grayish sand at top. 25 ft.	Upper Miocene Choctawhatchee formation. Perhaps con- temporaneous with parts of both Ecphora and Cancellaria Zones.
3. Gray calcareous sand highly fos- siliferous. 10 to 15 ft.		Ecphora bed 30 ft.	5. Chesapeake gray marl. 35 ft.	Upper Miocene Chesapeake marl Ecphora Beds	Upper Miocene Chesapeake marl. Ecphora Beds.	Miocene Choctaw- hatchee formation Ecphora Beds	5. Brown or dirty-green fine sand mixed with clay; shells very abun- dant throughout but less so at bottom than higher. 15 ft.	Upper Miocene Choctawhatchee formation Ecphora Zone
4. Gray sand slightly calcareous, no fos- sils. 5 ft.		Alum Bluff Beds. 15 ft.	6. Alum Bluff sands with streaks of clay. 21½ ft.	Miocene Alum Bluff Beds	Oligocene	Oligocene Apalachicola Group. Chipola marl member and sands of the Alum Bluff formation.	Erosional unconformity?	
5. Light yellow sand, containing pockets of fossils. Where there are no shells the sand is very calcareous. To water's edge, 35 ft.							4 and 3. The fossil leaf- bearing sands. 6 ft.	Middle Miocene Alum Bluff Group.
							Unconformity.	
							2. Light-gray tough cal- careous sand; fossil mol- luskus sparingly through- out. 16 ft.	Lower Miocene Alum Bluff Group. Chipola formation.
Under water at time of Langdon's visit.	Under water	Chipola marl 5 ft.	7. Hard Chipola marl to water (variable). 3½ ft.	Miocene Chipola marl			1. Fine quartz in yellowish calcareous clay, loaded with shells merging into over-lying bed. Water- level. 4 ft.	

¹ Langdon, Daniel W., Some Florida Miocene: Amer. Jour. of Sci., vol. 38, 3rd Series, pp. 322 to 324, 1889.² Langdon, Daniel W., Geological section along the Chattahoochee River from Columbus to Alum Bluff: Georgia Geol. Surv., First Rept. Prog. 1890-1891, p. 97, 1891.³ Dall, W. H., The Neocene of North America: U. S. Geol. Surv., Bull. 84, p. 113, 1892.⁴ Dall, W. H., and Stanley-Brown, J., Cenozoic Geology along the Apalachicola River: Bull. Geol. Soc. of Amer., vol. 5, p. 157, 1894.⁵ Dall, W. H., Description of Tertiary fossils from the Antillan region: U. S. Nat. Mus. Proc., vol. 19, No. 1110, pp. 303-305, 1896.⁶ Matson, G. C., and Clapp, F. G., A preliminary report on the Geology of Florida: Florida Geol. Surv., 2nd Ann. Rept. 1909.⁷ Sellards, E. H., and Gunter, H., The fullers earth deposits of Gadsden County: Florida Geol. Surv., 2nd Ann. Rept., p. 275, 1909. Berry, E. W., The physical conditions and age indicated by the flora of the Alum Bluff formation: U. S. Geol. Surv. Prof. Paper 98-E, p. 41, 1916.

Cooke, C. W., and Mossom, S., Geology of Florida: Florida Geol. Surv., 20th Ann. Rept., p. 107, 1929.

nated and has stood the test of time. The mollusks collected here by Dr. Smith were identified by Prof. Angelo Heilprin as being of Miocene age and the information was republished⁵ in 1884. Cooke and Mossom place this outcrop in the Hawthorn formation. When excavating for a swimming pool at the spring in 1930 the Ocala limestone (Eocene) was encountered at a depth of 8 feet below water-level and therefore it would appear that the above correlation is correct. No foraminifera were preserved at this locality.

In 1887 Daniel W. Langdon discovered the exposure at Alum Bluff on the Apalachicola River, and assisted by Dr. T. H. Aldrich identified the mollusks as Miocene species. This was published in 1889⁶. In 1891⁷ it was republished under the heading "Alum Bluff, Series." As Cooke and Mossom⁸ state "This early and very appropriate use of the term Alum Bluff was apparently overlooked by Matson and Clapp⁹ who named the formation Choctawhatchee formation, from the Choctawhatchee River, and used the name Alum Bluff formation with a different significance." Cooke and Mossom¹⁰ further state that Dall's "Alum Bluff beds" and "Chipola marl" discovered in 1889 by Frank Burns and published in 1892¹¹ were under water at the time of Langdon's visit. This was apparently true only for the "Chipola Marl" as shown by sections in Table No. 2 of this report.

The section at Alum Bluff has been of such importance in the correlation of the Florida Miocene that we present in Table No. 2 the sections made by various investigators and the several correlations.

It will be seen from Table No. 2 that Alum Bluff, Liberty County, does not present a very representative section as a type locality of the Alum Bluff Group. The only fossiliferous bed, of real value, of the Alum Bluff Group present there, namely, the Chipola formation, is usually under water. However, the name Alum Bluff Group is now so firmly fixed in literature that it should be retained, unless investigations should show different relationships of the formations that compose the Group.

⁵ Heilprin, Angelo, The Tertiary Geology of the Eastern and Southern United States: Jour. of the Acad. of Nat. Sci. Phila., vol. 9, pt. 1, 1884.

⁶ Langdon, Daniel W., Some Florida Miocene: Amer. Jour. of Sci., 3rd Ser., vol. 38, pp. 322 to 324, 1889.

⁷ Langdon, Daniel W., Geological Section along the Chattahoochee River from Columbus to Alum Bluff; Georgia Geol. Survey, First Report, Prog. 1890-1891, p. 97, 1891.

⁸ Cooke, C. W., and Mossom, S., Geology of Florida: Florida Geol. Survey, 20th Ann. Rept., p. 138, 1929.

⁹ Matson, G. C., and Clapp, F. C., A Preliminary Report on the Geology of Florida: Florida Geol. Survey, 2nd Ann. Rept., p. 108, 1909.

¹⁰ Op. cit. p. 138.

¹¹ Dall, W. H., and Harris, G. D., The Neocene of North America: U. S. Geol. Surv. Bull. 84, p. 122, 1892.

Dall's¹² "Alum Bluff Beds" and "Chipola Marl" were raised to formational rank by Matson and Clapp¹³ as the "Alum Bluff Formation" which included as members the "Chipola Marl," the "Oak Grove Sands" of Dall, and the "Shoal River Marl." Gardner¹⁴ in turn raised it in rank to that of group, composed of the Chipola formation, the Oak Grove sand and the Shoal River formation. Gardner included in the Chipola and Shoal River formations some associated beds not included in the marl members of the same name by Matson and Clapp.

Cooke and Mossom¹⁵ state the Oak Grove sand and the Shoal River formation have not been recognized east of the Choctawhatchee River, and that the Chipola formation extends east as far as the Apalachicola River.

To the Alum Bluff Group, Cooke and Mossom¹⁶ add a fourth formation, the Hawthorn, which they state is contemporaneous in part with the other divisions of the Group, and includes all beds of Alum Bluff age in Florida east of the Apalachicola River. They¹⁷ tentatively placed in the Hawthorn several beds which may be younger in age than the Alum Bluff.

At the majority of the exposures of Hawthorn where fossils occur, and there are many very fossiliferous outcrops, we find few specimens which can be accurately identified owing to their poor preservation. This holds true for both the molluscan and foraminiferal faunas.

THE HAWTHORN FORMATION

In the Hawthorn we have found practically no locality where the foraminifera are sufficiently well preserved for specific identification with the exception of the form which we have tentatively called *Sorites?* sp.? This form has not been found in beds younger than typical Chipola, unless, as will be discussed later, some of the Hawthorn beds in which this form occurs, is slightly younger than the typical Chipola. It is possible that this species or one very close to it occurs in the Tampa limestone.

In addition to the distribution as shown in Table No. 1 we have found *Sorites?* sp.? at the following Hawthorn and Chipola localities.

¹² Dall, W. H., and Harris, G. D., The Neocene of North America: U. S. Geol. Survey Bull. 84, p. 122, 1892.

¹³ Matson, G. C., and Clapp, F. G., A Preliminary Report on the Geology of Florida: Florida Geol. Survey, 2nd Ann. Rept. p. 91, 1909.

¹⁴ Gardner, Julia A., The Molluscan Fauna of the Alum Bluff Group of Florida: U. S. Geol. Survey Prof. Paper 142-A, p. 2, 1926.

¹⁵ Cooke, C. W., and Mossom, S., Geology of Florida: Florida Geol. Survey, 20th Ann. Rept., p. 98, 1929.

¹⁶ Op. cit. p. 98.

¹⁷ Op. cit. p. 98.

Sample No. 43.—Ponto Springs in the northeast corner of Gadsden County. Collected by W. C. Mansfield and G. M. Ponton, April 23, 1931 and March 21, 1932. Cooke and Mossom¹⁸ apparently did not see the entire section at this locality and correlated the portions (the two basal beds) they saw in two ways viz., as Glendon and Tampa, and Tampa and Hawthorn. The following section made by Mansfield and Ponton at this locality makes the correlation somewhat more definite.

Top—Unconsolidated sands and soil.

Bed "C"—Top 3 feet of bed highly fossiliferous containing oysters and other shells with numerous *Sorites?* sp?, balance of bed composed of sand and clay with oysters throughout but the basal 3 to 4 feet with numerous oysters.....15 feet.

Bed "B"—White to gray very sandy marl containing oysters at the base and sparingly scattered throughout. No other fossils noted except a few *Sorites?* sp?.....8 to 10 feet.

Possible unconformity.

Bed "A"—Hard compact rather gray to bluff limestone containing no determinable organisms.....10 feet.

Bed "A" is likely Tampa limestone, and Beds "B" and "C" are Hawthorn. The oyster is probably *Ostrea normalis*.

Sample No. 44.—Econfina River on R. L. Gainer farm, Sec. 4, T. 1 S., R. 13 W., Bay County. Collected by W. C. Mansfield and G. M. Ponton, April 15, 1932. This hard indurated limestone underlying the *Cancellaria* zone of the Choctawhatchee and reported by Mansfield¹⁹ at U. S. G. S. station No. 1/953 is apparently Chipola, and contains numerous impressions of mollusca including *Orthaulax gabbi* and the foraminifer *Sorites?* sp?.

Sample No. 45.—Edge of Lake Lafayette Basin, Sec. 26, T. 1 N., R. 1 E., about 5 miles east of Tallahassee, Leon County. Ten feet of hard indurated limestone exposed with quite numerous *Sorites?* sp? and a few very poorly preserved casts of mollusks. Hawthorn formation. Collected by H. Gunter and G. M. Ponton, December 18, 1931.

Sample No. 46.—Rouse's Mill Creek near W. C. Rouse's house 3 miles north of Sopchoppy, Wakulla County. This is typical of the old "Sopchoppy limestone" of Dall and correlated by Gardner²⁰ as a very shallow-water phase of the Chipola but placed in the Hawthorn by Cooke and Mossom. Dall²¹ states that the horizon is probably not far from that of the Chipola marl, and contains Conrad's *orbitolite* (*Orbitolites floridanus*) now referred to *Archaias floridanus*. No specimens of *A. floridanus* were found but numerous specimens of *Sorites?* sp?. *A. floridanus* appears to be restricted to the Tampa limestone. Collected by W. C. Mansfield and G. M. Ponton, April 16, 1931. (U. S. G. S. localities 4977 and 4978 as given by Gardner in U. S. G. S. Prof. Paper 142-A, p. 3 should be corrected as follows: For "W. C. Rose's" put "W. C. Rouse's", for "Rose's Mill Creek" put "Rouse's

¹⁸ Op. cit. pp. 95 and 122.

¹⁹ Mansfield, W. C., Miocene Gastropods and Scaphopods of the Choctawhatchee Formation of Florida: Bull. 3, Florida Geol. Survey, p. 19, 1930.

²⁰ Gardner, Julia A., The Molluscan Fauna of the Alum Bluff Group of Florida: U. S. G. S. Prof. Paper 142-A, p. 2, 1926.

²¹ Dall, W. H., and Harris, G. D., The Neocene of North America: U. S. G. S. Bull. 84, p. 120, 1892.

Mill Creek" and for "3 miles west of Sopchoppy" put "3 miles north of Sopchoppy".)

Sample No. 47.—Road cut about 1 mile west of Tallahassee near Prince Murat's homestead on old Jackson Bluff road. Collected by S. Mossom 1926 and W. C. Mansfield and G. M. Ponton, April 1932. Quite numerous *Sorites?* sp? occur with *Anomia suwanneensis?* and *Ostrea normalis*. This locality is reported by Cooke and Mossom as Hawthorn formation on page 124 of Florida Geol. Survey 20th Ann. Report.

Sample No. 48.—Aspalaga Bluff on left bank of Apalachicola River, Gadsden County, 7 or 8 miles south of Georgia-Florida State line, at elevation of about 50 feet above river. (River fairly high stage.) Collected by W. C. Mansfield and G. M. Ponton, April 14, 1931. Quite numerous *Sorites?* sp?. Likely Hawthorn formation.

Sample No. 49.—Dug well of Jesse Dennis (colored) near Long Pond about 6 miles northeast of Tallahassee, Leon County, depth 60 feet. Quite numerous specimens of *Sorites* sp? from a fairly hard gray impure limestone. Collected by G. M. Ponton, March 1930.

Sample No. 50.—Dismal Sink about 10 miles southwest of Tallahassee, Leon County, 15 feet or more of gray to yellow, fairly soft, sandy limestone contains *Sorites?* sp? and Alum Bluff mollusks. Collected by W. C. Mansfield and G. M. Ponton, March 1932.

Sample No. 51.—J. H. Atkinson's farm in NW $\frac{1}{4}$ Sec. 8, T. 1 N., R. 1 W., Leon County. Numerous *Sorites?* sp? in a hard, buff, sandy limestone of the Hawthorn formation. Collected by H. Gunter and J. C. Simpson, March 8, 1932.

Sample No. 52.—At spring on left bank of Suwannee River, $\frac{1}{2}$ mile above old wagon bridge at White Springs, Suwannee County. Collected by E. H. Sellards and T. W. Vaughan, November 1913.

THE CHIPOLA FORMATION

Miss Gardner²² in regard to the molluscan fauna from the bed of Econfinia River (Sample No. 7) advises as follows: "The mollusca on the whole indicate the Chipola age of the outcrop, although there are a few species that are not typical of the Chipola formation, notably the slender *Turritella* which has a spiral sculpture about midway between that of the common *Turritella* of the Chipola and that of the Shoal River, I should place the fauna at the top of the Chipola." The foraminiferal fauna at this locality shows affinities to both the Chipola and Oak Grove. For example *Elphidium chipolensis* and *Virgulina pontoni* are common to both, while *Amphistegina floridana*, likely an excellent species for correlation purposes, shows a very decided relationship to the Oak Grove. The absence of the Miliolidae and Peneroplidae and the presence of *Buliminella ele-*

²² Letter of October 14, 1931.

gantissima and others suggest a difference in conditions of deposition from that of the typical Chipola, possibly somewhat deeper water.

The fauna of the Chipola marl, while in many species related to the Choctawhatchee, is, nevertheless, rather distinctive in its general character. They represent for the most part a shallow warm water group. Most of the species are either identical with, or very closely related to, species now living about coral reefs of the general southern Florida or West Indian regions. The fauna, however, contains many new and interesting species, as well as some interesting genera. The species not only show relationships with those now living off the same general region, but also with those of the Oligocene of Mississippi and elsewhere.

One of the largest and most striking foraminifera of the Chipola and part of the Hawthorn is a large species belonging to the family Peneroplidae. It is related to *Sorites*, but a study of the types of Ehrenberg's *Sorites dominicensis* must be made before the exact identity of this species can be given. This particular form is one of the best markers of this zone, and does not occur elsewhere in that part of the Florida Miocene under consideration as far as we have seen. At some stations it is very abundant.

One of the striking things of this warm water Chipola fauna is the lack of *Archaias* which is one of the most dominant genera of faunas now living in the West Indian region under similar conditions. In the Tampa limestone (Lower Miocene) immediately underlying the Chipola we find *Archaias floridanus* (Conrad) in large numbers, and the genus does not appear again in the Florida section until the Pliocene.

THE OAK GROVE SANDS

For the history and distribution of the Oak Grove sands we quote Cooke and Mossom²³. "Johnson was the first to record the presence of a shell bed on Yellow River at Oak Grove, Okaloosa County. Collections made by Johnson and by Burns from this bed were studied by Dall, who correlated the Oak Grove sand with his "Alum Bluff sands" which overlies the "Chipola marl" at Alum Bluff. Matson and Clapp, accepting this correlation, regarded the bed as a member of the Alum Bluff formation. Critical study of the Alum Bluff faunas convinced Miss Gardner that the shells at Oak Grove were younger than those in Dall's "Alum Bluff sands," which are more closely related to the Chipola species, and that the Oak Grove sand is worthy of formational rank.

²³ Cooke, C. W., and Mossom, S., Geology of Florida: Florida Geol. Survey, 20th Ann. Rept., p. 110, 1929.

The Oak Grove sand is known in Florida only in a very small area along Yellow River and its tributaries in Okaloosa County, which has been mapped with the Shoal River.”

The exposure at Tanner’s Mill (Our sample No. 29) referred by Matson and Clapp²⁴ to the “Shoal River marl” was placed by Gardner in the Oak Grove sand, although the molluscan fauna showed a higher percentage of Shoal River forms than at the typical Oak Grove locality. The evidence using the foraminiferal fauna at this station is very inconclusive. Taking the four following species, which are about as distinctive as any at this station, we arrive at unsatisfactory results. *Bigenerina floridana*, a very striking species occurs here and nowhere else except at one station in the Shoal River; *Chrysalidinella pulchella* except for the Oak Grove and sample No. 4 is characteristic of stations higher up in the section; *Bolivina plicatella*, var. *mera* occurs elsewhere only in the Oak Grove and Chipola; on the other hand *Bolivina paula* occurs only in the Shoal River and above.

The Oak Grove has a distinct fauna with various striking species, not representing as warm shallow water as the typical Chipola, but showing decided relationships to that formation as well as to the Shoal River formation above.

THE SHOAL RIVER FORMATION

As to history of the Shoal River formation we quote Cooke and Mossom²⁵; “In 1903 and 1908 T. W. Vaughan made field studies which were the basis of the description of the “Shoal River marl member” of the “Alum Bluff formation” by Matson and Clapp in 1909. Later Julia Gardner raised the Alum Bluff to the rank of group and introduced the name Shoal River formation to include the “Shoal River marl member of Matson and Clapp and underlying sands and clays containing the same fauna.”

Authors appear to have overlooked the statement by Dr. Truman H. Aldrich²⁶ with regard to the position of the outcrop of the Shoal River formation at its type locality and its Miocene age. Quoting Dr. Aldrich; “This species” (*Conus waltonensis* from Shell Bluff, Shoal River, Walton County, Florida,) “has been in my possession for many years and until lately was not known from any other locality, but in looking over some specimens of fossils from the

²⁴ Matson, G. C., and Clapp, F. C., A Preliminary Report on the Geology of Florida: Florida Geol. Survey, 2nd Ann. Rept., p. 105, 1909.

²⁵ Cooke, C. W., and Mossom, S., Geology of Florida: Florida Geol. Survey, 20th Ann. Rept., p. 111, 1929.

²⁶ Aldrich, Truman H., A New *Conus* from the Tertiary of Florida: The Nautilus, vol. 16, No. 11, pp. 131 & 132, March 1903.

Number Two well of the Mobile Oil Company, bored near Mobile, Alabama, I found two or three specimens of it, and from its position over three hundred feet above the Oak Grove (Fla.) horizon in this well, it would seem to indicate that this deposit on Shoal Creek is much younger than the Oak Grove beds. The assignment of these beds to the Oligocene must, in the writer's opinion, be better substantiated than at present. There are so few species common to the "Chipola" of Dall and the Vicksburg formation, it would seem better to confine the use of the term "Oligocene" to the latter, which is in accordance with Conrad's original diagnosis, and put the Chipola, Shoal River and Chattahoochee beds in one formation calling them all Miocene * * * *."

The foraminiferal fauna is distinct with several striking species and the fauna shows definite relationships with both the Oak Grove formation below, and the Choctawhatchee formation above. The fauna of the *Cardium* bed has been discussed in a note after the description of sample No. 4b on page 9.

THE CHOCTAWHATCHEE FORMATION

It has been thought well to reprint in this bulletin the paper on the "Faunal zones in the Miocene Choctawhatchee formation of Florida" by W. C. Mansfield and G. M. Ponton which appeared originally in the Journal of the Washington Academy of Sciences, vol. 22, No. 4, Feb. 19, 1932. Since this paper was published Mansfield has brought the stratigraphy of the Choctawhatchee formation up-to-date in a report entitled Miocene Pelecypods of the Choctawhatchee Formation of Florida: Florida Geological Survey Bulletin No. 8, 1932 and to this bulletin we would refer those interested.

*Faunal zones in the Miocene Choctawhatchee formation of Florida.*¹ WENDELL C. MANSFIELD, U. S. Geological Survey, and Gerald M. Ponton, Florida Geological Survey.

In March, 1930, the writers discovered fossiliferous outcrops of Miocene beds in the valley of Alaqua Creek, Walton County, Florida, farther south than fossils had previously been reported from this region.² Fossils from these beds, when studied by the senior author, showed that they belong to the Choctawhatchee formation. They not only give more substantial evidence of the close faunal relationship of the Shoal River formation to the succeeding Choctawhatchee formation but also reveal the sequence of the zones of the Choctawhatchee formation and the position in the formation of the typical deposits at Red Bay.

The map (Figure 1) shows the type localities of the Shoal River and Choctawhatchee formations and the places at which fossils have been

¹ Published by permission of the Director of the U. S. Geological Survey and of the State Geologist of Florida. Received January 12, 1932.

² Station 3747, reported by Gardner (U. S. Geol. Survey Prof. Paper 142) as 8 miles south of Lake DeFuniak, is 8 miles nearly due west of DeFuniak Springs, in SW¼ Sec. 34, T. 3 N., R. 20 W.—an error of the clerk in copying the station record. The shells were found at a depth of 30 feet in a well dug for water.

collected near Alaquia Creek. The numbers on the map are the serial numbers recorded in the station book of the U. S. Geological Survey kept at the National Museum. The boundary between the Shoal River formation and the Choctawhatchee formation as drawn is entirely conjectural. The newly discovered localities are stations 12044-48, 12060, and 12527. The following are the explanations of the station numbers:

- 3742. Shell Bluff. Type locality of the Shoal River formation.
- 3747. Parker place. Shoal River formation.
- 4975, 7152. Red Bay. Choctawhatchee formation (*Ecphora* zone and upper part of *Arca* zone).
- 5618. Langley's old farm. Shoal River formation.
- 9959. One-fourth mile west of Pleasant Ridge Church. Shoal River formation.
- 10612. Chester Spence's farm. Provisionally placed in the Shoal River formation.
- 12044. Bell farm, upper locality. Choctawhatchee formation (*Arca* zone).
- 12045. Bell farm, lower locality. Choctawhatchee formation (*Arca* zone).
- 12046. Vaughan Creek, upper locality. Choctawhatchee formation (*Arca* zone).
- 12047. Vaughan Creek, lower locality. Choctawhatchee formation (*Arca* zone).
- 12048. Permenter's old place. Choctawhatchee formation (*Ecphora* zone).
- 12060. Frazier's old farm. Choctawhatchee formation (*Yoldia* zone).
- 12527. Alice Creek. Choctawhatchee formation (upper part of *Arca* zone).

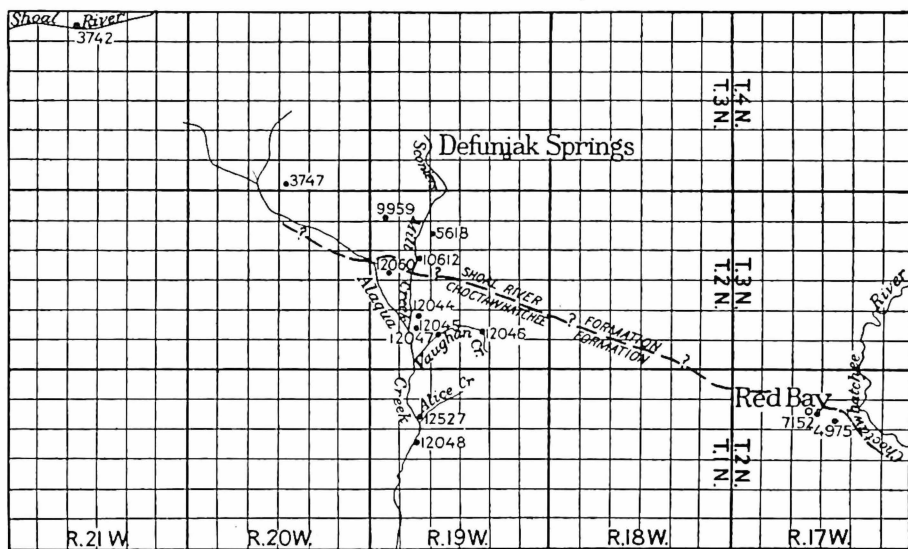


Fig. 1. Fossiliferous localities in Walton County, Florida.

The most southerly locality in the valley of Alaquia Creek at which fossils had previously been collected is the Chester Spence farm in the NE $\frac{1}{4}$ sec. 17, T. 2 N., R. 19 W. (U. S. G. S. station 10612). The fauna at this place appears to be transitional from that of the Shoal River formation to that of the Choctawhatchee formation. This fauna is provisionally left in the Shoal River formation, where it was placed by Gardner; but it may eventually be placed in the basal part of the Choctawhatchee formation.

The following generalized section shows the divisions that are now recognized in the Choctawhatchee formation.

GENERALIZED SECTION OF THE CHOCTAWHATCHEE FORMATION

	Feet
5. <i>Cancellaria</i> zone. Fine to coarse clayey fossiliferous sand.....	25-30
4. "Aluminous clay." Grayish unfossiliferous clay	25
3. <i>Ecphora</i> zone. Sandy fossiliferous clay	15-25
2. <i>Arca</i> zone. Gray sandy fossiliferous marl	55
1. <i>Yoldia</i> zone. Dark-gray to bluish micaceous and carbonaceous clayey fossiliferous sand	15

The *Yoldia* zone, which is here recognized for the first time, and the *Arca* zone are now regarded as representing the upper part of the middle Miocene; the *Ecphora* zone, the "aluminous clay," and the *Cancellaria* zone are referred to the upper Miocene.

Yoldia zone.—A new name, *Yoldia* zone, is here proposed for a bed carrying many individuals of the genus, *Yoldia*. The type locality is the Frazier farm (formerly the Spencer farm), Walton County, in SE $\frac{1}{4}$ sec. 18, T. 2 N., R. 19 W. (station 12060). The sediments composing the zone consist of dark-gray to bluish micaceous clayey sand with inclusions of carbonaceous particles. The thickness has not been accurately determined, but it probably does not exceed 15 feet.

The zone is believed to represent the basal bed of the Choctawhatchee formation although the contact with the underlying Shoal River formation which may be conformable with it has not been recognized with certainty. The zone is separated from the overlying *Arca* zone because of its abundant content of large *Yoldia* shells, a genus which usually indicates that the temperature of the water in which it lived was rather cold.

Arca zone.—The name *Arca* zone was proposed by Mansfield³ in 1929. The zone is typically exposed at Red Bay, Walton County, where it forms the lowermost fossiliferous bed, about 21 feet thick, in the exposure (stations 4975, 7152). A nearly unfossiliferous upper bed of clay at this locality, which was formerly included in the *Arca* zone, is now placed in the *Ecphora* zone.

The *Arca* zone consists mainly of very fossiliferous gray sandy marl having an estimated total thickness of about 55 feet. It probably rests conformably upon the *Yoldia* zone. The upper limit of the *Arca* zone is provisionally placed at the contact of the marl with an overlying plastic clay bed which, in the section at Red Bay, carries no determinable fossils. The shells in the marl are worn and broken. The absence of fossils from the clay and the lithologic difference between the marl and the clay suggest an unconformity between the two beds, but this relationship has not been fully established.

The *Arca* zone was observed in the Alaqu Creek Valley at the head of small branches flowing into Sconiers Mill Creek, on the Bell farm, in the NE $\frac{1}{4}$ sec. 29, T. 2 N., R. 19 W. (stations 12044-45); on Vaughan Creek, in secs. 27 and 28, T. 2 N., R. 19 W. (stations 12046-47); and at Alice Creek, in the SE $\frac{1}{4}$ sec. 8, T. 1 N., R. 19 W. (station 12527).

The beds exposed at the Bell farm and along Vaughan Creek are believed to carry the earliest fauna of the *Arca* zone, whereas the lower fossiliferous bed at Red Bay carries the latest fauna of this zone. The senior author, basing his evidence upon the study of the mollusks, believes the beds at the Bell farm and along Vaughan Creek have nearly if not the same stratigraphic position, but the junior author, basing his evidence upon the study of the foraminifera, is inclined to believe that the beds along Vaughan Creek are lower in the section than those at the Bell farm.

Ecphora zone.—The *Ecphora* "bed," named by Dall and Harris,⁴ is now known as the *Ecphora* zone.⁵ Its type locality is at Alum Bluff, Apalachicola River, Liberty County, Fla., where it forms the uppermost fossiliferous bed

³ W. C. Mansfield in C. W. Cooke and Stuart Mossom, *Geology of Florida*, Florida Geol. Survey Ann. Rept. 20: 140. 1929; and W. C. Mansfield, *Miocene gastropods and scaphopods of the Choctawhatchee formation of Florida*, Florida Geol. Survey Bull. 3: 15. 1930.

⁴ W. H. Dall and G. D. Harris, *The Neocene of North America*, U. S. Geol. Survey Bull. 84: 123-124. 1892.

⁵ W. C. Mansfield in *Geology of Florida*, p. 140, 1929.

of the section. The sediments composing the zone consist of a sandy clay which is bluish where unweathered. The bed ranges in thickness from 15 to 25 feet at Alum Bluff.

At Alum Bluff the *Ecphora* zone, with somewhat doubtful unconformable relations, rests upon a fossil leaf-bearing sand which Cooke and Mossom⁶ questionably refer to the Alum Bluff group. It is conformably overlain by the "aluminous clay" of Dall.

An exposure in the east bank of Alaquia Creek on Permenter's old place, in sec. 17, T. 1 N., R. 19 W. (station 12048) apparently represents the *Ecphora* zone. At Red Clay the upper poorly fossiliferous plastic clay bed, about 27 feet thick, is placed in this zone.

The "*aluminous clay*."—The "aluminous clay," a name applied by Dall⁷ to a 25-foot bed of grayish clay overlying the *Ecphora* zone at Alum Bluff, Liberty County, Fla., has not been recognized in the Alaquia Creek Valley.

Cancellaria zone.—The name *Cancellaria* zone was proposed by Mansfield⁸ to include beds that carry the latest Miocene fauna. This zone is typically exposed in the highest fossiliferous beds along Harveys Creek, in the SW¼ sec. 9, T. 1 S., R. 3 W., Leon County, Fla. The *Cancellaria* zone is composed of fine to coarse grained clayey sand replete with fossils, having an estimated total thickness of 25 to 30 feet. It has not been recognized in the Alaquia Creek Valley.

The relationships of the Choctawhatchee marl have already been noted in Bulletin 4 of the Florida Geological Survey. The more recent collections have only confirmed those relationships, and while some species have been added, they are as a rule confirmatory of our previous findings.

The foraminiferal fauna of the lower part of the Choctawhatchee not covered in Bulletin 4 is distinctive and shows relationships to the upper zones of the Choctawhatchee and to the Shoal River below. The fauna of the *Yoldia* zone has been discussed at some length in a note after description of sample No. 4b on page 9.

Mansfield²⁷ has correlated a fauna at Alexander Spring, in the northeast corner of Lake County about 5 miles south of Astor, as belonging to the *Ecphora* zone of the Choctawhatchee and material from a well at a depth of between 65 and 100 feet near Kissimmee, Osceola County, as belonging to the *Cancellaria* zone of the Choctawhatchee.

In confirmation of the presence of Choctawhatchee formation in east central Florida, the foraminifera from well cuttings from seven drainage wells in the vicinity of Orlando, Orange County, between depths of 35 to 85 feet represented Choctawhatchee formation. The material is not younger than the *Cancellaria* zone nor older than the *Ecphora* zone, and likely both zones are represented. The correlation is made using 44 species. The samples below 85 feet to a depth of about 130 feet are phosphatic sandy marl of the Hawthorn

⁶ C. W. Cooke and Stuart Mossom, Geology of Florida, Florida Geol. Survey Ann. Rept. 20: 108. 1929.

⁷ W. H. Dall and Joseph Stanley-Brown, Cenozoic geology along the Apalachicola River, Geol. Soc. Am. Bull. 5: 163-169. 1894.

⁸ W. C. Mansfield in Geology of Florida, p. 140. 1929.

²⁷ Mansfield W. C., Miocene Pelecypods of the Choctawhatchee Formation of Florida: Florida Geol. Survey, Bull. 8, pp. 16 and 19, 1932.

formation but with no foraminifera in this interval. At a depth of 124 feet fragments of *Pecten acanikos* Gardner and other Alum Bluff mollusks occurred.

FLORIDA MIOCENE AND MIOCENE NORTH OF FLORIDA COMPARED

Mansfield²⁸ has stated that "The fauna of the *Cancellaria* zone is closely allied to the fauna of the Duplin marl of the Carolinas and appears to have lived at the same time," and that "the fauna of the *Ecphora* zone is nearly related to that in the bed underlying the fragmental series of the Yorktown formation of Virginia," and in his more recent paper, Bulletin 8, he states "the fauna of the *Arca* zone appears to be most closely related to that of the Gatun formation of Panama * * * *," and "the fauna of the St. Marys formation of Maryland and Virginia appears to have lived at about the same time."

Using the foraminiferal faunas as a basis for correlating the Florida Miocene with the Miocene to the north we find but very few species that can be used. Most of the forms to the north are either colder water or comparatively deep water forms and much more widely ranging ones. As we go northward into the Miocene there are but very few forms coming in, and they are mostly forms which have little to do with the Florida series. However, the only striking species that seems to connect the Florida Miocene with that to the north is *Virgulina* (*Virgulinella*) *miocenica* Cushman and Ponton which occurs in considerable numbers in the Choptank and also in the St. Marys formations of Maryland. A much more definite correlation might be made if we knew more about the Miocene of Virginia and the Carolinas, but at present material from those states is very scanty.

RELATIVE AGES

The *Cancellaria* and *Ecphora* zones of the Choctawhatchee have been placed in the Upper Miocene and the *Arca* and *Yoldia* zones in the Upper Middle Miocene by Mansfield and Ponton.

Woodring²⁹ places the dividing line between the Middle and Lower Miocene at the top of the Chipola formation. We have followed Woodring in this.

However, we find it not so easy to definitely assign the various beds of the Hawthorn.

²⁸ Mansfield, W. C., Miocene Gastropods and Scaphopods of the Choctawhatchee Formation of Florida: Florida Geol. Survey, Bull. 3, pp. 16 & 17, 1930.

²⁹ Woodring, W. P., Miocene mollusks from Bowden, Jamaica, Carnegie Institution of Washington, Publication No. 385, Part 2, 1928, p. 90.

Originally Simpson stated that the land mammal fauna of the fuller's earth deposits at Midway and Quincy, Gadsden County, "may be referred to the Middle Miocene with some confidence",³⁰ and that the fauna from the Griscom Plantation, Leon County, and the Franklin Phosphate Company's mine, Alachua County, "cannot be earlier than Miocene nor later than Lower Miocene"³¹ all of these localities are placed in the Hawthorn formation.

Recently, however, the Florida Geological Survey has collected a considerably larger vertebrate fauna from Midway, Gadsden County, and from a new locality in Gilchrist County. These Simpson has studied and his findings are being published by the Florida Survey as Bulletin No. 10.

Eliminating many important details and referring only to the two localities, viz. The Fullers Earth Company's mine at Midway and the Floridin Company's mine at Quincy, Gadsden County, where we have both a land mammalian and marine molluscan fauna, Simpson has found that the mammalian faunas have affinities with both Lower and Middle Miocene, with perhaps a leaning towards the Middle, and the evidence suggests the fauna covers the transition from Lower to Middle Miocene.

It is apparent that the marine fauna from Midway and Quincy quite definitely referred to the old "Sopchoppy limestone," now placed in the Hawthorn which Dall thought to be close to Chipola, and which Gardner correlated "as a very shallow water phase of the Chipola," is not typical Chipola but at the same time the two must be close in age. At Midway, and at Sopchoppy, occur many *Turritellas* which appear to be closer to Oak Grove forms than to the Chipola. It is possible, therefore, that further critical study of the mollusks of that part of the Hawthorn represented by the "Sopchoppy limestone" may prove to be slightly younger than typical Chipola, and perhaps represents a transition phase from Lower to Middle Miocene. The marine fauna in the bed of Econfinia River (See sample No. 7) and placed at the top of the Chipola is another link between the typical Chipola of the Lower Miocene and the Oak Grove sand of the Middle.

SEDIMENTATION AND ECOLOGY

The general low relief of Florida, the slight dip to the formations, the lack of continuous exposures, with only random elevations to rely on, have forced investigators to work out the stratigraphy from

³⁰ Simpson, G. G., The Tertiary Land Mammals of Florida: Bull. Amer. Mus. of Nat. Hist., vol. 59, art. 3, p. 160, 1930.

³¹ Idem. p. 160.

a critical study of the fossils. Under such a system it is only natural that some shifting of beds will take place from time to time as new evidence is revealed.

Cooke and Mossom³² have given the following information with regard to the conformability of the various formations:

Citronelle formation—Pliocene—

Unconformity.

Choctawhatchee formation—

Unconformity (reasonably certain).

Shoal River formation—

Conformity (likely).

Oak Grove sand—

Unknown.

Chipola and Hawthorn formations—

Conformity (apparently).

Tampa limestone.

It is difficult indeed with our present knowledge of the Tampa limestone to arrive at a definite conclusion as to its contact with the overlying Miocene. Careful collecting and critical study of its fauna will likely make it possible to zone it. However, in the case of the Chipola formation along the Chipola River, at and near its type locality, we find the soft, greenish-gray shell marl of the Chipola lying on what looks like the eroded surface of the hard, white to buff limestone of the Tampa. The great difference between the sediments alone would suggest an unconformity. At White Springs on the Suwannee River there is strong evidence that the Hawthorn formation rests on the eroded surface of the Tampa, but here it is possible that the Tampa exposed represents a lower zone of the Tampa. It is possible to believe that where the earliest part of the Hawthorn rests on the latest part of the Tampa, there will be a conformable contact, but to our knowledge such a condition has not been recognized.

While the contact between the Chipola and Oak Grove has not been recognized, the evidence of the faunas tend to show that they are conformable, for the fauna of the typical Chipola by easy gradations changes to that of the upper Chipola, and then to the Oak Grove fauna. On similar evidence Cooke and Mossom work out the probable conformability of the Oak Grove and Shoal River. At the time that Cooke and Mossom made their investigations the lower zones of the Choctawhatchee were unknown, and the probable unconformity between the Choctawhatchee and the Shoal River was supported by the difference between the molluscan faunas of the

³² Cooke, C. W., and Mossom, S., *Geology of Florida*: Florida Geol. Survey, 20th Ann. Rept., pp. 103, 111, 115, and 133, 1929.

Shoal River and the lowest then known bed of the Choctawhatchee. It has been found that the lower zones of the Choctawhatchee are so closely related to the underlying Shoal River in their molluscan faunas that it is now quite certain that the Choctawhatchee lies conformably on the Shoal River. This has been confirmed by the discovery at Chester Spence farm (See samples Nos. 4a and 4b) of the *Yoldia* zone likely in contact with the Shoal River.

The shore-line during this period was a very variable feature, advancing and retreating, depositing beds of varying thickness but all comparatively thin, and forming over-laps to such an extent that it is possible that such over-laps might be mistaken for an unconformity, even between successive zones at any one exposure.

An intensive petrographic study of the section might reveal important information, as mere visual examination of the material making up the formations leaves too much to assumption, in that most outcrops are to such a degree weathered and oxidized that one can often only assume what they appeared like in their original condition. There is a considerable degree of similarity between the unaltered material of the shell marls from the various formations.

To summarize: This period of time was characterized, here, by frequent changes in the position of the shore-line and the formation of more or less extensive embayments. These affected the oceanic currents and the bathymetric conditions. There is no suggestion, however, that a depth was reached which would support a characteristic deep-water fauna. The climate in typical Chipola times was probably warm, tropical to sub-tropical. A gradual cooling off likely took place during the time in which the succeeding beds were being deposited. This cooling was climaxed at the end of the *Ecphora* zone of the Choctawhatchee. The climate in the succeeding *Cancellaria* zone times was probably milder, possibly semi-tropical and transitional to the probable tropical to sub-tropical temperatures of Pliocene times.

CHARACTERISTIC SPECIES

We have already discussed the form we tentatively name *Sorites?* sp?. Another striking type of foraminifer found in the Florida Miocene is that of *Virgulina*, a subgenus of the genus *Virgulina*, which has peculiar processes formed across the sutures. Species of this particular group have already been described from Florida under the names, *Virgulina gunteri* and *Virgulina miocenica*. A new variety of the former has been added. Forms similar to or identical with these range northward as far as Maryland in the Miocene, but have not been recorded elsewhere in the Western Hemisphere. It is

interesting to note that the other representatives of this subgenus occur in central Europe and are of equivalent age. Such forms may well be used for index fossils for this part of the Miocene, in these two regions at least, as they are very striking, and in North America at least widely distributed in the Miocene of the Atlantic Coastal Plain.

The following lists of species have been prepared from the distribution table, and might be termed, in a sense, the characteristic species of the zones and groups of zones. However, many species which are characteristic are not included in such a list and for such, reference to the text is necessary. For example, *Virgulina gunteri* occurs commonly in all samples from the *Arca* zone of the Choctawhatchee, it occurs very rarely in the *Cancellaria*, and it occurs also in the upper beds of the Shoal River formation but here rarely and then always associated with *Virgulina miocenica*. It also must be stressed that even though the characteristic species are important, the grouping of the species cannot be neglected.

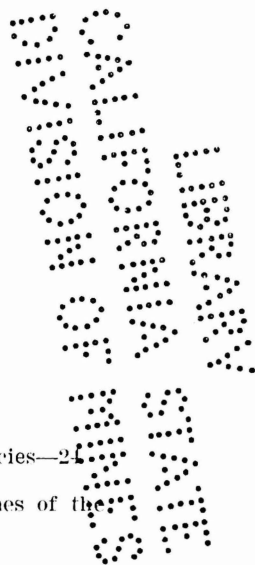
1. Species confined to the *Cancellaria* Zone:

Textularia floridana
foliacea, var. *occidentalis*
Bigennerina nodosaria, var. *textilarioidea*
Massilina gunteri
Spiroloculina sp.
Triloculina asperula
Planularia sp.
Lingulina sp.
Nodosaria calomorpha
Lagena quadrata
Pyrulina albatrossi
Sigmomorphina williamsoni
Elphidium incertum
Pavonina miocenica
Buliminella subteres
Bulimina marginata
Bolivina pulchella, var. *primitiva*
Reussia spinulosa var.
Patellina corrugata
Discorbis orbicularis
Eponides lateralis
Amphistegina lessonii
Rectocibicides miocenicus
Acervulina inhaerens

Total number of species—24

2. Species occurring in both the *Cancellaria* and the *Ecphora* Zones of the Choctawhatchee but not elsewhere in the Florida Miocene:

Textularia mayori
Quinqueloculina cf. *fusca*



Lagena hexagona, var. *scalariformis*

costata, var. *amphora*

Guttulina costatula

Pseudopolymorphina rutila

Virgulina fusiformis

Bolivina plicatella

Discorbis consobrina

Total number of species— 9

3. Species confined to the Ecphora Zone of the Choctawhatchee:

Quinqueloculina contorta

Spiroloculina depressa

Marginulina dubia

Marginulina sp.

Virgulina gunteri, var. *curtata*

Reussia spinulosa, var.

Uvigerina parkeri

Total number of species— 7

4. Species occurring in both the Ecphora and Arca Zones of the Choctawhatchee but not elsewhere:

Spiroloculina planulata

Lagena sulcata

orbignyana, var. *lacunata*

Ellipsolagena bidens

Spirillina orbicularis

Total number of species— 5

5. Species confined to the Arca Zone of the Choctawhatchee:

Massilina quadrans, var.

Flintina floridana

Robulus floridana

catenulatus

Planularia sp.

Marginulina sp.

Guttulina austriaca

Globulina rotundata

Elphidium sagrum

Elphidium sp.

Plectofrondicularia floridana

Bulimina ovata

Bolivina advena

Loxostomum gunteri

Siphogenerina lamellata

Chilostomella oolina

Total number of species—16

6. Species confined to the Yoldia Zone of the Choctawhatchee:

Amorphina sp.

Nodogenerina advena

Bulimina buchiana

Total number of species— 3

7. Species confined to the Choctawhatchee but not included in the above groups:

Pseudarcella arenata

Triloculina rotunda

Nodosaria catesbyi

Lagena clavata
 Bulimina gracilis
 inflata
 Virgulina punctata
 Discorbis floridana
 Cassidulina crassa
 Planulina depressa

Total number of species—10

TOTAL NUMBER OF SPECIES CONFINED TO THE
 CHOCTAWHATCHEE

73

8. Species confined to the Shoal River Formation:

Textularia warreni
 Textularia sp.
 Marginulina glabra
 Bulimina gracilis, var.
 Globobulimina pacifica
 Bolivina robusta
 Lamarekiana atlantica
 Siphonina jacksonensis, var. limbosa

Total number of species— 8

9. Species occurring in both the Shoal River and Oak Grove but not elsewhere:

Bigenerina floridana

Total number of species— 1

10. Species confined to the Oak Grove:

Reussia spinulosa, var.
 Asterigerina miocenica

Total number of species— 2

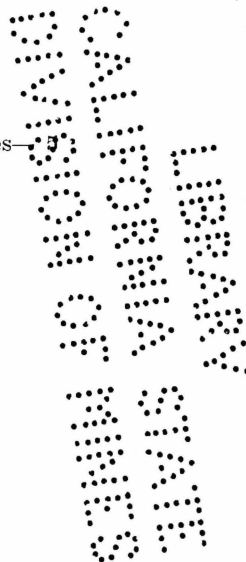
11. Species occurring in both the Oak Grove and the Chipola; but not elsewhere:

Quinqueloculina crassa, var. subcuneata
 Sigmomorphina pearceyi
 Bolivina plicatella, var. mera
 Amphistegina floridana
 Cycloloculina miocenica

Total number of species— 5

12. Species confined to the Chipola:

Clavulina tricarinata
 Quinqueloculina candeiana
 chipolensis
 Massilina inaequalis
 boschiana
 quadrans
 incisa
 spinata
 spinata, var. chipolensis
 spinata, var. glabrata
 Spiroloculina grateloupi
 Hauerina bradyi
 Articulina sagra, var. miocenica
 mayori



Triloculina trigonula
 oblonga
 gracilis
 quadrilateralis
 quadrilateralis, var. *longicostata*
 brongniartii
Pyrgo denticulata
Vertebralina cassis
 multilocularis
Denticulina sp.
Polymorphina advena
Sigmomorphina undulosa
Elphidium incertum, var.
Peneroplis proteus
 bradyi
Sorites? sp?
Discorbis candeiana, var. *bullata*
Eponides repandus
Asterigerina carinata
Amphistegina chipolensis
Cassidulina chipolensis
Cibicidella variabilis
Annulocibicides projectus
Acervulina chipolensis
Gypsina vesicularis

Total number of species—39

13. Species confined to the Alum Bluff Group and not included in the above groups:

Guttulina lactea
 caudata
Elphidium chipolensis

Virgulina floridana
Eponides antillarum

Total number of species— 5

TOTAL NUMBER OF SPECIES CONFINED TO THE
ALUM BLUFF GROUP

60

The figures above are interesting in that they bring out the large number of species that are confined to the two end zones, viz. the *Utracellaria* zone of the Choctawhatchee, and the typical Chipola of the Alum Bluff Group. The importance of the *Arca* zone of the Choctawhatchee is also clear. As worked out in the distribution of species table, and definitely indicated in the above lists, there are plenty of forms to distinguish the different main groups, but on the other hand, some of the stations are much less easy to determine, probably due in a large part to their deeper water position.

PERCENTAGE OF RECENT FORAMINIFERA IN THE ZONES
AND FORMATIONS

That the ecologic factor is often much more important than the actual age one, especially in the Tertiary, appears to be borne out when the percentages of Recent forms in the various beds are studied.

In computing the percentages in the list below we have deemed as Recent those forms which have been recorded as living in any region at the present time.

<i>Cancellaria</i> zone.....74%	} Choctawhatchee formation.....64%	
<i>Eophora</i> zone.....70%		
<i>Arca</i> zone.....63%		
<i>Yoldia</i> zone.....59%		
<i>Cardium</i> bed.....52%	} Shoal River formation62%	
Middle zone.....66%		
Type zone.....61%		
Transition zone.....53%	} Oak Grove formation58%	} Alum Bluff Group62%
Type zone.....65%		
Upper zone.....74%	} Chipola formation69%	
Type zone.....68%		

That the Chipola has such a high percentage of Recent forms is due, we believe, to the fact that conditions have rather uniformly existed since that time in the shallow warm waters of the Floridian and West Indian region, and that the conditions existing between the Eephora zone of the Choctawhatchee and the Oak Grove times represents a greater change in ecologic conditions for this area.

Perhaps the percentage for the Oak Grove sands as a whole should be higher. It so happens that the sample representing the transition zone was a very small and old one, and it was impossible to re-sample the locality, as it was deeply sanded over.

The high percentage for the Upper zone of the Chipola may be due in some degree to the relatively small fauna at the single locality sampled but, at the same time, the high percentage would incline one to place this locality in the Chipola rather than the Oak Grove, especially as the critical study of the fauna proved very inconclusive and showed relationships to both the Chipola and the Oak Grove.

Mansfield⁵³ has given the following list of the percentage of recent forms occurring in the three upper zones of the Choctawhatchee, using the species recorded in Bull. 4 of the Florida Geol. Survey:

<i>Cancellaria</i> zone	79%
<i>Ecphora</i> zone	78%
<i>Arca</i> zone	63%

³³ Mansfield, W. C., Florida Geol. Survey Bull. 8, p. 19, 1932.

It is interesting to note that the percentage obtainable for the *Arca* zone by Mansfield and us is the same. The difference in the percentages for the two upper zones is due to the extension, in this new work, of the range of some of the forms upward, and the recording of a few new forms.

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The holotypes and figured specimens, together with the first selection of all the species, are deposited in the collections of the Cushman Laboratory at Sharon, Massachusetts, and are to go later to the collections of the United States National Museum. Duplicate sets of the species are in the collections of the Florida State Geological Survey at Tallahassee, Florida.

SYSTEMATIC DESCRIPTIONS OF SPECIES

Family SACCAMMINIDAE

Subfamily Saccammininae

Genus PROTEONINA Williamson, 1858

PROTEONINA DIFFLUGIFORMIS (H. B. Brady) (?)

(See Florida Geol. Survey Bull. 4, p. 15, pl. 1, figs. 1 *a*, *b*, 1930)

This species already recorded as rare from the *Arca* zone of the Choctawhatchee formation has appeared in our new material from a station in the Oak Grove sand, but in none of the other formations examined.

Genus URNULINA Gruber, 1884

URNULINA COMPRESSA Cushman

(See Florida Geol. Survey Bull. 4, p. 15, pl. 1, figs. 2 *a*, *b*, 1930)

This species was described from a single station in the *Cancellaria* zone of the Choctawhatchee formation in the previous bulletin. It is interesting, therefore, to record a single typical specimen from the Oak Grove sand.

Genus PSEUDARCELLA Spandel, 1909

PSEUDARCELLA ARENATA Cushman

(See Florida Geol. Survey Bull. 4, p. 15, pl. 1, figs. 3 *a*, *b*, 1930)

There are additional records for this species from the *Arca* zone of the Choctawhatchee, from Jim Kennedy Branch 1 mile east of Red Bay, Walton County.

Family TEXTULARIIDAE

Subfamily Textulariinae

Genus TEXTULARIA Defrance, 1824

TEXTULARIA AGGLUTINANS d'Orbigny

(See Florida Geol. Survey Bull. 4, p. 16, pl. 1, figs. 4 *a*, *b*, 1930)

Specimens which are referred to this species occur rather widely distributed in the Miocene of Florida. As will be seen from the table, specimens occur at five stations in each of the *Cancellaria* and *Ecphora* zones, and one station in the *Arca* zone. There are specimens from the typical Oak Grove sand, and numerous specimens from the typical Chipola.

TEXTULARIA GRAMEN d'Orbigny

(See Florida Geol. Survey, Bull. 4, p. 17, pl. 1, figs. 5 *a*, *b*, 1930)

This species is easily confused with the early stages of some of the others that occur in the Miocene, especially the young of *Textularia mayori*. Rather typical specimens have occurred at two stations of the *Cancellaria* zone of the Choctawhatchee, and at one station in the typical Chipola.

TEXTULARIA ARTICULATA d'Orbigny

Plate 1, figures 1 a, b

Textularia articulata d'Orbigny, Foram. Foss. Bass. tert. Vienne, p. 250, pl. 15, figs. 16-18, 1846.—Hosius, Ver. Nat. Hist. Vereins Pr. Rheinlande, vol. 50, p. 109, 1893.—Bagg, Bull. Amer. Pal., vol. 2, No. 10, p. 19, 1898; Maryland Geol. Survey, Miocene, p. 471, pl. 132, figs. 6, 7, 1904.—Cushman, U. S. Geol. Survey, Bull. 676, p. 46, 1918.

Test elongate, two or three times as long as broad, compressed, rather evenly tapering with the greatest breadth toward the apertural end, periphery acute and slightly keeled; chambers distinct, ten or more pairs in the adult, high and increasing in height toward the apertural end; sutures distinct, somewhat curved, extending strongly backward; wall distinctly arenaceous with much cement, smoothly finished; aperture fairly large, at the base of the inner margin of the chamber. Length 0.60-0.75 mm.; breadth 0.30-0.35 mm.; thickness 0.18-0.20 mm.

This species was originally described by d'Orbigny from the Miocene of the Vienna Basin where it is fairly common and of distinctive character. This species was not previously recorded from Florida in Bulletin 4, but is apparently widely distributed in the Miocene, particularly of Maryland. It has proved to be a very characteristic and abundant species of the *Arca* zone of the Choctawhatchee, and occurs less commonly in the *Ecphora* zone. There are records from the Shoal River in all three zones, and also from the Oak Grove at a single station. The species is characterized by sharply keeled peripheries, and the chambers making distinct lobes at the sides, very gradually increasing in width until the later portion, where the sides are nearly parallel.

TEXTULARIA MAYORI Cushman

Plate 1, figures 2, 3

(See Florida Geol. Survey, Bull. 4, p. 17, pl. 1, figs. 6-8, 1930)

In the new material examined this species has proved to be very abundant and representative of the *Cancellaria* and *Ecphora* zones of the Choctawhatchee, but occasional specimens also occur in the *Yoldia* zone of the Choctawhatchee and the *Cardium* bed of the Shoal River. The figured specimens show the very great range from practically smooth specimens without spines to those which have not only prominent spinose projections but in some cases have double spines at the periphery. There are all gradations between these two extremes, and large series have shown the very great variability of this species as represented in the Upper Miocene. Similar variations occur in Recent material from off the present coast of Florida.

TEXTULARIA FLORIDANA Cushman

(See Florida Geol. Survey, Bull. 4, p. 18, pl. 1, figs. 9 *a*, *b*, 1930)

The only record is that in Bulletin 4 from a single station in the *Cancellaria* zone of the Chowtawhatchee.

TEXTULARIA CANDEIANA d'Orbigny

Plate 8, figures 4 *a*, *b*

Textularia candeiana d'Orbigny, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminifères," p. 143, pl. 1, figs. 25-27, 1839.—Fornasini, Mem. Accad. Sci., Bologna, ser. 5, vol. 10, p. 303 (7), pl. 0, fig. 8, 1903.—Chapman, Rep't For. Subantarctic Ids., New Zealand, p. 329, 1909.—Cushman, U. S. Nat. Mus., Bull. 71, pt. 2, p. 12, figs. 14-17 (in text), 1911; Carnegie Inst. Washington, Publ. 291, p. 32, 1919; Proc. U. S. Nat. Mus., vol. 59, p. 50, pl. 11, figs. 7, 8, 1921; U. S. Nat. Mus., Bull. 100, vol. 4, p. 109, 1921; Carnegie Inst. Washington, Publ. 311, p. 23, pl. 2, fig. 2, 1922; U. S. Nat. Mus., Bull. 104, pt. 3, p. 8, pl. 1, figs. 1-3, 1922.

Textularia sagittula DeFrance, var. *candeiana* Millett, Journ. Roy. Micr. Soc., p. 562, pl. 7, fig. 2, 1899.

Test elongate, club-shaped, the early portion narrow, much compressed, the edges almost carinate, slightly tapering to the round-pointed apex, the later chambers enlarging rapidly, much inflated; chambers numerous; wall rather coarsely arenaceous; aperture in a broad but shallow sinus, at the base of the inner margin of the chamber. Length up to 1.00 mm.; breadth 0.35 mm.; thickness 0.30 mm.

This is a common species in the present waters of the West Indian region including that of southern Florida. Specimens here referred to this species occur in all the formations of the Miocene, but usually as rare specimens. Specimens are fairly common and most typical in the typical Chipola as might be expected from the warm water conditions prevailing at that time.

TEXTULARIA FOLIACEA Heron-Allen and Earland, var.

OCCIDENTALIS Cushman

Plate 1, figures 4, 5

Textularia concava Flint (part) (not Karrer), Rep't U. S. Nat. Mus., p. 283, 1897 (1899).

Textularia foliacea Heron-Allen and Earland, var. *occidentalis* Cushman, U. S. Nat. Mus., Bull. 104, pt. 3, p. 16, pl. 2, fig. 13, 1922.

Test broadly rhomboid in shape, very much compressed, the flat faces of the test nearly parallel; chambers comparatively few and large; sutures distinct, straight, but strongly oblique; wall very coarsely arenaceous, with a roughened surface formed by coarse fragments only partially incorporated in the wall of the test. Maximum length 1.05 mm.; breadth 0.85 mm.; thickness 0.20 mm.

This form has already been recorded from off the coast of Florida and in other parts of the Gulf and Atlantic coasts. It has occurred rarely at two stations in the *Cancellaria* zone of the Choctawhatchee and questionable specimens from a single station in the typical Chipola.

TEXTULARIA WARRENI Cushman and Ellisor

Plate 1, figures 6 *a*, *b*

Textularia warreni Cushman and Ellisor, Contr. Cushman Lab. Foram. Res., vol. 7, p. 51, pl. 7, figs. 2 *a*, *b*, 1931.

Test much compressed, broad, periphery subacute, median line somewhat raised, outline generally rhomboid; chambers distinct, fairly numerous, low and broad; sutures distinct, slightly raised, meeting in a definite, raised area along the middle, slightly curved, the inner portion forming an angle from 20-25° with the median line, slightly more curved toward the periphery; wall distinctly arenaceous with considerable proportion of cement, and rather smoothly finished; aperture small, in the median line at the base of the last-formed chamber. Length up to 1.20 mm.; breadth 0.60-0.95mm.; thickness 0.25 mm.

Specimens have occurred in the Middle zone of the Shoal River formation about 4½ miles south of Argyle, Walton County, which seem identical with this species recently described from the Lower Oligocene of Texas. It is fairly common at this one locality, but was not observed elsewhere.

TEXTULARIA sp (?)

Plate 1, figures 7 *a*, *b*

The figured specimen shows a peculiar form which is rare in the Cardium beds of the Shoal River formation, ¼ mile west of Alaqua, Walton County.

Genus **BIGENERINA** d'Orbigny, 1826

BIGENERINA NODOSARIA d'Orbigny, var. **TEXTULARIOIDEA** (Goës)

Plate 1, figure 8

(See Florida Geol. Survey, Bull. 4, p. 18, pl. 1, fig. 10, 1930)

This variety which is one of the most common of the forms of shallow water in the general West Indian region has occurred only in the upper part of the Choctawhatchee formation in the *Cancellaria* zone at four stations.

BIGENERINA FLORIDANA Cushman and Ponton, n.sp.

Plate 1, figures 9-12

Test elongate, slender, tapering, the early portion biserial consisting of from seven to ten pairs of alternating chambers followed in the adult by from two to four subglobular chambers uniserially arranged,

periphery rounded; sutures distinct, very slightly depressed, nearly straight in the biserial portion, and strongly oblique; wall finely arenaceous with much cement, smoothly finished; aperture in the early biserial portion similar to that in *Textularia*, in the adult uniserial portion terminal, broadly oval. Length 0.85-1.25 mm.; breadth 0.30-0.40 mm.; thickness 0.20-0.25 mm.

Holotype (Cushman Coll. No. 16310) from the Middle zone of the Shoal River formation, White's Creek—Gully south of road and east of bridge over creek on Eucheeanna-Knoxhill road, 1 mile west of Valley Church, Walton County.

Besides the type locality where the species is abundant there are a few immature specimens which seem to be the same from one station in the Oak Grove sand. This species is an unusual one with the biserial portion making up a large part of the test. It should make a very good index fossil for this part of the Shoal River formation.

CLAVULINA TRICARINATA d'Orbigny

Plate 1, figures 13 a, b

Clavulina tricarinata d'Orbigny, in De la Sagra. Hist. Fis. Pol. Nat. Cuba, "Foraminifères," p. 111, pl. 2, figs. 16-18, 1839.—Cushman, Proc. U. S. Nat. Mus., vol. 59, p. 52, pl. 12, figs. 1, 2, 1921; Carnegie Inst. Washington, Publ. 311, p. 29, pl. 3, fig. 3, 1922; U. S. Nat. Mus., Bull. 104, pt. 3, p. 89, pl. 17, figs. 3, 4, 1922.

Clavulina angularis Woodward (not d'Orbigny), Journ. New York Micr. Soc., p. 150, 1885.—Goës, Bull. Mus. Comp. Zool., vol. 29, p. 37, 1896.—Flint, Rep't U. S. Nat. Mus., p. 289, pl. 36, fig. 2, 1897 (1899).—Cushman, Papers Dept. Marine Biol. Carnegie Inst. Washington, vol. 9, pp. 271 et seq., 1918.

Valvulina triangularis d'Orbigny, forma *Clavulina angularis* Goës, Königl. Svensk. Vet.-Akad. Handl., vol. 19, No. 4, p. 86, pl. 11, figs. 387-389, 1882.

The figured specimen represents the only record for this typical West Indian species in the Florida Miocene. It has occurred in the typical Chipola with numerous other warm water West Indian species.

Family MILIOLIDAE

Genus QUINQUELOCULINA d'Orbigny, 1826

QUINQUELOCULINA cf. FUSCA H. B. Brady

(See Florida Geol. Survey, Bull. 4, p. 19, pl. 1, figs. 11, 12, 1930)

There are a very few specimens from three stations in the *Cancellaria* zone and one station in the *Ecphora* zone of the Choctawhatchee.

QUINQUELOCULINA SEMINULA (Linné)

(See Florida Geol. Survey, Bull. 4, p. 19, pl. 2, figs. 1, 2, 1930)

The numerous records for this species as far as our material shows are all from the *Cancellaria* and *Ecphora* zones of the Choctawhatchee, and from the typical Chipola where it is common.

QUINQUELOCULINA LAMARCKIANA d'Orbigny

(See Florida Geol. Survey, Bull. 4, p. 20, pl. 2, figs. 3-5, 1930)

This species is more widely distributed than any of the others of the genus in the Florida Miocene, occurring in the *Cancellaria*, *Ecphora* and *Arca* zones of the Choctawhatchee, in the typical Shoal River material, and at two stations in the typical Chipola. It is a common species in the general West Indian region, and it is not surprising to find it in considerable numbers in the warm water material represented by the Chipola.

QUINQUELOCULINA CANDEIANA d'Orbigny

Plate 2, figures 1 a-c

Quinqueloculina candeiana d'Orbigny, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminifères," p. 199, pl. 12, figs. 24-26, 1839.—Cushman, Carnegie Instit. Washington, Publ. 311, p. 65, pl. 13, fig. 1, 1922; Publ. 344, p. 81, 1926; U. S. Nat. Mus., Bull. 104, pt. 6, p. 27, pl. 3, figs. 1 a-c, 1929.

Test nearly twice as long as broad; chambers distinct from one another, triangular in transverse section, the periphery sharply keeled; sutures sharply marked; wall smooth, shiny; aperture comparatively small, with a simple tooth, extending somewhat above the outline of the aperture. Length 1.00-1.15 mm.; breadth 0.60-0.65 mm.; thickness 0.35-0.40 mm.

All records for this species in the Miocene material examined are from the Chipola formation. As a living species this is known from numerous localities in the general West Indian region.

QUINQUELOCULINA CONTORTA d'Orbigny

(See Florida Geol. Survey, Bull. 4, p. 20, pl. 2, figs. 6 a-c, 1930)

No specimens were found in our recent collections. In Bulletin 4 it is recorded from one station in the *Ecphora* zone of the Choctawhatchee.

QUINQUELOCULINA SUBPOEYANA Cushman

Plate 2, figures 4 a-c

(See Florida Geol. Survey, Bull. 4, p. 21, pl. 2, figs. 7 a-b, 1930)

This was previously found to be very rare in the Choctawhatchee, but in this new material has occurred only at one station in the typical Chipola. As a living species it is common in shallow water about Florida and in the general West Indian region.

QUINQUELOCULINA COSTATA d'Orbigny

Plate 2, figures 2, 3

Quinqueloculina costata d'Orbigny, Ann. Sci. Nat., vol. 7, p. 301, No. 3, 1826.—Terquem, Mem. Soc. géol. France, ser. 3, vol. 1, p. 63, pl. 6 (11), figs. 3a-5c, 1878.—Cushman, U. S. Nat. Mus., Bull. 71, pt. 6, p. 49, pl. 15, fig. 1, 1917; Carnegie Instit. Washington, Publ. 311, p. 66, pl. 11, fig. 5, 1922; U. S. Nat. Mus., Bull. 104, pt. 6, p. 31, pl. 3, figs. 7a-c, 1929.

Miliolina costata Heron-Allen and Earland, Trans. Zool. Soc. London, vol. 20, p. 579, pl. 44, figs. 9-12, 1915.

Test somewhat longer than broad, periphery broadly rounded, the apertural end slightly projecting; chambers distinct, inflated, rounded in transverse section; sutures distinct, slightly depressed; wall ornamented by numerous, very distinct, longitudinal costae which for the most part are distinctly oblique to the periphery; aperture broadly ovate, with a distinct lip which is somewhat projecting and a distinct tooth raised somewhat above the level of the lip. Length 1.00-1.60 mm.; breadth 0.60-1.00 mm.; thickness 0.35-0.45 mm.

Typical specimens of this species are fairly common especially in the typical Chipola, but there are rare specimens apparently identical with it from a single station in the *Cancellaria* zone of the Choctawhatchee, and in the typical Shoal River.

In the Chipola it grows to fairly large size, and is very beautifully costate. The specimens figured are from the typical Chipola.

QUINQUELOCULINA CRASSA d'Orbigny, var. **SUBCUNEATA** Cushman

Plate 2, figures 5a-c

Miliolina crassa Heron-Allen and Earland (part) (not d'Orbigny). Trans. Zool. Soc. London, vol. 20, p. 572, pl. 42, fig. 41 (not 37-40), 1915.

Quinqueloculina crassa d'Orbigny, var. *subcuneata* Cushman, U. S. Nat. Mus., Bull. 100, vol. 4, p. 423, pl. 89, figs. 4a-c, 1921; Carnegie Instit. Washington, Publ. 342, p. 62, pl. 23, fig. 7, 1924; U. S. Nat. Mus., Bull. 104, pt. 6, p. 30, pl. 5, figs. 1a-c, 1929.

Quinqueloculina crassa Cushman (not d'Orbigny), Carnegie Instit. Washington, Publ. 344, p. 82, 1926.

Test short and broad, with the chambers wedge-shaped, often sharp at the periphery, and the surface ornamented by somewhat obscure costae, slightly oblique to the periphery of the chambers.

There are a few records of this species from off Porto Rico, and in the Miocene it occurs in the typical Chipola and also similar specimens in the typical Oak Grove sand.

QUINQUELOCULINA CHIPOLENSIS Cushman and Ponton, n. sp.

Plate 3, figures 1-3

Test subcircular in side view, very slightly longer than broad in the adult, peripheral angle sharp and keeled; chambers distinct, the sides flattened giving a very angular appearance to the test in end view; sutures distinct, very slightly depressed; wall smooth except for the very fine ornamentation which consists of a regular fine pitting extending over the entire surface of the test; aperture very slightly extending beyond the outline of the test, broadly oval, with a simple tooth. Length 0.80-1.10 mm.; breadth 0.50-0.85 mm.; thickness 0.50-0.60 mm.

Holotype (Cushman Cat. No. 16311) from the typical Chipola formation, Tenmile Creek, $\frac{1}{2}$ mile below bridge on Marianna-Clarksville road, 22 miles south of Marianna in Calhoun County.

This is a very distinct species with its sharp angles and peculiar ornamentation, and should be an excellent marker for the typical Chipola. Besides the type station it occurs at two others, showing that it probably is to be found in most collections of the Chipola.

Genus *MASSILINA* Schlumberger, 1893

MASSILINA INAEQUALIS Cushman

Plate 3, figures 4a-c

Massilina inaequalis Cushman, Proc. U. S. Nat. Mus., vol. 59, p. 72, pl. 17, figs. 12, 13, 1921; U. S. Nat. Mus., Bull. 104, pt. 6, p. 38, pl. 7, figs. 6a-c, 1929.

Test much elongate, in the adult spiroloculine, from one side very much excavated, the other nearly plane; early chambers quinqueloculine, later ones spiroloculine, chambers very elongate, irregularly quadrate in transverse section, the peripheral side broader than the inner ones, one of the sides angled, the other straight; surface polished, shiny, but with numerous, fine, linear depressions breaking the evenness of the surface; aperture rounded, apertural end of the test somewhat projecting. Length 1.40 mm.; breadth 0.55 mm.; thickness 0.30 mm.

This species which was described from the northern coast of Jamaica where it is fairly common, has not been found elsewhere in the West Indian region. It is, therefore, interesting to record this from the typical Chipola formation although it is as far as seen very rare.

MASSILINA BOSCIANA (d'Orbigny)

Plate 3, figures 5a-c

Quinqueloculina bosciana d'Orbigny, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminifères," p. 191, pl. 11, figs. 22-24, 1839.

Test elongate, more than twice as long as broad, compressed, periphery rounded, apertural end slightly projecting; chambers distinct, the basal end much expanded and slightly expanded again toward the aperture giving a peculiar appearance to the test; sutures distinct, slightly depressed; wall with somewhat broken costae, slightly oblique to the periphery; aperture rounded, with a distinct tooth which stands slightly above the lip of the aperture. Length 0.80-0.90 mm.; breadth 0.35 mm.; thickness 0.12-0.15 mm.

This species which was originally described by d'Orbigny from the West Indian region occurred only in the Chipola formation, and there only as rare specimens.

MASSILINA QUADRANS Cushman and Ponton, n. sp.

Plate 3, figures 6-8

Test much compressed, only slightly longer than broad in side view, periphery truncate; chambers distinct, numerous, quadrate in transverse section, the sides nearly parallel, the periphery almost squarely truncate but usually without distinct keels; sutures very distinct, slightly depressed; wall smooth; aperture an elongate oval, with a very elongate tooth and a distinct lip; with a slight projection at the peripheral end. Length 0.90-1.20 mm.; breadth 0.65-0.70 mm.; thickness 0.18-0.20 mm.

Holotype (Cushman Coll. No. 16312) from the typical Chipola formation, Tenmile Creek, $\frac{1}{2}$ mile below bridge on Marianna-Clarksville road, 22 miles south of Marianna in Calhoun County.

MASSILINA QUADRANS Cushman and Ponton, var.

At the station near the head of Vaughans Creek in the *Arca* zone of the Choctawhatchee a form occurred which is not typical of the species. There were too few specimens found to definitely describe the characters.

MASSILINA GUNTERI Cushman and Ponton, n. sp.

Plate 4, figures 1a-c

Test slightly longer than broad, very much compressed, periphery rounded or subacute; chambers distinct, numerous, rather broad in side view; sutures distinct, slightly depressed; wall ornamented by comparatively few coarse costae, usually slightly oblique to the peripheral margin; aperture broadly oval, with a distinct tooth and slight lip. Length 1.00 mm.; breadth 0.60 mm.; thickness 0.15 mm.

Holotype (Cushman Coll. No. 16313) from the *Cancellaria* zone of the Choctawhatchee formation, Hosford's Mill (Old Coe's Mill) on Big Creek about 2 miles north by east of Hosford, Liberty County.

Besides being very abundant at the type locality, this is found at one other station in the *Cancellaria* zone, and as it is the only species of this genus found in the upper part of the Choctawhatchee, it should be a good index species for this part of the formation.

This species is named in honor of Mr. Herman Gunter, State Geologist of Florida.

MASSILINA INCISA Cushman and Ponton, n. sp.

Plate 4, figures 2-6

Test large, very broad, much compressed, periphery broadly rounded or truncate; chambers distinct, broad, sides flattened, the early quinqueloculine ones somewhat raised in the center of the test above the general flat surface; sutures fairly distinct, not usually much

depressed; wall dull, due to the ornamentation which consists of numerous short incised lines, in general slightly oblique to the periphery, often giving a rough appearance to the surface; aperture elongate, with a distinct lip and an elongate tooth which is frequently bifid at the tip. Length 1.00-1.60 mm.; breadth 0.70-1.25 mm.; thickness 0.30-0.35 mm.

Holotype (Cushman Coll. No. 16314) from the typical Chipola formation, Tenmile Creek, $\frac{1}{2}$ mile below bridge on Marianna-Clarksville road, 22 miles south of Marianna in Calhoun County, where it is very common.

MASSILINA SPINATA Cushman and Ponton, n. sp.

Plate 5, figures 1-3

Test somewhat longer than broad, much compressed, the ends projecting, especially the apertural end which forms an elongate neck, the periphery acute and the basal half with a series of distinct spinose projections often extending somewhat backward; chambers distinct, broad; sutures distinct, slightly depressed; wall ornamented by a few rather distinct, coarse, longitudinal costae, for the most part nearly parallel with the periphery; aperture subcircular, at the end of a projecting neck, with a slight lip and usually simple tooth, which may extend slightly above the outline of the lip in side view. Length 1.00-1.20 mm.; breadth 0.60-0.75 mm.; thickness 0.15-0.18 mm.

Holotype (Cushman Coll. No. 16316) from the typical Chipola formation, Tenmile Creek, $\frac{1}{2}$ mile below bridge on Marianna-Clarksville road, 22 miles south of Marianna in Calhoun County.

This is the most distinctive species of the genus in the Florida Miocene, and has its nearest counterpart in *Massilina pulcherrima* Cushman and Valentine described from off the coast of California (Contr. Dept. Geol. Stanford Univ., vol. 1, No. 1, p. 13, pl. 4, figs. 2a, b, 1930). The Florida species is much shorter and broader than the Recent, and the ornamentation is much less developed. With the type occurred two distinct varieties which are described below.

MASSILINA SPINATA Cushman and Ponton, var. CHIPOLENSIS Cushman and Ponton, n. var.

Plate 5, figures 4-6

Variety differing from the typical in the later chambers which instead of being compressed and acute become broadest at the periphery, truncate, and often with two distinct keels at the sides. The spinose projections are usually fairly distinct in this variety.

Holotype of variety (Cushman Coll. No. 16318) from the typical Chipola formation, Tenmile Creek, $\frac{1}{2}$ mile below bridge on Marianna-Clarksville road, 22 miles south of Marianna in Calhoun County.

As shown in the figures, there is a slight tendency for the last-formed chamber to be slightly less than the complete half coil so that, as in Pl. 5, fig. 6, the neck of the last-formed chamber extends out away from the previous coil.

MASSILINA SPINATA Cushman and Ponton, var. GLABRATA Cushman and Ponton, n. var.

Plate 5, figures 7a-c

Variety differing from the typical in the smooth surface, the typical costae of the surface usually entirely missing or seen only near the apertural end, and the spinose periphery indicated by only a very small and rare tooth-like projection near the base of the chamber.

Holotype of variety (Cushman Coll. No. 16329) from the typical Chipola formation, Tenmile Creek, $\frac{1}{2}$ mile below bridge on Marianna-Clarksville road, 22 miles south of Marianna in Calhoun County.

This variety occurs with the typical form and is distinct from it by the smooth surface and the almost complete reduction of the spines on the basal half of the chamber. These are, however, represented in most of these specimens by two or three very obscure teeth at the base of the chamber.

Genus SPIROLOCULINA d'Orbigny, 1826

SPIROLOCULINA PLANULATA (Lamarck)

(See Florida Geol. Survey, Bull. 4, p. 21, pl. 3, figs. 1a, b, 1930.)

Previously recorded as very rare at one station of the *Eophora* zone, the only additional specimen of this species is a single one from the *Arca* zone of the Choctawhatchee formation.

SPIROLOCULINA DEPRESSA d'Orbigny

(See Florida Geol. Survey, Bull. 4, p. 21, pl. 3, figs. 2a, b, 1930.)

No further specimens have been found. We have recorded it from the *Eophora* zone at Jackson Bluff, but it is possible the sample was from the *Cancellaria* zone of the Choctawhatchee.

SPIROLOCULINA GRATELOUPI d'Orbigny

Spiroloculina grateloupi d'Orbigny, Ann. Sci. Nat., vol. 7, p. 298, No. 3, 1826. Terquem, Mém. Soc. géol. France, sér. 3, vol. 1, p. 52, pl. 5 (10), figs. 5, 6, 1878.—Wiesner, Arch. Prot., vol. 25, p. 208, 1912.—Cushman, U. S. Nat. Mus., Bull. 71, pt. 6, p. 31, pl. 4, figs. 4, 5, 1917; U. S. Nat. Mus., Proc., vol. 56, p. 634, 1919; U. S. Nat. Mus., Bull. 100, vol. 4, p. 396, pl. 78, figs. 4a-b; pl. 100, fig. 3; figs. 17, 18 (in text), 1921; Carnegie Instit. Washington, Publ. 311, p. 59, 1922; Publ. 342, p. 56, pl. 20, figs. 3, 4, 1924; Publ. 344, p. 80, 1926; U. S. Nat. Mus., Bull. 104, pt. 6, p. 40, pl. 8, figs. 1a-b, 1929.

Spiroloculina excavata H. B. Brady (not d'Orbigny), Rep. Voy. Challenger, Zoology, vol. 9, p. 151, pl. 9, figs. 5, 6, 1884.

Test elongate, broadest in the center, tapering toward either end; chambers rapidly thickening as added, in end view the periphery much the broadest portion of the test, central portion deeply excavated, periphery of the chambers in end view much convex, especially in the central portion, the edges broadly rounded; chambers evenly curved, the final chamber somewhat projecting, both at the basal and at the apertural ends, the latter having a decided neck with a phialine lip, the aperture itself rounded and with either a single tooth with a bifid end, the two projections forming a concave extremity, or in some cases a pair of such bifid teeth opposite one another; surface of the test dull, somewhat roughened.

It is rather strange that this widely distributed species which occurs rather commonly in the Recent warm waters of the Florida and West Indian regions should be so rare in the Miocene. Single specimens were found at two stations in the typical Chipola, but neither of them was sufficiently well preserved to warrant figuring.

SPIROLOCULINA sp.(?)

(See Florida Geol. Survey, Bull. 4, p. 22, pl. 3, fig. 3, 1930.)

No further occurrence is noted of this form previously recorded from a single station of the *Cancellaria* zone of the Choctawhatchee.

Genus HAUERINA d'Orbigny, 1839

HAUERINA BRADYI Cushman

Plate 6, figures 1a-c

Hauerina compressa H. B. Brady (not *H. compressa* d'Orbigny), Rep. Voy. *Challenger*, vol. 9, p. 190, pl. 11, figs. 12, 13, 1884.

Hauerina bradyi Cushman, U. S. Nat. Mus., Bull. 71, pt. 6, p. 62, pl. 23, fig. 2, 1917; Proc. U. S. Nat. Mus., vol. 59, p. 72, 1921; Carnegie Instit. Washington, Publ. 311, p. 71, 1922; Publ. 344, p. 82, 1926; U. S. Nat. Mus., Bull. 104, pt. 6, p. 47, pl. 10, figs. 4-9, 1929.

Test much compressed, the very earliest ones milioline, later ones becoming spiroloculine, and finally in the last-formed coil more than two chambers appear; wall very finely striate-reticulate; periphery rounded or subearinate; aperture a sieve-plate the entire height of the chamber, curved, with numerous pores. Diameter 0.40 mm.; thickness 0.10 mm.

Rather typical specimens of this species occur at several stations in the Chipola formation, but not elsewhere in the Florida Miocene. As a Recent species it is widely distributed in tropical waters, and has been recorded from the Tortugas, Jamaica, and Porto Rico in the West Indian region.

Genus SIGMOILINA Schlumberger, 1887

SIGMOILINA TENUIS (Czjzek)

(See Florida Geol. Survey, Bull. 4, p. 22, pl. 2, figs. 8a-c, 1930.)

This species which was previously recorded from the three upper portions of the Choctawhatchee formation has occurred in the new material from these same portions, as well as a few specimens from the *Cardium* beds and middle zone of the Shoal River formation. As a species of rather deeper waters it is not surprising that it is absent in the Chipola.

Genus ARTICULINA d'Orbigny, 1826

ARTICULINA SAGRA d'Orbigny, var. MIOCENICA Cushman and Ponton, n. var.

Plate 6, figures 2-4

Test elongate, slender, tapering; chambers distinct, the early ones quinqueloculine, later ones uniserial, increasing only slightly in size as added, about twice as long as broad, thickest in the middle; sutures distinct, especially in the later portion; wall ornamented by straight, plate-like, longitudinal costae, those of adjacent chambers independent of one another; aperture rounded, with a distinct lip which is rounded and not greatly extending beyond the outline of the chamber. Length 0.85-1.10 mm.; diameter 0.20 mm.

Holotype of variety (Cushman Coll. No. 16330) from the typical Chipola formation, Tenmile Creek, $\frac{1}{2}$ mile below bridge on Marianna-Clarksville road, 22 miles south of Marianna in Calhoun County.

This variety differs from the typical form of the species, as developed in the West Indian region by the much narrower shape of the test as a whole, and the lip, which in the variety is narrow and rounded. The variety is very characteristic of the typical Chipola, occurring often in large numbers, and recorded in all of the stations from which we had material.

ARTICULINA MAYORI Cushman

Plate 6, figures 5a, b

Articulina mayori Cushman, Carnegie Instit. Washington, Publ. 311, p. 71, pl. 13, fig. 5, 1922; U. S. Nat. Mus., Bull. 104, pt. 6, p. 52, pl. 12, fig. 5, 1929.

Test elongate, early portion in the microspheric form milioline, in the megalospheric form *Cornuspira*-like, the remainder and larger portion of the test made up of a linear series of elongate chambers gradually increasing in size toward the apertural end; chambers truncate at the distal end, then somewhat circular without a lip; surface of the chambers with several rounded, longitudinal costae. Length up to 2.00 mm.; breadth 0.30 mm.

This species is only known from the Tortugas region off Florida, and the measurements here given are of Recent specimens. In its living form it is a slender species and easily broken so that complete specimens are rare. This will probably account for the fact that only broken chambers of this form have been found in our material. This occurred at two of the stations in the typical Chipola. It differs from the preceding in the very much longer chambers and in the less prominent costae.

Genus *TRILOCULINA* d'Orbigny, 1826

TRILOCULINA TRIGONULA (Lamarck)

Plate 6, figures 6a-c

Miliolites trigonula Lamarck, Ann. Mus., vol. 5, p. 351, No. 3, 1804; vol. 9, pl. 17, fig. 4, 1807.

Triloculina trigonula d'Orbigny, Ann. Sci. Nat., vol. 7, p. 299, No. 1, pl. 16, figs. 5-9, 1826; Modèles, No. 93, 1826.—Cushman, U. S. Nat. Mus., Bull. 104, pt. 6, p. 56, pl. 12, figs. 10, 11; pl. 13, figs. 1, 2, 1929.

Miliolina trigonula Williamson, Rec. Foram. Gt. Britain, p. 84, pl. 7, figs. 180-182, 1858.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, p. 164, pl. 3, figs. 14-16, 1884.

Test in the adult with three visible chambers, the angles rounded, the periphery broadly convex, whole test somewhat longer than wide, in end view rounded, triangular, the sides convex; sutures distinct; wall smooth; aperture with a rather broad bifid tooth. Length 0.65 mm.; breadth 0.30 mm.; thickness 0.20 mm.

Specimens referred to this species occur at only one station in the Chipola formation.

TRILOCULINA OBLONGA (Montagu)

Plate 6, figures 7a-c

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

Triloculina oblonga d'Orbigny, Ann. Sci. Nat., vol. 7, p. 300, No. 16, Modèles, No. 95, 1826. (For further references, see Cushman, U. S. Nat. Mus., Bull. 104, pt. 6, p. 57, 1929.)

Test elongate, in end view triangular, the sides broadly curved and angles rounded, the adult with three visible chambers, inflated, the last-formed chamber broadest near the initial end and longer than the preceding ones; sutures distinct, depressed; wall smooth and usually polished; aperture oval with the tooth simple, or narrow and bifid at the tip. Length 1.00 mm.; breadth 0.55 mm.; thickness 0.35 mm.

A few specimens are referred to this species, one of which is figured. They are from the Chipola formation only.

TRILOCULINA GRACILIS d'Orbigny

Plate 6, figures 8, 9

Triloculina gracilis d'Orbigny, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminifères," p. 181, pl. 11, figs. 10-12, 1839.—Cushman, Carnegie Instit. Washington, Publ. 311, p. 74, 1922; U. S. Nat. Mus., Bull. 104, pt. 6, p. 59, pl. 14, figs. 4a-c, 1929.

Test elongate, slender, triloculine; chambers rounded; sutures very slightly depressed; apertural end extended into a cylindrical neck, the outer end of which is enlarged and has a phialine lip; surface smooth or very finely striate; aperture circular, with a slight tooth. Length 0.35-0.45 mm.; breadth 0.12-0.18 mm.; thickness 0.06-0.10 mm.

This species was originally described from the West Indian region, and is small and easily overlooked, but probably widely distributed. As a living form it occurs at the Tortugas, and it is, therefore, interesting that it occurs at most of the stations in the typical Chipola material, but not in any considerable numbers. It is a distinctive species with an elongate neck, and can hardly be confused with any other species of the fauna.

TRILOCULINA QUADRILATERALIS d'Orbigny

Plate 7, figures 1a-c

Triloculina quadrilateralis d'Orbigny, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminifères," p. 173, pl. 9, figs. 14-16, 1839.—Cushman, Proc. U. S. Nat. Mus., vol. 59, p. 71, fig. 11, (in text), 1921; Carnegie Instit. Washington, Publ. 311, p. 76, 1922; U. S. Nat. Mus., Bull. 104, pt. 6, p. 64, 1929.

Test somewhat longer than broad, in the adult the exterior composed of three chambers, generally quadrangular in outline, the periphery slightly convex, but the angles acute and projecting, sides concave; wall with numerous fine, incised, short lines; aperture oblong, with a single elongate tooth, projecting slightly above the outline of the aperture. Length 0.90 mm.; breadth 0.70 mm.; thickness 0.50 mm.

This species described by d'Orbigny from the shore sands of Cuba is also known from the northern coast of Jamaica and from numerous stations off the coast of Florida. In our material it has only occurred in the Chipola formation from Tenmile Creek. It is a distinctive species in the sharp outline of the chambers and the very squarish form of the individual chambers in transverse section. The tooth often becomes distinctively bifid as shown in the figures, and extends somewhat above the surrounding lip.

TRILOCULINA QUADRILATERALIS d'Orbigny, var. LONGICOSTATA Cushman and Ponton, n. var.

Plate 7, figures 2a-c

Variety differing from the typical in the ornamentation of the test, which consists of numerous, distinct, very fine, raised, longitudinal costae, in general parallel to the periphery of the chamber.

Holotype of variety (Cushman Coll. No. 16332) from the typical Chipola formation, Tenmile Creek, $\frac{1}{2}$ mile below bridge on Marianna-Clarksville road, 22 miles south of Marianna in Calhoun County.

This variety is not as abundant as the typical form, but is very distinctive. It occurs at two stations in the Chipola formation but not elsewhere.

TRILOCULINA ROTUNDA d'Orbigny

Plate 6, figures 10a-c

Triloculina rotunda d'Orbigny, Ann. Sci. Nat., vol. 7, p. 299, No. 4, 1826.—Schlumberger, Mem. Soc. Zool. France. vol. 6, p. 206, pl. 1, figs. 48-50, 1893.—Cushman, Carnegie Instit. Washington, Publ. 311, p. 73, 1922; Publ. 344, p. 82, 1926; U. S. Nat. Mus., Bull. 104, pt. 6, p. 59, pl. 14, figs. 3a-c, 1929.

Miliolina rotunda Millett, Journ. Roy. Micr. Soc., p. 267, pl. 5, figs. 15, 16, 1898.—Sidebottom, Mem. Proc. Manchester Lit. Philos. Soc., vol. 48, No. 5, p. 8, 1904.

Test somewhat longer than wide; chambers rotund; periphery broadly rounded; surface of the test made up largely or entirely of the two last-formed chambers; sutures very slightly depressed; apertural end somewhat contracted, with a slightly thickened lip; aperture rounded, with a single bifid tooth, projecting somewhat above the outline of the aperture; surface of the test smooth and shining, often with transverse wrinkles. Length up to 1.00 mm.; breadth 0.90 mm.; thickness 0.65 mm.

This is the only species of the genus in our material not confined to the Chipola formation. We have specimens from the Choctawhatchee both in the *Cancellaria* and *Arca* zones, and it seems to be wanting entirely in the typical Chipola. In the *Arca* zone it is rather abundant at the one station at which it occurs.

TRILOCULINA BRONGNIARTII d'Orbigny

Plate 6, figures 11a-c

Triloculina brongniartii d'Orbigny, Ann. Sci. Nat., vol. 7, p. 300, No. 23, 1826.—Parker, Jones, and H. B. Brady, Ann. Mag. Nat. Hist., ser. 4, vol. 8, p. 250, pl. 8, fig. 9, 1871.—Cushman, U. S. Nat. Mus., Bull. 104, pt. 6, p. 63, pl. 16, fig. 4, 1929.

Miliolina brongniartii Howchin, Trans. Proc. Roy. Soc. S. Australia, vol. 12, p. 2, 1889.—Heron-Allen and Earland, Proc. Roy. Irish Acad., vol. 31, pt. 64, p. 33, 1913; Trans. Zool. Soc., London, vol. 20, p. 580, 1915; Trans. Linn. Soc. London, vol. 11, ser. 2, p. 214, 1916; British Antarctic Exped., Zool., vol. 6, p. 70, 1922.

Test small, elongate, somewhat more than twice as long as broad, periphery rounded; chambers distinct, the apertural end strongly projecting; sutures distinct, slightly depressed; wall ornamented by rather coarse longitudinal costae slightly oblique to the periphery;

aperture broadly elliptical, with a distinct phialine lip. Length 0.50 mm.; breadth 0.20 mm.; thickness 0.10 mm.

This species originally described by d'Orbigny from Soldani's figures from the Mediterranean seems to be very close to the form figured here. It occurs only in the Chipola formation, and is very rare at two stations.

TRILOCULINA SCHREIBERIANA d'Orbigny

(See Florida Geol. Survey, Bull. 4, p. 22, pl. 3, figs. 4a-c, 1930.)

This species was recorded in the earlier bulletin as very rare, occurring at a single station in the *Cancellaria* zone of the Choctawhatchee formation. We have found it only in the typical Chipola material in our more recent collections, although specimens were rather abundant at that one locality.

TRILOCULINA ASPERULA Cushman

(See Florida Geol. Survey, Bull. 4, p. 23, pl. 1, fig. 13, 1930.)

This was previously recorded from a single station in the *Cancellaria* zone of the Choctawhatchee, but no further specimens have been found.

Genus FLINTINA Cushman, 1921

FLINTINA FLORIDANA Cushman and Ponton, n. sp.

Plate 7, figures 3-6

Test much compressed in side view, periphery broadly rounded; chambers in the early stages two in each whorl, later with three chambers making up the adult coil in a single plane; chambers fairly distinct, increasing rather uniformly in size as added, in transverse section broadly oval; sutures fairly distinct, slightly depressed; wall ornamented by numerous, distinct, somewhat rounded, longitudinal costae, slightly oblique to the periphery; aperture broadly oval, with a distinct tooth and a very slight lip. Diameter 0.70-1.00 mm.; thickness 0.25-0.30 mm.

Holotype (Cushman Coll. No. 16333) from the *Arca* zone of the Choctawhatchee formation, 100 feet below falls near head of Vaughan's Creek (locally called Blount's Creek) in Sec. 27, T. 2 N., R. 19 W., Walton County.

This is a very fine and distinctive species which occurs abundantly at the type station but not elsewhere in the material that we have examined. It should, therefore, be a distinctive species for this part of the Choctawhatchee, especially as the genus is in most of its species confined to the Indo-Pacific region. It, therefore, apparently represents a distinct local development which, as often happens, became exceedingly abundant at that particular time and place.

Genus PYRGO Defrance, 1824

PYRGO SUBSPHAERICA (d'Orbigny)

(See Florida Geol. Survey, Bull. 4, p. 23, pl. 3, figs. 5a-c, 1930.)

While this species was previously recorded from the Choctawhatchee it must be extremely rare there as no further specimens were found. In the table we have noted this previous record in the *Ecphora* zone, and it is possible the original sample was from the *Cancellaria* zone. It is fairly common, however, in the typical Chipola material, occurring at three of the four stations. It is a common species in the present shallow water, warm areas about Florida and the West Indies. We have a single specimen from one station in the Choctawhatchee which is referred to this species with considerable question, and as far as the general characters show it is a characteristic species only of the Chipola.

PYRGO DENTICULATA (H. B. Brady)

Plate 7, figures 7, 8

Biloculina ringens Lamareck, var. *denticulata* H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, p. 143, pl. 3, figs. 4, 5, 1884.—Woodward, The Observer, vol. 4, p. 76, 1893.—Millett, Journ. Roy. Micr. Soc., p. 262, 1898.—Chapman, Journ. Linn. Soc. Zool., vol. 28, p. 398 (list), 1902.—Dakin, Rep't Pearl Oyster Fish, Ceylon, vol. 5, p. 228, 1906.—Heron-Allen and Earland, Trans. Zool. Soc. London, vol. 20, p. 551, pl. 40, figs. 11-13, 1915.

Biloculina denticulata Cushman, U. S. Nat. Mus., Bull. 71, pt. 6, p. 80, pl. 33, fig. 1, 1917; U. S. Nat. Mus., Bull. 100, vol. 4, p. 476, pl. 98, figs. 3a-b, 1921; Carnegie Instit. Washington, Publ. 311, p. 78, 1922; Publ. 342, p. 70, 1924; Publ. 344, p. 83, 1926.—Hanzawa, Jap. Journ. Geol. Pal., vol. 4, p. 38 (table), 1925 (1926).

Pyrgo denticulata Cushman, U. S. Nat. Mus., Bull. 104, pt. 6, p. 69, pl. 18, figs. 3, 4, 1929.

Test elongate, roughly quadrangular in front view; in end view somewhat compressed, biconvex; apertural end broadly rounded; opposite end with a series of short, irregular teeth; wall smooth, usually polished; aperture very broad and narrow, extending nearly the whole width of the test, the ends somewhat expanded, with a long narrow tooth, making the inner border of the aperture plate-like, somewhat raised above the level of the surface to which it is attached, as is the whole border of the aperture. Length up to 0.85 mm.; breadth 0.70 mm.; thickness 0.60 mm.

This species while characteristic of the Indo-Pacific region has, nevertheless, been recorded from the West Indies in shallow warm water. It is interesting, therefore, to find typical specimens at two of the stations in the Chipola formation. These are characteristic and show the usual range of variation in the species. No specimens of the striate variety, however, were found.

Family OPTHALMIDIIDAE

Subfamily Cornuspirinae

Genus CORUNSPIRA Schultze, 1854

CORNUSPIRA INVOLVENS (Reuss)

(See Florida Geol. Survey, Bull. 4, p. 23, pl. 3, fig. 6, 1930.)

In the previous Miocene bulletin this species was recorded only as a single specimen from the Choctawhatchee marl. It must be exceedingly rare there as no further specimens were found by us from that formation. It has, however, occurred at three of the four stations in the typical Chipola formation which would be expected as this is a species common in the shallow warm waters of the general West Indian region and elsewhere at the present time.

Genus VERTEBRALINA d'Orbigny, 1826

VERTEBRALINA CASSIS d'Orbigny

Plate 8, figures 1a, b

Vertebralina cassis d'Orbigny, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminifères," p. 51, pl. 7, figs. 14-15, 1839.—Cushman, Proc. U. S. Nat. Mus., vol. 59, p. 64, pl. 15, figs. 1, 4 (not 2, 3, 5-8), 1921; Carnegie Instit. Washington, Publ. 311, p. 62, 1922; U. S. Nat. Mus., Bull. 104, pt. 6, p. 96, pl. 22, figs. 4a, b, 1929.

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; earlier chambers were visibly spiroloculine. Length 0.50 mm.; breadth 0.40 mm.; thickness 0.12 mm.

The species originally described by d'Orbigny from the West Indian region is widely distributed there in warm shallow waters. We have found the species occurring at one of the stations in the Chipola formation. Specimens are not common, but are usually of smaller size than Recent ones.

VERTEBRALINA MULTILOCULARIS (H. B. Brady, Parker, and Jones)

Plate 8, figures 2, 3

Articulina multilocularis H. B. Brady, Parker, and Jones, Trans. Zool. Soc. London, vol. 12, p. 215, pl. 40, fig. 10, 1888.—Cushman, U. S. Nat. Mus., Bull. 104, pt. 6, p. 53, pl. 12, fig. 7, 1929.

Test planispiral, much compressed, the sides flattened or concave, periphery squarely truncate; chambers increasing in size rather rapidly as growth progresses; sutures distinct, very slightly if at all depressed; wall ornamented by a few, rounded, longitudinal costae, in general parallel to the periphery; aperture elongate, with a slight

lip, but without an apertural tooth. Length 0.50 m.; breadth 0.40 mm.; thickness 0.12 mm.

This species was originally described by Brady, Parker, and Jones from the Abrohlos Bank off Brazil. Our specimens from the Chipola formation seem to be identical with these Recent ones. The species is fairly common in the typical Chipola where it occurs at two stations. Our figures show some of the variations found in this species from the young stage to the adult.

Family LAGENIDAE

Subfamily Nodosariinae

Genus **ROBULUS** Montfort, 1808

ROBULUS AMERICANUS (Cushman)

(See Florida Geol. Survey, Bull. 4, p. 24, pl. 3, figs. 7a, b, 1930.)

This species was recorded in the previous report from the *Arca* zone of the Choctawhatchee. Our later material has been from this same zone and also from the *Yoldia* zone, and from stations collected in the *Cardium* beds and Middle zone of the Shoal River formation.

ROBULUS AMERICANUS (Cushman), var. **SPINOSUS** (Cushman)

(See Florida Geol. Survey, Bull. 4, p. 24, pl. 3, figs. 8a, b, 1930.)

In our new material this variety is somewhat more widely distributed than the typical form. It occurs at a single station in the *Ecphora* zone as well as in the *Arca* and *Yoldia* zones of the Choctawhatchee, and in all three zones of the Shoal River.

ROBULUS IOTUS (Cushman)

(See Florida Geol. Survey, Bull. 4, p. 25, pl. 4, figs. 1a, b, 1930.)

In the previous report this species was recorded from but a single station in the *Cancellaria* zone of the Choctawhatchee formation. Our more recent material has added records from the *Ecphora*, *Arca*, and the *Yoldia* zones of the Choctawhatchee, as well as from all three zones in the Shoal River formation. The young stages of this species seem to be quite distinctive, having only four or five very much flattened chambers with a distinct keel and usually with a clear space at the umbo. In the later stages the number of chambers increases considerably in the coil, and except for the intermediate stages connecting the two they might seem to be quite distinct forms.

ROBULUS FLORIDANUS (Cushman)

(See Florida Geol. Survey, Bull. 4, p. 25, pl. 4, figs. 2a, b, 1930.)

In Bulletin 4 this is recorded from a single station in the *Arca* zone of the Choctawhatchee. No further specimens were noted.

ROBULUS CATENULATUS (Cushman)

(See Florida Geol. Survey, Bull. 4, p. 25, pl. 4, figs. 3a, b, 1930.)

The only record in the Florida Miocene is that above, at two stations in the *Arca* zone of the Choctawhatchee.

ROBULUS VAUGHANI (Cushman)

Plate 8, figures 5-10

Cristellaria vauhani Cushman, U. S. Nat. Mus., Bull. 103, p. 61, pl. 22, fig. 3, 1918.

Test much compressed, with a tendency to uncoil in the last-formed chambers, periphery slightly keeled, not lobulated; chambers numerous, about nine in the last-formed coil, increasing gradually in size as added although those of the uncoiled portion often decrease progressively as added; sutures distinct, limbate, usually with lines of beads along the sutures from the umbilicus to the periphery, sometimes wanting, sutures in the uncoiled portion usually depressed; wall smooth except for the beaded sutures; apertural face truncated, with the edge slightly raised, the aperture itself radiate, sometimes with a slight neck.

This species was recorded from the Gatun formation as well as from the Culebra formation of the Oligocene of the Panama Canal Zone. It has occurred in considerable numbers in our newer material in both the *Ecphora*, *Arca* and *Yoldia* zones of the Choctawhatchee, and from the *Cardium* bed and the Middle zone of the Shoal River.

This is a very variable species, and is closely related to *Robulus vicksburgensis* from the Lower Oligocene of the Coastal Plain Region. The uncoiling is very noticeable at some stations, and figures of some of these forms are given.

Genus **PLANULARIA** Defrance, 1824**PLANULARIA** sp?

(See Florida Geol. Survey, Bull. 4, p. 26, pl. 4, figs. 4-6, 1930.)

There are a very few immature specimens of this genus which add little to the previous collections.

Genus **MARGINULINA** d'Orbigny, 1825**MARGINULINA GLABRA** d'Orbigny (?)

Plate 8, figures 12a, b

There are a very few specimens from the type zone of the Shoal River formation which may be referred to this species. One specimen is figured. The chambers are more or less globular throughout although there is some compression in the earlier part of the coiled portion.

MARGINULINA DUBIA Neugeboren

Plate 8, figures 11a, b

Marginulina dubia Neugeboren, Verh. Mitth. siebenburg. Ver. Nat., vol. 2, p. 120, pl. 4, fig. 1, 1851; Denkschr. Akad. Wiss. Wien, vol. 12, p. 100, 1856.—Cushman and Laiming, Journ. Pal., vol. 5, p. 98, pl. 10, fig. 7, 1931.—Cushman and Parker, Contr. Cushman Lab. Foram. Res., vol. 7, p. 3, pl. 1, fig. 6, 1931.

Marginulina sp? Cushman, Fla. Geol. Survey, Bull. 4, p. 27, pl. 4, figs. 8a, b, 1930.

Test elongate, the early chambers coiled, later ones in a uniserial series, the sides nearly parallel or slightly lobulate on the inner margin, somewhat compressed, elliptical in section; chambers distinct, the early ones close coiled, the later three to five uncoiled, somewhat overlapping; sutures distinct, very slightly depressed, in the later portion oblique; wall smooth, aperture radiate, at the dorsal side somewhat projecting. Length up to 1.30 mm.; breadth 0.30 mm.; thickness 0.15 mm.

This species described from the Tertiary of Europe and recorded from the Miocene of California has occurred also in the Choctawhatchee formation of Florida. The early coiled portion varies very much according to whether the specimen is a microspheric or megalospheric one, but the later chambers are more or less uniform in their general character. Our specimens are from the *Ecphora* zone of the Choctawhatchee.

MARGINULINA sp?

(See Florida Geol. Survey, Bull. 4, pp. 26 & 27, pl. 4, figs. 7a, b, and 9a, b, 1930.)

As in the previous report, there are a few immature specimens of *Marginulina* which cannot be definitely assigned to a species owing to the lack of material.

Genus SARACENARIA DeFrance, 1824

SARACENARIA ACUTAURICULARIS (Fichtel and Moll)

(See Florida Geol. Survey, Bull. 4, p. 27, pl. 4, figs. 10a, b, 1930.)

In the previous report this species was recorded from the *Arca* zone of the Choctawhatchee. In our newer collections it has been recorded from that same zone, as well as from the *Ecphora* and *Yoldia* zones and also from the *Cardium* bed and the Middle zone of the Shoal River formation.

Genus LIGULINA d'Orbigny, 1826

LIGULINA sp(?)

Plate 12, figures 13a, b

This is a single small specimen which is here figured which seems to belong to this genus. It is from the Upper *Cancellaria* zone of the Choctawhatchee marl, and was not found elsewhere.

Genus DENTALINA d'Orbigny, 1826

DENTALINA COMMUNIS d'Orbigny

(See Florida Geol. Survey, Bull. 4, p. 27, pl. 5, fig. 1, 1930.)

The present collections extend considerably the range of this species in the Florida Miocene. The previous report records it from several stations in the *Arca* zone of the Choctawhatchee, but we have material also from the *Ecphora* and *Yoldia* zone as well as from the *Cardium* bed and the type zone of the Shoal River marl.

DENTALINA CONSOBRINA d'Orbigny, var. **EMACIATA** Reuss

(See Florida Geol. Survey, Bull. 4, p. 28, pl. 5, fig. 2, 1930.)

A few additions extend the range of this form to the *Ecphora* zone of the Choctawhatchee and to the type zone of the Shoal River formation.

DENTALINA PYRULA d'Orbigny

Plate 9, figures 5, 6

(See Florida Geol. Survey, Bull. 4, p. 28, pl. 5, fig. 3, 1930.)

There are a very few broken specimens which from the shape and arrangement of their chambers strongly suggest that they should be placed under this species. They are from the *Ecphora* and *Arca* zones of the Choctawhatchee formation, and it is probable that the fragmentary specimen figured in the previous report (pl. 5, fig. 3) also belongs here. That specimen also was from the *Arca* zone.

DENTALINA sp(?)

Plate 9, figures 1, 2

There are very rare specimens mostly incomplete from the type zone of the Shoal River formation and the Upper zone of the Chipola which are figured here. The chambers are subglobular and are marked by rather coarse costae evidently obsolescent in the later chambers. So far as can be made out the initial end has a short spine, and the aperture is decidedly at one side. As no really complete specimens were obtained it seems best not to give this a specific name.

DENTALINA sp(?)

Plate 9, figures 3, 4

From the same station in the Upper zone of the Chipola there are even more fragmentary specimens of another species which is also costate, the costae becoming somewhat spiral, few in number, sharp, and thin. The chambers are elongate, and the aperture is decidedly at one side of the axis. From the small amount of material no specific name can be assigned to this form.

Genus NODOSARIA Lamarck, 1812**NODOSARIA CATESBYI** d'Orbigny

(See Florida Geol. Survey, Bull. 4, p. 28, pl. 5, fig. 4, 1930.)

This species has previously been recorded from *Cancellaria*, *Ecphora* and *Arca* zones of the Choctawhatchee formation and our specimens in this new material are confined to the *Ecphora* zone.

NODOSARIA CALOMORPHA Reuss

Plate 9, figure 7

At a single station in the *Cancellaria* zone of the Choctawhatchee there are a few fragmentary specimens, the best one of which is here figured. These are very similar to specimens found off the East

Coast of South America and recently recorded under this specific name (Cushman and Parker, Proc. U. S. Nat. Mus., vol. 80, Art. 3, p. 7, pl. 3, figs. 1, 2, 1931.) It should also be noted that d'Orbigny in his Cuban Monograph of 1839 figured a peculiar form (pl. 1, fig. 4) which consists of a series of subglobular chambers. Our specimens, however, are more elongate in the chamber form.

NODOSARIA LONGISCATA d'Orbigny

Nodosaria longiscata d'Orbigny, Foram. Foss. du Bassin Tert. Vienne, p. 32, pl. 1, figs. 10-12, 1846.—Cushman, Contr. Cushman Lab. Foram. Res., vol. 5, pt. 4, p. 86, pl. 12, figs. 25, 26, 1929.—Cole and Ponton, Florida Geol. Survey, Bull. 5, p. 33, pl. 6, fig. 4, 1930.

This species described by d'Orbigny from the Miocene of the Vienna Basin was found in some numbers at one station of the *Cardium* bed of the Shoal River formation and no where else in the Florida Miocene. It has been recorded from the Miocene of Venezuela and Trinidad, the Marianna limestone of Florida, and the Alazan of Mexico.

Subfamily Lageninae

Genus **LAGENA** Walker and Jacob, 1798

LAGENA PERLUCIDA (Montagu)

(See Florida Geol. Survey, Bull. 4, p. 29, pl. 5, fig. 5, 1930.)

This is a widely distributed species previously recorded from the upper three zones of the Choctawhatchee from which we again have material at almost every station, as well as stations in the middle and the type zones of the Shoal River formation, the type zone of the Oak Grove sand, and from the typical Chipola. The species varies greatly in the shape of the test.

LAGENA CLAVATA d'Orbigny

(See Florida Geol. Survey, Bull. 4, p. 29, pl. 5, figs. 6a, b, 1930.)

This species was previously recorded in the three upper zones of the Choctawhatchee. In our later material it was found only in the *Arca* zone of the Choctawhatchee.

LAGENA HEXAGONA (Williamson)

(See Florida Geol. Survey, Bull. 4, p. 30, pl. 5, figs. 11a, b, 1930.)

In the previous report this species was recorded as rare in the *Cancellaria* zone of the Choctawhatchee. We have found no additional specimens in this formation, but have specimens from the middle zone of the Shoal River formation, and the upper zone of the Chipola.

LAGENA HEXAGONA (Williamson), var. SCALARIFORMIS (Williamson)

(See Florida Geol. Survey, Bull. 4, p. 30, pl. 5, figs. 7a, b, 1930.)

As in the previous report this variety has been found to be fairly common in the *Cancellaria* and *Ecphora* zones of the Choctawhatchee.

LAGENA SULCATA (Walker and Jacob)

(See Florida Geol. Survey, Bull. 4, p. 31, pl. 5, fig. 10, 1930.)

This species was previously recorded from the *Ecphora* and *Arca* zones of the Choctawhatchee. Our study of these newer collections has shown it to be present in both of these zones, but we have not found it elsewhere to extend its range in the Florida Miocene.

LAGENA SUBSTRIATA Williamson

(See Florida Geol. Survey, Bull. 4, p. 31, pl. 5, fig. 14, 1930.)

While this species is very common in the Choctawhatchee formation we have it but from one station in the lower series, that being from the middle zone of the Shoal River formation.

LAGENA COSTATA (Williamson), var. **AMPHORA** Reuss

(See Florida Geol. Survey, Bull. 4, p. 31, pl. 5, fig. 8, 1930.)

In our present material this species is confined to the *Cancellaria* zone of the Choctawhatchee. Previously it was recorded in that zone as well as from one station in the *Ecphora* zone.

LAGENA cf. **STRIATO-PUNCTATA** Parker and Jones

(See Florida Geol. Survey, Bull. 4, p. 32, pl. 5, fig. 9, 1930.)

Our later collections have shown this species to be present in the *Cancellaria* and *Ecphora* zones of the Choctawhatchee, and also in the upper and typical zones of the Chipola.

LAGENA ORBIGNYANA (Seguenza), var. **LACUNATA** Burrows and Holland

(See Florida Geol. Survey, Bull. 4, p. 32, pl. 5, figs. 13a, b, 1930.)

This species was found only in the *Cancellaria* zone of the Choctawhatchee in our new samples but previously was also recorded from the *Ecphora* zone of the same formation.

LAGENA cf. **MARGINATO-PERFORATA** (Seguenza)

(See Florida Geol. Survey, Bull. 4, p. 32, pl. 5, fig. 12, 1930.)

This species already recorded from the Choctawhatchee formation, where it is most common, has occurred also at a single station in the *Cardium* bed of the Shoal River and the typical Oak Grove sand.

LAGENA MARGINATA (Walker and Jacob)

Plate 8, figure 13

We have a very few specimens which may be referred to this rather variable species from single stations in the upper three zones of the Choctawhatchee and also from the typical Oak Grove sand.

LAGENA GRACILIS Williamson

Plate 9, figures 8, 9

Lagena gracilis Williamson, Ann. Mag. Nat. Hist., ser. 2, vol. 1, p. 13, pl. 1, fig. 5, 1848.—Cushman, U. S. Nat. Mus., Bull. 104, pt. 4, p. 22, pl. 4, figs. 3, 4, 1923.—Heron-Allen and Earland, Journ. Roy. Micr. Soc., p. 148, 1924.—Chapman and Parr, Journ. Linn. Soc. Zool., vol. 36, p. 374, pl. 17, fig. 4, 1926.—Cushman, Bull. Scripps Instit. Oceanography, Tech. Ser., vol. 1, No. 10, p. 144, 1927.—G. D. Hanna and C. C. Church, Journ. Pal., vol. 1, p. 198, 1928.—Cushman, Contr. Cushman Lab. Foram Res., vol. 5, p. 67, pl. 11, fig. 2; p. 88, pl. 13, fig. 11, 1929.—Heron-Allen and Earland, Journ. Roy. Micr. Soc., vol. 50, p. 164, 1930.—Cushman and Moyer, Contr. Cushman Lab. Foram Res., vol. 6, p. 53, 1930.—Macfadyen, Geol. Survey Egypt, p. 66, 1930 (1931).—Hada, Sci. Rep't Tohoku Imp. Univ., ser. 4, Biol., vol. 6, p. 106, fig. 61 (in text), 1931.

Test elongate, fusiform, broadest in the middle, apertural end tapering into a long cylindrical neck with a slightly expanded lip, opposite end pointed, closed, surface ornamented by a few distinct longitudinal costae.

There are excellent, well developed specimens of this species in three stations in the *Arca* zone of the Choctawhatchee formation and one station in the *Cardium* bed of the Shoal River, and there are less well developed ones from a single station in the typical zone of the same formation. The references above are those since the publication of Bulletin 104 to which the reader is referred for complete references to this species.

LAGENA QUADRATA (Williamson)

Plate 12, figures 17, 18

In the upper part of the Choctawhatchee formation there are a very few specimens, two of which are here figured, which seem somewhat like this species described by Williamson. It evidently should be included in *Entosolenia* as there is a distinct internal tube, but is here kept with *Lagena* until someone shall have an opportunity to work out the various relationships of the different species which have been usually termed *Lagena*. One of the specimens seems to show somewhat of a division into two distinct parts.

Family POLYMORPHINIDAEGenus **GUTTULINA** d'Orbigny, 1826**GUTTULINA IRREGULARIS** (d'Orbigny)

Plate 9, figures 10-12

(See Florida Geol. Survey, Bull. 4, p. 33, 1930.)

In the previous Florida report this species was recorded from a single station in the *Arca* zone of the Choctawhatchee formation. However, later collections have added no others from the Choctaw-

hatchee, but it has been found to be common in the Chipola, occurring at all the stations, as well as in the middle zone of the Shoal River formation.

GUTTULINA COSTATULA Galloway and Wissler

(See Florida Geol. Survey, Bull. 4, p. 33, pl. 5, fig. 15, 1930.)

This species is fairly common, but occurred only in the upper two zones of the Choctawhatchee where it is represented at about half of the stations.

GUTTULINA LACTEA (Walker and Jacob)

Plate 9, figures 15a, b

(For references to this species see Cushman and Ozawa, Proc. U. S. Nat. Mus., vol. 77, Art. 6, p. 43, 1930.)

Test ovate, rounded triangular in section, tapering but little, rounded at the base; chambers elongate, somewhat compressed, arranged in a contra-clockwise quinqueloculine series, often tending to become a sigmoid series, each succeeding chamber very slightly removed from the base; sutures depressed, distinct; wall smooth, translucent; aperture radiate.

Specimens seemingly referable to this species occurred in the middle and typical zones of the Shoal River formation, and in the upper and typical zones of the Chipola.

GUTTULINA LACTEA (Walker and Jacob), var. **EARLANDI** Cushman and Ozawa
(See Florida Geol. Survey, Bull. 4, p. 34, pl. 5, fig. 19, 1930.)

A few specimens seemingly referable to this variety occurred in the Cancellaria zone of the Choctawhatchee and very rarely in the middle zone of the Shoal River formation.

GUTTULINA CAUDATA d'Orbigny

Plate 9, figures 16, 17

Guttulina caudata d'Orbigny, Ann. Sci. Nat., vol. 7, p. 266. No. 16, 1826.—
Fornasini, Boll. Soc. Geol. Ital., vol. 19, p. 137, fig. 2 (in text), 1900.—
Cushman and Ozawa, Proc. U. S. Nat. Mus., vol. 77, Art. 6, p. 36, pl. 6, figs. 4, 5, 1930.

Test unequally compressed, in side view irregularly rhomboid, initial end with a spine; chambers elongate, arranged in a clockwise quinqueloculine series, each chamber reaching nearly to the base; sutures slightly depressed, distinct; wall smooth; aperture terminal, radiate. Length 0.60 mm.; breadth 0.30 mm.; thickness 0.20 mm.

Rather typical specimens of this species occur at two stations, in the middle zone of the Shoal River marl, and upper zone of the Chipola.

GUTTULINA AUSTRIACA d'Orbigny (?)

Plate 9, figures 13, 14

The figured specimens show what may be perhaps representative of this species. These specimens are the only ones we have, and are

from the *Arca* zone of the Choctawhatchee. The species is a common one in the Miocene of Europe.

GUTTULINA ROEMERI (Reuss)

Under this name Cushman and Ozawa (Proc. U. S. Nat. Mus., vol. 77, Art. 6, 1930, p. 41) recorded a single, apparently young specimen from the *Arca* zone of the Choctawhatchee formation near Red Bay, Florida.

We have found no further specimens to be referred to this species.

Genus PYRULINA d'Orbigny, 1826

PYRULINA ALBATROSSI Cushman and Ozawa

(See Florida Geol. Survey, Bull. 4, p. 34, pl. 5, figs. 17, 18, 1930.)

This species was recorded in Bulletin 4 from one station in the *Cancellaria* zone of the Choctawhatchee. We have no other specimens.

Genus GLOBULINA d'Orbigny, 1826

GLOBULINA GIBBA d'Orbigny

Plate 10, figures 3a, c

(See Florida Geol. Survey, Bull. 4, p. 34, pl. 5, fig. 21, 1930.)

In our recent collections this species, besides being present in the *Cancellaria* and *Arca* zones of the Choctawhatchee, occurs commonly in the Chipola, and there are records for it also from the middle zone of the Shoal River formation, as well as the Oak Grove sand.

GLOBULINA INAEQUALIS Reuss

Plate 10, figures 1a-c

(See Florida Geol. Survey, Bull. 4, p. 35, pl. 5, fig. 22, 1930.)

This is a very widely distributed species, occurring in nearly all the zones of the Florida Miocene as shown by the table. The specimens recorded by Cushman and Ozawa (Proc. U. S. Nat. Mus., vol. 77, Art. 6, 1930, p. 65) as *Globulina gibba* d'Orbigny, var. *globosa* (V. Münster) from Red Bay, Florida, evidently belong here.

GLOBULINA INAEQUALIS Reuss, var. CARIBAEA d'Orbigny

Plate 10, figure 2

Globulina caribaea d'Orbigny, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminifères," p. 135, pl. 2, figs. 7, 8, 1839.

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

Variety differing from the typical in having the wall ornamented wholly or in part with fine short spines.

This variety is fairly common in the West Indian region today. It is interesting, therefore, to find that it occurs at numerous stations in the Florida Miocene, particularly from the Choctawhatchee formation, but it is also represented in the Chipola.

GLOBULINA ROTUNDATA (Bornemann)

(See Florida Geol. Survey, Bull. 4, p. 35, pl. 5, fig. 16, 1930.)

Previously recorded from two stations in the *Arca* zone of the Choctawhatchee but not found in our recent collections.

Genus PSEUDOPOLYMORPHINA Cushman and Ozawa, 1928

PSEUDOPOLYMORPHINA DUMBLEI (Cushman and Applin)

(See Florida Geol. Survey, Bull. 4, p. 35, pl. 6, fig. 5, 1930.)

This species has been found in the three upper zones of the Choctawhatchee, and it also occurs in the typical Shoal River formation, as well as in the Chipola.

PSEUDOPOLYMORPHINA RUTILA (Cushman)

(See Florida Geol. Survey, Bull. 4, p. 36, pl. 5, fig. 20, 1930.)

As in the previous report this species occurs only in the *Cancellaria* and *Ecphora* zones of the Choctawhatchee formation for which it should be an excellent index fossil.

Genus POLYMORPHINA d'Orbigny, 1826

POLYMORPHINA ADVENA Cushman

Plate 10, figure 4

Polymorphina advena Cushman, U. S. Geol. Survey Prof. Paper 129-F, p. 132, pl. 31, fig. 4, 1922; Contr. Cushman Lab. Foram. Res., vol. 5, p. 41, pl. 7, fig. 5, 1929.—Cushman and Ozawa, Proc. U. S. Nat. Mus., vol. 77, Art. 6, p. 118, pl. 30, figs. 10a, b, 1930.

Test much compressed, strongly ovate; chambers numerous, elongate, alternating, much the broadest near the peripheral end; sutures slightly depressed, very oblique; surface ornamented with numerous, fine, longitudinal costae, except the last-formed one or two chambers which are smooth, at least at the apertural end; aperture radiate. Length 0.45 mm.; breadth 0.20 mm.; thickness 0.05 mm.

This species which was originally described from the Lower Oligocene of Mississippi occurs in the Chipola formation in typical form. It is very rare, however.

Genus SIGMOMORPHINA Cushman and Ozawa, 1928

SIGMOMORPHINA WILLIAMSONI (Terquem)

(See Florida Geol. Survey, Bull. 4, p. 36, pl. 6, fig. 4, 1930.)

Recorded previously from a single station in the *Cancellaria* zone of the Choctawhatchee, this species has not been found in our recent collections.

SIGMOMORPHINA PEARCEYI Cushman and Ozawa

Plate 10, figures 5a, b

Polymorphina inflata Pearcey, Trans. Roy. Soc. Edinburgh, vol. 49, p. 1,023, pl. 2, figs. 14-16, 1914.

Sigmomorphina pearceyi Cushman and Ozawa, Proc. U. S. Nat. Mus., vol. 77, Art. 6, p. 132, pl. 35, figs. 2, 3, 1930.

Test elongate, clavate, the greatest breadth in the upper half, tapering toward the base, apertural end rounded; chambers more or less compressed, early ones elongated, later becoming rounded, generally the last one much inflated and large, arranged in a contra-clockwise sigmoid series, each succeeding chamber, especially the last one or two, removed farther from the base; sutures depressed, distinct; wall smooth, thin, translucent; aperture near the center of the last chamber. Length 0.75 mm.; breadth 0.50 mm.; thickness 0.35 mm.

This species has already been recorded as living off the coast of Florida in 18 fathoms off the Tortugas. We have specimens which may be referred to it from the Oak Grove and Chipola formations.

SIGMOMORPHINA UNDULOSA (Terquem)

Plate 10, figures 6a-c

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

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

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

Test oval to ovate, compressed; chambers elongated, embracing, arranged in a contra-clockwise sigmoid series, each succeeding chamber not much removed from the base; sutures depressed, distinct; wall smooth, rather thin, often covered with fistulose tubes; aperture radiate. Length 0.50 mm.; breadth 0.30 mm.; thickness 0.12 mm.

This species is rather widely distributed in the Atlantic. It has been recorded as living in 18 fathoms off the Dry Tortugas off Florida. Very typical specimens were obtained from the upper part of the Chipola formation, one of which is figured here.

Family NONIONIDAE

Genus NONION Montfort, 1808

NONION GRATELOUPI (d'Orbigny)

(See Florida Geol. Survey, Bull. 4, p. 36, pl. 6, figs. 1-3, 1930.)

This species which is common in the Recent warm waters of the West Indian region has been also recorded from the Miocene of Cuba, Santo Domingo, Panama, and the Coastal Plain of the United States. Previously it was recorded from the *Cancellaria* and *Ecphora* zones of the Choctawhatchee formation of Florida. Our new material extends its range into the *Arca* and *Yoldia* zones of the Choctawhatchee, and there are records for it in all three zones of the Shoal River, in both of the stations from the Oak Grove, and at two stations in the Chipola.

There is a tendency, as was previously noted, for some of the specimens to become somewhat like *Nonionella* in their later growth. At some stations it is rather difficult to distinguish this species from the following as the variation of the two is considerable. Apparently *N. grateloupi* is a much more widely distributed form than *N. pizarrensis* in the Miocene.

NONION PIZARRENSIS Berry

(See Florida Geol. Survey, Bull. 4, p. 37, pl. 6, figs. 7, 8, 1930.)

In the previous report this species was only recorded from the *Arca* zone in the Choctawhatchee. Later material has shown it to be present in some numbers in the *Ecphora* and *Yoldia* zones of the Choctawhatchee, as well as the *Arca* zone. It has also occurred in all three zones of the Shoal River marl, and in the upper zone of the Chipola.

NONION GLABRELLUM Cushman

(See Florida Geol. Survey, Bull. 4, p. 38, pl. 6, figs. 6a, b, 1930.)

This species was originally described from the *Cancellaria* zone of the Choctawhatchee in the earlier bulletin. It is interesting to note that in our later collections we have recorded it from most of the stations in the *Cancellaria* zone, and it has also occurred at single stations in the *Ecphora* and *Arca* zones. In the Alum Bluff group it has occurred in the Cardium Beds and middle zone of the Shoal River marl, at both stations in the Oak Grove, and at four of the five stations in the Chipola.

It is, therefore, a widely distributed species, but its characters seem to be held throughout this rather wide range in the Miocene.

Genus **NONIONELLA** Cushman, 1926

NONIONELLA AURIS (d'Orbigny)

(See Florida Geol. Survey, Bull. 4, p. 38, pl. 7, figs. 1a-c, 1930.)

This has proved to be one of the most common species in our recent collections. It occurs at nearly all of the stations in the upper four zones of the Choctawhatchee, at all of the stations in the three zones of the Shoal River formation, both stations in the Oak Grove, and at three of the five stations in the Chipola. It also has a wide distribution in Recent waters.

Genus **ELPHIDIUM** Monfort, 1808

ELPHIDIUM POEYANUM (d'Orbigny)

(See Florida Geol. Survey, Bull. 4, p. 39, pl. 7, figs. 3, 4, 1930.)

This species is very widely distributed, occurring at all but seven of the stations, and these represent all the zones of the Florida Miocene. It is a common species, originally described from the West

Indian region, and it is widely distributed both in the Pliocene and Miocene of this general area.

ELPHIDIUM INCERTUM (Williamson)

(See Florida Geol. Survey, Bull. 4, p. 39, pl. 7, figs. 2*a*, *b*, 1930.)

There is considerable difficulty in distinguishing this species from the preceding in the Florida Miocene collections. Most of the specimens which were previously included under this species have now been grouped under *E. poeyanum*. In its present day distribution, *E. incertum* is a more northern, colder water species. There are specimens, however, from one station in the upper Choctawhatchee which seem to be this species.

ELPHIDIUM INCERTUM (Williamson), var.

There are varietal forms in the Chipola which probably belong here, although material is not abundant.

ELPHIDIUM SAGRUM (d'Orbigny)

(See Florida Geol. Survey, Bull. 4, p. 40, pl. 7, figs. 6*a*, *b*, 1930.)

As in the preceding report, the only records for this rather distinctive species are from the *Arca* zone of the Choctawhatchee.

ELPHIDIUM ADVENUM (Cushman)

Plate 11, figures 1*a*, *b*

(See Florida Geol. Survey, Bull. 4, p. 40, pl. 7, figs. 7*a*, *b*, 1930.)

This species has proved to be of rather wide range as shown in the table. It is, however, missing in several of the zones, and is most abundant in the *Cancellaria* and *Arca* zones of the Choctawhatchee.

ELPHIDIUM FIMBRIATULUM (Cushman)

Plate 11, figures 2*a*, *b*

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

Elphidium fimbriatulum Cole, Florida Geol. Survey, Bull. 6, p. 33, pl. 4, fig. 7, 1931.

This species originally described from the Pliocene of Florida seems to occur also in the Choctawhatchee and the upper zone of the Chipola. It is rather abundant at the upper Chipola station from which the figured specimen came. It may be distinguished from the preceding species by the more definite ring at the center, and by the more heavily raised ribs, which are much narrower, leaving the portion with the retral processes much wider.

ELPHIDIUM CHIPOLENSIS (Cushman)

Plate 11, figures 3*a*, *b*

Polystomella chipolensis Cushman, U. S. Geol. Survey Prof. Paper 128-B, p. 72, pl. 11, fig. 23, 1920.

Test with the periphery rounded, composed of ten to twelve chambers in the last-formed coil; chambers fairly distinct, but not inflated; sutures more or less indistinct, due to the surface costae which occupy the whole area between the sutures, and in the earlier portions becoming fused and nearly continuous. Diameter 1.25 mm.

This species was originally described from the Chipola formation. In our later collections it has proved to be common, occurring at all of the stations in the Chipola, both stations in the Oak Grove, and at one station in the Shoal River, and also numerous specimens occurred in the Hawthorn formation on the Suwannee River at White Springs.

It is a striking species with its rounded form and the very long retral processes between the sutures.

ELPHIDIUM (sp?)

(See Florida Geol. Survey, Bull. 4, p. 41, pl. 7, figs. 5a, b, 1930.)

The recent collections gave no further specimens.

Family PENEROPLIDAE

Subfamily Spirolininae

Genus PENEROPLIS Montfort, 1808

PENEROPLIS PROTEUS d'Orbigny

Plate 10, figures 7-11, 14

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

Peneroplis proteus Cushman, Proc. U. S. Nat. Mus., vol. 59, p. 75, pl. 18, figs. 13-19, 1921; Carnegie Instit. Washington, Publ. 311, p. 79, 1922; Publ. 344, p. 83, 1926; U. S. Nat. Mus., Bull. 104, pt. 7, p. 37, pl. 13, figs. 1-17, 1930.

Peneroplis dubius d'Orbigny, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminifères," p. 62, pl. 6, figs. 21, 22, 1839.

Orbiculina adunca H. B. Brady, (part), Rep. Voy. *Challenger*, Zoology, vol. 9, pl. 14, figs. 3, 4, 1884.

Test with the early portion close coiled and completely involute, thickened, later portion assuming various shapes and variously flaring but not becoming entirely embracing; chambers numerous, ten to twelve usually in the coils of the early portion, usually somewhat higher than in most species; sutures distinct, depressed; wall very smooth, thick, usually opaque; apertures formed by the row of pores along the median line of the apertural face. Length up to 2.00 mm.

This species is a very common one, and the most common species of the genus in the warmer regions of the western Atlantic. It is, therefore, interesting to find that it occurs in great abundance in

the Chipola formation. We have it from four of the five stations. As in Recent material there is a great variation in the shape of the test, and the series of figures given here will show some of these.

PENEROPLIS BRADYI Cushman

Plate 10, figures 12, 13

Peneroplis planatus Cushman, (not Fichtel and Moll), Proc. U. S. Nat. Mus., vol. 59, p. 75, pl. 18, fig. 9, 1921; Carnegie Instit. Washington, Publ. 311, p. 79, 1922.

Peneroplis pertusus, var. *planatus* Woodward, The Observer, vol. 4, p. 77, 1893.

Peneroplis bradyi Cushman, U. S. Nat. Mus., Bull. 104, pt. 7, p. 40, pl. 14, figs. 8-10, 1930.

Test small, very greatly compressed, early portion planispirally coiled, usually partially evolute, later portion broadening, forming a flaring test; chambers distinct, long and low; sutures very distinct, depressed; wall finely pitted but not striate; apertures in the central line of the apertural face. Length, usually less than 1.000 mm., often much less.

In the present fauna off the coast of Florida this species is next in abundance to *Peneroplis proteus* d'Orbigny. It is, therefore, not surprising to find it associated with *P. proteus* in the Chipola formation. It is a much thinner form and the early stages are evolute, whereas *P. proteus* is involute throughout.

SORITES (?) sp (?)

Plate 17, figures 1-8

There is in the Chipola marl as one of its most characteristic species, a large, circular, flattened species which is here referred to the genus *Sorites*. In the plate both microspheric and megalospheric forms are figured. The microspheric form has a spherical proloculum followed by an elongate chamber coiled about it, and making a little less than one-half a coil. This is followed by shorter chambers, three or four in number, after which chambers are developed which are low and broad and divided into chamberlets. In the megalospheric form the proloculum is large and polygonal, followed by another large chamber, after which chambers are taken on which are low and broad, and divided into chamberlets. Succeeding chambers quickly become annular, and continue in this manner through the adult stages.

The structure in section is shown in the figures. Chamberlets in the same annular series communicate with the adjacent lateral ones and also with the alternating chamberlets in the next succeeding annular series. This is the structure that Douvillé has shown for the genus *Sorites*. This species from the Miocene of Florida has the structure somewhat modified but it is essentially the same. In

vertical section there are single chambers with several openings through into the adjacent ones in the adult, and single openings in the young stages. On the outer peripheral face the apertures are numerous, arranged in a narrow band in the middle of the face. The pores themselves are of irregular shape and size. They are, therefore, somewhat different from *Sorites marginalis* and other simple species, but while in some ways they resemble *Amphisorus* there are not double series of chambers as in that genus. The whole structure, therefore, is that of *Sorites* although it is more complex than most of the species assigned to that genus.

This form may be identical with *Sorites dominicensis* Ehrenberg described from Santo Domingo, the types of which are in Berlin. It is hoped that these types may be restudied this year, and then it may be definitely determined whether or not the species of the Chipola and that of Santo Domingo are identical. Meanwhile the figures are available for this very striking form.

Figures 4-8 on Plate 17 are from sections and photographs made by Mr. Lloyd G. Henbest of the U. S. Geological Survey.

Family HETEROHELICIDAE

Subfamily Pavonininae

Genus PAVONINA d'Orbigny, 1826

PAVONINA MIOCENICA Cushman and Ponton, n. sp.

Plate 12, figures 19a, b

Test much compressed, flattened sides nearly parallel, periphery of basal portion forming a broad angle, carinate, outer portion forming a broad curve, concave and keeled at each side; early chambers biserial, later ones uniserial, broad and low, curved, extending across the whole outer peripheral face; sutures distinct, not raised, somewhat limbate; wall coarsely perforate; aperture consisting of several small pores irregularly arranged in the outer peripheral face. Length 0.60 mm.; breadth 0.70 mm.; thickness 0.10 mm.

Holotype (Cushman Coll. No. 16334) from the Miocene of Harveys Creek, Sec. 9, T. 1 S., R. 3 W., Leon County.

This is a distinctive new species most closely related to *Pavonina atlantica* Cushman, known in Recent collections from off Florida and the West Indies. It has so far been found only at the type locality of the *Cancellaria* zone of the Choctawhatchee formation.

The incomplete specimens referred to "*Pavonina* sp." in Florida Geol. Survey, Bulletin 4, p. 41, 1930, have been found to belong to *Rectocibicides miocenicus* Cushman and Ponton.

Subfamily Plectofrondiculariinae

Genus PLECTOFRONDICULARIA Liebus, 1903

PLECTOFRONDICULARIA FLORIDANA Cushman

Plate 11, figure 8

(See Florida Geol. Survey, Bull. 4, p. 41, pl. 8, fig. 1, 1930.)

This species as in the previous collections has proved to be an index fossil of the *Arca* zone of the Choctawhatchee formation, being common at those stations and not found elsewhere. It may be easily distinguished from the following species by the decided median keel, and a rounded periphery in addition to the two lateral ones. A figure of this species is given for comparison with the following.

PLECTOFRONDICULARIA MANSFIELDI Cushman and Ponton

Plate 11, figures 7a, b

Plectofrondicularia mansfieldi Cushman and Ponton, Contr. Cushman Lab. Foram. Res., vol. 7, p. 60, pl. 8, figs. 1a, b, 1931.

Test very much compressed, much elongated, very slightly tapering, the later portion with the sides nearly parallel, sides sharply truncate or slightly concave with distinct keels, giving a narrow rectangular shape in end view; chambers numerous, the earliest ones biserial, soon becoming uniserial, and increasing rather rapidly in height toward the apertural end, somewhat inflated; sutures very distinct, slightly depressed, especially in the later portion, usually not distinctly limbate, convexly curved; wall mostly smooth, but the basal end with one or two very short costae; aperture not shown. Length up to 1.50 mm.; maximum breadth 0.25 mm.; thickness 0.12 mm.

Holotype (Cushman Coll. No. 15,483) from the Miocene of Old Frazier Farm NW $\frac{1}{4}$ of SE $\frac{1}{4}$ Sec. 18, T. 2 N., R. 19 S., Walton County.

This species was recently described from the Miocene of Florida, being named for Dr. W. C. Mansfield of the United States Geological Survey, and has proved to be very definite in its distribution. The uppermost occurrence is in the *Yoldia* zone of the Choctawhatchee, and in addition it occurs in all three zones of the Shoal River formation but not elsewhere. It is distinguished by the truncate periphery without the central keel, and the shape of the chambers is quite different, with the sutures also much more curved, not limbate, and much compressed, all characters distinct from those of *P. floridana*. The later chambers become relatively high, and it may be that the broken specimens later referred to the genus *Amphimorphina* may be the adult of this form because they occur at the same stations in the *Yoldia* zone.

Genus AMPHIMORPHINA Neugeboren, 1850

AMPHIMORPHINA sp(?)

Plate 11, figures 4-6

The fragmentary specimens seem to be the end chambers of a form which should be referred to this genus. As they occur with *Plectofrondicularia mansfieldi* it may be that they represent the adult stages of that form. Although the original material was carefully searched no complete specimens were found to settle this point.

Genus NODOGENERINA Cushman, 1927

NODOGENERINA ADVENA Cushman and Laiming

Plate 11, figure 10

Nodogenerina advena Cushman and Laiming, Journ. Pal., vol. 5, p. 106, pl. 11, figs. 19a, b, 1931.

Test elongate, tapering, circular in transverse section; chambers distinct, inflated, closely set, and slightly overlapping, of fairly uniform shape, increasing gradually in size as added, later ones slightly higher than the earlier ones; sutures distinct, depressed; wall smooth, or showing traces of slight roughenings in longitudinal lines; aperture elliptical, extended, with a slight lip. Length 0.60-0.70 mm.; diameter 0.12-0.15 mm.

This small species was originally described from the Miocene of California. It occurs fairly frequently in the *Yoldia* zone of the Choctawhatchee formation, but specimens compared with the types seem to show that the two forms from California and Florida should probably be included under one name.

Family BULIMINIDAE

Subfamily Turriliniinae

Genus BULIMINELLA Cushman, 1911

BULIMINELLA ELEGANTISSIMA (d'Orbigny)

(See Florida Geol. Survey, Bull. 4, p. 42, pl. 8, figs. 2, 3, 1930.)

This has proved to be very widely distributed in the Florida Miocene, occurring at all but four of the stations in the Choctawhatchee formation, and represented also in two zones of the Shoal River, in both stations in the Oak Grove and in the upper zone of the Chipola. It has, however, not occurred in the typical Chipola which is not surprising, as this species is usually found in deeper water than that in which the typical Chipola was deposited.

BULIMINELLA CURTA Cushman

(See Florida Geol. Survey, Bull. 4, p. 43, pl. 8, fig. 4, 1930.)

This species is widely distributed in the Miocene of California and Florida. Well developed specimens occur in the middle portion

of the section, but are absent from the Chipola at the base and from the *Cancellaria* zone of the Choctawhatchee at the top.

BULIMINELLA SUBTERES (H. B. Brady)

Plate 11, figures 9a, b

Bulimina presli Reuss, var. *elegantissima* Parker and Jones, Philos. Trans., vol. 155, p. 374, pl. 15, figs. 12-17, 1865.

Bulimina elegantissima H. B. Brady, (var.) Ann. Mag. Nat. Hist., ser. 5, vol. 1, p. 436, pl. 20, fig. 12, 1878.

Bulimina subteres H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, p. 55, 1881.—J. Wright, Proc. Belfast Nat. Field Club, App., p. 180, pl. 8, figs. 2, 2a, 1880-81.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, p. 403, pl. 50, figs. 17, 18, 1884.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, p. 289, pl. 8, figs. 73, 74, 1893.—Goës, Königl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, p. 46, pl. 9, figs. 445-453, 1894.—Chapman, Rep't Foram. Subantarctic Ids. New Zealand, p. 330, pl. 14, fig. 10, 1909.—Bagg, U. S. Geol. Survey, Bull. 513, p. 39, pl. 9, figs. 7a-d; pl. 11, figs. 1-5, 1912.—Heron-Allen and Earland, Proc. Roy. Irish Acad., vol. 31, pt. 64, p. 62, pl. 4, figs. 13, 14, 1913.

Buliminella subteres Cushman, U. S. Nat. Mus., Bull. 71, pt. 2, p. 89, figs. 142a, b, (in text), 1911.—U. S. Nat. Mus., Bull. 104, pt. 3, p. 110, pl. 22, figs. 3-5, 1922.

Test elongate, ovate, fusiform, the initial end more pointed than the apertural end; chambers oblique, forming two or three irregularly spiral coils, inflated, increasing in size as added; sutures distinct, somewhat depressed; wall usually translucent, smooth, finely perforate; aperture a long, narrow, slightly curved slit at the edge of the ventral face of the chamber, often in a depressed umbilical area. Length 0.25 mm.; breadth 0.12 mm.; thickness 0.10 mm.

This species is represented by a single well developed specimen from a station in the Choctawhatchee formation in the upper *Cancellaria* zone. The species is recorded from numerous stations in the western Atlantic so that its occurrence in the Miocene of Florida is not strange. The reference above to U. S. Nat. Mus., Bulletin 104, will give numerous records for this species which are without figures. Only those references which have figured specimens have been copied here.

Genus *BULIMINA* d'Orbigny, 1826

BULIMINA GRACILIS Cushman

(See Florida Geol. Survey, Bull. 4, p. 43, pl. 8, figs. 5a, b, 1930.)

This species was originally described in Bulletin 4, the above reference. It has been found to be very abundant in the *Arca* zone of the Choctawhatchee formation and much less so in the two higher zones of the Choctawhatchee. In the material from the *Arca* zone

particularly, the test becomes very much elongated and the chambers tend to become biserial or so loosely arranged that they simulate a uniserial form.

BULIMINA GRACILIS Cushman, var. (?)

This is a varietal form which occurs in the typical Shoal River in which there are fine spinose projections at the base of the test. Specimens are fairly rare and some of them tend to become smooth like the typical form. It may later be discovered that this is a definite variety characteristic of this earlier portion of the section.

BULIMINA INFLATA Seguenza

(See Florida Geol. Survey, Bull. 4, p. 43, pl. 8, figs. 6a, b, 1930.)

This species is characteristic of the Choctawhatchee and especially of the *Arca* zone, occurring at all but one of the stations, but in the upper zones occurring at only four stations, and then in very few numbers.

BULIMINA MARGINATA d'Orbigny

Plate 11, figure 12

Bulimina marginata d'Orbigny, Ann. Sci. Nat., vol. 7, p. 269, No. 4, pl. 12, figs. 10-12, 1826.—Parker and Jones, Ann. Mag. Nat. Hist., ser. 2, vol. 19, p. 296, pl. 11, figs. 35-40, 1857.—Balkwill and Wright, Proc. Roy. Irish Acad., ser. 2, vol. 3, p. 547, 1882.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, p. 405, pl. 51, figs. 3-5, 1884.—Cushman, U. S. Nat. Mus., Bull. 104, pt. 3, p. 91, pl. 21, figs. 4, 5, 1922. (For a more complete synonymy of this species see Bulletin 104.)

Bulimina pupoides d'Orbigny, var. *marginata* Williamson, Rec. Foram. Gt. Britain, p. 62, pl. 5, figs. 126, 127, 1858.

Bulimina presli Reuss, var. *marginata* Parker and Jones, Philos. Trans., vol. 155, p. 372, pl. 15, fig. 10; pl. 17, fig. 70, 1865.

Test ovate, somewhat tapering; chambers numerous, inflated, all visible from the exterior, ventral margin of the chambers extending out from the preceding at a definite acute angle, forming a definite rim to the chamber which has a series of short spines or crenulations, the remainder of the chamber smooth and curved; sutures distinct, depressed; wall thin and transparent, usually in older specimens somewhat thickened, white, and nearly opaque; aperture a comma-shaped slit in a slight depression of the inner face of the chamber, often with a slightly raised border.

Specimens referred to this species occur in rather few numbers at three stations in the *Cancellaria* zone of the Choctawhatchee formation but nowhere else in the section. They are similar to this species which is known living off the coast of Florida and widely distributed elsewhere.

BULIMINA BUCHIANA d'Orbigny

Plate 12, figures 1a, b

Bulimina buchiana d'Orbigny, Foram. Foss. Bass. Tert. Vienne, p. 186, pl. 11, figs. 15-18, 1846.—Reuss, Sitz. Akad. Wiss. Wien, vol. 55, p. 95, pl. 4, figs. 10a, b, 1867.—Terrigi, Atti Accad. Pont. Nuovi Lincei, vol. 33, p. 195, pl. 2, fig. 37, 1880.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, p. 407, pl. 51, figs. 18, 19, 1884; Journ. Roy. Micr. Soc., p. 899, 1887.—Wright, Proc. Roy. Irish Acad., ser. 3, vol. 1, p. 474, 1891.—Egger, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, p. 286, pl. 8, figs. 68, 77, 1893.—Chapman, Proc. Zool. Soc., London, p. 22, 1895; Proc. Cal. Acad. Sci., vol. 1, ser. 3, p. 244, pl. 29, fig. 5, 1900; Jour. Quekett Micr. Club, ser. 2, vol. 10, p. 127, pl. 9, fig. 6, 1907.—Bagg, Proc. U. S. Nat. Mus., vol. 34, p. 135, 1908.—Chapman, Journ. Linn. Soc. Zool., vol. 30, p. 403, 1910.—Cushman, U. S. Nat. Mus., Bull. 71, pt. 2, p. 85, figs. 138a, b (in text), 1911.—Pearcey, Trans. Roy. Soc. Edinburgh, vol. 49, p. 1014, 1914.—Chapman, Biol. Results *Endeavour*, vol. 3, pt. 1, p. 18, 1915.—Cushman, U. S. Geol. Survey, Bull. 676, p. 50, 1918; U. S. Nat. Mus., Bull. 100, vol. 4, p. 160, 1921; Bull. 104, pt. 3, p. 95, pl. 20, fig. 4, 1922.

Bulimina prestli Reuss, var. *buchiana* Parker and Jones, Philos. Trans., vol. 155, p. 374, pl. 17, fig. 71, 1865.

Bolivina karreriana Bagg, Proc. U. S. Nat. Mus., vol. 34, p. 138, 1908, (not *B. karreriana* H. B. Brady).

Test ovate, broadest above the middle, composed of numerous inflated chambers, the remainder of the test consisting of longitudinal plate-like costae, confluent from the apex to the base of the last-formed chamber; chambers distinct, inflated, smooth except for the longitudinal costae; sutures distinct, somewhat depressed; wall in young specimens thin and translucent, in the adults thickened and opaque; aperture a loop-like opening of the inner margin of the chamber with a definite margined lip. Length 0.70-0.85 mm.; diameter 0.35-0.40 mm.

This species was originally described by d'Orbigny from the Miocene of the Vienna Basin. It has been rather widely recorded from both fossil and Recent samples. In our recent collections it has been found to be common in the *Yoldia* zone of the Choctaw-hatchee formation, but has not been found above or below this zone in any other Miocene material examined from Florida.

BULIMINA OVATA d'Orbigny

Plate 11, figure 11

Bulimina ovata d'Orbigny, Foram. Foss. Bass. Tert. Vienne, p. 185, pl. 11, figs. 13, 14, 1846.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, p. 400, pl. 50, figs. 13a, b, 1884.—Cushman, U. S. Nat. Mus., Bull. 71, pt. 2, p. 77, figs. 125a-c (in text), 1911; Bull. 100, vol. 4, p. 164, fig. 4 (in text), 1921; Bull. 104, pt. 3, p. 100, pl. 21, fig. 3, 1922.

There are a few smooth specimens from the *Area* zone of the Choctawhatchee formation which are evidently identical with this species described by d'Orbigny from the Miocene of the Vienna Basin. In all the material we have examined it has not occurred in any of the other zones, and is comparatively rare in this one.

Genus *GLOBOBULIMINA* Cushman, 1927

GLOBOBULIMINA PACIFICA Cushman

Plate 12, figure 2

Globobulimina pacifica Cushman, Contr. Cushman Lab. Foram. Res., vol. 3, pt. 1, p. 67, pl. 14, fig. 12, 1927; Bull. Scripps Instit. Oceanography, Tech. Ser., vol. 1, No. 10, p. 153, pl. 3, fig. 1, 1927.—Galloway and Wissler, Journ. Pal., vol. 1, p. 74, pl. 11, fig. 18, 1927.—Cushman and Moyer, Contr. Cushman Lab. Foram. Res., vol. 6, p. 57, 1930.—Cushman, Stewart and Stewart, Trans. San Diego Soc. Nat. Hist., vol. 6, p. 66, pl. 5, fig. 4, 1930.—Cushman and Jarvis, Journ. Pal., vol. 4, p. 362, pl. 33, fig. 6, 1930.—Cushman and Laming, Journ. Pal., vol. 5, p. 108, pl. 12, figs. 1a, b, 1931.—Cushman and Parker, Contr. Cushman Lab. Foram. Res., vol. 7, p. 9, pl. 1, fig. 30, 1931.

Test subglobular in the adult with the last three chambers making up the exterior by enclosing the preceding ones; sutures distinct, slightly depressed; wall very thin, finely perforate, smooth; aperture loop-shaped, with a slight border, a broad apertural tooth or plate, and an internal spiral tube.

This species is known from Recent to Miocene. Most of the records are from the Pacific coast of the United States, but it has also been recorded from the Miocene of Buff Bay, Jamaica. In the Florida Miocene it has occurred at a single station in the middle zone of the Shoal River formation.

Genus *VIRGULINA* d'Orbigny, 1826

VIRGULINA PUNCTATA d'Orbigny

(See Florida Geol. Survey, Bull. 4, p. 44, pl. 8, figs. 7a, b, 1930.)

This species has been found to be much more abundant in our later material than in the earlier collections, occurring in the three upper zones of the Choctawhatchee and the middle zone of the Shoal River. It is a widely distributed species in the present warm waters off Florida and also in the Miocene of the general Gulf and West Indian region.

VIRGULINA FUSIFORMIS Cushman

(See Florida Geol. Survey, Bull. 4, p. 45, pl. 8, figs. 8a, b, 1930.)

Our later collections show that this species which was originally described in Bulletin 4 is limited to the same zones from which it was described, namely the *Cancellaria* and *Ecphora* zones of the Choctawhatchee. It is a peculiar small species with a very definite

shape and very small aperture, and could hardly be confused with any other species.

VIRGULINA PONTONI Cushman

Plate 12, figures 10, 11

Virgulina floridana Cushman and Laiming (not Cushman, 1920), Journ. Pal., vol. 5, p. 109, pl. 12, figs. 3a, b, 1931.

Virgulina pontoni Cushman, Contr. Cushman Lab. Foram. Res., vol. 8, p. 17, pl. 3, fig. 7, 1932.

Test elongate, tapering, greatest breadth toward the apertural end, somewhat compressed; chambers fairly numerous, elongate, slightly inflated; sutures distinct, depressed; wall smooth, finely perforate; aperture comparatively large and broad. Length 0.60 mm.; breadth 0.20 mm.

This species was originally described from the Oak Grove sand of Yellow River, Okaloosa County, Florida. It has been found in our recent collections in the upper and lower beds of the Shoal River formation, at both stations in the Oak Grove, and at four of the five stations in the Chipola. It thus has a much lower range in the section than either of the other forms, and is the only member of the genus to appear in the Chipola. It is apparently replaced in the Choctawhatchee formation by *V. punctata*.

Subgenus **VIRGULINELLA Cushman, 1932**

VIRGULINA (VIRGULINELLA) GUNTERI Cushman

Plate 12, figure 7

(See Florida Geol. Survey, Bull. 4, p. 44, pl. 9, figs. 1, 2, 1930.)

This species described from the Choctawhatchee formation is most abundant in the *Arca* zone, but occurs much less abundantly in the *Cancellaria*, *Ecphora* and *Yoldia* zones, and specimens referred to it occur in the upper beds of the Shoal River formation, but it is missing from the other zones. It is, however, replaced by the following variety in the *Ecphora* zone and by *V. miocenica* in the lower portion of the section.

VIRGULINA (VIRGULINELLA) GUNTERI Cushman, var. CURTATA
Cushman and Ponton

Plate 12, figure 8

Virgulina gunteri Cushman, var. *curtata* Cushman and Ponton, Contr. Cushman Lab. Foram. Res., vol. 8, p. 4, pl. 1, fig. 2, 1932.

Variety differing from the typical in the short rounded form and comparatively few chambers.

Holotype of variety (Cushman Coll. No. 16,304) from Darling Slide in the *Ecphora* zone of the Choctawhatchee formation.

This peculiar short rounded form takes the place of the typical in the *Ecphora* of the Choctawhatchee, and at some of the stations becomes very abundant.

VIRGULINA (VIRGULINELLA) MIOCENICA Cushman and Ponton

Plate 12, figure 9

Virgulina miocenica Cushman and Ponton, Contr. Cushman Lab. Foram. Res., vol. 7, p. 32, pl. 4, figs. 14-16, 1931.

Test elongate, slender, somewhat compressed, gradually tapering from the subacute initial end to the greatest breadth formed by the last two chambers, somewhat twisted; chambers numerous, distinct, inflated; sutures distinct, depressed, marked by numerous depressions, the sides of which extend backward to the preceding chamber in short distinct processes; wall except for the markings of the sutures, smooth, very finely perforate; aperture very elongate, narrow, slightly curved, running nearly from the apex of the last-formed chamber to the inner margin. Length 0.75-0.90 mm.; breadth 0.25-0.30 mm.; thickness 0.20-0.25 mm.

Holotype (Cushman Coll. No. 15481) from the Miocene, Shoal River formation, Shell Bluff, Walton County.

In the lower part of the section this species occurs from the lower portion of the *Arca* zone of the Choctawhatchee as its upper limit to the Oak Grove, but does not occur in the Chipola. It is very different in shape from *V. gunteri*, having its greatest width toward the apertural end and usually slender and tapering.

Genus **BOLIVINA** d'Orbigny, 1839

BOLIVINA MARGINATA Cushman

Bolivina marginata Cushman, U. S. Geol. Survey, Bull. 676, p. 48, pl. 10, fig. 1, 1918; Contr. Cushman Lab. Foram. Res., vol. 1, p. 30, pl. 5, figs. 5a, b, 1925; Florida Geol. Survey, Bull. 4, p. 45, pl. 8, figs. 9a, b, 1930.—Cushman and Laiming, Journ. Pal., vol. 5, p. 110, pl. 12, figs. 6-8, 1931.—Cushman and Parker, Contr. Cushman Lab. Foram. Res., vol. 7, p. 9, pl. 2, fig. 1, 1931.

Test much compressed, of medium size for the genus, periphery acute, keeled throughout or sometimes obsolete at the apertural end; sutures usually distinctly limbate, oblique; chambers numerous, distinct, seven or eight chambers making up the last half of the test, earlier ones long and narrow, later ones much higher; wall thin, rather coarsely perforate, surface smooth; aperture elongate, narrow. Length usually less than 1.00 mm.; breadth 0.25-0.30 mm.; thickness 0.12-0.15 mm.

This species which is now known from the Miocene of Florida and California was previously recorded from the Choctawhatchee forma-

tion. It occurs in the *Eophora*, *Arca* and *Yoldia* zones of the Choctawhatchee as well as in all three zones of the Shoal River, but is apparently absent from the upper portion of the Choctawhatchee and from the lower Miocene series included in the Oak Grove and Chipola.

BOLIVINA MARGINATA Cushman, var. **MULTICOSTATA** Cushman

Bolivina aenariensis (Costa), var. *multicostata* Cushman, U. S. Geol. Survey, Bull. 676, p. 48, pl. 10, fig. 2, 1918.

Bolivina marginata Cushman, var. *multicostata* Cushman, Florida Geol. Survey, Bull. 4, p. 46, pl. 8, figs. 13, 14, 1930.

Variety differing from the typical in the ornamentation of the test which consists of a series of longitudinal costae of varying lengths.

The varietal form of the species is slightly more restricted than the typical smooth form according to our records, but the two are usually found associated with one another.

BOLIVINA FLORIDANA Cushman

Bolivina floridana Cushman, U. S. Geol. Survey, Bull. 676, p. 49, pl. 10, fig. 4, 1918.—Nuttall, Quart. Journ. Geol. Soc., vol. 84, p. 74, 1928.—Cushman, Contr. Cushman Lab. Foram. Res., vol. 5, p. 93, 1929; Florida Geol. Survey, Bull. 4, p. 46, pl. 8, figs. 15a, b, 1930.—Cushman and Parker, Contr. Cushman Lab. Foram. Res., vol. 7, p. 9, pl. 2, fig. 2, 1931. *Bolivina decussata* Cushman (not H. B. Brady), Contr. Cushman Lab. Foram. Res., vol. 1, pt. 2, p. 31, pl. 5, figs. 6a, b, 1925; vol. 2, pt. 3, p. 54, 1926.

This is a widely distributed Miocene species now known from Florida, Trinidad, Venezuela, and California. In our recent material from Florida this species is limited to the *Arca* and *Yoldia* zones of the Choctawhatchee, the *Cardium* bed and the middle zone of the Shoal River formation.

BOLIVINA PLICATELLA Cushman

Bolivina plicatella Cushman, Florida Geol. Survey, Bull. 4, p. 46, pl. 8, figs. 10a, b, 1930.—Cole, Florida Geol. Survey, Bull. 6, p. 41, 1931.

This species in our recent collections was limited to the *Cancellaria* zone of the Choctawhatchee, but in Bulletin No. 4 was recorded from four stations in the *Eophora* zone. It is also recorded by Cole from the Pliocene of Florida.

BOLIVINA PLICATELLA Cushman, var. **MERA** Cushman and Ponton, n. var.

Plate 12, figures 4a, b

Variety differing from the typical in the much less excavated middle line, but otherwise having many of the characteristics of this species.

Holotype of variety (Cushman Coll. No. 16320) from the Oak Grove sand from Tanner's Mill, 4 miles southwest of Laurel Hill, Okaloosa County.

At this locality this variety is very common. It is apparently a primitive form of *B. plicatella* in which the characters are not fully developed. The coarse perforations of the test and slight twisting are very similar. It occurs only in the Oak Grove sand and the typical Chipola.

BOLIVINA PULCHELLA d'Orbigny, var. **PRIMITIVA** Cushman

Bolivina pulchella d'Orbigny, var. *primitiva* Cushman, Florida Geol. Survey, Bull. 4, p. 47, pl. 8, figs. 12a, b, 1930.—Cole, Florida Geol. Survey, Bull. 6, p. 41, pl. 2, fig. 10, 1931.

This form occurs only in the *Cancellaria* zone of the upper Choctawhatchee formation, and it is interesting to note that it is also recorded by Cole from the Pliocene of Florida.

BOLIVINA ADVENA Cushman

Plate 12, figure 3

Bolivina advena Cushman, Contr. Cushman Lab. Foram. Res., vol. 1, pt. 2, p. 29, pl. 5, figs. 1a, b, 1925; vol. 2, pt. 3, p. 54, 1926.—Cushman, Stewart and Stewart, Trans. San Diego Soc. Nat. Hist., vol. 6, p. 67, 1930.

Test of early portion compressed, later portion thickened, periphery rounded, increasing gradually in width toward the apertural end; early chambers low, close set, not inflated, later ones higher and more inflated; sutures of the early portion limbate, in the later portion narrow and somewhat depressed; wall smooth but distinctly perforate.

This species originally described from California occurs in typical form but in few numbers in the *Arca* zone of the Choctawhatchee formation.

BOLIVINA ROBUSTA H. B. Brady

Plate 12, figure 5

Bolivina robusta H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, p. 57, 1881; Rep. Voy. *Challenger*, Zoology, vol. 9, p. 421, pl. 53, figs. 7-9, 1884.

There is a single specimen from one of the stations in the middle zone of the Shoal River formation. It is here figured, and seems to be identical with Brady's species which has been widely recorded from Eocene to Recent material. It is characterized by the lobe toward the inner margin of each chamber in the adult. It is somewhat similar to *B. alazanensis* Cushman, but is not keeled nor is the central line raised.

BOLIVINA PAULA Cushman and Cahill (MS.), n. sp.

Plate 12, figures 6a, b

Test minute, much compressed, periphery subacute, sides for the most part nearly parallel, initial end tapering; chambers numerous, often twelve or more pairs in the adult test, increasing somewhat in height as added, some of the earliest ones being very low; sutures distinct, very slightly if at all depressed, slightly limbate, rather strongly curved backward; wall smooth, finely perforate; aperture an elongate, somewhat comma-shaped opening in the median line of the apertural face. Length 0.30-0.35 mm.; breadth 0.15 mm.; thickness 0.06-0.08 mm.

This species known from the Miocene of Chesapeake Beach, Maryland, occurs rather widely distributed in the various members of the Miocene of Florida, and is a small inconspicuous species and likely to be overlooked.

Genus **LOXOSTOMUM** Ehrenberg, 1854**LOXOSTOMUM GUNTERI** Cushman

(See Florida Geol. Survey, Bull. 4, p. 47, pl. 8, figs. 11a, b, 1930.)

Our material adds nothing further to the distribution of this species which is confined to the *Arca* zone of the Choctawhatchee formation.

Subfamily Reussiinae

Genus **REUSSIA** Schwager, 1877**REUSSIA SPINULOSA** (Reuss)

Plate 12, figures 14-16

(See Florida Geol. Survey, Bull. 4, p. 48, pl. 8, figs. 17a, b, 1930.)

The development of this species in the various members of the Miocene of Florida is an interesting one. The species occurs in the *Cancellaria* zone of the Choctawhatchee where it develops chambers which are very angled, and at the basal margin project strongly. These projections are not only spinose, but represent very distinct angular projections of the chambers themselves under the general margin. This form is most common in the *Cancellaria* zone. A varietal form occurs in the *Arca* zone of the Choctawhatchee where it has smooth margins with almost no trace of spines, and is not seen again until in the typical Oak Grove marl where specimens occur which are somewhat spinose at the margin but the chambers are not usually as projecting as in the development of the species in the *Cancellaria* zone of the Choctawhatchee. These three forms may be distinguished but the first and third occur together, and as the species is a variable one, it seems a question as to whether definite names should be given to these three forms even though they have

somewhat distinctive ranges in the Florida Miocene. All three forms are here figured for comparison.

Genus *CHRYSALIDINELLA* Schubert, 1907

CHRYSALIDINELLA PULCHELLA (Cushman)

(See Florida Geol. Survey, Bull. 4, p. 48, pl. 8, figs. 16a, b, 1930.)

This species is most common in the *Arca* zone of the Choctawhatchee, but is widely distributed, occurring in the *Cancellaria* zone, as well as in the upper bed of the Shoal River formation, and in the Oak Grove. Being a rather deep water species it is not strange to find that it does not occur in the shoal water material of the Chipola.

Subfamily Uvigerininae

Genus *UVIGERINA* d'Orbigny, 1826

UVIGERINA PEREGRINA Cushman

Uvigerina pygmaea Flint (not *U. pigmea* d'Orbigny), Rep't U. S. Nat. Mus., p. 320, pl. 68, fig. 2, 1897 (1899).

Uvigerina cf. *pygmaea* Cushman, Florida Geol. Survey, Bull. 4, p. 49, pl. 9, figs. 3-6, 1930.

Uvigerina peregrina Cushman, U. S. Nat. Mus., Bull. 104, pt. 4, p. 166, pl. 42, figs. 7-10, 1923; Bull. Scripps Instit. Oceanography, Tech. Ser., vol. 1, No. 10, p. 158, pl. 3, fig. 13, 1927.—Galloway and Wissler, Journ. Pal., vol. 1, p. 76, pl. 12, figs. 1, 2, 1927.—Church, Journ. Pal., vol. 1, p. 268, 1928.—R. E. and K. C. Stewart, Bull. Amer. Assoc. Petr. Geol., vol. 14, p. 1448, 1930.—Cushman, Stewart and Stewart, Trans. San Diego Soc. Nat. Hist., vol. 6, p. 69, pl. 5, fig. 11, 1930.

Test elongate, about two and one-half times as long as broad, widest in the middle, ends rounded; chambers fairly numerous, inflated, distinct; sutures depressed but the line of the sutures indistinct; wall ornamented with longitudinal costae, about ten on a full-grown chamber, those of each chamber usually not continuous with those of adjacent chambers, high and very thin and sharp, toward the basal and apertural ends of the test becoming broken up into spinose or irregular short portions, the wall between the costae and the costae themselves distinctly granular; aperture circular, at the end of a distinct cylindrical neck, often spinose and with a phialine lip.

The species has been recorded as *Uvigerina pigmea* d'Orbigny in the Tertiary and Recent collections off both coasts of America, and evidently ranges as far back as the Miocene. This species like most of those of the genus is variable, but *U. pigmea* d'Orbigny is now established as a definite species of entirely different characters (See Cushman, Contr. Cushman Lab. Foram. Res., vol. 6, 1930, p. 62, pl. 9, figs. 14-20).

This species originally described from the West Indian region is now known from the Miocene, Pliocene, and Pleistocene of Florida, and from the Miocene of California. It is rather widely distributed, occurring in all the formations of the Miocene of Florida but not at all the zones. It is most common in the upper *Cancellaria* zone of the Choctawhatchee.

Family ELLIPSOIDINIDAE

Genus ELLIPSOLAGENA A. Silvestri, 1923

ELLIPSOLAGENA BIDENS Cushman

(See Florida Geol. Survey, Bull. 4, p. 50, pl. 9, figs. 11a, b, 1930.)

In our newer material this species originally described in Bulletin 4, and recorded mainly from the *Arca* zone of the Choctawhatchee, with a single station in the *Ecphora* zone, has occurred only in the *Arca* zone. It is, therefore, to be considered a characteristic species of this portion of the Choctawhatchee.

Family ROTALIIDAE

Subfamily Spirillininae

Genus SPIRILLINA Ehrenberg, 1841

SPIRILLINA ORBICULARIS Bagg

(See Florida Geol. Survey, Bull. 4, p. 51, pl. 9, figs. 12a, b, 1930.)

This species is apparently very rare and did not occur in our recent collections.

Subfamily Discorbisinae

Genus PATELLINA Williamson, 1858

PATELLINA CORRUGATA Williamson

Plate 13, figures 1a, b

Patellina corrugata Williamson, Recent Foram. Gt. Britain, p. 46, pl. 3, figs. 86-89, 1858.

Test usually free, conical, or plano-convex, early portion composed of chambers spirally arranged, later ones elongating and finally becoming annular or nearly so in the last-formed portion of the test; chambers partially divided by internal septa which are visible from the exterior, showing clearly in the last-formed chambers from the ventral side; somewhat umbilicate ventrally; walls comparatively thin and translucent; aperture somewhat elongate, situated at the inner border of the chamber.

This species is rare in the Miocene of Florida, occurring at but two stations in the *Cancellaria* zone of the Choctawhatchee. The specimens are fairly typical, and one of them is figured. For additional references to this species see Cushman, U. S. Nat. Mus., Bull. 104, pt. 8, p. 11, 1931.

Genus DISCORBIS Lamarck, 1804

DISCORBIS FLORIDANA Cushman

Plate 13, figures 2a-c

Discorbis floridana Cushman, Carnegie Instit. Washington, Publ. 311, p. 39, pl. 5, figs. 11, 12, 1922; U. S. Nat. Mus., Bull. 104, pt. 8, p. 21, pl. 4, figs. 7, 8, 1931.

Discorbis rosacea Cushman (not d'Orbigny), Florida Geol. Survey, Bull. 4, p. 51, pl. 9, figs. 13a-c, 1930.

Discorbis subaraucana Cushman, Florida Geol. Survey, Bull. 4, p. 52, pl. 10, figs. 1a-c (not Cushman, 1922), 1930.

Test rotaliform, periphery slightly, if at all, lobulated, dorsal side rounded, much convex, ventral side concave, somewhat umbilicate; chambers comparatively few, five or six in the last-formed coil, on the dorsal side coarsely punctate, on the ventral side punctate near the periphery, but on the inner concave portion smooth, with very fine punctae, if any; sutures in the younger portion slightly limbate, aperture an elongate, arched opening at the base of the last-formed chamber, opening on the umbilicate area, often with a slight lip.

This species originally described from the Tortugas region of Florida and occurring also in the West Indies is common in the *Cancellaria* zone and much less common in the *Ecphora* and *Arca* zones of the Choctawhatchee formation. The specimens referred to as *Discorbis rosacea* in Florida Geol. Survey, Bulletin 4, p. 51, pl. 9, figs. 13a-c, 1930, are probably referred to this species, as the original *Rotalia rosacea* d'Orbigny has proved from a study of the original model of that species to belong to *Amphistegina*, and the specimens referred to *Discorbis subaraucana* in the previous bulletin have been all referred to *Discorbis floridana* in our revision of that material.

DISCORBIS CONSOBRINA (d'Orbigny)

Plate 13, figures 3a-c

Rosalina consobrina d'Orbigny, Voy. Amér. Mérid., vol. 5, pt. 5, "Foraminifères," p. 46, pl. 7, figs. 4-6, 1839.

Discorbis consobrina Cushman and Kellett, Proc. U. S. Nat. Mus., vol. 75, Art. 25, p. 10, pl. 4, figs. 1, 2, 1929.—Cushman, Florida Geol. Survey, Bull. 4, p. 53, pl. 10, figs. 4a-c, 1930.

Specimens referred to this species occurred in samples from both the *Cancellaria* and *Ecphora* zones of the Choctawhatchee formation.

DISCORBIS CANDEIANA (d'Orbigny)

Plate 13, figures 4a-c

Rosalina candeiana d'Orbigny, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminifères," p. 97, pl. 4, figs. 2-4, 1839.

Truncatulina candeiana Cushman, Proc. U. S. Nat. Mus., vol. 59, p. 57, pl. 13, figs. 4, 5, 1921; Carnegie Instit. Washington, Publ. 311, p. 47, pl. 6, figs. 7-9, 1922; Publ. 344, p. 78, 1926.

Discorbina orbicularis H. B. Brady, Rey. Voy. *Challenger*, Zoology, vol. 9, p. 647, pl. 88, figs. 4-8, 1884.

Discorbis mira Cushman, Florida Geol. Survey, Bull. 4, p. 52, pl. 10, figs. 2a-c, 1930.

Test plano-convex, the dorsal side forming a low cone, ventrally flat or more often somewhat concave, circular in outline, periphery acute; chambers elongate, each often making nearly half of the circumference, distinct; sutures slightly depressed, distinct; wall finely to coarsely perforate, smooth; aperture ventral, an elongated opening beneath the somewhat extended central portion of the last-formed chamber.

This species is very abundant in the shallow water off the coast of Florida and in the general West Indian region. In the Miocene of Florida it seems to be limited to the Choctawhatchee formation in the *Cancellaria* zone. This is the species which was referred to in Bulletin 4 as *Discorbis mira* (p. 52, pl. 10, figs. 2a-c). It is not the same as the *D. mira* described from the Tortugas.

DISCORBIS VALVULATA (d'Orbigny)

Rosalina valvulata d'Orbigny, Ann. Sci. Nat., vol. 7, p. 271, No. 4, 1826; in De la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminifères," p. 96, pl. 3, figs. 21-23, 1839; in Barker, Webb and Berthelot, Hist. Nat. Iles Canaries, "Foraminifères," p. 136, pl. 2, figs. 19-21, 1839.

Discorbina valvulata Jones and Parker (?), Quart. Journ. Geol. Soc., vol. 28, p. 114, 1872.—Goës, Kongl. Svensk. Vet.-Akad. Handl., vol. 19, No. 4, p. 106, pl. 8, figs. 258-261, 1882.—Woodward, The Observer, vol. 4, p. 176, 1893.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, p. 69, 1896.

Discorbis valvulata Cushman, Proc. U. S. Nat. Mus., vol. 59, p. 59, pl. 14, figs. 4, 5, 1921; Carnegie Instit. Washington, Publ. 344, p. 78, 1926; Florida Geol. Survey, Bull. 4, p. 53, pl. 10, figs. 5a-c, 1930.

Test longer than broad, plano-convex, spire very low and compressed, ventral side flattened or concave, periphery with a rounded keel; chambers distinct, increasing rather rapidly in size, on the ventral side with a distinct valvular lip over the umbilical region; sutures on the dorsal side somewhat thickened, not depressed, curved, ventrally sinuate; wall smooth, finely perforate; aperture elongate, narrow, below the valvular projection of the chamber near the umbilicus.

This species is not at all common, but we have found occasional specimens which may be referred to it from rather widely separated parts of the section as will be shown by the table. As a Recent species it is also rather widely distributed in the West Indian region, but is never represented by many specimens at any one station.

Genus LAMARCKINA Berthelin, 1881

LAMARCKINA ATLANTICA Cushman

Plate 13, figures 7a-c

Lamarckina atlantica Cushman, U. S. Nat. Mus., Bull. 104, pt. 8, p. 35, pl. 7, figs. 7a-c, 1931.

Test slightly longer than broad, biconvex, ventral side the more strongly convex, umbilicate, periphery keeled and subacute; chambers rapidly increasing in size as added, the last-formed chamber on the ventral side making up nearly half the area of the test; sutures slightly limbate, slightly depressed on the dorsal side, more strongly so on the ventral side; all very slightly roughened on the dorsal side, smooth and polished on the ventral side; aperture at the umbilical end of the chamber ventrally.

This species was originally described from off the coast of Florida in 22 fathoms. The only record for it in our Miocene material is from the middle zone of the Shoal River formation where it is well developed and fairly common. The species is evidently the same as the Recent one from the same general region. It is most easily confused with *Canceris sagra* with which it occurs at this station, but the *Lamarckina* has very strongly limbate sutures in the early portion which are raised above the surface, the ventral side, as usual in the genus, is highly polished, and the umbilical depression is large and deep.

Genus VALVULINERIA Cushman, 1926

VALVULINERIA FLORIDANA Cushman

(See Florida Geol. Survey, Bull. 4, p. 54, pl. 10, figs. 6a-c, 1930.)

Test biconvex, somewhat involute on the dorsal side, almost completely so on the ventral side, periphery rounded, early portion somewhat angled; chambers inflated, especially on the ventral side, very distinct; sutures distinct, nearly radial, only slightly curved, not limbate; wall smooth, polished; aperture below the distinct plate-like extension of the umbilical end of the chamber.

This species was described from the *Arca* zone of the Choctawhatchee formation in Bulletin 4. We have found it to be rather widely distributed in our further studies. Outside the original position in the *Arca* zone we have a single station in the *Ecphora* zone, but none in either the *Cancellaria* zone of the Choctawhatchee or the Oak Grove sand. It has, however, occurred at all three zones of the Shoal River and also in the Chipola formation. It has as a whole a polished test and distinct flap-like extension from the aperture which distinguished it from the other related forms from the Florida Miocene.

Subfamily Rotaliinae

Genus EPONIDES Montfort, 1808

EPONIDES MANSFIELDI Cushman

(See Florida Geol. Survey, Bull. 4, p. 54, pl. 11, figs. 1a-c, 1930.)

This species previously described from the Choctawhatchee occurs abundantly in the lower zones particularly, and occurs also in two zones of the Shoal River, but we have no specimens from either the Oak Grove or the Chipola formation. It has been recorded from the Miocene of California, and also occurs in the Miocene of the Atlantic Coastal Plain northward from Florida. There is considerable variation in the amount of the limbation of the sutures of the dorsal side and of the granular character of the ventral side.

EPONIDES LATERALIS (Terquem)

Plate 13, figures 8a-c

(See Florida Geol. Survey, Bull. 4, p. 55, pl. 10, figs. 7a-c, 1930.)

In the previous bulletin this species was recorded from two stations in the *Cancellaria* zone of the Choctawhatchee formation. Our later studies have shown it to be confined to that portion of the section, but we have it from numerous stations within that zone. It is somewhat similar to the following species, both of which are figured here for comparison. *E. lateralis* is usually a much more compressed species with the dorsal side very strongly limbate, the sutures raised, and the ventral side of the last-formed chamber with large perforations.

EPONIDES REPANDUS (Fichtel and Moll)

Plate 13, figures 9a-c

Nautilus repandus Fichtel and Moll, Test. Micr., p. 35, pl. 3, figs. a-d, 1798.*Eponides repandus* Montfort, Conch. Syst., vol. 1, p. 127, 32e genre, 1808.—

Cushman, Contr. Cushman Lab. Foram. Res., vol. 3, pl. 16, fig. 9, 1927;

Cushman Lab. Foram. Res., Special Publ. No. 1, pl. 40, fig. 1; pl. 41,

fig. 9, 1928.—Cushman and Kellett, Proc. U. S. Nat. Mus., vol. 75,

Art. 25, p. 11, pl. 4, figs. 7a-c, 1929.—Cushman, U. S. Nat. Mus., Bull.

104, pt. 8, p. 49, pl. 10, figs. 7a-c, 1931.

Pulvinulina repanda Carpenter, Introd. Foram., p. 210, 1862.—H. B. Brady,

Rep. Voy. Challenger, Zoology, vol. 9, p. 684, pl. 104, figs. 18a-c, 1884.

This species differs from the preceding in the Miocene material, in the shape of the test which is strongly plano-convex, the dorsal side being usually flattened and the ventral side strongly convex, the chambers fewer, usually five or six, and the last chamber usually without perforations. This species which is characteristic of warm shallow water, frequently has the wall flaked off due to its structure and ease of erosion so that the characters are often obscured. Our

specimens are only from the Chipola formation where it is not common. It is recorded living from numerous stations off the coast of Florida in comparatively shallow water.

EPONIDES ANTILLARUM, (d'Orbigny)

Plate 14, figures 1a-c

Rotalina antillarum d'Orbigny, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminifères," p. 75, pl. 5, figs. 4-6, 1839.

Truncatulina antillarum Fornasini, Mem. Accad. Sci. Istit. Bologna, ser. 5, vol. 10, p. 63, 1902.—Cushman, Proc. U. S. Nat. Mus., vol. 59, p. 57, pl. 13, figs. 6-8, 1921; Carnegie Instit. Washington, Publ. 311, p. 48, 1922.

Pulvinulina incerata Cushman, Carnegie Instit. Washington, Publ. 311, p. 51, pl. 9, figs. 1-3, 1922; Publ. 344, p. 79, 1926.

Eponides antillarum Cushman, U. S. Nat. Mus., Bull. 104, pt. 8, p. 42, pl. 9, figs. 2a-c, 1931.

Test unequally biconvex, dorsal side somewhat more convex than the ventral, periphery subacute; chambers numerous, seven or eight in the last-formed coil; sutures oblique, rather indistinct and very slightly if at all depressed on the dorsal side, nearly radiate and somewhat depressed on the ventral side; wall fairly thick, finely punctate, otherwise smooth, ventrally somewhat umbilicate, the apertural face of the last-formed chamber obliquely angled; aperture elongate, at the base of the last-formed chamber.

d'Orbigny described this species in his Cuban monograph, and it has been largely neglected since. It is, however, common off the coast of Florida and in the West Indies. It has proved to be rare in our collections from the Miocene, and the only stations are from the middle zone of the Shoal River and a single station in the Chipola. The species is a very well characterized one, and probably represents a later development of the general form recorded from the Eocene and Oligocene of the general Gulf Coastal Plain as *E. byramensis*, *E. jacksonensis*, etc.

Genus ROTALIA Lamarck, 1804

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

(See Florida Geol. Survey, Bull. 4, p. 56, pl. 11, figs. 3a-c, 1930.)

This variety was previously recorded in Bulletin 4 from the upper three zones of the Choctawhatchee formation. In our more recent collections we have it from a number of stations in the *Cancellaria* zone and at one station in the *Yoldia* zone of the Choctawhatchee, and specimens also from the *Cardium* bed and the middle zone of the Shoal River, from the Oak Grove, and at one station in the Chipola formation.

Subfamily Siphonininae

Genus SIPHONINA Reuss, 1849

SIPHONINA JACKSONENSIS Cushman and Applin, var. LIMBOSA Cushman

Plate 14, figures 2a-c

Siphonina jacksonensis Cushman and Applin, var. *limbosa* Cushman, Proc. U. S. Nat. Mus., vol. 72, Art. 20, p. 5, pl. 4, fig. 2, 1927.

We have a single specimen from the middle zone of the Shoal River formation which is here figured and which resembles very strongly this species originally described from the Alazan Clay of Mexico. The periphery is somewhat keeled and serrate while the sutures are very limbate in character.

Subfamily Baggininae

Genus CANCRIS Montfort, 1808

CANCERIS SAGRA (d'Orbigny)

Plate 14, figures 3a-c

(See Florida Geol. Survey, Bull. 4, p. 56, pl. 11, figs. 4a-c, 1930.)

This species is one of the most abundant in the Florida Miocene, occurring at nearly all the stations in the four zones of the Choctawhatchee and at all of the stations in the Shoal River, but there are no specimens from the Oak Grove or the Chipola formations. This is probably accounted for by the fact that the species is usually more common in fairly deep water although there are records for it in shoal water off the coast of Florida and in the West Indies. At some stations the species shows a great deal of variation in the position of the chambers, especially the last ones which are added in a different plane from the previous ones. The last chambers are also often very much expanded and rounded. It may be distinguished from *Lamarckina* by the ventral surface which is very finely perforate instead of being polished and does not have an open umbilical area. The last chamber also has a clear lunate area at the ventral side.

Family AMPHISTEGINIDAE

Genus ASTERIGERINA d'Orbigny, 1839

ASTERIGERINA CARINATA d'Orbigny

Asterigerina carinata d'Orbigny, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminifères," p. 118, pl. 5, fig. 25, pl. 6, figs. 1, 2, 1839.—Cushman, Carnegie Instit. Washington, Publ. 291, p. 45, 1919; Proc. U. S. Nat. Mus., vol. 59, p. 60, pl. 14, figs. 6-8, 1921; Carnegie Instit. Washington, Publ. 311, p. 54, pl. 9, figs. 4-6, 1922; Cushman Lab. Foram. Res., Special Publ. No. 1, pl. 42, fig. 1; pl. 44, fig. 4, 1928; U. S. Nat. Mus., Bull. 104, pt. 8, p. 77, pl. 15, figs. 4, 5, 1931.

Test unequally biconvex, coiled, the dorsal side very slightly convex, the ventral side strongly so, almost conical; chambers numer-

ous, about three coils, six or seven forming the last-formed coil; sutures oblique, very slightly limbate, produced to form a slight translucent keel, sutures curved and oblique on the dorsal side, on the ventral side the supplementary chambers extending nearly to the periphery, forming rhomboid areas, sutures distinct and depressed; wall smooth, finely punctate and usually glistening, often somewhat roughened by lines of small granules near the aperture, which is an elongate, narrow slit, extending from the umbilical region about halfway to the periphery, and usually with a slight thin lip.

This is a rather common and characteristic West Indian species particularly in shallow water. It is one of those species that would be expected to be found rather commonly in the Chipola samples as the conditions in which they were deposited must have been very close to those of the warm shallow waters of the West Indian region at the present time. It is very surprising, therefore, to have found only one specimen in the Chipola formation.

ASTERIGERINA MIOCENICA Cushman and Ponton, n. sp.

Plate 14, figures 4a-c

Test small, much compressed, nearly equally biconvex, periphery with a distinct, thin keel of clear shell material; six or seven chambers in the last-formed whorl, large, with the intermediate asterigerine chambers small; sutures not limbate nor depressed; wall rather coarsely perforate; aperture on the ventral side, small, midway between the umbilical area and the periphery along the ventral margin of the chamber.

Holotype (Cushman Coll. No. 16322) from the Oak Grove sand at Tanner's Mill (Old Senterfeit's Mill) 4 miles southwest of Laurel Hill, Okaloosa County.

This is a very small inconspicuous species, and has only occurred at the type station from which there are several specimens. It is a much smaller and a much more compressed species than the preceding.

Genus AMPHISTEGINA d'Orbigny, 1826

AMPHISTEGINA LESSONII d'Orbigny

Plate 14, figures 5a-c

(See Florida Geol. Survey, Bull. 4, p. 57, pl. 11, figs. 5a-c, 1930.)

Rather typical specimens of this species, which has previously been recorded from the upper *Cancellaria* zone of the Choctawhatchee, were found at two stations. They are large and well developed with a subacute periphery, and the test lenticular, often slightly more convex on one side than on the other. This is close to Recent material from the West Indies. There are rather fragmentary specimens from

two stations in the *Arca* zone of the Choctawhatchee which are not well enough preserved to be given any specific determination, but which in some respects resemble this species rather than the following.

AMPHISTEGINA FLORIDANA Cushman and Ponton, n. sp.

Plate 14, figures 6, 7

Test fairly large, usually plano-convex or unequally biconvex, periphery subacute; chambers margined but without a keel, and in the adult the periphery becomes somewhat lobulated, on the dorsal side the chambers become distinctly evolute, with ten or more chambers in the final whorl, inflated; sutures distinct, in the early stages somewhat limbate, and on the dorsal side with a distinct angle toward or about at the inner third, in the adult becoming very much lessened or entirely a simple curve, on the ventral side with the intermediate chambers short and irregularly rhomboid, sutures strongly curved especially in the early portion, becoming more nearly straight in the adult; wall distinctly perforate, otherwise smooth except about the aperture which is papillate; aperture on the ventral side between the periphery and the umbilical region.

Holotype (Cushman Coll. No. 16323) from the upper zone of the Chipola formation, bed of Econfina Creek, Bryant Scott's farm, Sec. 28, T. 2 N., R. 12 W., Bay County.

This seems to be a very distinctive species, occurring only in the Oak Grove sand and at one station in the upper Chipola. It is very distinct from *A. lessonii* in the pronounced evolute character of the adult. The young stages show much less of this character, and the periphery is distinctly carinate in many of the young specimens, but in the adult this is lost and the evolute character becomes very pronounced.

AMPHISTEGINA CHIPOLENSIS Cushman and Ponton, n. sp.

Plate 15, figures 1a-c

Test unequally biconvex, the ventral side strongly convex and prominently umbonate with a large clear boss, periphery sharp and very distinct, carinate; three or more chambers in the adult, not inflated, in the adult becoming slightly evolute, the test very transparent so that all the chambers are visible to the interior through the clear test wall, from the ventral side the early chambers are also visible through the clear umbonate region when wet; sutures slightly limbate, those of the dorsal side with a slight angle toward the inner end, strongly curved, on the ventral side rather evenly and strongly curved, the intermediate chambers more or less irregular in shape, pointed toward the outer end; wall distinctly perforate, smooth,

except about the apertural end which is strongly papillate; aperture at the base of the ventral border of the last-formed chamber.

Holotype (Cushman Coll. No. 16325) from the typical Chipola formation, Tenmile Creek, $\frac{1}{2}$ mile below bridge on Marianna-Clarkesville road, 22 miles south of Marianna, Calhoun County.

This species which is the ancestral form of the preceding has a very distinct keel throughout its development. The intermediate chambers on the ventral side are much less definitely rhomboid than in the preceding, and the test does not become so distinctly evolute.

These three species of *Amphistegina* are characteristic, the first of the *Cancellaria* zone of the Choctawhatchee, the second of the Oak Grove and upper Chipola, and the last species characteristic of the typical Chipola, being found at a majority of the stations in that formation.

Family CASSIDULINIDAE

Subfamily Ceratobulimininae

Genus PULVINULINELLA Cushman, 1926

PULVINULINELLA PONTONI Cushman

(See Florida Geol. Survey, Bull. 4, p. 57, pl. 11, figs. 2a-c, 1930.)

This small but distinctive species which was previously described in Bulletin 4 from the *Arca* and *Ecphora* zones of the Choctawhatchee has been found in our later collections. These have extended its range into all four zones of the Choctawhatchee, but it is most abundant in the *Arca* zone with specimens also occurring in the *Cardium* and type beds of the Shoal River formation. No specimens have been found in either the Oak Grove or the Chipola formations.

Subfamily Cassidulininae

Genus CASSIDULINA d'Orbigny, 1826

CASSIDULINA CRASSA d'Orbigny

(See Florida Geol. Survey, Bull. 4, p. 58, pl. 11, figs. 6a, b, 1930.)

This species was found as in the earlier report from the *Cancellaria*, *Ecphora* and *Arca* zones of the Choctawhatchee. No specimens have been found below the *Arca* zone.

CASSIDULINA LAEVIGATA d'Orbigny, var. CARINATA Cushman

(See Florida Geol. Survey, Bull. 4, p. 58, pl. 11, figs. 7a, b, 1930.)

The previous report recorded this from the three upper zones of the Choctawhatchee, and later material has shown it to be present also in the *Yoldia* zone of the Choctawhatchee as well as in all three zones of the Shoal River formation. No specimens were found in the Oak Grove or Chipola formations.

CASSIDULINA CHIPOLENSIS Cushman and Ponton, n. sp.

Plate 15, figures 2a-c

Test minute, consisting of subglobular chambers, four pairs making up the last whorl, periphery strongly lobulated; chambers very distinct, inflated, in alternating pairs at each side of the axis of coiling extending over slightly onto the opposite side at the periphery; sutures deeply depressed, distinct; wall smooth, finely perforate; aperture a definite elongate opening in the line of coiling.

Holotype (Cushman Coll. No. 16326) from the Chipola formation, $\frac{1}{2}$ mile below type locality on west bank of Chipola River at mouth of Senterfeit Branch, Calhoun County.

This species also occurs in the Chipola at Tenmile Creek. It is a very small, easily overlooked species, but very distinct in the character of its globular chambers.

Genus **CASSIDULINOIDES** Cushman, 1927**CASSIDULINOIDES BRADYI** Cushman

(See Florida Geol. Survey, Bull. 4, p. 58, pl. 11, figs. 8a, b, 1930.)

This species was previously recorded from the *Arca* zone of the Choctawhatchee formation in Bulletin 4. Our later material has shown it to be present also in the *Ecphora* zone, and there are typical specimens from the middle and typical zones of the Shoal River formation. There are no records for it in either the Oak Grove or Chipola formations which is not surprising as this is for the most part a species of deeper rather than shoal water.

Family **CHILOSTOMELLIDAE**Subfamily **Chilostomellinae**Genus **CHILOSTOMELLA** Reuss, 1850**CHILOSTOMELLA OOLINA** Schwager

(See Florida Geol. Survey, Bull. 4, p. 59, 1930.)

The single broken specimen from a station in the *Arca* zone of the Choctawhatchee, as reported in Bulletin No. 4 is the only record of this species.

Family **GLOBIGERINIDAE**Subfamily **Globigerininae**Genus **GLOBIGERINA** d'Orbigny, 1826

There are in some of the samples a considerable number of Globigerinidae which it seems wise to leave until a study of the type specimens can be made.

Genus **GLOBIGERINOIDES** Cushman, 1927

The preceding remarks apply to this genus also as far as the fossil representatives are concerned.

Genus *HASTIGERINA* Wyville Thompson, 1876

HASTIGERINA PELAGICA (d'Orbigny)

Quite a number of fragments which apparently belong to this species were found in samples from the *Cancellaria* zone to the *Yoldia* zone of the Choctawhatchee but only two entire specimens were found, one from the *Ecphora* zone at Darling Slide, Calhoun County, one from the *Yoldia* zone on the Chester Spence farm, Walton County.

It is interesting to note that this species ranges downward into the Miocene. The only other fossil record for it is apparently that of Schubert from the late Tertiary probably Pliocene of the Bismarck Archipelago in the Pacific.

Subfamily Orbulininae

Genus *ORBULINA* d'Orbigny, 1826

ORBULINA UNIVERSA d'Orbigny

(See Florida Geol. Survey, Bull. 4, p. 59, 1930.)

Specimens of this species are most common in the *Arca* and *Yoldia* zones of the Choctawhatchee but are represented in all the zones of the Florida Miocene.

Family GLOBOROTALIIDAE

Genus *GLOBOROTALIA* Cushman, 1927

GLOBOROTALIA MENARDII (d'Orbigny)

(See Florida Geol. Survey, Bull. 4, p. 60, pl. 12, figs. 1a-c, 1930.)

Our recent studies of new material have shown this species to be present in all the zones from the lower Shoal River to the upper Choctawhatchee. No specimens have, however, occurred in either the Oak Grove or Chipola formations. This being a species of deep water or pelagic, it is not surprising to find it absent from these two formations which are represented for the most part by shoal water conditions.

Genus *CYCLOLOCULINA* Heron-Allen and Earland, 1908

CYCLOLOCULINA MIOCENICA Cushman and Ponton

Plate 15, figures 3, 4

Cycloloculina miocenica Cushman and Ponton, Contr. Cushman Lab. Foram. Res., vol. 8, p. 3, pl. 1, figs. 3, 4, 1932.

Test circular, very much compressed, periphery rounded, the two sides either flattened or even slightly concave toward the center; early chambers subglobular, rapidly increasing in breadth as added until annular chambers are formed, after which chambers of this sort are continued throughout the development; sutures fairly distinct, very slightly depressed; wall very coarsely perforate, and

with numerous radial folds; apertures formed by the coarse perforations of the test. Diameter up to 1.00 mm.

Holotype (Cushman Coll. No. 16305) from the Chipola formation, $\frac{1}{2}$ mile below type locality on west bank of Chipola River at mouth of Senterfeit Branch, Calhoun County.

This species, which extends the range of the genus from the Eocene, is closely related to the other known species of the genus. Some of the specimens when mounted in balsam show by transmitted light a peculiar spinose condition of the peripheral wall, with long thorn-like projections extending both forward into the new chamber and backward into the old one. This varies considerably in different specimens, but does not seem to occur on the outer periphery of any of the specimens examined.

This species occurs at one station in the Chipola formation, and also at one in the Oak Grove sand, but does not occur higher up in the section. This genus has heretofore been considered characteristic of the Eocene, but these records extend its vertical range to the Lower Miocene.

Family ANOMALINIDAE

Subfamily Anomaliniinae

Genus PLANULINA d'Orbigny, 1826

PLANULINA DEPRESSA (d'Orbigny)

(See Florida Geol. Survey, Bull. 4, p. 60, pl. 12, figs. 2a-c, 1930.)

This species is very abundant in the *Cancellaria* zone of the Choctawhatchee and somewhat less so in the *Ecphora* zone, and was recorded in Bulletin 4 from one station of the *Arca* zone. It does not seem to extend into the lower formations. To this should probably be referred those specimens which were previously recorded in Bulletin 4 as *Cibicides lobatulus* (Walker and Jacob), var. *ornatus* (Cushman). The question of their relationship was noted in Bulletin 4. It is also to be suspected from a study of d'Orbigny's figures in the Cuban monograph that his *Rosalina edwardsiana* may quite probably be the same as this form. A study of the type specimens, however, would be necessary to finally determine this relationship.

Subfamily Cibicidinae

Genus CIBICIDES Montfort, 1808

CIBICIDES FLORIDANUS (Cushman)

Truncatulina floridana Cushman, U. S. Geol. Survey, Bull. 676, p. 62, pl. 19, figs. 2a-c, 1918.—Nuttall, Quart. Journ. Geol. Soc., vol. 84, p. 98, pl. 7, figs. 14, 16, 1928.

Cibicides floridanus Cushman, Florida Geol. Survey, Bull. 4, p. 61, pl. 12, figs. 3a-c, 1930.—Cushman and Laiming, Journ. Pal., vol. 5, p. 119, pl. 14, figs. 8a-c, 1931.—Cushman and Parker, Contr. Cushman Lab. Foram. Res., vol. 7, p. 16, pl. 3, figs. 2a-c, 1931.

This species is not common but in our more recent collections has occurred in the *Arca* and *Yoldia* zones of the Choctawhatchee, and also in the *Cardium* bed and the middle zone of the Shoal River formation. It is known from the Miocene of California, as well as occurring at numerous stations off the coast of Florida at the present time. All of the Recent material examined occurs in depths of 30 fathoms or more which may explain somewhat its scarcity in the Florida Miocene.

CIBICIDES CONCENTRICUS (Cushman)

Truncatulina concentrica Cushman, U. S. Geol. Survey, Bull. 676, p. 64, pl. 21, fig. 3, 1918.

Cibicides concentricus Cushman, Florida Geol. Survey, Bull. 4 p., 61, pl. 12, figs. 4a-c, 1930; U. S. Nat. Mus., Bull. 104, pt. 8, p. 120, pl. 21, figs. 4, 5; pl. 22, figs. 1, 2, 1931.—Cushman and Parker, Proc. U. S. Nat. Mus., vol. 80, Art. 3, p. 22, 1931.

This is quite probably the most widely distributed species in the Florida Miocene, occurring not only in every zone of all the formations but recorded at all but four stations from which material was examined. It is somewhat variable and probably the specimens referred to *C. americanus* Cushman in the earlier Bulletin 4 should be considered as the young of this species. *C. americanus*, however, has a definite range in the Oligocene and possibly the early Miocene of other areas. The species has been found to be a common one off the coast of Florida.

CIBICIDES LOBATULUS (Walker and Jacob)

There are a few specimens which are very finely perforate which may be referred to this species. There are scattered specimens in the *Ecphora* and *Arca* zones of the Choctawhatchee, in the middle zone of the Shoal River, and in the Oak Grove sand. They are very few in number, however, and it is evidently not a characteristic species of this region, as it is in colder northern waters at the present time.

CIBICIDES REFULGENS (Montfort)

Although this species was earlier recorded from Coe's Mill in Bulletin 676 of the U. S. Geological Survey, our studies of additional material have not confirmed its record, but have found the species rather widely distributed in the typical Chipola formation where it occurs at three of the four stations.

Genus DYOCIBICIDES Cushman and Valentine, 1930

DYOCIBICIDES BISERIALIS Cushman and Valentine

Dyocibicides biserialis Cushman and Valentine, Contr. Dept. Geol. Stanford University, vol. 1, p. 31, pl. 10, figs. 1, 2, 1930.—Cushman, Florida Geol. Survey, Bull. 4, p. 62, pl. 12, figs. 6a, b, 1930; Contr. Cushman Lab. Foram. Res., vol. 6, pl. 12, fig. 12, 1930; U. S. Nat. Mus., Bull. 104, pt. 8, p. 126, pl. 24, fig. 2, 1931.—Cushman and Parker, Proc. U. S. Nat. Mus., vol. 80, Art. 3, p. 22, pl. 4, fig. 8, 1931.—Cole, Florida Geol. Survey, Bull. 6, p. 57, pl. 5, figs. 11, 12, 1931.

Truncatulina variabilis H. B. Brady, Parker, and Jones (not d'Orbigny), Trans. Zool. Soc. London, vol. 12, p. 227, pl. 45, fig. 17, 1888.

This species originally described from off the coast of Florida has been found to be widely distributed also in the western Atlantic, and occurs in both the Pliocene and Miocene of Florida. It has been found to be almost as common in our collections as *C. concentricus*, occurring very rarely indeed in the Chipola, being absent from the Oak Grove, but occurring in all other zones at nearly all the stations. It is variable in its form and characters.

Genus CIBICIDELLA Cushman, 1927

CIBICIDELLA VARIABILIS (d'Orbigny)

Plate 15, figures 5-7

Truncatulina variabilis d'Orbigny, in Barker, Webb and Berthelot, Hist. Nat. Iles Canaries, vol. 2, pt. 2, "Foraminifères," p. 135, pl. 2, fig. 29, 1839.—Cushman, U. S. Nat. Mus., Bull. 104, pt. 8, p. 127, pl. 24, fig. 3, 1931.

The test in the early stages is, as will be seen in the figures, very closely allied to *Cibicides*, but the later chambers become very much enlarged and inflated on the ventral side, with the apertures appearing as distinct tubular openings with a slight lip, usually one on each side of the chamber. There are numerous beautifully developed specimens at several stations in the Chipola formation which have irregular, inflated chambers and very coarse perforations which may be referred to this species. They were not found in any of the later formations of the Florida Miocene. Several specimens are figured to show the stages in the development of this form.

Genus ANNULOCIBICIDES Cushman and Ponton, 1932

GENOHOLOTYPE, *Annulocibicides projectus* Cushman and Ponton, Contr. Cushman Lab. Foram. Res., vol. 8, p. 1, 1932.

This recently described genus is related to *Cibicides* in the early stages. It rather soon becomes annular in its development, and the apertures are developed at the periphery with rather large tubular projections. In its apertural characters and general appearance it

is quite distinct from the somewhat allied *Cyclocibicides* of the Mediterranean.

ANNULOCIBICIDES PROJECTUS Cushman and Ponton

Plate 16, figures 1a, b

Annulocibicides projectus Cushman and Ponton, Contr. Cushman Lab. Foram. Res., vol. 8, p. 2, pl. 1, figs. 1a, b, 1932.

Test in the early stages slightly trochoid, the chambers in a single plane, attached, soon becoming broader and finally annular, periphery rounded, except for the tubular projections; chambers slightly inflated, fairly distinct from both sides; sutures distinct, slightly depressed, not limbate; wall opaque, rather granular in appearance, finely perforate; apertures in the adult at the peripheral margin of the test, large, oval or elliptical, with a distinct tubular neck. Diameter up to 1.00 mm.

Holotype (Cushman Coll. No. 16300) from the Chipola marl, type locality McClelland's farm, on right (west) bank of Chipola River, about 3 miles east of village of Carr, Calhoun County.

The species also occurs at two other stations in the Chipola formation, but has not been found in any of the formations above. This is a very peculiar type in its very large and distinct tubular apertures from the periphery of the test and the annular chambers. It was evidently an attached form.

GENUS RECTOCIBICIDES Cushman and Ponton, 1932

GENOHOLOTYPE, *Rectocibicides miocenicus* Cushman and Ponton, Contr. Cushman Lab. Foram. Res., vol. 8, p. 2, 1932.

This genus is one which is distinctly developed from *Cibicides* by having a uniserial development immediately following after the close coiled *Cibicides* stage. The rectilinear portion may expand somewhat, but does not tend to reach back to the original portion to form annulae nor does it show any trace of becoming biserial.

RECTOCIBICIDES MIOCENICUS Cushman and Ponton

Plate 16, figures 2-4

Pavonina sp(?) Cushman, Florida Geol. Survey, Bull. 4, p. 41, 1930.

Rectocibicides miocenicus Cushman and Ponton, Contr. Cushman Lab. Foram. Res., vol. 8, p. 2, pl. 1, figs. 5-7, 1932.

Test attached, compressed, the early stages close coiled, somewhat trochoid, later becoming uncoiled with the chambers in a rectilinear series, somewhat spread laterally, distinct; sutures distinct and depressed on the ventral side, distinct but not depressed, strongly limbate, on the attached dorsal side; wall coarsely perforate and cancellated on the ventral side, more finely perforate and fairly

smooth on the attached dorsal side; aperture on the dorsal side as in *Cibicides* in the early stages, in the rectilinear portion becoming large and tubular at the periphery. Diameter up to 1.30 mm.

Holotype (Cushman Coll. No. 16301) from the *Cancellaria* zone of the Choctawhatchee formation, about $\frac{1}{2}$ mile upstream from the type locality of the *Cancellaria* zone on Harvey's Creek at Yankeetown, Leon County.

This species is very abundant at the type locality, and although it is an attached form and is, therefore, somewhat variable, it, nevertheless, has very distinct characters. In its aperture it somewhat resembles the preceding genus and species, but the type of development of the test is very different, keeping throughout its development to a rectilinear form although this may be somewhat variable due to the shape of the attached surface. It also occurs in another collection from about the same locality, but it has not been found elsewhere in the Florida Miocene. Portions of the later growth were referred to in the earlier Bull. 4 as *Pavonina* sp(?), no complete specimens showing the early stages having at that time been found.

Family PLANORBULINIDAE

Genus ACERVULINA Schultze, 1854

ACERVULINA INHAERENS Schultze

Plate 16, figures 5, 6

Accervulina inhaerens Schultze, Organ. Polythal., p. 68, pl. 6, fig. 12, 1854.—

Cushman, Florida Geol. Survey, Bull. 4, p. 63, 1930; U. S. Nat. Mus.,

Bull. 104, pt. 8, p. 134, pl. 25, figs. 2a-c, 1931.

Gypsina inhaerens H. B. Brady, Rep. Voy. Challenger, Zoology, vol. 9, p. 718, pl. 102, figs. 1-6, 1884.

There are a few specimens of an attached form which has its chambers more or less distinct and irregular in form and which may be referred to this species. They are from three stations in the *Cancellaria* zone of the Choctawhatchee.

ACERVULINA CHIPOLENSIS Cushman and Ponton, n. sp.

Plate 16, figures 7, 8

Test attached, the chambers forming a generally circular compressed test with the periphery acute at the plane of attachment, later chambers piling up and obscuring the earlier ones, of irregular shape but opening at the base, the opening being on the same side as the chamber itself, the edges very thin; sutures distinct, slightly depressed especially on the outer side; wall rather coarsely perforate, otherwise smooth; apertures formed by the open portion of the chamber along the line of attachment.

Holotype (Cushman Coll. No. 16327) from the Chipola formation, Tenmile Creek, $\frac{1}{2}$ mile below bridge on Marianna-Clarkesville road, 22 miles south of Marianna, Calhoun County.

The species also occurs at two other stations in the Chipola formation, but in none of the younger formations. It seems to be a very distinct species from the preceding.

Genus GYPSINA Carter, 1877

GYPSINA VESICULARIS (Parker and Jones)

Plate 16, figures 9a, b

Orbitolina vesicularis Parker and Jones, Ann. Mag. Nat. Hist., ser. 3, vol. 6, p. 31, No. 5, 1860.

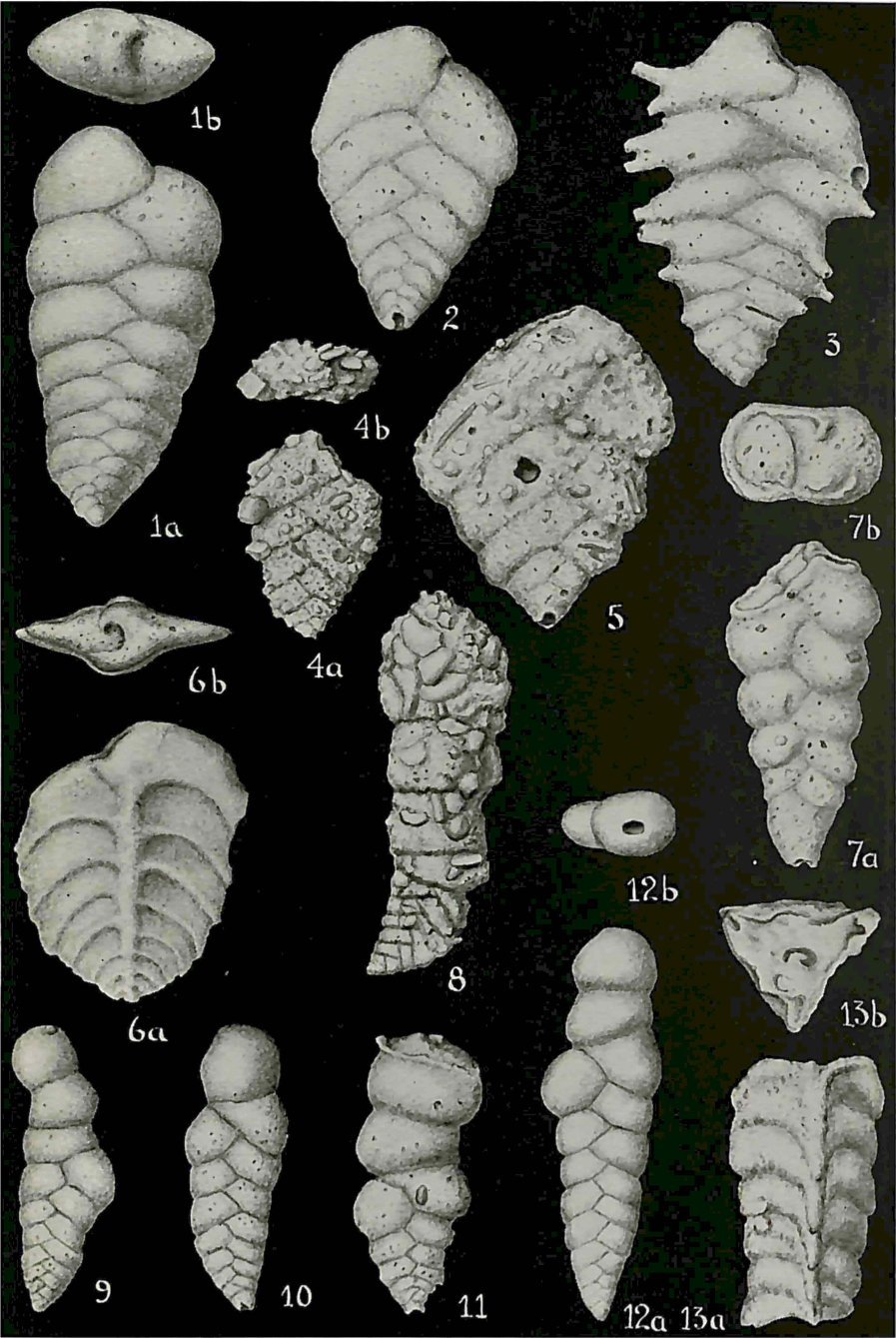
Gypsina vesicularis Carter, Ann. Mag. Nat. Hist., ser. 4, vol. 20, p. 173, 1877.
—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, p. 718, pl. 101, figs. 9-12, 1884.—Balkwill and Wright, Trans. Roy. Irish Acad., vol. 28, Sci., p. 352, 1885.—Kiaer, Rep't Norwegian Fish. and Mar. Invest., vol. 1, No. 7, p. 48, 1900.—Wright, Irish Nat., p. 55 (list), 1900.—Millett, Rec. Foram. Galway, p. 7, 1908.—Heron-Allen and Earland, Proc. Roy. Irish Acad., vol. 31, pt. 64, p. 140, pl. 13, fig. 11, 1913; Trans. Linn. Soc. London, ser. 2, vol. 11, p. 278, 1916.

There is a single specimen which is here figured from the Chipola formation and which in its plano-convex form seems to represent this species which has already been recorded as Recent from off Florida.

PLATES 1-17

PLATE 1

- FIGS. 1 *a, b. Textularia articulata* d'Orbigny. $\times 40$. *a*, front view; *b*, apertural view. Locality 15. Page 40.
- 2, 3. *Textularia majori* Cushman. $\times 40$. Fig. 2, specimen with nearly entire outline. Fig. 3, specimen with unusual spinosity, later chambers with double spines. Locality 3. Page 40.
- 4, 5. *Textularia foliacea* Heron-Allen and Earland, var. *occidentalis* Cushman. $\times 40$. Fig. 4*a*, front view; *b*, apertural view. Fig. 4, locality 6. Fig. 5, locality 14. Page 41.
- 6 *a, b. Textularia warreni* Cushman and Ellisor. $\times 40$. *a*, front view; *b*, apertural view. Locality 16. Page 42.
- 7 *a, b. Textularia* sp (?). $\times 40$. *a*, front view; *b*, apertural view. Locality 5. Page 42.
8. *Bigenerina nodosaria* d'Orbigny, var. *textularioides* (Goës). $\times 40$. Locality 6. Page 42.
- 9-12. *Bigenerina floridana* Cushman and Ponton, n. sp. $\times 40$. Fig. 12, holotype Fig. 12*a*, front view; *b*, apertural view. Page 42.
- 13 *a, b. Clavulina tricarinata* d'Orbigny. $\times 40$. Broken specimen. *a*, side view; *b*, end view. Page 43.



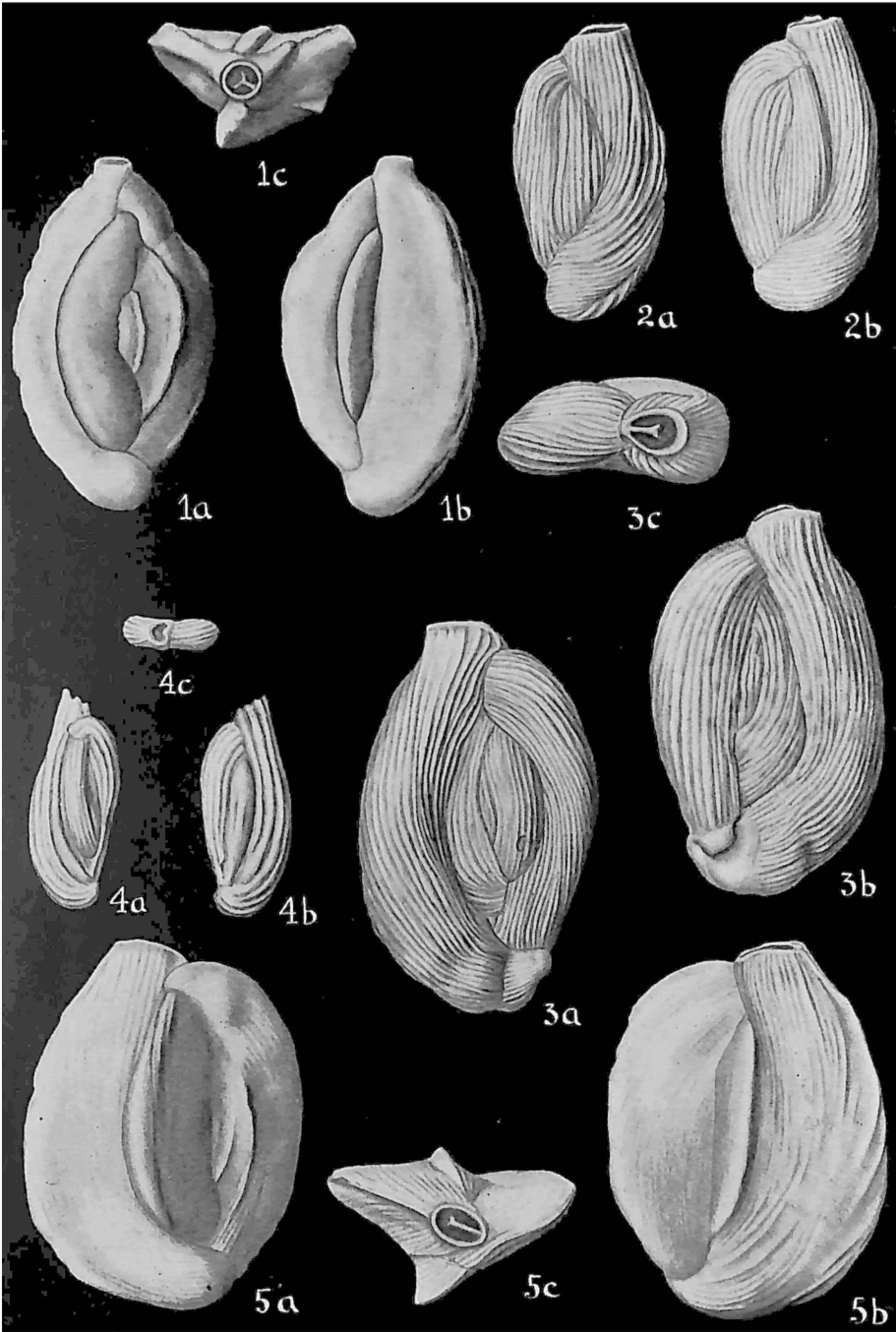


PLATE 2

- FIGS. 1 *a-c*. *Quinqueloculina candiana* d'Orbigny. $\times 40$. *a*, *b*, opposite sides; *c*, apertural view. Locality 10. Page 44.
- 2, 3. *Quinqueloculina costata* d'Orbigny. $\times 32$. *a*, *a*, *b*, *b*, opposite sides; *c*, apertural view. Locality 10. Page 44.
- 4 *a-c*. *Quinqueloculina subpocjana* Cushman. $\times 75$. *a*, *b*, opposite sides; *c*, apertural view. Locality 20. Page 44.
- 5 *a-c*. *Quinqueloculina crassa* d'Orbigny, var. *subcuneata* Cushman. $\times 40$. *a*, *b*, opposite sides; *c*, apertural view. Locality 10. Page 45.

PLATE 3

- FIGS. 1-3. *Quinqueloculina chipolensis* Cushman and Ponton, n. sp. $\times 40$.
Fig. 1, holotype. Fig. 1a, side view; b, apertural view. Fig.
2a, b, opposite sides. Locality 10. Page 45.
- 4 a-c. *Massilina inaequalis* Cushman. $\times 40$. a, b, opposite sides;
c, apertural view. Locality 10. Page 46.
- 5 a-c. *Massilina bosciana* (d'Orbigny). $\times 60$. a, b, opposite sides;
c, apertural view. Locality 10. Page 46.
- 6-8. *Massilina quadrans* Cushman and Ponton, n. sp. $\times 40$. Fig. 6,
holotype. Fig. 6 a, b, opposite sides; c, apertural view. Lo-
cality 10. Page 47.

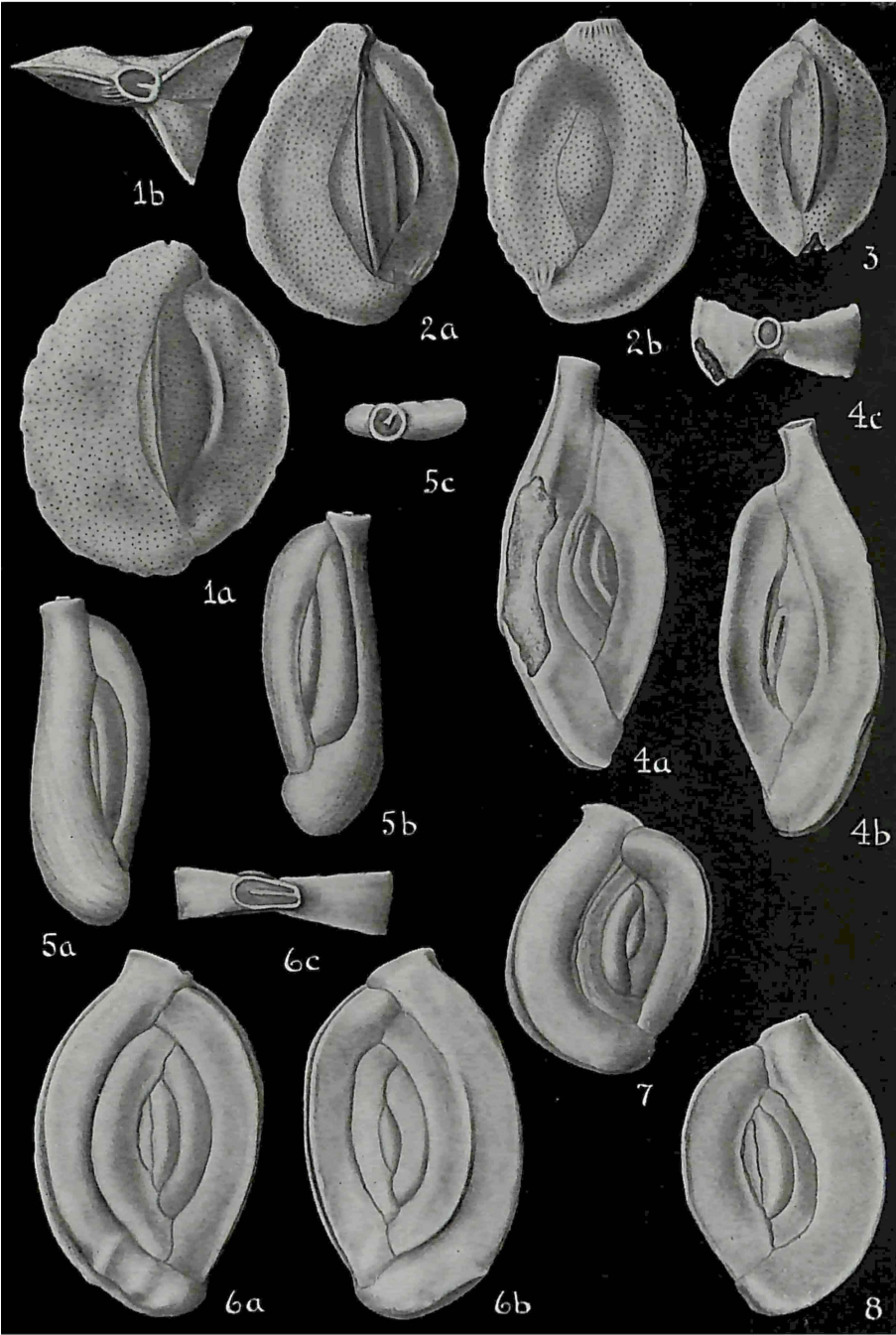


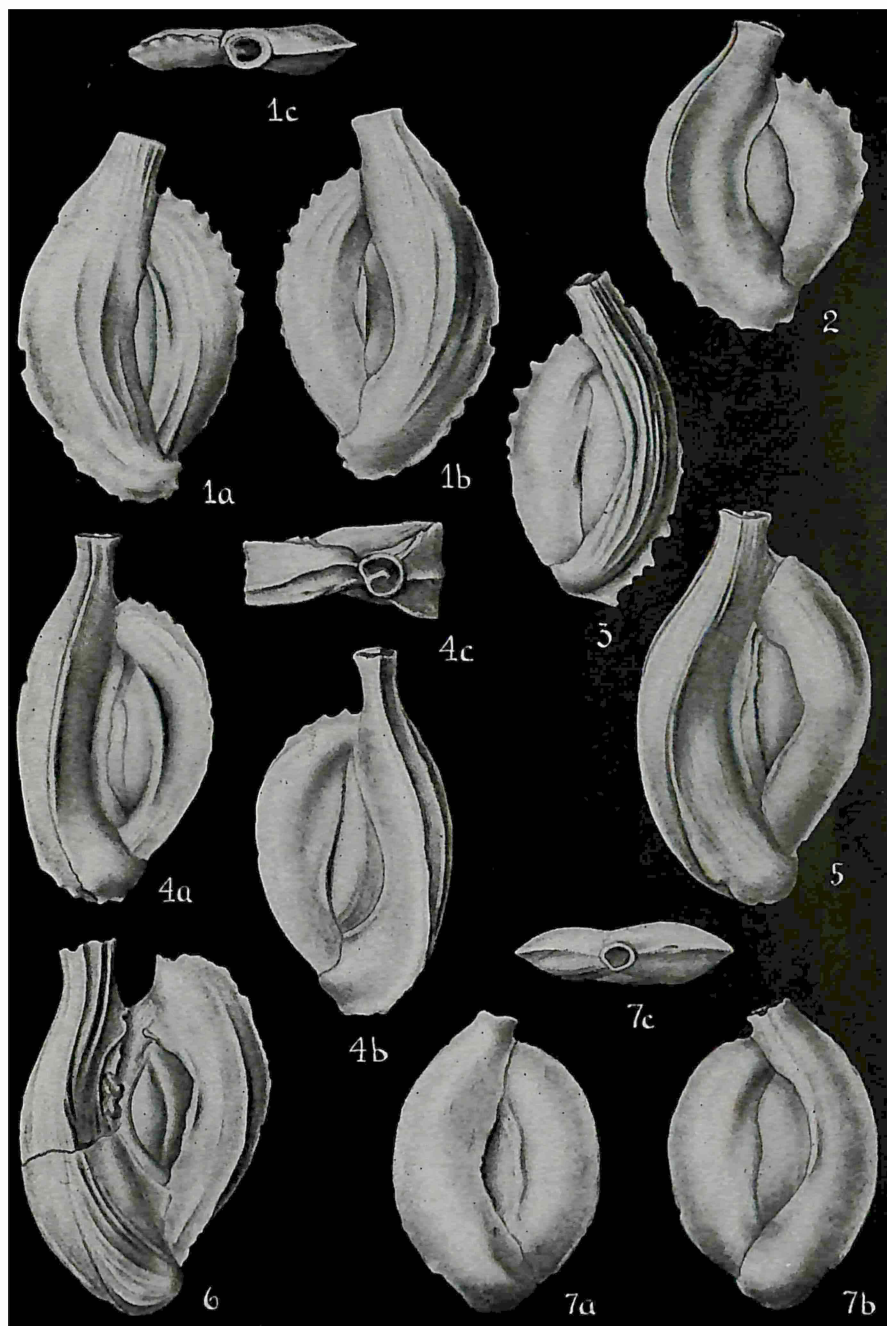


PLATE 4

- FIGS. 1 *a-c*. *Massilina gunteri* Cushman and Ponton, n. sp. $\times 40$. *a*, *b*, opposite sides; *c*, apertural view. Locality 18. Page 47.
- 2-6. *Massilina incisa* Cushman and Ponton, n. sp. $\times 32$. Fig. 6, holotype. Fig. 6 *a*, *b*, opposite sides; *c*, apertural view. Figs. 2-5, showing variations in the surface and in the projection of the quinqueloculine chambers in the early portion. Locality 10. Page 47.

PLATE 5

- Figs. 1-3. *Massilina spinata* Cushman and Ponton, n. sp. $\times 40$. Fig. 1, holotype. Fig. 1 *a*, *b*, opposite sides; *c*, apertural view. Figs. 2, 3, showing variations in the amount of ornamentation of the surface. Locality 10. Page 48.
- 4-6. *Massilina spinata* Cushman and Ponton, var. *chipolensis* Cushman and Ponton, n. var. $\times 40$. Fig. 4, holotype. Fig. 4 *a*, *b*, opposite sides; *c*, apertural view. Figs. 5, 6, showing variation in the ornamentation. Fig. 6, showing a specimen which in its old age condition fails to have the last chamber complete the after coil. Page 48.
- 7 *a-c*. *Massilina spinata* Cushman and Ponton, var. *glabrata* Cushman and Ponton, n. var. $\times 40$. *a*, *b*, opposite sides; *c*, apertural view. Locality 10. Page 49.



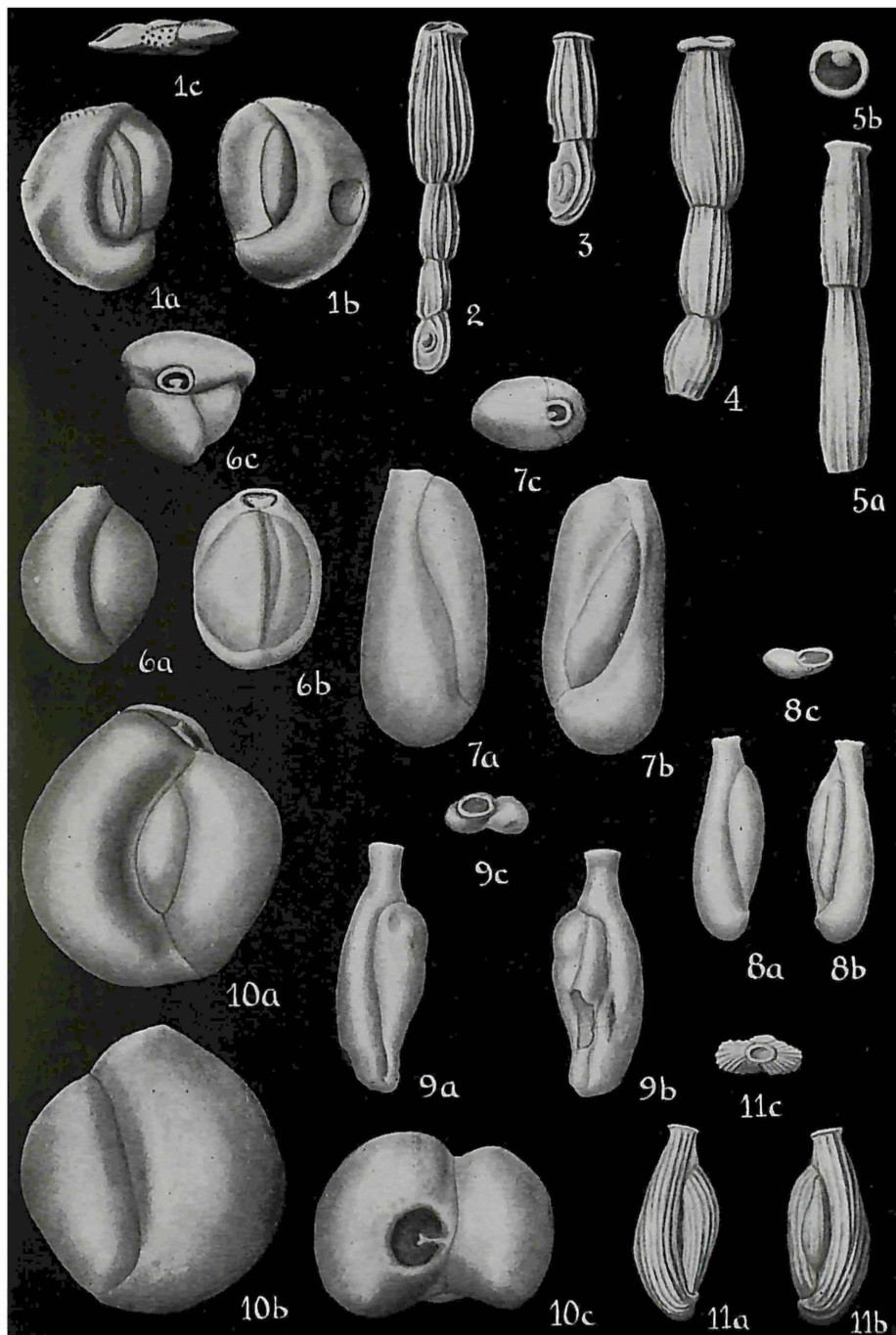
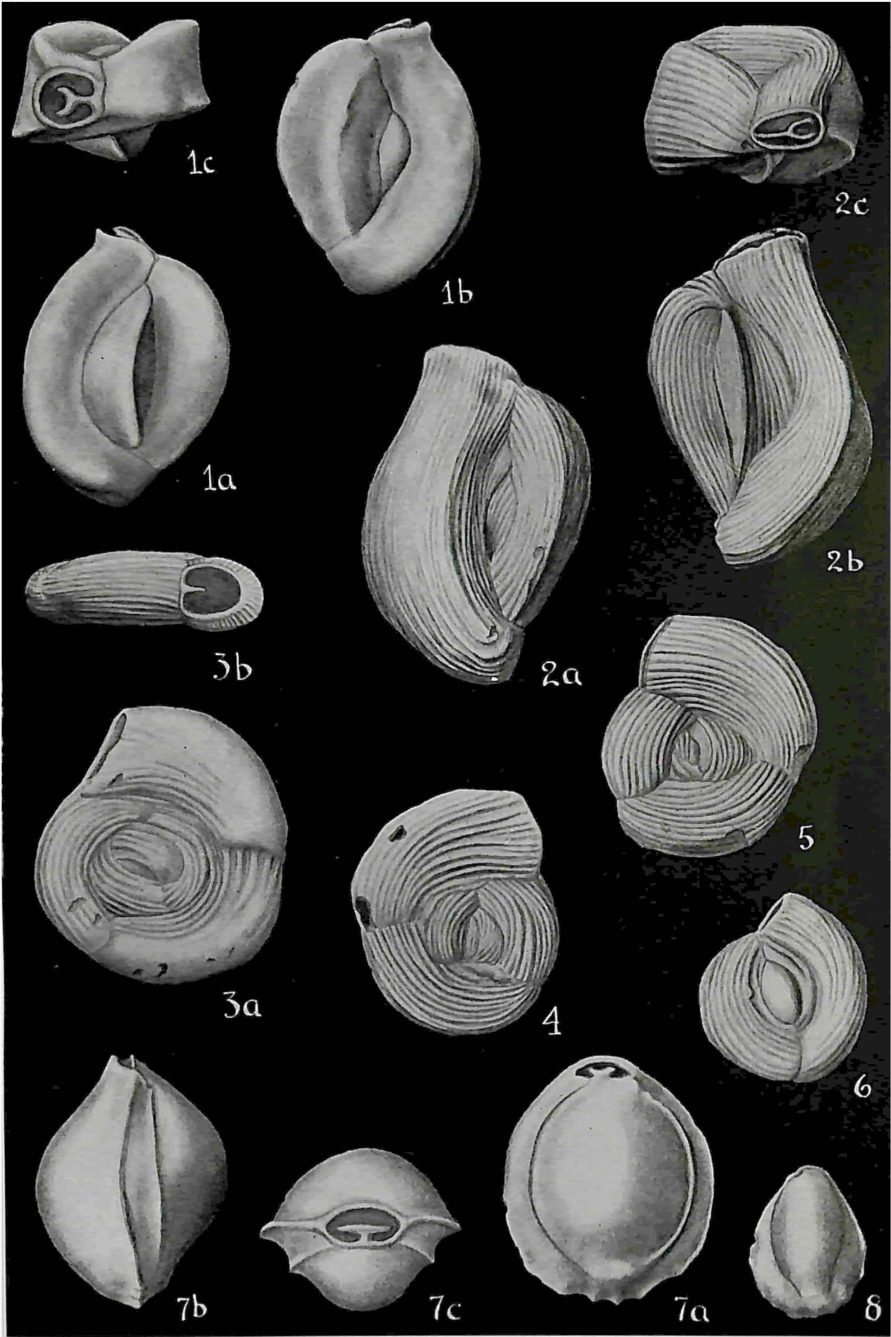


PLATE 6

- Figs. 1 *a-c*. *Haucrina bradyi* Cushman. $\times 75$. *a*, *b*, opposite sides; *c*, apertural view. Locality 10. Page 50.
- 2-4. *Articulina sagra* d'Orbigny, var. *miocenica* Cushman and Ponton, n. var. Figs. 2, 3, $\times 40$. Fig. 4, $\times 60$. Fig. 2, holotype. Fig. 3, young stage with one chamber. Fig. 4, last three chambers showing a thick lip at the aperture. Locality 27. Page 51.
- 5 *a-b*. *Articulina mayori* Cushman. $\times 75$. *a*, side view; *b*, apertural view of apertural end of broken test. Locality 10. Page 51.
- 6 *a-c*. *Triloculina trigonula* (Lamarek). $\times 60$. *a*, side view; *b*, front view; *c*, apertural view. Locality 10. Page 52.
- 7 *a-c*. *Triloculina oblonga* (Montagu). $\times 60$. *a*, *b*, opposite sides; *c*, apertural view. Locality 10. Page 52.
- 8, 9. *Triloculina gracilis* d'Orbigny. $\times 75$. *a*, *a*, *b*, *b*, opposite sides; *c*, *c*, apertural views. Locality 10. Page 53.
- 10 *a-c*. *Triloculina rotunda* d'Orbigny. $\times 40$. *a*, *b*, opposite sides; *c*, apertural view. Locality 8. Page 54.
- 11 *a-c*. *Triloculina brongniartii* d'Orbigny. $\times 60$. *a*, *b*, opposite sides; *c*, apertural view. Locality 10. Page 54.

PLATE 7

- FIGS. 1 *a-c*. *Triloculina quadrilateralis* d'Orbigny. $\times 40$. *a*, *b*, opposite sides; *c*, apertural view. Locality 10. Page 53.
- 2 *a-c*. *Triloculina quadrilateralis* d'Orbigny, var. *longicostata* Cushman and Ponton, n. var. $\times 40$. *a*, *b*, opposite sides; *c*, apertural view. Locality 10. Page 53.
- 3-6. *Flintina floridana* Cushman and Ponton, n. sp. $\times 40$. Fig. 3, holotype. Fig. 3 *a*, side view; *b*, apertural view. Figs. 4, 5, opposite sides of same specimen. Fig. 6, early stage. Locality 8. Page 55.
- 7, 8. *Pyrgo denticulata* (H. B. Brady). $\times 40$. Fig. 7 *a*, front view; *b*, side view; *c*, apertural view. Locality 10. Page 56.



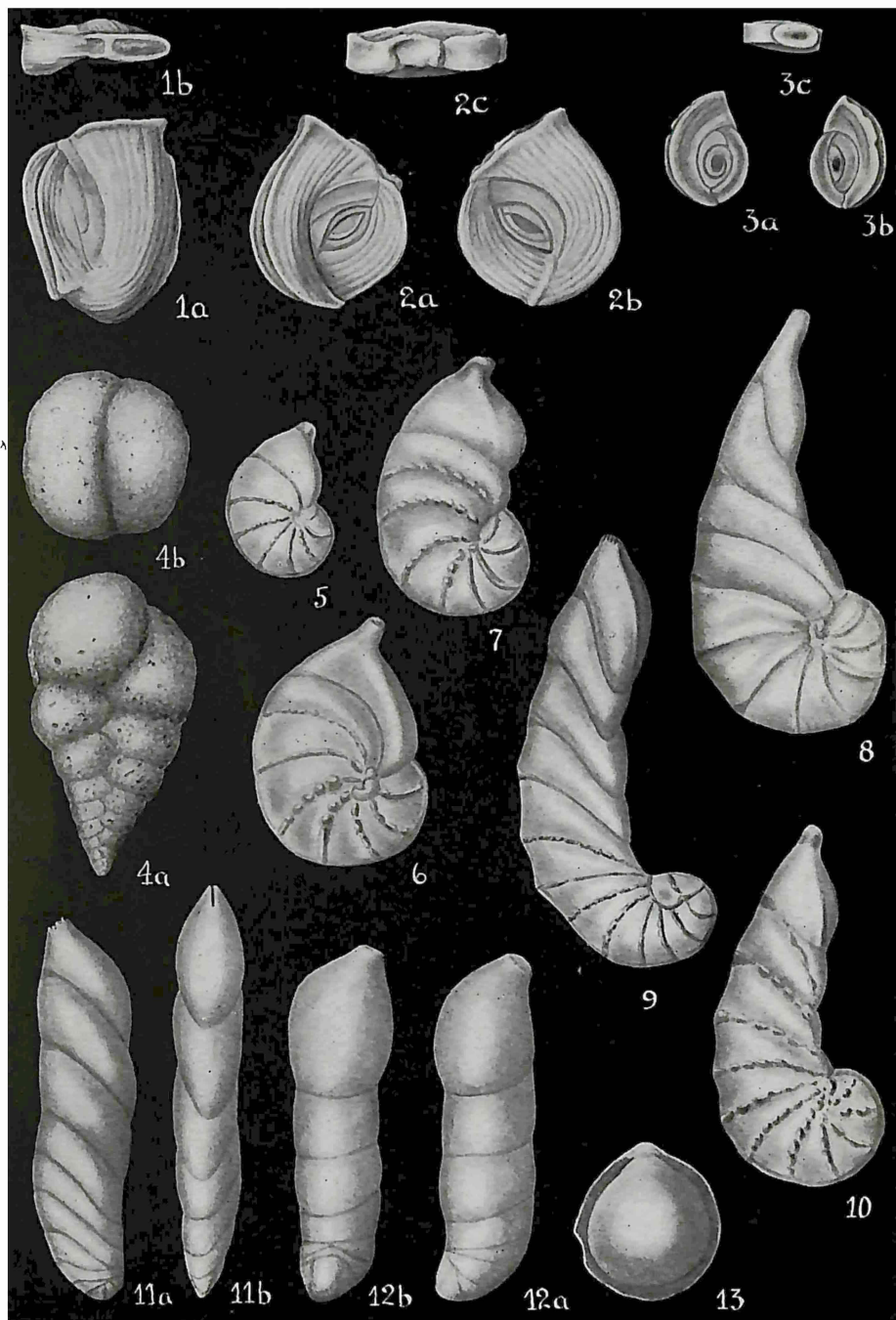
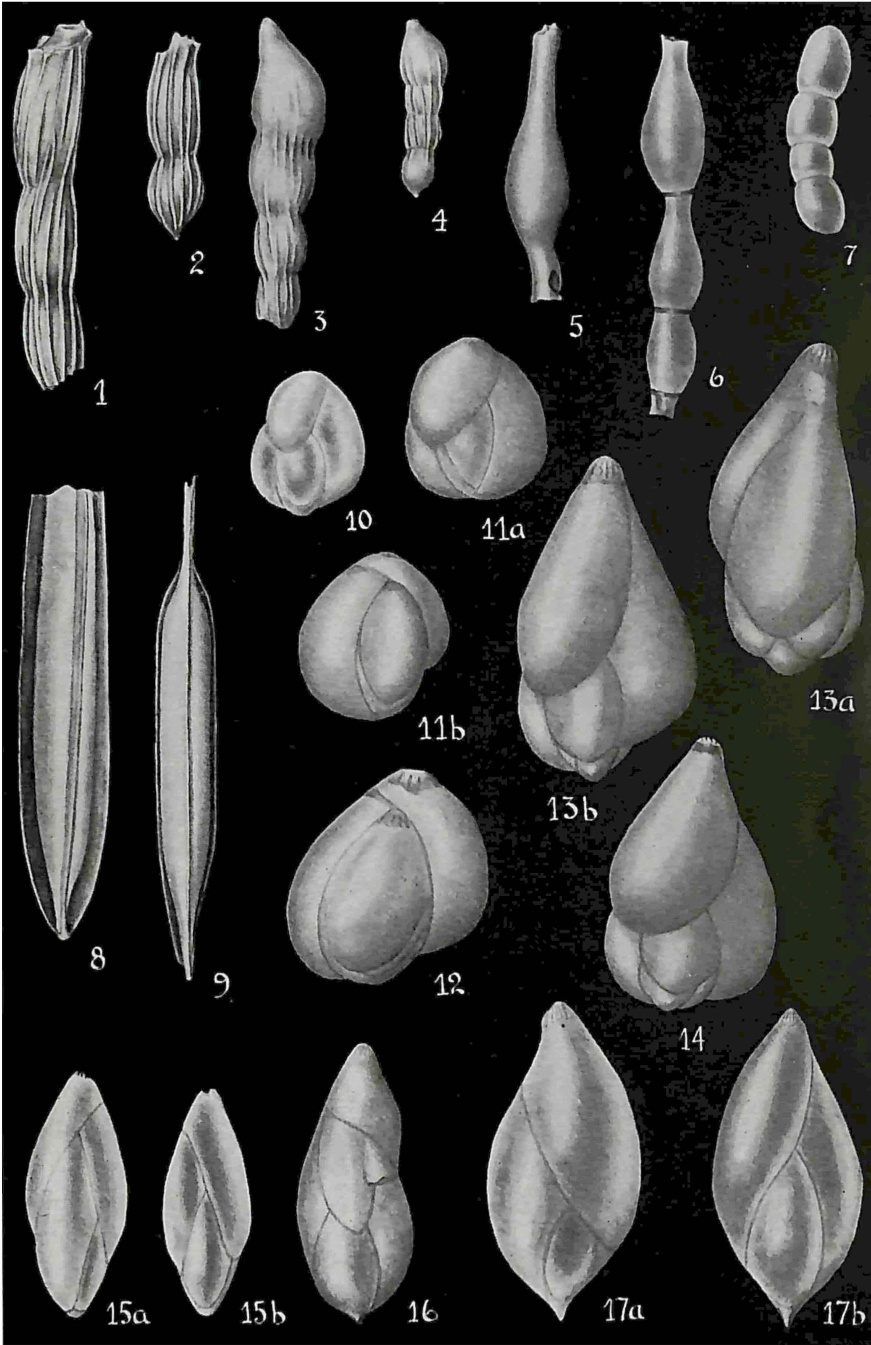


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- FIGS. 1 *a, b.* *Vertebralina cassis* d'Orbigny. $\times 60$. *a*, side view; *b*, apertural view. Locality 10. Page 57.
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 3, 4. *Dentalina* sp (?). $\times 60$. Locality 7. Page 61.
 5, 6. *Dentalina pyrula* d'Orbigny. $\times 60$. Broken specimens. Locality 12. Page 61.
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 13, 14. *Guttulina austriaca* d'Orbigny (?). $\times 60$. Fig. 13 *a*, side view; *b*, front view. Fig. 13, locality 11. Fig. 14, locality 15. Page 65.
 15 *a, b*. *Guttulina lactea* (Walker and Jacob). $\times 75$. *a, b*, opposite sides. Locality 10. Page 65.
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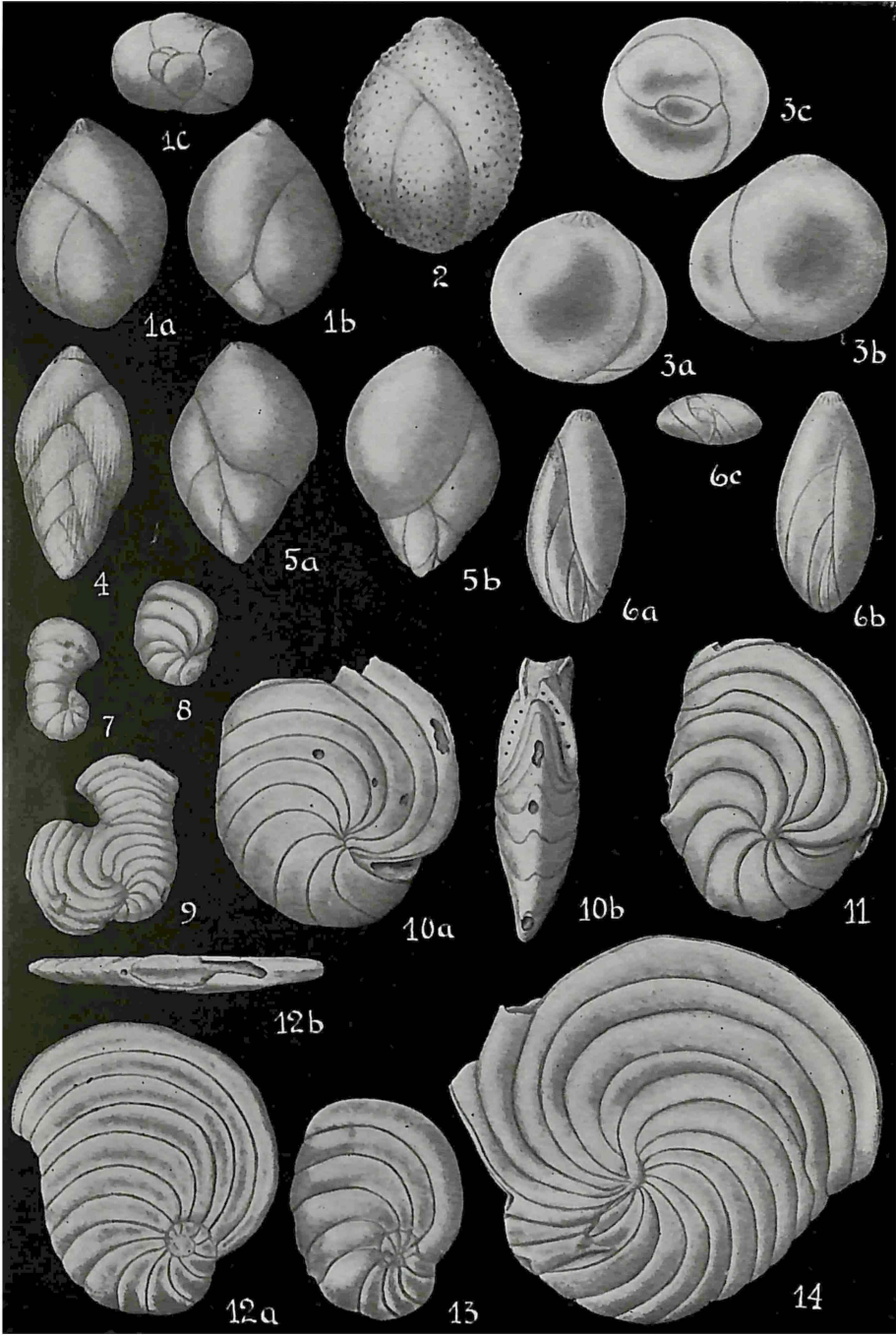
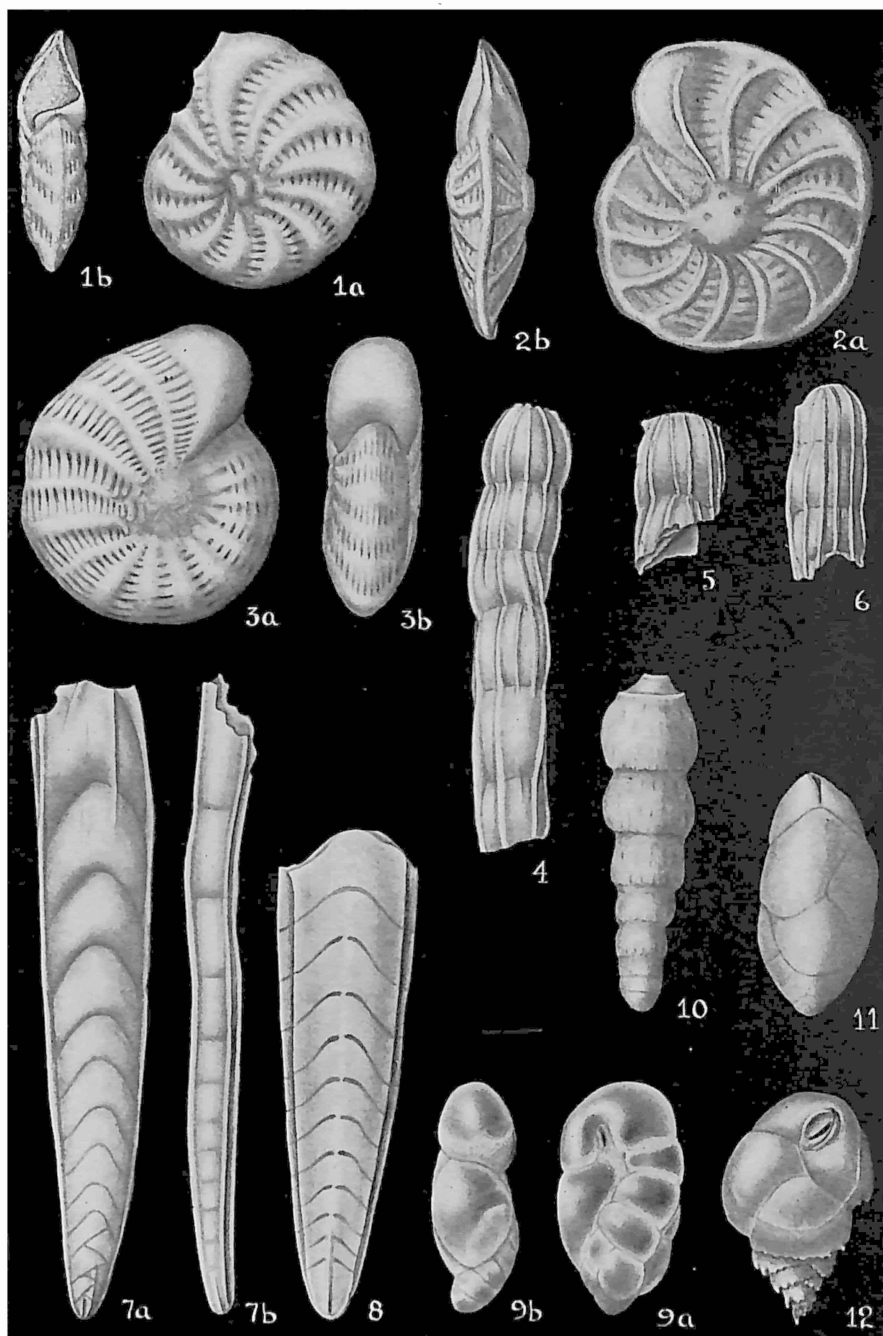


PLATE 10

- FIGS. 1 *a-c*. *Globulina inaequalis* Reuss. $\times 60$. *a*, *b*, opposite sides; *c*, basal view. Locality 10. Page 66.
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- 3 *a-c*. *Globulina gibba* d'Orbigny. $\times 50$. *a*, *b*, opposite sides; *c*, basal view. Locality 10. Page 66.
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- 12, 13. *Pencroplis bradyi* Cushman. $\times 40$. Fig. 12 *a*, side view; *b*, peripheral view. Locality 10. Page 72.

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- FIGS. 1 *a, b. Elphidium advenum* (Cushman). $\times 55$. *a*, side view; *b*, peripheral view. Locality 14. Page 70.
- 2 *a, b. Elphidium fimbriatulum* (Cushman). $\times 55$. *a*, side view; *b*, peripheral view. Locality 7. Page 70.
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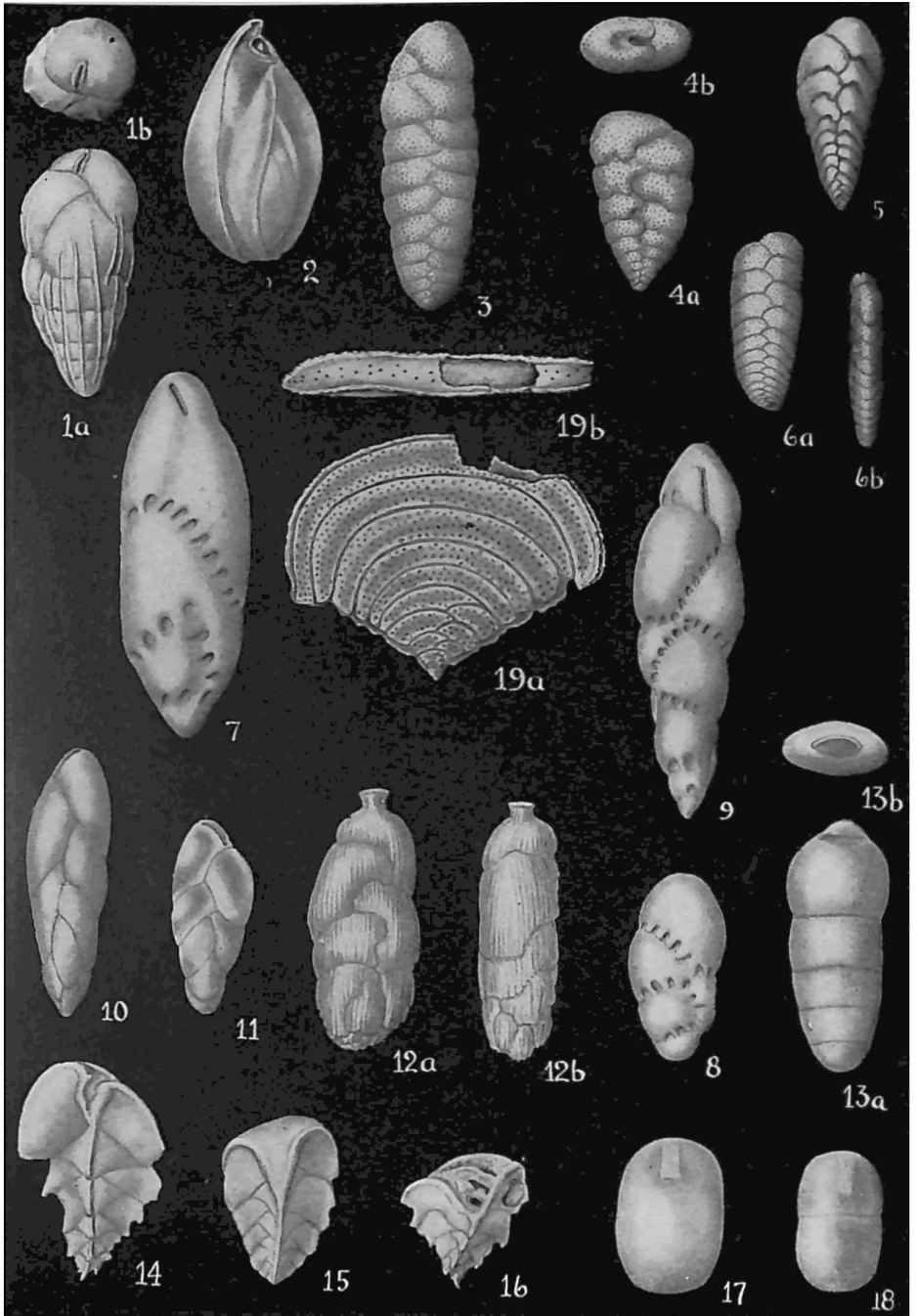
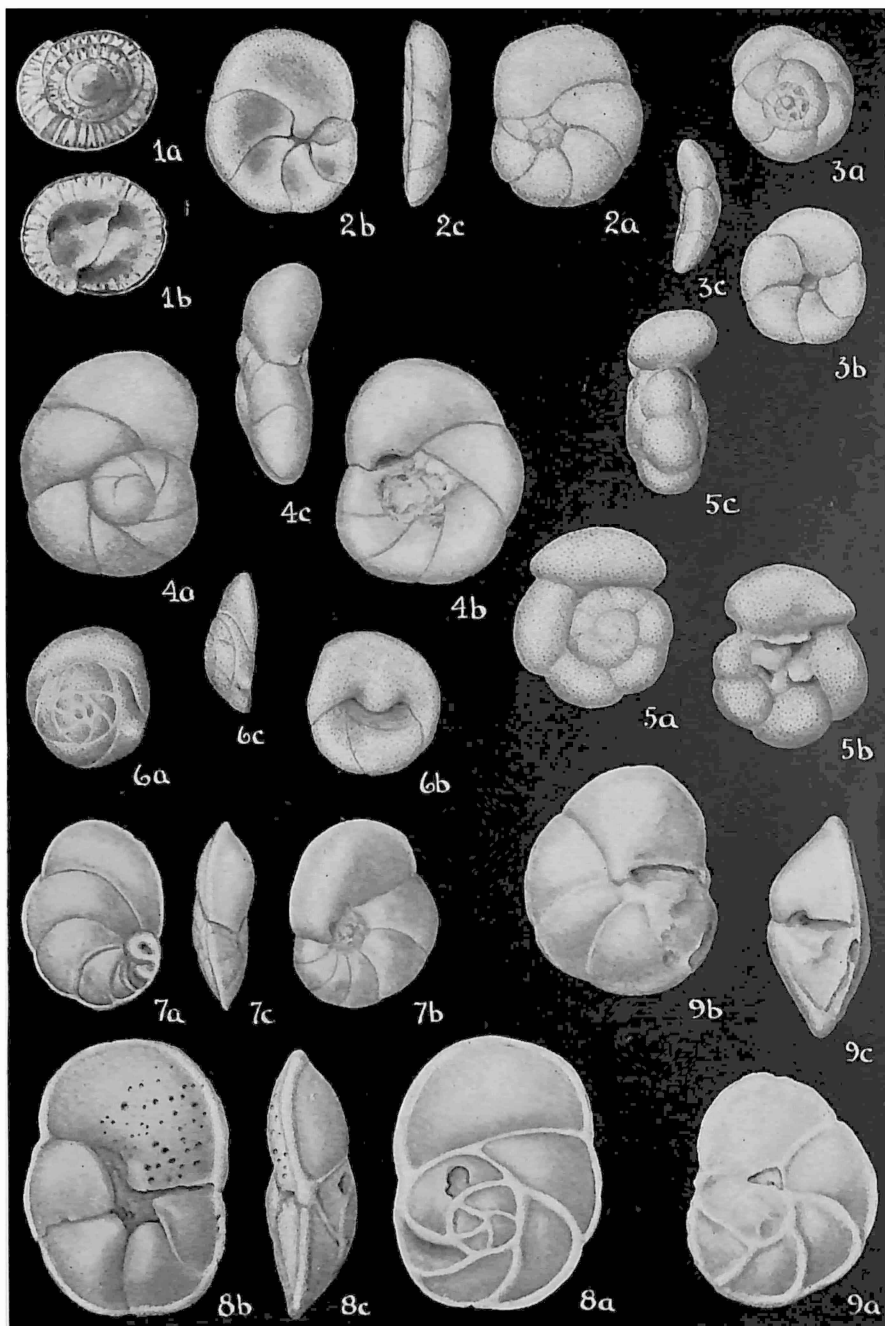


PLATE 12

- FIGS. 1 *a, b.* *Bulimina buchiana* d'Orbigny. $\times 50$. *a*, front view; *b*, apertural view. Locality 9. Page 78.
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- 12 *a, b.* *Uvigerina parkeri* Karrer. $\times 55$. *a*, front view; *b*, side view. Locality 12. Page 86.
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- FIGS. 1 *a, b. Patellina corrugata* Williamson. $\times 75$. *a*, dorsal view; *b*, ventral view. Locality 3. Page 87.
- 2 *a-c. Discorbis floridana* Cushman. $\times 55$. *a*, dorsal view; *b*, ventral view; *c*, peripheral view. Locality 6. Page 88.
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- 5 *a-c. Discorbis candeiana* (d'Orbigny), var. *bullata* Cushman and Ponton, n. var. $\times 55$. *a*, dorsal view; *b*, ventral view; *c*, peripheral view. Locality 27. Page 89.
- 6 *a-c. Discorbis orbicularis* (Terquem). $\times 55$. *a*, dorsal view; *b*, ventral view; *c*, peripheral view. Locality 6. Page 89.
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- 8 *a-c. Eponides lateralis* (Terquem). $\times 32$. *a*, dorsal view; *b*, ventral view; *c*, peripheral view. Locality 3. Page 92.
- 9 *a-c. Eponides repandus* (Fichtel and Moll). $\times 40$. *a*, dorsal view; *b*, ventral view; *c*, peripheral view. Locality 22. Page 92.



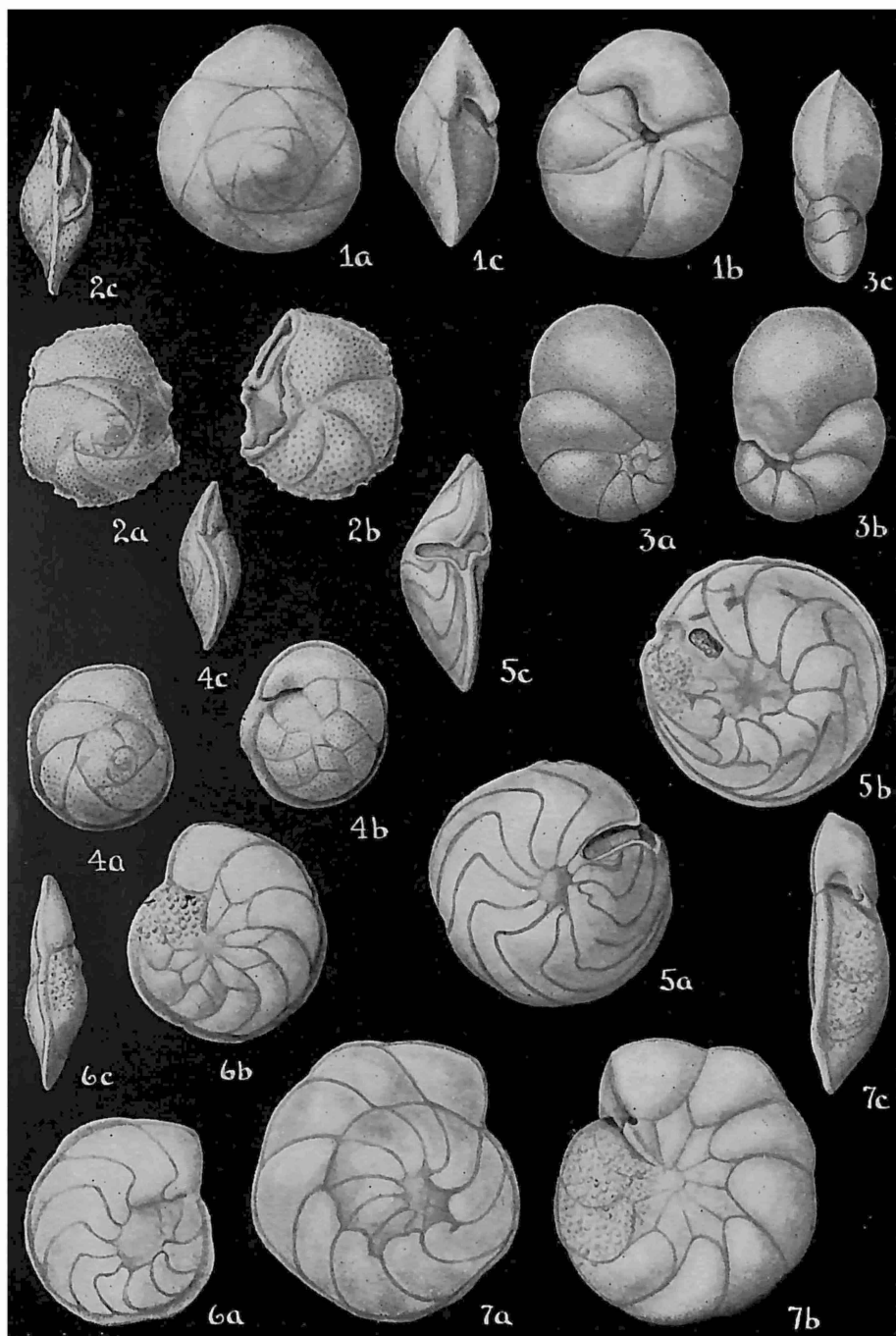
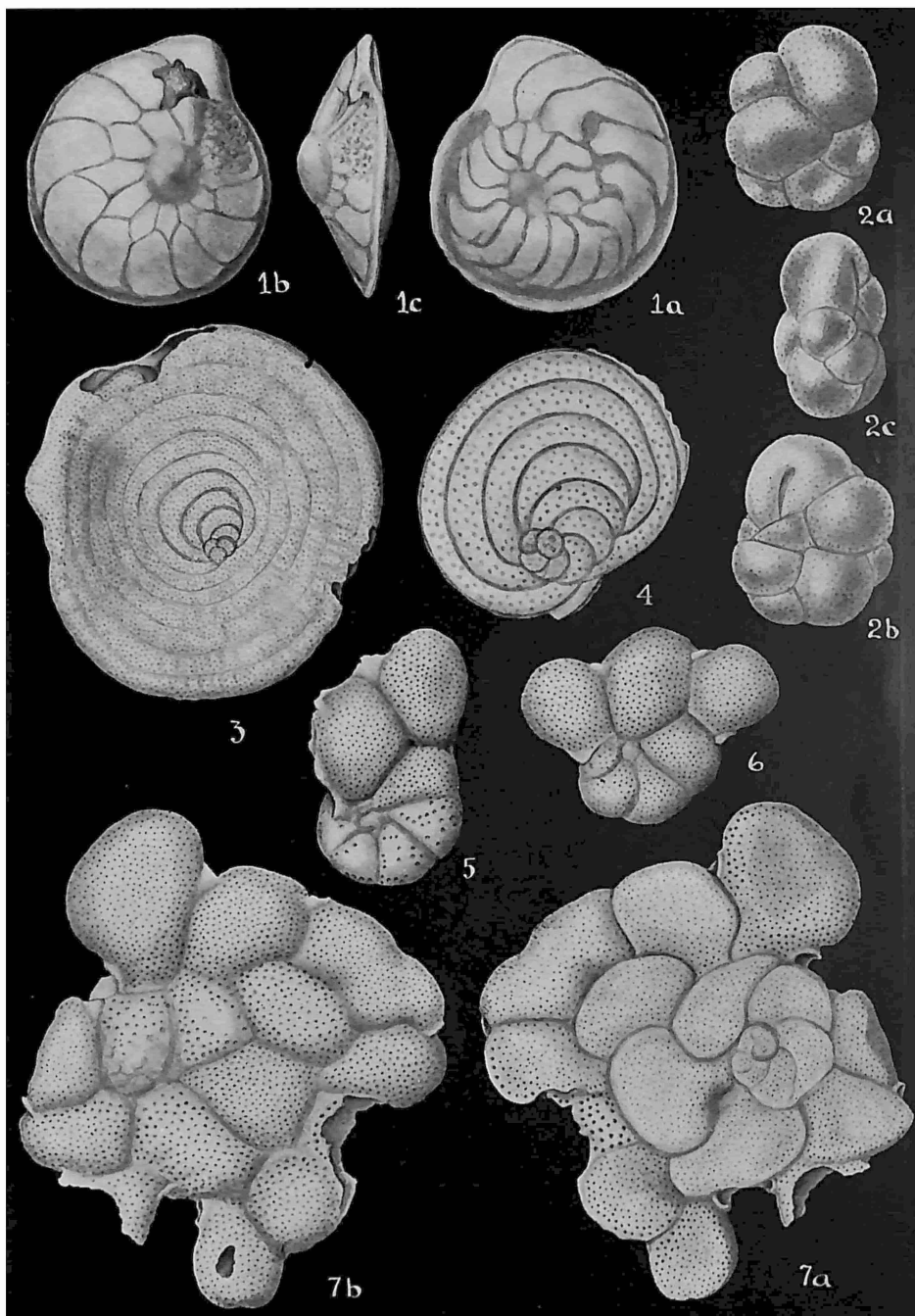


PLATE 14

- FIGS. 1 *a-c*. *Eponides antillarum* (d'Orbigny). $\times 50$. *a*, dorsal view; *b*, ventral view; *c*, peripheral view. Locality 28. Page 93.
- 2 *a-c*. *Siphonina jacksonensis* Cushman and Applin, var. *limbosa* Cushman. $\times 55$. *a*, dorsal view; *b*, ventral view; *c*, peripheral view. Locality 16. Page 94.
- 3 *a-c*. *Canceris sagra* (d'Orbigny). $\times 40$. *a*, dorsal view; *b*, ventral view; *c*, peripheral view. Locality 8. Page 94.
- 4 *a-c*. *Asterigerina miocenica* Cushman and Ponton, n. sp. $\times 125$. *a*, dorsal view; *b*, ventral view; *c*, peripheral view. Locality 29. Page 95.
- 5 *a-c*. *Amphistegina lessonii* d'Orbigny. $\times 40$. *a*, dorsal view; *b*, ventral view; *c*, peripheral view. Locality 3. Page 95.
- 6, 7. *Amphistegina floridana* Cushman and Ponton, n. sp. $\times 40$. *a, a*, dorsal views; *b, b*, ventral views; *c, c*, peripheral view. Fig. 6, paratype. Locality 26. Fig. 7, holotype. Locality 7. Page 96.

PLATE 15

- FIGS. 1 *a-c. Amphistegina chipolensis* Cushman and Ponton, n. sp. $\times 40$.
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- 2 *a-c. Cassidulina chipolensis* Cushman and Ponton, n. sp. $\times 150$.
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- 3, 4. *Cycloloculina miocenica* Cushman and Ponton. Fig. 3, $\times 55$.
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- 5-7. *Cibicides variabilis* (d'Orbigny). $\times 32$. Figs. 5, 6, early stages. Fig. 7, adult form. Fig 7 *a*, dorsal view; *b*, ventral view. Locality 22. Page 102.



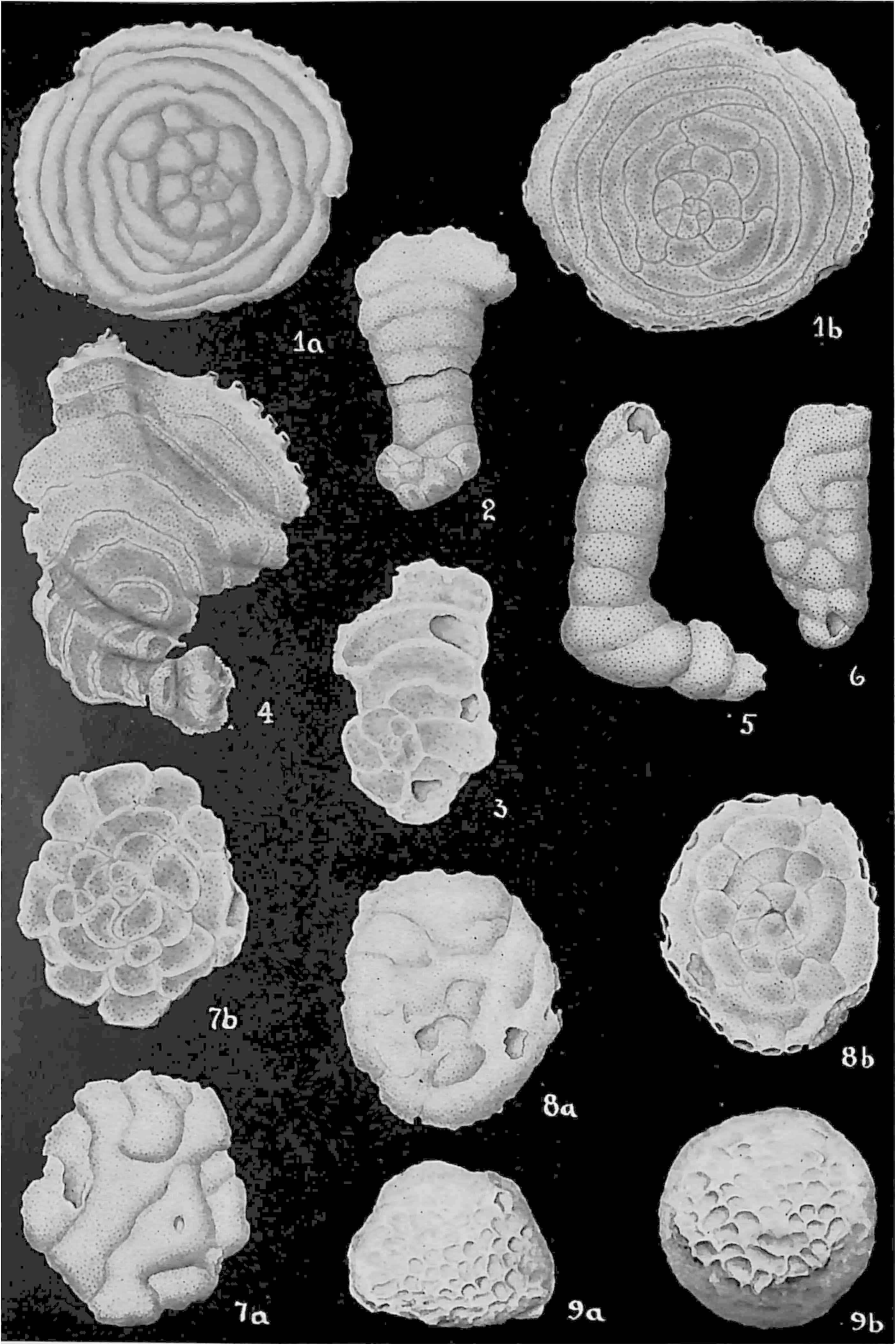


PLATE 16

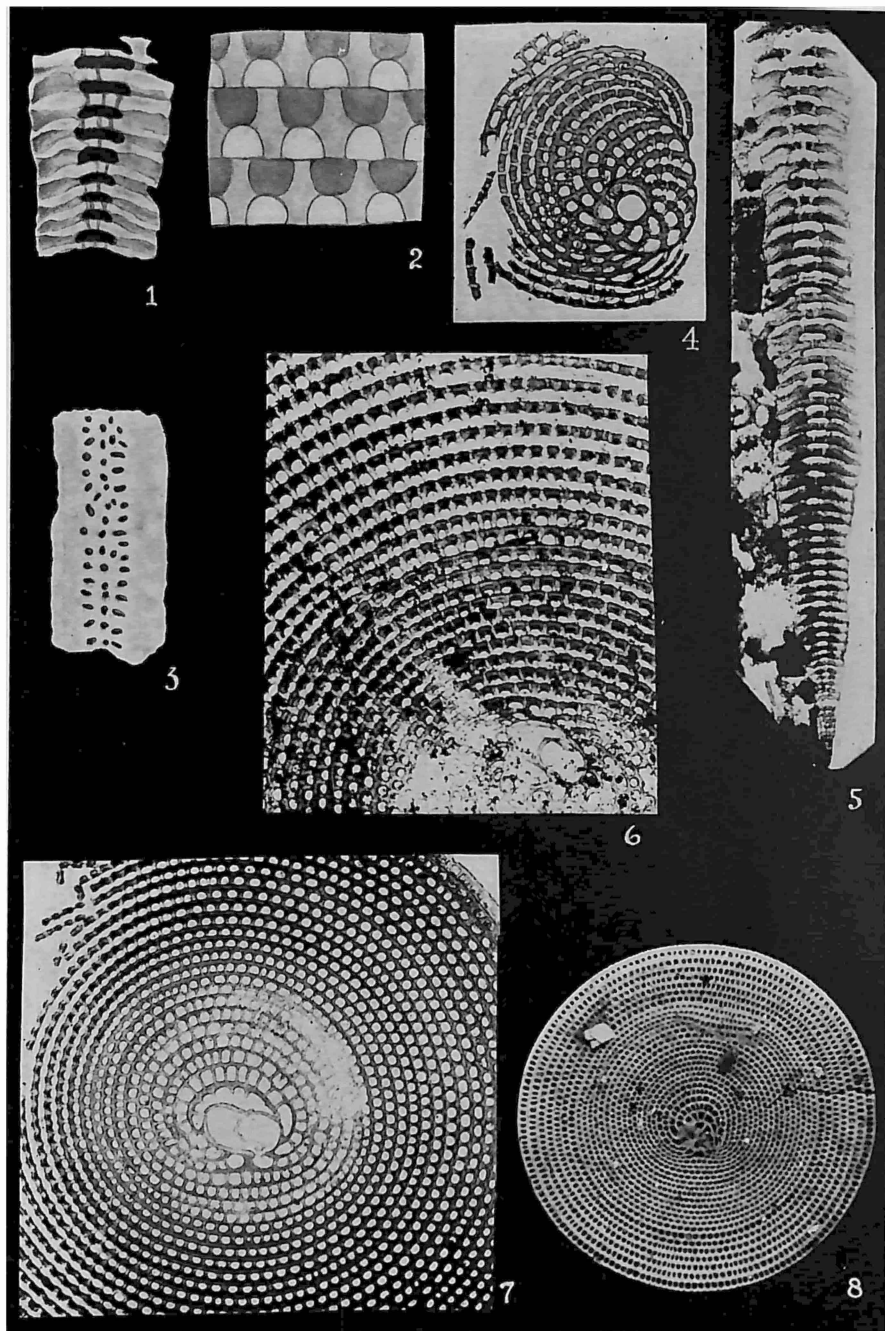
- FIGS. 1 *a, b. Annulocibicides projectus* Cushman and Ponton. $\times 40$. *a*, dorsal view; *b*, ventral view. Locality 22. Page 103.
- 2-4. *Rectocibicides miocenicus* Cushman and Ponton. $\times 32$. Fig. 2, holotype, ventral exterior view. Fig. 3, dorsal attached side. Fig. 4, adult expanded specimen from attached side. Locality 6. Page 103.
- 5, 6. *Accervulina inhaerens* Schultze. $\times 40$. Locality 13. Page 104.
- 7, 8. *Accervulina chipolensis* Cushman and Ponton, n. sp. $\times 40$. *a, a*, ventral external sides; *b, b*, dorsal attached sides. Fig. 7, holotype. Fig. 8, paratype. Locality 10. Page 104.
- 9 *a, b. Gypsina vesicularis* (Parker and Jones). $\times 50$. *a*, side view; *b*, viewed from above. Locality 19. Page 105.

EXPLANATION OF PLATE 17

Sorites (?) sp. (?)

- FIG. 1.—Fragment of vertical section. $\times 50$. Showing the single chambers and the several channels connecting them. Locality 10. Page 72.
- FIG. 2.—Schematic arrangement of the chambers and their connections, the chamberlets themselves being white, the connecting areas in light gray, and the thickened wall in the darkest tone. $\times 160$. Locality 10. Page 72.
- FIG. 3.—Exterior. Peripheral face showing the pores in a band along the median line. $\times 50$. Locality 10. Page 72.
- FIG. 4.—Horizontal section of the early portion of a microspheric specimen showing the proloculum and succeeding chambers. $\times 50$. Locality 10. Page 72.
- FIG. 5.—Vertical section of one-half of an adult specimen. $\times 50$. Locality 10. Page 72.
- FIG. 6.—Horizontal section of a megalospheric specimen showing the details of the structure shown in Figure 2. $\times 75$. Locality 10. Page 72.
- FIG. 7.—Horizontal section of a megalospheric specimen showing the arrangement of the early chambers. $\times 75$. Locality 10. Page 72.
- FIG. 8.—Specimen from the exterior showing the arrangement of chambers in the megalospheric form. This specimen has been eroded so that the openings represent the chamberlets. $\times 15$. Locality 10. Page 72.

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Planorbulinidae	104	Shell Bluff, Shoal River forma-	
Planularia sp.	59	tion at	17
Planulina depressa	100	Shoal River, Shoal River forma-	
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Polymorphina advena	67	Shoal River formation, localities	
Polymorphinidae	64	(See also Cardium beds) :	
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Pseudarcella arenata	39	Shell Bluff	17
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Pyrgo denticulata	56	Sigmomorphina pearceyi	67
subsp. haerica	56	undulosa	68
Pyrulina albatrossi	66	williamsoni	67
Q		Siphogenerina lamellata	86
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chipolensis	45	limbosa	94
contorta	44	Senterfeits Branch, Chipola for-	
costata	44	mation on	15
crassa, var. subcuneata	45	"Sopchoppy limestone"	21, 30
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lamarekiana	44	near	21
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Robulus americanus	58	sp.	50
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catenulatus	58	at	12
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iotus	58	mation in	22
vaughani	59	Suwannee River, Hawthorn for-	
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Rotalia becarrii, var. parkinson-		Tallahassee, Hawthorn formation	
iana	93	at	22
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Rouse's Mill Creek, Hawthorn		near	16
formation on	21	Taylor Branch, Arca zone on.....	18
		Tenmile Creek, Chipola formation	
		on	14

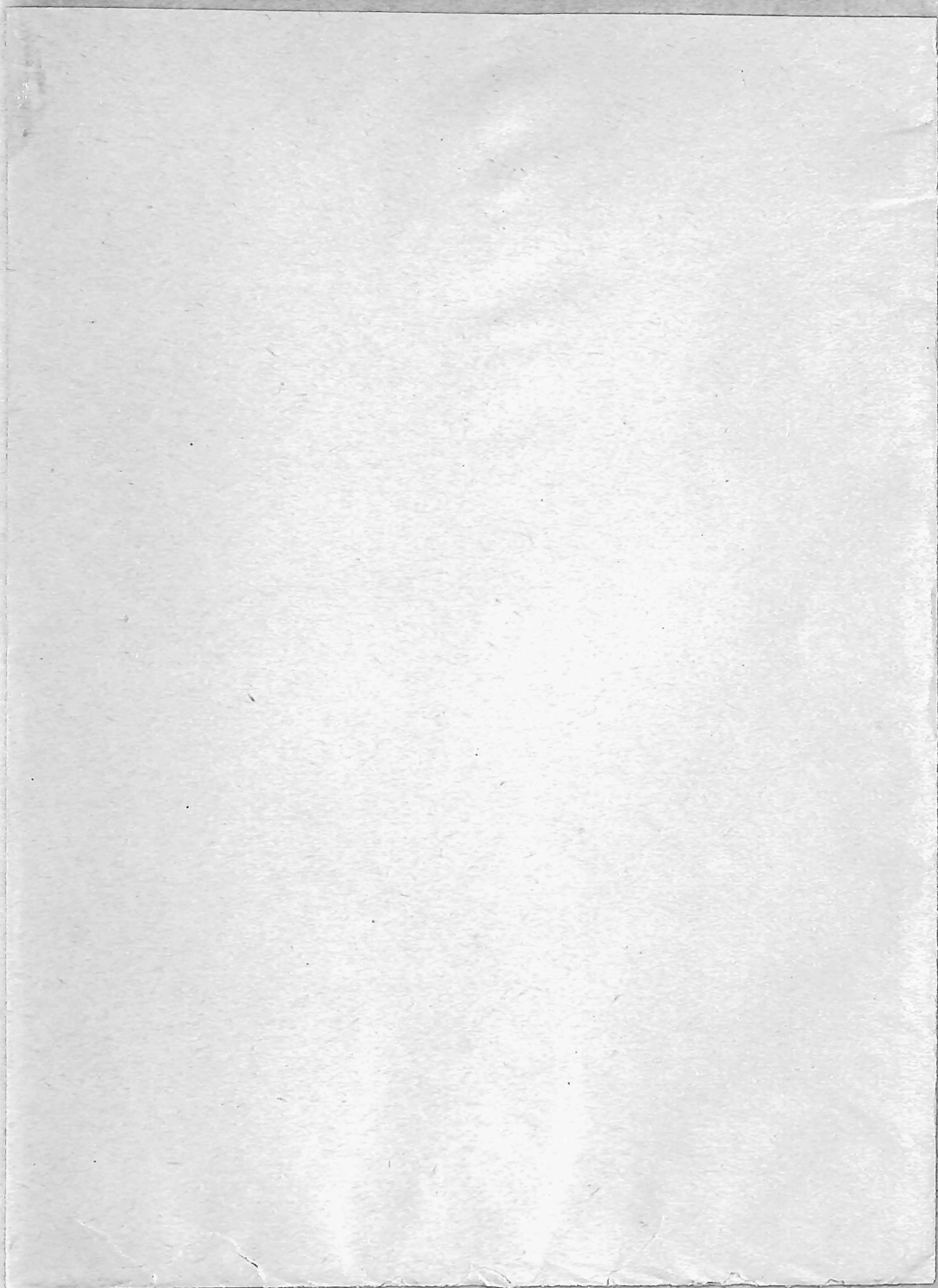
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Textularia agglutinans	39	Anderson's, John, farm, Arca	
articulata	40	zone at	18
caudeiana	41	Argyle, 4½ miles south of,	
floridana	41	Shoal River formation	15
foliacea, var. occidentalis	41	Bell's farm, Arca zone at	14
gramen	39	Frazier's, farm, Yoldia zone	
mayori	40	and Cardium bed at	13
warreni	42	Gomillion's, E., farm, Arca	
sp.	42	zone at	18
Textulariidae	39	Jim Kennedy, Branch, Arca	
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brongniartii	54	Langley's farm, Cardium bed at	12
gracilis	53	Permenter's old farm, Ecphora	
oblonga	52	zone at	15
quadrilateralis	53	Shell Bluff, Shoal River forma-	
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U		Whites Creek, Shoal River forma-	
Urnulina compressa	39	tion on	16
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parkeri	86	Gully Sink, Cancellaria zone	
peregrina	85	at	9
V		Hamlin Pond, Cancellaria zone	
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Alice Creek, Arca zone on.....	16	Yorktown formation.....	29

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Table Number One.
DISTRIBUTION OF SPECIES.

SPECIES	FLORIDA GEOLOGICAL SURVEY CATALOGUE NUMBER	Upper Miocene										Middle Miocene										Lower Miocene																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
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