DEPARTMENT OF THE INTERIOR
HUBERT WORK, Secretary

UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, Director

PROFESSIONAL PAPER 133

THE CORRELATION OF THE VICKSBURG GROUP

BY

C. WYTHE COOKE

AND

THE FORAMINIFERA OF THE VICKSBURG GROUP

BY

JOSEPH A. CUSHMAN

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CONTENTS.

ILLUSTRATIONS.

INSERT.

ERRATA, PROFESSIONAL PAPER 133.

Page 13, fourth line of text, "unusually" should read "usually."
Page 15, second column, heading should read "Textularia agglutinans D'Orbigny."
Page 23, first column, sixth line of synonymy under "Bulimina ovata," "Prof. Paper 29" should read "Prof. Paper 129."
Page 23, second column, third and fourth lines should read "are much more elongate and more evenly tapering and have fewer and more prominent," etc.
Page 26, first column, eighth line of synonymy under "Lagena striata," "pl. 129" should read "pl. 29."
Page 60, heading for figure 1 should read "Textularia agglutinans D'Orbigny."

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THE CORRELATION OF THE VICKSBURG GROUP.

By C. WYTHE COOKE.

The purpose of this paper is to make public the results of recent investigations on the Oligocene formations of the southeastern part of the United States, to correct certain errors in the standard correlation tables, and to establish on a firmer foundation the correlation of formations on the continent of North America with those in the West Indies and, through them, with the classic time scale of Europe.

DIVISIONS OF THE VICKSBURG GROUP.

The current classification of the Vicksburg group was first proposed in my unpublished manuscript prepared for the Mississippi Geological Survey in 1916. In 1917 part of it was used by O. B. Hopkins,[1] and in 1918 I published a summary of the stratigraphy of the Vicksburg group in Mississippi and Alabama.[2] The correlation table from the latter paper was republished, together with a short description of the youngest formation, in my paper on the Byram calcareous marl of Mississippi.[3] Later investigations have necessitated only one change in this classification: the Glendon limestone, formerly regarded as a member of the Marianna limestone, is here raised to the rank of formation.

Named in descending order, the divisions of the Vicksburg group now recognized are the following:

Byram calcareous marl.
Glendon formation.
Marianna limestone.
    Mint Spring calcareous marl member.
Red Bluff clay and Forest Hill sand (contemporaneous).

[1] Hopkins, O. B., Oil and gas possibilities of the Hatchetigbee anticline, Alabama: U. S. Geol. Survey Bull. 661, pp. 281–313, 1917.

[2] Cooke, C. W., Correlation of the deposits of Jackson and Vicksburg ages in Mississippi and Alabama: Washington Acad. Sci. Jour., vol. 8, pp. 186–198, 1918.

[3] U. S. Geol. Survey Prof. Paper 129, pp. 79–122, 1922.

FOREST HILL SAND.

The name Forest Hill sand (from Forest Hill, 5½ miles southwest of Jackson, Miss.) replaces the "Madison sands" of Lowe.[4] The Forest Hill sand appears to rest conformably upon the Yazoo clay member of the Jackson formation. Although the character of the sediments indicates a change at the end of Jackson time from marine to very shallow water or palustrine conditions, it is probable that the change was gradual and that deposition was nearly continuous. The Forest Hill is overlain conformably by the Mint Spring marl member of the Marianna limestone. The relations of the Forest Hill to the Red Bluff clay are not definitely known, but it is thought that the two were formed contemporaneously, the Red Bluff in the open sea and the Forest Hill in the Mississippi embayment.

In the type area the Forest Hill sand consists chiefly of cross-bedded or laminated, more or less ferruginous, siliceous sand and some clay. Farther west the formation is more argillaceous and contains lenses of lignite and lignitic clay. The thickness ranges from about 50 to 70 feet.

Fragments of petrified wood, leaves, and other plant remains are common in the Forest Hill sand, but few of them are identifiable. No animal remains have been found in the formation.

The Forest Hill sand is known only in Mississippi. It crops out along the bluffs of Mississippi and Yazoo rivers from Vicksburg northward to a point within a few miles of Satartia. Exposures are numerous in eastern Hinds County and in Rankin County as far

[4] Lowe, E. N., Mississippi, its geology, geography, soils, and mineral resources: Mississippi Geol. Survey Bull. 12, p. 82, 1915. The name Madison was applied to sandstone in Wisconsin as early as 1875 and to several other formations since then.

east as Rankin. Outliers of the Vicksburg beds in Madison County afford good exposures of the Forest Hill sand. Lignitic clays that are tentatively referred to the Forest Hill have been seen at several places in Smith County.

RED BLUFF CLAY.

The Red Bluff clay is known only in Wayne and Clarke counties, Miss., and in Choctaw, Washington, and Clarke counties, Ala. The type locality is Red Bluff, on Chickasawhay River, Miss., 1½ miles below Shubuta.

The Red Bluff clay lies conformably above the Jackson formation (Eocene) and below the Marianna limestone. As the formation has not been traced as far west as the easternmost known outcrops of the Forest Hill sand, its relations to the Forest Hill are conjectural, but the Red Bluff clay is probably the marine equivalent of the swamp or delta deposits that constitute the Forest Hill sand. In Alabama the Red Bluff clay merges laterally into the Marianna limestone.

The Red Bluff clay consists chiefly of stiff blue or greenish gypseous clay, with discontinuous ledges of marlstone or sandstone and a thin bed of shell marl. On Bucatunna Creek the formation is 70 feet thick, but it thins rapidly toward the east.

The Red Bluff fauna is unmistakably marine. It includes more than 128 mollusks, 6 corals, 36 Bryozoa, and 50 Foraminifera. Of the 134 mollusks and corals, about 60 appear to be restricted to the Red Bluff beds; about 55 varietal or specifically identical forms are present in the Mint Spring marl; and about 49 species or varieties are known in the Byram marl. Of the Byram marl species 10 have not yet been found in the Mint Spring marl. Twelve mollusks, three of which range through the Vicksburg group, are listed also from the Jackson formation, but some of them are characterless species of supposedly very long range.

MARIANNA LIMESTONE.

The Marianna limestone extends from Mississippi River across Mississippi, Alabama, and western Florida to Chipola River. It has not been recognized in peninsular Florida or in Georgia. The type locality is near Chipola River at Marianna, Fla.

"Chimney rock" facies.—The typical Marianna limestone is very homogeneous, is white or cream-colored, and when first quarried is so soft that it is easily sawed into building blocks. Because of its extensive use for building chimneys, it is popularly known as "chimney rock." This facies of the Marianna limestone extends with remarkable uniformity from Marianna nearly to Pearl River, Miss. The thickness of the bed ranges from about 30 feet at Marianna to 74 feet at St. Stephens Bluff, Tombigbee River, but diminishes to about 20 feet near Brandon, Miss.

The large orbitoid foraminifer *Lepidocyclina mantelli* (Morton) is the most characteristic fossil of the typical Marianna "chimney rock." *Pecten poulsoni* Morton is also abundant but has a wider range. Bryozoa are rare at the type locality but are very abundant at many places in Alabama and Mississippi.

In Florida and southeastern Alabama the Marianna rests conformably upon the Ocala limestone, but in Washington and Choctaw counties, Ala., and in eastern Mississippi it lies upon the Red Bluff clay. The basal part of the Marianna in the type area is probably equivalent in age to the Red Bluff clay. The transition from Red Bluff into Marianna takes place in the area between Alabama and Tombigbee rivers. At St. Stephens Bluff, on Tombigbee River, the Red Bluff, although not characteristically developed, is still recognizable.

Mint Spring calcareous marl member.—The "chimney rock" facies of the Marianna limestone is replaced in western Mississippi by sands and shell marls—the Mint Spring calcareous marl member, named from Mint Spring Bayou, at Vicksburg. Between Vicksburg and Pearl River the Mint Spring marl occupies the entire interval between the Glendon limestone and the Forest Hill sand, but east of Pearl River it is overlain by a thickening wedge of Marianna "chimney rock." It has not been recognized east of Chickasawhay River, on which it is exposed 1¼ miles northwest of the mouth of Limestone Creek. Other conspicuous exposures occur along Glass Bayou at Vicksburg and at Haynes Bluff, 14 miles north of Vicksburg, where it is 25 feet thick.

The fauna of the Mint Spring marl includes 160 mollusks, 3 corals, and about 84 species or

varieties of Foraminifera. Bryozoa are less numerous than in the "chimney rock."

According to Cushman [5] the Foraminifera indicate that the Mint Spring marl was deposited under water about 50 fathoms deep.

GLENDON FORMATION.

The Glendon formation, named from a village on the Southern Railway in Clarke County, Ala., was originally described [6] as the Glendon limestone member of the Marianna limestone, but inasmuch as beds of Glendon age are now known to have a wider distribution than the typical Marianna, to contain a large and characteristic fauna, and to transgress older formations, it seems advisable to regard the Glendon as of formational rank. It overlies the Marianna conformably. In the type area the formation consists of a series of ledges of hard, partly crystalline yellowish or pinkish limestone interbedded with softer strata of impure limestone, aggregating 18 or 20 feet in thickness. The formation probably extends westward as far as Mississippi River, where the hard ledges in the bluffs at Vicksburg are tentatively placed in the Glendon, but the identification of the Glendon limestone in western Mississippi is somewhat questionable. East of Clarke County, Ala., the Glendon limestone can be traced as far as McGowans Bridge, Conecuh River. In southeastern Alabama, in western Florida, and in Georgia the formation shows two facies: Under cover and where the cover has recently been removed the formation is white or yellowish limestone; elsewhere most or all of the lime has been removed or replaced by silica, leaving lumps of chert mingled with residual sands and clays. This cherty facies, to which the name Glendon chert may be applied, covers about 2,000 square miles in the southeast corner of Alabama, a much larger area in Georgia, and a small area in western Florida. It overlaps the Marianna limestone, the Ocala limestone, the Claiborne group, and part of the Wilcox group. Most of the limestone and chert in Georgia formerly classed as Chattahoochee is now considered Glendon. A discussion of the correlation of the faunas of these cherty beds and of the typical Glendon limestone is given below.

[5] Cushman, J. A., The Foraminifera of the Mint Spring calcareous member of the Marianna limestone: U. S. Geol. Survey Prof. Paper 129, p. 123, 1922.

[6] Cooke, C. W., Correlation of the deposits of Jackson and Vicksburg ages in Mississippi and Alabama: Washington Acad. Sci. Jour., vol. 8, p. 195, 1918.

BYRAM CALCAREOUS MARL.

Although its name dates only from 1918,[7] the Byram calcareous marl, the topmost formation of the Vicksburg group as now recognized, may be regarded as the type division of the Vicksburg. In a recent paper [8] I described the Byram in Mississippi and listed the corals, mollusks, and Bryozoa that have been found in it there. The formation extends across southern Alabama and into the adjacent part of western Florida. In Alabama the most conspicuous part of it is friable marlstone containing molds of fossils. Green to black plastic clay somewhat resembling the Red Bluff and, like it, containing crystals of gypsum is less commonly exposed. In Florida the formation is made up chiefly of soft porous yellow marlstone from which most of the lime has been leached.

THE CHERT BEDS OF FLINT RIVER, GA.

The coralliferous cherts of Flint River, near Bainbridge, Ga., have been known for many years. In December, 1893, Pumpelly [9] wrote about them as follows:

> At numerous points in southwestern Georgia there occur between the Eocene and Chattahoochee masses of columnar corals chalcedonized. They are not present at the majority of the points of observed contact. Nor has their exact relation to the Eocene or Chattahoochee been observed. Mr. Dall writes me regarding some that I sent him, that they belong at the base of the Miocene. The observations lead me to think that they probably grew during the interval between the Vicksburg and Chattahoochee, upon the submerged Eocene surface.

The section along Flint River was more fully described by Foerste [10] in the following year and illustrated by an excellent sketch map. According to Foerste, several successive zones of silicified limestone alternating with soft white marl are crossed by Flint River below Bainbridge, all forming part of what he identified as Vicksburg (Ocala) limestone. This interpretation has not been verified by later observations.

[7] Cooke, C. W., Correlation of the deposits of Jackson and Vicksburg age in Mississippi and Alabama: Washington Acad. Sci. Jour., vol. 8, pp. 186–198, 1918.

[8] Cooke, C. W., The Byram calcareous marl of Mississippi: U. S. Geol. Survey Prof. Paper 129, pp. 79–85, 1922.

[9] Pumpelly, Raphael, An apparent time break between the Eocene and Chattahoochee Miocene in southwestern Georgia: Am. Jour. Sci., 3d ser., vol. 46, p. 447, 1893.

[10] Foerste, A. F., The upper Vicksburg Eocene and the Chattahoochee Miocene of southwest Georgia and adjacent Florida: Am. Jour. Sci., 3d ser., vol. 48, pp. 41–54, 1894.

Subsequent writers have referred the cherts and the sands and clays in which they are embedded to the Chattahoochee, and so far as I am aware this correlation has never before been challenged.

The so-called "basal Chattahoochee" chert beds of Flint River are noted chiefly because of the fossil coral reef which forms part of them. Although Vaughan [11] called attention to this reef in 1900, his systematic description of the coral fauna remains unpublished. The corals of the chert beds number between 25 and 30 species. Of these, 11 or more are present in the fauna of the Antigua formation of Antigua, but only two or three are common to the Tampa coral fauna, which is younger.

The chert beds contain a large molluscan fauna. Dall,[12] who critically studied the mollusks in 1916, lists 87 species, of which 36 were described as new. Ten are represented as present also in the Jackson or Ocala Eocene, 12 in the Vicksburgian Oligocene, 20 in the *Orthaulax pugnax* zone at Tampa, and 5 in the Chipola fauna. According to Dall the fossils are immediately separable into two groups, characterizing two zones, the upper zone represented chiefly south of Bainbridge and the lower zone around and north of Bainbridge. The upper zone was regarded by Dall as probably equivalent to the *Orthaulaux pugnax* zone of Tampa, Fla., and the lower as occupying a position near the base of the upper Oligocene. In my opinion this hypothetical separation into zones is not corroborated by the stratigraphic evidence. T. Wayland Vaughan and I have on several occasions spent considerable time in field studies around Bainbridge, and we collected most of the fossils upon which Dall's paper was based. We both think that there is only one principal chert-bearing zone above the Ocala limestone. Dall was probably influenced by the presence of *Orthaulax pugnax* in some of the collections from Bainbridge, but, as I have shown elsewhere,[13] *Orthaulax pugnax* occurs also in the Antigua formation, which is older than the Tampa "silex bed."

[11] Vaughan, T. W., A Tertiary coral reef near Bainbridge, Ga.: Science, new ser., vol. 12, pp. 873–875, 1900.

[12] Dall, W. H., A contribution to the invertebrate fauna of the Oligocene beds of Flint River, Ga.: U. S. Nat. Mus. Proc., vol. 51, pp. 487–524, pls. 83–88, 1916.

[13] Cooke, C. W., *Orthaulax*, a Tertiary guide fossil: U. S. Geol. Survey Prof. Paper 129, pp. 23–37, 1921.

DISTRIBUTION AND FAUNA OF THE CHERTS IN ALABAMA AND FLORIDA.

The characteristic mollusks of the coral-reef fauna were first recognized outside of Georgia in 1920, by Miss Julia Gardner, among fossils collected near Geneva, Ala., and sent by F. G. Clapp to the United States Geological Survey for identification. In 1921 Miss Gardner and I traced the cherty beds from Chattahoochee River westward and made collections from the cherts at many places in Houston, Henry, Dale, Geneva, and Coffee counties, Ala., and in Holmes and Washington counties, Fla. The beds overlap the Ocala limestone, the Claiborne group, and part of the Wilcox group.

The following list of fossils is especially significant in that it shows some of the characteristic species from Flint River, including *Orthaulax pugnax*, far west of their previously known range and associated with typical Vicksburg shells. The letter F preceding the name of the species signifies that the species so marked occurs also in the coral-reef fauna on Flint River near Bainbridge; the letter V indicates that it occurs also in the Vicksburg group of Mississippi or Alabama.

Station $\frac{1}{104}$. Holmes County, Fla., half a mile south of the State line on the road from Geneva, Ala., to Westville, Fla. Cooke and Gardner, collectors, June 9, 1921.

Lepidocyclina undosa Cushman (also Antigua). [14]
VF Lepidocyclina gigas Cushman var. (also Antigua). [14]
Lepidocyclina sp.
Nummulites sp.
F Orthaulax pugnax (Heilprin).
F Ampullina streptostoma (Heilprin)?
V Ficus mississippiensis Conrad.
Xenophora sp.
VF Ostrea vicksburgensis Conrad.
V Pteria argentea (Conrad).
VF Pecten anatipes Morton.
V Pecten poulsoni Morton.
F Spondylus filiaris Dall.
F Arcoperna inflata Dall.
Cardium sp.
V Chione sp. cf. C. mississippiensis Conrad.
V Clypeaster rogersi (Morton).
Crab claw.

So far as I know, *Pecten poulsoni* and *Clypeaster rogersi* have never been found in deposits other than those of Vicksburg age.

The cherts near Goodman, Ala., have yielded the following fossils, most of which occur also near Bainbridge:

[14] Identified by T. W Vaughan.

Station $\frac{1}{107}$. Sec. 25, T. 4 N., R. 20 E., on road to Elba, three-quarters of a mile north of Goodman, Coffee County, Ala. Cooke and Gardner, collectors, May 12, 1921.

V Lepidocyclina supera (Conrad).[14]
Lepidocyclina undosa Cushman var.[14]
Cassis sp.
F Orthaulax pugnax (Heilprin).
Pecten sp. aff. P. "thetidis" Cooke, not Sowerby.
FV Pecten anatipes Morton.
Pecten n. sp. (P. "alpha" Dall).
Pecten n. sp. aff. P. gabbi Dall.
Glycymeris cookei Dall.
Glycymeris n. sp.
Lima n. sp.
Protocardia diversa (Conrad)?
Cardium sp. cf. C. glebosum Conrad.
Cardium sp.
Chione bainbridgensis Dall.
Pitaria (Lamelliconcha) calcanea var. silicifluvia Dall.
Phacoides (Miltha) perovatus Dall.
Phacoides (Miltha) hillsboroensis (Heilprin)?
Phacoides (Miltha) sp.
Clypeaster rogersi (Morton).

[14] Identified by T. W. Vaughan.

MOLLUSKS FROM THE CHERT BEDS NEAR BAINBRIDGE.

In order to reconcile the remarkable similarity of the faunas of the chert beds of Alabama and of the Vicksburg group with the dissimilarity reported by Dall between the faunas of the Vicksburg and of the so-called "basal Chattahoochee" cherts of the Bainbridge area, I have examined carefully the collections in the National Museum upon which Dall's paper was based and prepared the following revised list. Dall's identifications that differ from mine are given in the second column. The distribution of species is based upon my own knowledge of the faunas. The species whose names are preceded by an asterisk (*) were described as new in the paper cited.

Revised list of mollusks from the Oligocene cherts of Bainbridge, Ga.

Species.	Dall's name, 1916 (if changed in this list).	Eocene.	Vicksburg group.	Tampa.
Arca subprotracta Heilprin?	Arca subprotracta Heilprin		×	
Barbatia cuculloides (Conrad)		×	×	
*Glycymeris cookei Dall			×	
Glycymeris mississippiensis (Conrad)			×	
Ostrea sp	O. mauricensis Gabb			
Ostrea vicksburgensis Conrad		×	×	
Ostrea cf. O. podagrina Dall		×		
Pecten n. sp	Pecten alpha Dall			
Pecten n. sp	Pecten suwanneensis Dall			
Pecten anatipes Morton			×	
*Spondylus filiaris Dall				×
*Lima halensis Dall				
Modiolus grammatus Dall				×
Modiolaria sp. undet				
*Arcoperna inflata Dall				
Lithophaga nuda Dall				×
Crassatellites mississippiensis Conrad	*C. paramesus Dall		×	
Venericardia n. sp	Venericardia praecisa Dall			
Venericardia serricosta (Heilprin)	Cardita shepardi Dall			×
*Phacoides perovatus Dall				
Phacoides (Here) wacissanus Dall	P. (H.) cf. P. wacissanus Dall		×	×
Phacoides sp. undet				
Phacoides (Miltha) hillsboroensis (Heilprin).	P. (M.) hillsboroensis (Heilprin) and P. ocalanus Dall.			×
Cardium glebosum Conrad			×	
Cardium sp. undet	Cardium eversum Conrad			
Cardium (Trachycardium) sp. undet				
Cardium (Laevicardium) sp. undet				
*Chione bainbridgensis Dall				
Macrocallista (Chionella) sp. undet	M. (C.) cf. M. ovata (Rogers)			
Antigona aff. A. caesarina Dall				×
Pitaria (Lamelliconcha) calcanea var. silicifluvia Dall.	P. calcanea and *P. silicifluvia		×	
*Psammobia cerasia Dall				
Tellina sp. undet	Tellina segregata Dall			
Semele? sp. undet				
Mactra mississippiensis Conrad			×	
*Conus vaughani Dall				
*Conus cookei Dall				

Revised list of mollusks from the Oligocene cherts of Bainbridge, Ga.—Continued.

Species.	Dall's name, 1916 (if changed in this list).	Eocene.	Vicksburg group.	Tampa.
Conus alveatus Conrad	C. demiurgus Dall and C. tortilis Conrad.		×	
Conus sp. undet.				
Genus and sp. undet.	Turris sp. undet.			
*Marginella silicifluvia Dall				
*Marginella halensis Dall			×	
*Lyria mansfieldi Dall				
Lyria sp. undet.	L. sp. aff. L. silicata Dall			
Conomitra sp. cf. C. staminea (Conrad)	M. syra Dall		×	
Conomitra sp. cf. C. vicksburgensis (Conrad)	M. syra Dall		×	
Xancus wilsoni (Conrad)			×	
Phos sp. aff. P. vicksburgensis (Aldrich)	Fusinus nexilis Dall		×	
*Murex rufirupicolus Dall				
*Epitonium? dubiosum Dall				
*Cymatium cecilianum Dall				
*Bursa victrix Dall				
Cassis caelatura Conrad	C. sulcifera Sowerby and C. globosa Dall.		×	
Orthaulax pugnax (Heilprin)	O. pugnax and O. inornatus Gabb			×
Strombus sp. undet.	Strombus chipolanus Dall			
Strombus sp. undet.				
*Bittium silicium Dall				
*Diastoma georgiana Dall				
*Cerithium silicifluvium Dall				
*Cerithium mascotianum Dall				
*Cerithium halense Dall				
*Cerithium vaughani Dall				
*Cerithium cookei Dall				
*Cerithium corallicolum Dall				
*Cerithium eutextile Dall				
*Cerithium vaginatum Dall				
*Cerithium insulatum Dall				
*Cerithiopsis diagona Dall				
Turritella mississippiensis Conrad	*T. halensis Dall and T. tampae Dall.		×	
Turritella sp. undet.				
Calyptraea trochiformis Lamarck		×	×	×
Xenophora conchyliophora (Born)		×	×	×
Ampullina sp.	A. solidula Dall			
Ampullina streptostoma (Heilprin)?				×
Amauropsis n. sp.	A. ocalana Dall			
Sinum sp. undet.	Sinum imperforatum Dall			
*Margarites corallicolus Dall				
*Teinostoma sublimata Dall				
*Liotia (Arene) halensis Dall				
*Liotia? persculpturata Dall				
Nerita tampaensis Dall?	N. tampaensis Dall.			×
*Dentalium ladinum Dall				

Of the 31 species in the revised list whose distribution is indicated, 21, or 67 per cent, occur in the Vicksburg group and 12, or 39 per cent, in the *Orthaulax pugnax* zone at Tampa. This shows that the fauna at Bainbridge has much more in common with the Vicksburg beds than with the *Orthaulax pugnax* zone at Tampa. If, in addition to this evidence, we take into consideration the presence of many other characteristic Vicksburg organisms in the cherts of southeastern Alabama, which obviously are of the same age as the cherts of Flint River, the conclusion seems inevitable that the cherts are of Vicksburg age.

CORRELATION OF THE CHERT BEDS WITH THE GLENDON LIMESTONE.

The evidence already presented seems conclusive that the chert beds of Flint River belong in the Vicksburg group, but with what part of the group they should be correlated is still to be shown.

In 1915 I established the correlation of the Ocala limestone at Bainbridge with the top of the Ocala at Marianna, Fla.,[15] which appears to be conformable with the overlying Marianna limestone. As the Ocala at Bainbridge is

[15] Cooke, C. W., The age of the Ocala limestone: U. S. Geol. Survey Prof. Paper 95, p. 110, 1915.

separated by a pronounced erosional unconformity from the Oligocene chert beds, it is evident that at least part of the Marianna limestone is not now represented by deposits at Bainbridge, and it seems probable that the hiatus includes all of the Marianna "chimney rock." The chert beds, therefore, can not be as old as the Marianna "chimney rock."

The remaining divisions of the Vicksburg group in Mississippi and Alabama are the Glendon limestone and the Byram marl. With each of these formations the chert beds have certain characteristics in common. That the chert or silicified limestone beds of Flint River were derived from limestone resembling the Glendon is shown by near-by exposures of unaltered fossiliferous limestone in sinks and wells. Furthermore, 40 feet of limestone resembling the Glendon but carrying the fauna characteristic of the beds on Flint River occurs at Cedar Grove and at several other places near Chipley, Fla. The fossils in the following list were obtained from this bed:

Station $\frac{1}{4}\frac{6}{5}$. Cedar Grove, 2.3 miles south of Chipley, Washington County, Fla. Cooke and Gardner, collectors, April 29, 1921.

Station $\frac{1}{4}\frac{7}{5}$. Road at sink about 2½ miles southeast of Chipley, Fla. May 3, 1921.

Station $\frac{1}{1}\frac{1}{7}$. Rock pile in town of Chipley, Fla. Reported to have come from Cedar Grove.

Lepidocyclina gigas Cushman var.[16]
Lepidocyclina n. sp. (A small robust species.[16])
Diploastrea crassolamellata (Duncan) Vaughan.[16]
Antiguastrea cellulosa (Duncan) Vaughan.[16]
Stylophora sp.[16]
Conomitra vicksburgensis (Conrad)?
Turbo? sp.
Architectonica sp.
Crucibulum sp.
Cassis caelatura (Conrad.)
Cypraea sp.
Lima halensis Dall.
Ostrea vicksburgensis Conrad.
Pecten anatipes Morton.
Pecten sp. cf. P. gabbi Dall.
Pecten sp.
Pecten sp.
Teredo sp.
Calcareous algae.

The fauna of the typical Glendon limestone has not been thoroughly explored, but it includes the following species:

Lepidocyclina chattahoocheensis Cushman.
Lepidocyclina supera (Conrad).
Ostrea vicksburgensis Conrad.
Pecten poulsoni Morton.
Pecten n. sp. aff. P. poulsoni Morton.
Pecten anatipes Morton.
Pecten n. sp. aff. P. gabbi Dall.
Spondylus dumosus (Morton)?
Pteria argentea (Conrad).
Clypeaster rogersi (Morton).
Calcareous algae.
Bryzoa.

Several of these Glendon species occur also in the typical fauna of the chert beds of Flint River, and most of the others have been found in Alabama associated with fossils characteristic of those chert beds. The paleontologic evidence, therefore, strongly supports the correlation of the chert beds with the Glendon limestone and is in accord with the lithologic evidence.

With the Byram marl the chert beds have less in common. The two formations are unlike in lithology. Some species occur in both formations, but that is not surprising, for less than 40 per cent of the Byram species are restricted to the Byram.[17] The most significant tie point is the presence of *Scapharca lesueuri* Dall, which elsewhere seems diagnostic of the Byram, in a few collections of fossils from Alabama that can be correlated only with the chert beds of Flint River. On the other hand, the cherts contain *Glycymeris cookei* Dall, *Clypeaster rogersi* Morton, and *Lepidocyclina chattahoocheensis* Cushman—species elsewhere restricted to either the Glendon or the Marianna limestones.

The chert beds of Flint River, therefore, in my opinion are of Glendon age, and it seems appropriate to apply to them the name Glendon chert.

The Glendon chert is widely distributed in Georgia. Besides the well-known exposures near Bainbridge, which were described by Vaughan [18] (under the name Chattahoochee), the Glendon chert covers large areas in the Flint River drainage basin, and it has been traced northeastward by means of its characteristic fossils as far as Johnson County. Similar cherts in Jenkins, Screven, and Burke counties, Ga., are probably of the same age.

That the correlation of the cherts of the upper Flint River with the Glendon chert near

[16] Identified by T. W. Vaughan.

[17] Cooke, C. W., The Byram calcareous marl of Mississippi: U. S. Geol. Survey Prof. Paper 129, pp. 79–85, 1922.

[18] Veatch, Otto, and Stephenson, L. W., Preliminary report on the geology of the Coastal Plain of Georgia: Georgia Geol. Survey Bull. 26, pp. 329–332, 1911.

Bainbridge is supported by more than lithologic similarity is shown by the following list, which includes many fossils characteristic of the beds at Bainbridge:

Station 7118. Albany Road near Jones Creek, 1¼ miles southwest of Oakfield, Worth County, Ga.; C. Wythe Cooke and J. E. Brantly, collectors, September 28, 1914.

Lepidocyclina sp.
Conus cookei Dall.
Conus alveatus Conrad.
Lyria? sp.
Xancus wilsoni (Conrad).
Phalium caelatura (Conrad).
Murex sp.
Cypraea sp.
Cerithium mascotianum Dall?
Cerithium halense Dall.
Cerithium corallicolum Dall.
Cerithium cookei Dall.
Ampullina mississippiensis (Conrad)?
Glycymeris mississippiensis (Conrad)?
Arca sp. cf. A. subprotracta Heilprin.
Pecten n. sp.
Pecten n. sp.
Pecten anatipes Morton.
Pecten poulsoni Morton?
Spondylus filiaris Dall.
Lima halensis Dall.
Modiolus mississippiensis Conrad.
Macrocallista (Chionella) sobrina (Conrad).
Chione bainbridgensis Dall.
Phacoides (Miltha) sp.
Phacoides (Here) wacissanus Dall.
Cardium glebosum Conrad.
Cardium sp.
Crassatellites sp.

THE AGE OF THE "CORAL LIMESTONE."

Smith and Johnson [19] described the "coral limestone" at Salt Mountain, Ala., as the upper member of the "White limestone," which included also the Jackson formation and the "orbitoidal Vicksburg" (now called Marianna limestone), and referred it doubtfully to the Vicksburg group. In 1918 I thought that the section at Salt Mountain included part of the Marianna "chimney rock," the Glendon, the Bryam, and possibly younger deposits.[20] The basis of this last supposition was the occurrence of the two species of corals from Salt Mountain in the coral reef at Bainbridge, which was then thought to be younger than the Vicksburg group. Vaughan [21] in 1919 definitely placed the "coral limestone" at the horizon of the chert beds of Flint River. With this correlation I concur. I now regard Salt Mountain as a tilted block brought up by the Jackson fault and containing no deposits younger than the Glendon limestone, although clays and marls of Bryam age are exposed not far away.

CORRELATION OF THE VICKSBURG GROUP WITH WEST INDIAN AND EUROPEAN STAGES.

The discovery that the Glendon limestone of Alabama is of the same age as the Oligocene cherts of Flint River has an important bearing on the correlation of the Vicksburg group with formations in the West Indies and Europe. As early as 1900 Vaughan [22] stated that the coral reef near Bainbridge is the stratigraphic equivalent of the Antigua formation of the island of Antigua. Out of a total coral fauna of 25 or 30 species, 11 or more are identical with species in the Antigua formation—a high proportion considering the distance between Georgia and Antigua and the sensitiveness of corals to their environment. There is also a striking similarity between the larger Foraminifera of the two formations, and the mollusks show some resemblance. The correlation of the Glendon limestone with the Antigua formation may therefore be considered well established.

This new correlation goes far toward bridging the gap in deposition that was supposed to intervene between the Antigua formation and the latest Eocene rocks in the West Indies. Recent tables of Tertiary formations in the West Indies [23] show no correlatives of the Vicksburg group, with the possible exception of formations in Jamaica and the Dominican Republic. If the Antigua is middle Vicks-

[19] Smith, E. A., and Johnson, L. C., Tertiary and Cretaceous strata of the Tuscaloosa, Tombigbee, and Alabama rivers: U. S. Geol. Survey Bull. 43, pp. 18–21, 1887.

[20] Cooke, C. W., Correlation of the deposits of Jackson and Vicksburg ages in Mississippi and Alabama: Washington Acad. Sci. Jour., vol. 8, pp. 196–197, 1918.

[21] Vaughan, T. W., Fossil corals from Central America, Cuba, and Porto Rico, with an account of the American Tertiary, Pleistocene, and Recent coral reefs: U. S. Nat. Mus. Bull. 103, p. 199, 1919.

[22] Vaughan, T. W., A Tertiary coral reef near Bainbridge, Ga.: Science, new ser., vol. 12, pp. 873–875, 1900.

[23] Vaughan, T. W., Fossil corals from Central America [etc.]: U. S. Nat. Mus. Bull. 103, table facing p. 595, 1919, copied by Cushman in U. S. Geol. Survey Prof. Paper 125, facing p. 40, 1920.

Vaughan, T. W., Cooke, C. W., Condit, D. D., Ross, C. P., Woodring, W. P., and Calkins, F. C., A geological reconnaissance of the Dominican Republic: Dominican Republic Geol. Survey Mem., vol. 1, p. 57, 1921; Spanish edition, p. 63.

Cooke, C. W., *Orthaulax*, a Tertiary guide fossil: U. S. Geol. Survey Prof. Paper 129, p. 26, 1921.

Vaughan, T. W., Correlation of the Tertiary formations of Central America and the West Indies: First Pan-Pacific Scientific Conference Proc., Bernice P. Bishop Mus. Special Pub. 7, facing p. 826, 1921.

burgian, instead of post-Vicksburg in age, the supposed gap is reduced to the time interval represented by the Marianna limestone. It is probable that deposition was continuous, at least in parts of the West Indies, throughout Vicksburg time.

Correlation of formations in America with those in Europe is based on evidence of two kinds—relative stratigraphic position and similarity of faunas. That the upper Eocene Jackson formation of the United States corresponds in age to the Bartonian and Ludian of Europe is generally agreed. Likewise, the equivalence of the Tampa formation of Florida and the Aquitanian is conceded. I have not reviewed the evidence upon which these correlations are based but accept the conclusions of those who have studied that problem. The intervening stages of the Oligocene in Europe are the Lattorfian, the Rupelian (Stampian), and the Casselian (Chattian). In Mississippi and Alabama the corresponding time interval is represented by the Red Bluff, the Marianna, the Glendon, and the Byram. The exact equivalence of the individual stages can not be determined by this method. Because of the similarity of the coral faunas Vaughan [24] places the Antigua formation in the Rupelian. Twelve genera of corals are represented by closely related species in Italy and in Antigua or at Bainbridge, and some of the species may be identical.

In the accompanying correlation table the Byram is placed opposite the Chattian, the Glendon opposite the Rupelian, and the Red Bluff and the Marianna opposite the Lattorfian. As explained above, this correlation has been arrived at by a process of intercalation between beds of known age above and below, with the additional tie point of similarity between the corals of the Glendon and the Rupelian of Italy.

[24] Vaughan, T. W., Fossil coral from Central America [etc.]: U. S. Nat. Mus. Bull. 103, pp. 202–203, 1919.

Correlation of the Vicksburg group.

Series.	Mississippi.	Alabama.	West Florida.	Georgia.	Central Florida.	Leeward Islands.	Dominican Republic.	Europe.
Oligocene.	Catahoula sandstone.			Chattahoochee limestone.	Tampa formation.	Anguilla formation.	Cevicos limestone.	Aquitanian.
	Vicksburg group. Byram calcareous marl.[a]			Probably absent.	Unknown.	Unknown.	Unknown.	Chattian.
	Glendon formation.				(?)	Antigua formation.	Tabera formation.	Rupelian.
	Mint Spring calcareous marl member. / Marianna limestone ("chimney rock").			Probably absent.		Unknown.		Lattorfian.
	Forest Hill sand.	Red Bluff clay.						
Eocene.	Jackson formation.			Ocala limestone.		St. Bartholomew limestone.	Limestone.	Ludian.
								Bartonian.

[a] Correlation of the Byram marl with the Chattian needs verification.

THE FORAMINIFERA OF THE VICKSBURG GROUP.

By JOSEPH AUGUSTINE CUSHMAN.

INTRODUCTION.

The Vicksburg group is paleontologically more or less a faunal unit. Although the foraminiferal faunas of the different formations are fairly distinct from one another many of the species range throughout the group. There is a great difference in the condition of their preservation, as will be noted under the divisions. The fauna as a whole is distinct from the upper Oligocene and also from the Eocene, although certain of the species are found in the Jackson and other divisions of the upper Eocene.

There are many undescribed species. The material studied is mostly from Mississippi and Alabama, with a few stations in northern Florida. (See list of stations, pp. 13–14.) These deposits represent a portion of the great embayment of the Gulf of Mexico during Oligocene time. From a study of the faunas it is possible to make out some of the differences in ecologic conditions in different parts of the area in which these deposits were laid down. The species show many peculiarities of distribution, certain species being confined to the Byram calcareous marl and others to the Red Bluff clay, the typical Marianna limestone, or other divisions. Certain others are found in combinations, in general showing the closeness of the faunas of the Glendon limestone, Byram marl, and Mint Spring marl, and still other species show the Red Bluff clay to be related faunally to certain parts of the Marianna limestone. It has been possible by means of the specimens from St. Stephens Bluff to correlate very closely certain of the lower layers at that locality with the Red Bluff clay, farther west. In the table (p. 14) some of the stations may not be placed in the position they will finally occupy when comparisons are made with other groups, but the tentative arrangement will be of convenience to anyone using the distribution as a guide in correlation.

The general faunal relations of the Foraminifera of the Vicksburg group are interesting. A few species are identical with or closely similar to species now living in the Gulf of Mexico. Others are closely related to or identical with those of the Miocene of the southeastern United States. A few of them are related to the Oligocene of Panama. The most interesting relation, however, is that of this Oligocene fauna to the living fauna of the general Indo-Pacific region. A number of the fossil specimens seem to be identical with living species known only from that general region. Others, although described here as new, have specific relations entirely with living species from the Indo-Pacific. I have already[1] called attention to this relation, especially in respect to the fauna of the Byram marl. Similar relations are apparent, though not so distinctly marked, in the other divisions of the Vicksburg group.

The fauna of the Vicksburg group contains 158 species and varieties of Foraminifera, which may be compared with 193 species and varieties of Bryozoa recorded by Canu and Bassler[2] from the same deposits.

The plates accompanying this paper show only those species which are new to the Vicksburg group and those for which good material was not available when my papers on the Byram marl and Mint Spring marl[3] were prepared. The full descriptions have been given in order that all the data on the Vicksburgian Foraminifera of the Southeastern States, except part of the illustrations, may be available in a single paper.

BYRAM CALCAREOUS MARL.

The upper formation of the Vicksburg group is the Byram calcareous marl, which is typically exposed at the bridge over Pearl

[1] Washington Acad. Sci. Jour. vol. 10, No. 1, pp. 798–801, 1920.
[2] U. S. Nat. Mus. Bull. 106, 1920.
[3] U. S. Geol. Survey Prof. Paper 129, pp. 79–152, 1922 (Prof. Papers 129-E, 129-F).

River at Byram, Hinds County, Miss. The formation is mainly a sandy glauconitic marl, with thin beds of impure limestone, clay, and sand. As will be seen from the list of localities, the collections from this formation were all obtained in Mississippi. The Foraminifera are more numerous in the Byram marl than in any other division of the Vicksburg group, 95 species and varieties being recorded in this paper.

From a study of these species it would seem that the Byram marl was deposited in warm shallow water (temperature 20°–24° C.; depth 10–25 fathoms = 18–46 meters). There is a much larger percentage of Miliolidae in the Byram marl than in any of the other formations of the group, which seems to indicate deposition in shallower water than that in which the other formations were laid down. Most of the species of the Byram fauna are very closely related to or identical with those now living in the Indo-Pacific region. According to Cooke,[4] of the 136 species of mollusks and 6 of corals recorded from the Byram marl "81 occur also in the Mint Spring marl, 46 persisted from the Red Bluff clay (including 6 which have not been found in the Mint Spring marl), and 55 appear to be peculiar to the Byram marl." Of the 95 species and varieties of Foraminifera found in the Byram marl, 49 occur also in the Mint Spring marl, 29 persisted from the Red Bluff clay (including 2 which have not been found in the Mint Spring marl), and 34 appear to be peculiar to the Byram marl itself. Thirty species are common to the Byram marl and the Glendon limestone and 37 to the Byram marl and typical Marianna limestone. These figures show that the Byram calcareous marl is more closely allied to the Mint Spring marl member of the Marianna limestone than to any of the other divisions of the Vicksburg group.

GLENDON LIMESTONE.

The type locality of the Glendon formation is at Glendon, Ala., where it is 18 to 20 feet thick. At Glendon, according to Cooke (p. 3), it is a "hard, partly crystalline yellowish or pinkish limestone interbedded with softer strata of impure limestone."

The collections from the Glendon which I have examined were obtained mostly from the softer layers, and from these it is possible to wash out a certain number of identifiable Foraminifera, but most of the forms are not well preserved and can be identified, as a rule, only by comparison with better specimens from other divisions. The species and varieties here recorded from the Glendon number 43, of which 3 are peculiar to it. Of these species 33 are also found in the typical Marianna, 30 in the Byram marl, 33 in the Mint Spring marl, and 23 in the Red Bluff clay.

MINT SPRING CALCAREOUS MARL MEMBER OF MARIANNA LIMESTONE.

The type locality for the Mint Spring marl is beneath a waterfall in the lower course of Mint Spring Bayou, a stream that enters Centennial Lake just south of the National Cemetery at Vicksburg, Miss. This marl is developed mostly in western Mississippi. The species obtained from it suggest that it was deposited under conditions similar to those of the Byram marl, except that the absence of numerous shallow-water species found in the Byram marl indicates that the water was somewhat deeper. Cooke[5] gives the following statement in regard to the fauna of the Mint Spring marl:

> The list of species collected in the Mint Spring marl includes 160 mollusks and 3 corals. Of these, 81 occur in the Byram marl, about 55 are found at Red Bluff or are represented there by varieties, and about 66 appear to be restricted to the Mint Spring marl.

The Mint Spring marl has yielded 81 species and varieties of Foraminifera, 21 of which are peculiar to it. Of these, 49 occur also in the Byram marl, 37 are common to the Mint Spring marl and the typical Marianna limestone, 32 to the Mint Spring marl and the Glendon limestone, and 32 to the Mint Spring marl and the Red Bluff clay. These figures show that the Mint Spring marl is most closely related to the Byram marl and next to the typical Marianna limestone. Although the Red Bluff clay and the Glendon formation show the same number of species in common with the Mint Spring marl, it should be noted that the fauna of the Glendon contains only 43 species and varieties, being smaller than the fauna of any other division in the Vicksburg group.

[4] Washington Acad. Sci. Jour., vol. 8, p. 197, 1918.

[5] Washington Acad. Sci. Jour., vol. 8, p. 196, 1918.

TYPICAL MARIANNA LIMESTONE.

The type locality of the Marianna limestone is at Marianna, Fla., where it is a soft porous material in which Foraminifera are abundant but not unusually well preserved. The most conspicuous species is *Lepidocyclina mantelli* (Morton), which is one of the index fossils of this formation. From rocks at other localities in Alabama and Mississippi that are here referred to the Marianna numerous species have been obtained, giving a total of 65 identified species and varieties. Much of this material is difficult to wash, and the surfaces of the specimens are not well preserved. Some of the material, however, yields well-preserved specimens, and on these the larger part of the fauna is based. A number of the stations assigned to the typical Marianna in the table of distribution may belong to some of the other divisions of the Vicksburg group, but this point is left to be determined from future collections.

RED BLUFF CLAY.

The type locality of the Red Bluff clay is at Red Bluff, on Chickasawhay River near Hiwannee, Miss. From what is known of the formation it seems to be conformable with the underlying Jackson, and it contains a number of characteristic Jackson species. The formation consists of clays, with harder materials in some portions. Several stations in Alabama, including the lowest three members of the Oligocene at St. Stephen's Bluff, Tombigbee River, and with them one of the members of a section 1 mile southeast of Fail, are assigned to the Red Bluff clay in the table of distribution. Cooke[6] gives the following statement in regard to the fauna of the Red Bluff clay:

> The Red Bluff fauna includes more than 128 mollusks, 6 corals, and a considerable number of Bryozoa. Of the 134 species listed from Mississippi, about 60 appear to be restricted to the Red Bluff beds, about 55 are present in the Mint Spring marl or have varieties there, and about 49 species or varieties are known in the Byram marl; of these species 10 have not yet been found in the Mint Spring marl. Twelve mollusks, three of which range through the Vicksburg group, are listed also from the Jackson formation, but some of these are characterless species of supposedly very long range.

The Foraminifera show 49 species and varieties, 7 of which are peculiar to the Red Bluff clay itself. Of the others, 16 range throughout the Vicksburg group, 32 occur in the Mint Spring marl, 35 in the typical Marianna, and 29 in the Byram marl.

[6] Washington Acad. Sci. Jour., vol. 8, p. 193, 1918.

LOCALITIES.

The following list includes the localities from which the Foraminifera described in this paper have been obtained. They are arranged as far as possible according to the divisions of the Vicksburg group recognized in Florida, Alabama, and Mississippi. The numbers refer to the records of the U. S. Geological Survey, where full stratigraphic data are given.

BYRAM CALCAREOUS MARL.

5615. Three-quarters of a mile southeast of Blakney, Miss., on west bank of Leaf River, No. 2 of section. Nearest town is Taylorsville, on Gulf & Ship Island Railroad, which is about 8 miles south of Blakney. G. C. Matson, collector.

6449. 600 to 700 feet north of bridge over Glass Bayou, Vicksburg, Miss., in upper fossiliferous zone. C. W. Cooke, collector.

6454. Pearl River, just above bridge at Byram, Miss. C. W. Cooke, collector.

6455. Pearl River at bridge at Byram, Miss. E. N. Lowe, collector.

6648. Chickasawhay River at wagon bridge a quarter of a mile west of Woodward, 2 miles northwest of Waynesboro, Miss. C. W. Cooke, collector.

6649. Southwest bank of Chickasawhay River 500 feet west of bridge, 2½ miles south of Waynesboro, Miss. C. W. Cooke, collector.

7165. Bluff east of Jackson-Rockville road, 200 yards north of Salt Creek, Ala., bed 5 of section. C. W. Cooke, collector.

7372. Road north of National Cemetery, Vicksburg, Miss., beds 8–9 of section. C. W. Cooke, collector.

7373*a*. Gulf & Ship Island Railroad 1½ miles south of Plain, 7 miles south of Jackson, Miss., bed 1 of section. C. W. Cooke, collector.

7376. Leaf River half a mile below bridge on Taylorsville-Silvarena road, near old Blakney post office, Miss. C. W. Cooke and E. N. Lowe, collectors.

7385. Haynes Bluff, 14 miles north of Vicksburg, Miss. C. W. Cooke, collector.

7389. Railroad cut east of Brandon, Miss., calcareous sands. C. W. Cooke, collector.

8240. Vicksburg, Miss. Alva Schaefer, collector.

GLENDON LIMESTONE.

6446. Loose blocks of limestone below waterfall in Glass Bayou, Vicksburg, Miss. E. N. Lowe and C. W. Cooke, collectors.

6548. Robinson's quarry, 4 miles east of Brandon, south of Rankin, Miss., on Alabama & Vicksburg Railway. T. W. Vaughan, collector.

6749. West bank of Conecuh River at McGowan's Bridge, about 1 mile below the mouth of Sepulga River, Ala. C. W. Cooke, collector.

7164. Jackson-Rockville road, 200 yards north of Salt Creek, Ala., bed 3 of section. C. W. Cooke, collector.

7735. Tiger Hill, east bluff of East Tallahala Creek, sec. 7, T. 1 N., R. 12 E., 10 miles in an air line south by east of Bay Springs, Miss. C. W. Cooke, collector.

"CHIMNEY ROCK" FACIES OF MARIANNA LIMESTONE.

3296. North side of Salt Mountain, 5 miles south of Jackson, Ala. T. W. Vaughan, collector.

5609. St. Stephen's Bluff, right bank of Tombigbee River about 9 miles above Jackson, Ala. T. W. Vaughan, collector.

6645. Roadside on hill in sec. 2, T. 10 N., R. 10 W., 1½ miles south-southeast of Heidelberg, Miss., beds 1 to 5 of section. C. W. Cooke, collector.

6702. Hillside a quarter of a mile east of Alabama, Tennessee & Northern Railroad, 2½ miles north of Millry, Ala. C. W. Cooke, collector.

6709. St. Stephen's Bluff, right bank of Tombigbee River, about 9 miles above Jackson, Ala., bed 8 of section soft white chimney rock. C. W. Cooke, collector.

6710. Same locality as 6709, bed 7 of section.

6711. Same locality as 6709, bed 4 of section.

6716. Ravine east of road about three-quarters of a mile north of Monroeville, Monroe County, Ala. C. W. Cooke, collector.

6717. 1 mile north of Monroeville, Ala. C. W. Cooke, collector.

6721. Gully south of station at Drewry, Ala. C. W. Cooke, collector.

6728. Gully west of road from Perdue Hill to Claiborne, Ala., bed 1 of section (bottom), 250 feet above Alabama River. C. W. Cooke, collector.

6729. Same locality as 6728, bed 3 of section. C. W. Cooke, collector.

6732. East end of wagon bridge on Murder Creek east of Castleberry, Ala., bed 1 of section. The section begins at water level beneath the bridge and continues up an old road west of the present road. C. W. Cooke, collector.

6733. Same locality as 6732, bed 2 of section.

6734. Same locality as 6732, bed 3 of section.

6748. West bank of Conecuh River at bend about a quarter of a mile below mouth of Sepulga River, Scambia County, Ala. C. W. Cooke, collector.

6767. Quarry south of road at top of first hill west of bridge over Chipola River east of Marianna, Fla. C. W. Cooke, collector.

7156. Large gully about 300 feet north of ravine near residence of Jim Hill, southwest of Fisher's Creek, 2½ miles southwest of Whatley, Ala., bed 1 of section. C. W. Cooke, collector.

7214. Near head of small branch about 1 mile east by south of Fail, Ala., about 300 yards north of the road from Isney to Healing Springs. C. W. Cooke, collector.

7238. Murder Creek at bridge east of Castleberry, Ala., bottom of bed 1 of section. C. W. Cooke, collector.

7241. Quarries on south side of hill south of road and a quarter of a mile east of bridge over Chipola River east of Marianna, Fla. C. W. Cooke and W. C. Mansfield, collectors.

7371. Bluff east of small branch about 1½ miles northeast of Brandon, Miss., between the Alabama & Vicksburg Railway and the Jackson road, bed 1 of section. C. W. Cooke, collector.

7375. Bay Springs–Tallahala road east of Tallahala Creek, Miss. C. W. Cooke, collector.

7445. 2½ miles northeast of Calmar post office, Miss., altitude about 150 feet. O. B. Hopkins, collector.

MINT SPRING CALCAREOUS MARL MEMBER OF MARIANNA LIMESTONE.

6447. Below waterfall at Glass Bayou, Vicksburg, Miss. E. N. Lowe and C. W. Cooke, collectors.

6448. Sandy marl at foot of high waterfall in Glass Bayou, Vicksburg, Miss. C. W. Cooke, collector.

6451. Waterfall in Mint Spring Bayou, Vicksburg, Miss. E. N. Lowe and C. W. Cooke, collectors.

6452. Mint Spring Bayou, Vicksburg, Miss., shell and sand bed at foot of high waterfall. C. W. Cooke, collector.

6647. Chickasawhay River, 1¼ miles northwest of mouth of Limestone Creek, 4 miles northwest of Waynesboro, and 1½ miles southwest of Boice, Miss. C. W. Cooke, collector.

7671. Brown's Cave, east bluff of Leaf River half a mile above bridge on Bay Springs–Raleigh road in sec. 13, T. 2 N., R. 8 E., Smith County, Miss. C. W. Cooke, collector.

RED BLUFF CLAY.

5264. Chickasawhay River at Hiwannee, Miss. E. A. Smith and T. W. Vaughan, collectors.

5649. St. Stephen's Bluff, right bank of Tombigbee River about 9 miles above Jackson, Ala., lower bed. T. W. Vaughan, collector.

6456. Old Red Bluff landing on Chickasawhay River at Hiwannee, Miss., 3½ miles south of Shubuta. E. N. Lowe and C. W. Cooke, collectors.

6712. St. Stephen's Bluff, right bank of Tombigbee River about 9 miles above Jackson, Ala., bed 3 of section. C. W. Cooke, collector.

6713. Same locality as 6712, bed 2 of section.

6714. Same locality as 6712, bed 1 of section.

7213. Near head of small branch about 1 mile southeast of Fail, Ala., about 300 yards north of road from Fail to Millry, bed 4 of section. W. C. Mansfield, collector.

8752. Red Bluff, Chickasawhay River at Hiwannee, Miss. E. N. Lowe, collector.

	Byram calcareous marl													Glendon limestone					Typical Marianna limestone																								Mint Spring calcareous marl member of Marianna limestone						Red Bluff clay						
	6615	6449	6454	6455	6648	6649	7165	7372	7373a	7376	7385	7389	8240	6446	6518	6719	7164	7735	8296	8609	6645	6702	6709	6710	6711	6716	6717	6721	6728	6729	6732	673	6734	6748	6767	7156	7214	7233	7241	7371	7375	7445	6447	6448	6451	6452	6647	7671	8261	8649	6456	6712	6713	6714	7213	8752
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agglutinans		✓	×	×	×	×				×						×	×	×		×	✓								✓	×						×	✓			✓	×		✓	×	×	×	×									
subhauerii	×		×	×						×																																													
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mississippiensis		×		×								✓																																											
vicksburgensis														✓																																									
cooker																						✓			✓																														
honder														×		×						×			✓																														
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SYSTEMATIC DESCRIPTIONS.

Family TEXTULARIIDAE.

Genus TEXTULARIA Defrance, 1824.

Textularia tumidulum Cushman.

Textularia tumidulum Cushman, U. S. Geol. Survey Prof. Paper 129, pp. 89, 125, pl. 15, figs. 1, 2a, 2b, 1922.

Test large, elongate, compressed, thickest in the central region, thence thinning toward the periphery, initial end rapidly broadening in the adult, the sides almost parallel to a point near the apertural end, where the breadth of the test is often reduced; chambers numerous, in the adult about three times as wide as high, and often the last-formed chamber in old-age specimens somewhat distinctly set off from the others, the inner portion of each chamber much thicker than the other portions and in the rapid decrease in thickness often leaving a channel running lengthwise of the test between this central tumid area and the gradually sloping outer portion, usually very well marked in adult specimens; sutures distinct in well-preserved specimens; wall arenaceous but smoothly finished. Maximum length 2.5 millimeters.

This species, originally described from material collected in the Byram marl, is characteristic also of the Mint Spring marl member of the Marianna, and it occurs in the Glendon limestone at the two stations in Mississippi, but not at the one in Alabama. Likewise, the stations here assigned to the typical Marianna from which this species is recorded are all in Mississippi, and the species is not recorded from any of the Marianna stations in Alabama or Florida. From what is noted in the introduction in regard to the ecologic conditions of these two parts of the area it will be seen that this species is not only limited in its vertical distribution but also geographically. The specimens are very uniform in general character, being especially easy to identify by the central tumid area and large size. Both microspheric and megalospheric forms occur, the former being considerably larger and starting with a small, thin, rather rapidly flaring test, then quickly assuming the adult characters. The megalospheric form is shorter and comparatively broader.

Textularia tumidulum occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6454 and 6455; Vicksburg, Miss., 6449, 7372, and 8240; Haynes Bluff, Miss., 7385; Woodward, Miss., 6648.

Glendon limestone.—Vicksburg, Miss., 6446; Robinson's quarry, Miss., 6548; Brandon, Miss., 7389; Leaf River, Miss., 5615 and 7376; Tiger Hill, Miss., 7735.

Typical Marianna limestone.—Tallahala Road, Smith County, Miss., 7375; Brandon, Miss., 7371.

Mint Spring calcareous marl member.—Vicksburg, Miss., 6447, 6448, 6451, and 6452; Boice, Miss., 7671.

Ammobaculites agglutinans (D'Orbigny) Cushman.

Plate I, figure 1.

Textularia agglutinans D'Orbigny, in De la Sagra, Histoire physique, politique et naturelle de l'île de Cuba, Foraminifères, p. 136, pl. 1, figs. 17, 18, 32–34, 1839.

H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 363, pl. 43, figs. 1, 2, 1884.

Cushman, U. S. Nat. Mus. Bull. 71, pt. 2, p. 9, figs. 10a, b (in text), 1911; U. S. Geol. Survey Prof. Paper 129, p. 89, pl. 14, figs. 1a, 1b, 1923.

Test elongate, large and stout, gradually tapering from the initial end; chambers nearly as high as wide, tumid; sutures depressed, distinct, early portion somewhat compressed; wall coarsely arenaceous, but in section with a calcareous base; aperture in a well-marked depression at the base of the inner margin of the last-formed chamber; early chambers usually rougher than the later ones. Maximum length 2 millimeters.

Specimens very similar to this species as figured by D'Orbigny from the West Indies are found in all the Vicksburg formations except the Red Bluff clay. It seems to replace *T. tumidulum* at many of the stations, especially in the typical Marianna limestone, where the two do not occur together. This name has been used for a great variety of forms, but there seems to be a definite species in tropical waters to which the name should be confined.

Textularia agglutinans occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6454 and 6455; Vicksburg, Miss., 6449; Leaf River, Miss., 7376; Woodward, Miss., 6648; Waynesboro, Miss., 6649.

Glendon limestone.—Tiger Hill, Miss., 7735; McGowans Bridge, Ala., 6749.

Typical Marianna limestone.—Castleberry, Ala., 6732 and 7238; Perdue Hill, Ala., 6729; Salt Creek, Ala., 7164; St. Stephens, Ala., 5609; Fail, Ala., 7214; Heidelberg, Miss., 6645.

Mint Spring calcareous marl member.—Boice, Miss., 6647.

Textularia subhauerii Cushman.

Textularia subhauerii Cushman, U. S. Geol. Survey Prof. Paper 129, pp. 89, 126, pl. 14, figs. 2a, 2b, 1922.

Test large, stout, elongate, early portion rapidly increasing in width with each newly added chamber, later adult portion with the sides nearly parallel, slightly lobulate; periphery rounded, but the median portion nearly flat; chambers 18 to 20, increasing in height as added, those of the later portion nearly as high as broad; sutures usually rather indistinct; wall coarsely arenaceous; aperture at the base of the inner margin of the chamber. Maximum length 2 millimeters.

Although this species was recorded in my paper on the Mint Spring marl,[8] a reexamination of the specimens shows that typical *T. subhauerii* is confined to the Byram marl and is not found in the other divisions of the Vicksburg group. The most typical specimens are those from U. S. G. S. station 5616, one of which is figured here.

Heron-Allen and Earland[9] figure a *Textularia* from the Kerimba Archipelago, off the eastern coast of Africa, which they refer to *T. hauerii* D'Orbigny. In some of its characters the Byram marl species resembles this. A similar form from the Philippines I have referred to *P. hauerii*. A study of D'Orbigny's *P. hauerii* from the Vienna Basin, however, shows a form that is very different from that found in the Byram marl, and it would seem also different from the Philippine and Kerimba species.

Textularia subhauerii was found at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6454 and 6455; Leaf River, Miss., 5615 and 7376.

Textularia subhauerii Cushman, var.

Plate I, figure 7.

Textularia subhauerii Cushman, U. S. Geol. Survey Prof. Paper 129, p. 126, 1922.

At one of the stations in the Mint Spring marl (6647) were found specimens that in many ways resemble *T. subhauerii* but are much stouter and thicker. This variety seems to replace *T. tumidulum* at this station, it being the only one in the Mint Spring marl member of the Marianna from which that species was not obtained.

Textularia subhauerii var. occurs at the following U. S. G. S. stations:

Mint Spring calcareous marl member.—Boice, Miss., 6647.
Typical Marianna limestone.—Drewry, Ala., 6721; Fishers Creek, 7156; Fail, Ala., 7214; Heidelberg, Miss., 6645.

Textularia porrecta H. B. Brady.

Plate I, figure 8.

Textularia agglutinans D'Orbigny var. *porrecta* H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 364, pl. 43, fig. 4, 1884.
Textularia porrecta H. B. Brady. Egger, K. bayer Akad. Wiss. München Abh., vol. 18, p. 269, pl. 6, figs. 17, 18, 1893.

Test elongate, slightly compressed, subcylindrical, composed of numerous chambers, those of the adult portion nearly as high as broad; periphery broadly rounded; wall rather smoothly finished; sutures depressed; aperture small, rounded, at the inner margin at the base of the last-formed chamber. Maximum length 1.6 millimeters.

This species was described originally by Brady from specimens found on the coral reefs of the south Pacific Ocean. It occurs at a few stations in the Marianna limestone and at one in the Byram marl. These specimens are, as a rule, less even in diameter than recent specimens, but one or two very closely approach the typical form.

Textularia porrecta occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Woodward, Miss., 6648.
Typical Marianna limestone.—Castleberry, Ala., 6732; Millry, Ala., 6702; Fail, Ala., 7214; Brandon, Miss., 7371.

Textularia conica D'Orbigny.

Plate I, figures 5, 6.

Textularia conica D'Orbigny, in De la Sagra, Histoire physique, politique et naturelle de l'île de Cuba, Foraminifères, p. 143, pl. 1, figs. 19, 20, 1839.
H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 365, pl. 43, figs. 13, 14, 1884.
Millett, Roy. Micr. Soc. Jour., p. 563, 1899.
Chapman, Linnean Soc. Zool. Jour., vol. 18, p. 185, 1900.
Heron-Allen and Earland, Zool. Soc. London Trans., vol. 20, p. 629, 1915.
Cushman, U. S. Nat. Mus. Bull. 100, vol. 4, p. 123, pl. 25, figs. 2*a–c*, 1921; U. S. Nat. Mus. Proc., vol. 59, p. 50, pl. 11, figs. 4–6; Carnegie Inst. Washington Pub. 311, p. 24, 1922.

D'Orbigny originally described this species from material obtained in shore sands of Cuba, and it seems to be common in the West Indies in shallow water. It also occurs generally

[8] U. S. Geol. Survey Prof. Paper 129, p. 126, 1922.
[9] Zool. Soc. London Trans., vol. 20, p. 628, pl. 47, figs. 21–23, 1915.

throughout the Indo-Pacific region under similar conditions. A few specimens from the typical Marianna limestone and the Glendon limestone are close to or identical with this species.

Textularia conica occurs at the following U. S. G. S. stations:

Glendon limestone.—Tiger Hill, Miss., 7735; McGowans Bridge, Ala., 6749.

Typical Marianna limestone.—Castleberry, Ala., 7238; Tallahala Road, Miss., 7375.

Textularia mississippiensis Cushman.

Textularia mississippiensis Cushman, U. S. Geol. Survey Prof. Paper 129, pp. 90, 125, pl. 14, fig. 4, 1922.

Test elongate, fairly broad, thickest in the middle, thence thinning toward the periphery, in end view biconvex, central portion curved; chambers rather low and broad, especially in the early stages, becoming somewhat higher in the adult; sutures covered by a coarsely arenaceous layer, meeting in the center and at the periphery, leaving the central portion of each chamber uncovered; periphery irregular, not definitely or regularly spinose, chamber walls smooth and finely perforate. Length 0.40–0.75 millimeter.

From a study of the whole collection of the Vicksburg group this species is found to be almost entirely limited to the stations in Mississippi. It is characteristic of the Byram and Mint Spring marls and Red Bluff clay and occurs in the Marianna at the two Mississippi stations of the Glendon formation and at one other station in Mississippi. Elsewhere it is replaced in the Marianna by the variety *alabamensis*. In the Red Bluff clay it occurs at all the stations, a few of which are in Alabama.

In its general characters and size it is very uniform in the material studied. In some of its characters it resembles *T. carinata* H. B. Brady (*T. pseudo-carinata* Cushman, not *T. carinata* D'Orbigny), but it is much smaller and lacks the strongly rhomboidal shape in end view, and the carinae and especially the spines are not so definitely developed. *T. pseudo-carinata* is especially characteristic of the Philippine region. The Byram species also resembles very much the form I have described as *T. sagittula* var. *atrata*,[10] which was found in the eastern channel of the Korean Straits in 59 fathoms.

[10] U. S. Mus. Bull. 71, pt. 2, p. 7, figs. 2–5 (in text).

Textularia mississippiensis was found at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6454 and 6455; Vicksburg, Miss., 6449, 7372, and 8240; Leaf River, Miss., 7376.

Glendon limestone.—Vicksburg, Miss., 6446; Robinson's quarry, Miss., 6548; Tiger Hill, Miss., 7735.

Mint Spring calcareous marl member.—Vicksburg, Miss., 6447, 6448, 6451, and 6452; Leaf River, Miss., 7671; Boice, Miss., 6647.

Red Bluff clay.—Hiwanee, Miss., 5264, 6456, and 8752; St. Stephens, Ala., 6712, 6713, 6714, and 8752; Fail, Ala., 7213.

Textularia mississippiensis Cushman var. alabamensis Cushman, n. var.

Plate I, figure 4.

Variety differing from the typical species in the more elongate form, somewhat thicker test, especially in the center, the less well-defined peripheral carina, and the sutures excavated instead of being covered by an arenaceous layer.

In Alabama this variety seems to replace the typical form almost entirely. It is characteristic of the Marianna limestone and occurs at the Alabama station of the Glendon limestone and at one station in the Byram marl from which the typical form is not recorded.

Textularia mississippiensis var. *alabamensis* n. var. occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Woodward, Miss., 6648.

Glendon limestone.—McGowans Bridge, Ala., 6749; Robinson's quarry, Miss., 6548.

Typical Marianna limestone.—Castleberry, Ala., 6732, 6734, and 7238; Salt Creek, Ala., 7164; Fishers Creek, Ala., 7156; Millry, Ala., 6702; St. Stephens, Ala., 5609, 5649, 6710, and 6711; Fail, Ala., 7214; Heidelberg, Miss., 6645; Tallahala Road, Miss., 7375; Brandon, Miss., 7371.

Textularia recta Cushman, n. sp.

Plate I, figure 2.

Test elongate, somewhat compressed, early portion rapidly increasing in diameter, later portion in the adult with the sides parallel for a large part of the test; chambers numerous; sutures distinct; wall thick, colored with agglutinated calcareous grains but when worn showing an undertest which is coarsely perforated; apertural end obliquely truncate; aperture in a deep depression at the base of the last-formed chamber. Length of adult specimens 1.25 millimeters.

This species is easily recognized among the other Vicksburg group species of *Textularia* by its elongate form, with parallel sides, peculiar surface, and, where worn, by the peculiarly perforate undersurface.

Textularia recta occurs at the following U. S. G. S. stations:

Red Bluff clay.—Hiwannee, Miss., 6456 and 8752.

Textularia recta Cushman, var.

Plate I, figure 3.

Occurring with the typical form of the species are specimens in which the surface of the wall is similar to that in the typical form. These tests, however, instead of having parallel sides, are more or less tapered throughout. They also increase in thickness as growth continues, whereas in the typical form the same breadth and width are continued throughout the test. It may be that this variety represents the megalospheric form of the species.

Textularia recta var. occurs at the following U. S. G. S. stations:

Red Bluff clay.—Hiwannee, Miss., 6456 and 8752.

Textularia folium Parker and Jones.

Textularia folium Parker and Jones, Roy. Soc. Philos. Trans., vol. 155, pp. 370, 420, pl. 18, fig. 19, 1865.
Moebius, Beiträge zur Meeresfauna der Insel Mauritius, p. 92, pl. 8, figs. 16, 17, 1880.
H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 357, pl. 42, figs. 1–5, 1884.
Egger, K. bayer. Akad. Wiss. München Abh., Cl. 2, vol. 18, p. 272, pl. 6, figs. 27, 28, 1893.
Chapman, Linnean Soc. London Jour., Zoology, vol. 28, p. 184, 1902.
Rhumbler, Zool. Jahrb., Abt. Syst., vol. 24, p. 59, pl. 5, figs. 51, 52, 1906.
Bagg, U. S. Nat. Mus. Proc., vol. 34, p. 130, 1908.
Chapman, Quekett Micr. Club Jour., 2d ser., vol. 10, p. 127, pl. 9, fig. 4, (1907) 1909.
Cushman, U. S. Nat. Mus. Bull. 71, pt. 2, p. 19, figs. 31–33 (in text), 1911; U. S. Geol. Survey Prof. Paper 129, p. 90, 1922.
Heron-Allen and Earland, Zool. Soc. London Trans., vol. 20, p. 623, 1915.

Test small, very much flattened, broad, triangular in front view, narrow in edge view, tapering toward the acute margins; chambers, especially in later development, broad and low, somewhat recurved, the inner and distal margins thickened, prolonged at the periphery into short, backward-pointing spinose processes, smooth; wall fairly thick. Length not usually exceeding 0.5 millimeter.

This is one of the most interesting but the rarest species of the genus in the Vicksburg group. The note of its occurrence in the Byram marl [11] gave what is apparently the first record of this species in its fossil condition. It was originally described by Parker and Jones from material collected in shore sands of Melbourne, Australia. Since that time it has been recorded from numerous localities, a list of which is given in my paper on the Byram marl, just cited. These are confined to the Indo-Pacific region, extending from Hawaii on the east to Mauritius and the Kerimba Archipelago, off the east coast of Africa, on the west, and southward as far as Australia and many of the islands in the south Pacific Ocean. The specimen from the Byram marl is almost exactly like that figured by Parker and Jones in that it has a triangular form with short, backward-pointing spines at the angles of the chambers. In many of the recent species the test is broader and has large, lateral spinose processes from either side of the test. The recent records show that the species is most common on tropical coral reefs in the south Pacific, usually in 40 fathoms or less.

Textularia folium was found at the following U. S. G. S. station:

Byram calcareous marl.—Byram, Miss., 6455.

Genus BOLIVINA D'Orbigny, 1839.

Bolivina amygdalaeformis H. B. Brady.

Bolivina amygdalaeformis H. B. Brady, Quart. Jour. Micr. Sci., vol. 21, p. 59, 1881; *Challenger* Rept., Zoology, vol. 9, p. 426, pl. 53, figs. 28, 29, 1884.
Cushman, U. S. Nat. Mus. Bull. 71, pt. 2, p. 42, figs. 69*a*, *b* (in text), 1911; U. S. Geol. Survey Prof. Paper 129, p. 91, 1922.

Test elongate, somewhat fusiform, thickest in the middle, periphery well rounded; chambers comparatively few; sutures hidden by the ornamentation of the surface, consisting of numerous longitudinal irregularly anastomosing costae; the last-formed chambers lacking the costae, but with numerous large depressions; aperture terminal, elongate-oval, somewhat constricted near the middle. Maximum length 0.8 millimeter.

This species seems to occur only in the Byram marl, the upper formation of the Vicksburg group. Although not present in any con-

[11] U. S. Geol. Survey Prof. Paper 129, p. 90, 1922.

siderable numbers, it occurs at several stations. The species is also recorded from the present oceans, where it occurs from Torres Strait to Japan, as a rule at depths of 16 to 155 fathoms. This is one of the species which connects the Vicksburg fauna of the Coastal Plain with the recent faunas of the Indo-Pacific region.

Bolivina amygdalaeformis occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6454 and 6455; Vicksburg, Miss., 6449, 7372, 7385, and 8240.

Bolivina depressula Cushman, n. sp.

Test elongate, about three times as long as broad, composed of comparatively few chambers, each gradually enlarging as added; early portion compressed, later chambers more tumid; sutures distinct, depressed; earlier portion ornamented by numerous longitudinal costae not close together, surface otherwise smooth and polished, very finely punctate; aperture elongate, comma-shaped. Length 0.3 millimeter.

This is a rare species, so far as this collection shows, occurring at one station in the Marianna limestone and at another in the Red Bluff clay. It is unusual in its rounded chambers, combined with the rather remotely placed longitudinal costae.

Bolivina depressula occurs at the following U. S. G. S. stations:

Marianna limestone.—Tombigbee River, Ala., 5649.
Red Bluff clay.—St. Stephens, Ala., 6713.

Bolivina sp.?

Plate III, figure 2.

At one station in the Red Bluff clay there is a species of *Bolivina* which is here figured. It is peculiar in the deeply depressed sutures and the decided angle formed by the backward extension of the inner angle of each chamber.

Bolivina sp.? occurs at the following U. S. G. S. station:

Red Bluff clay.—St. Stephens, Ala., 6713.

Bolivina caelata Cushman, n. sp.

Plate II, figure 2.

Test elongate, compressed, rhomboid, nearly twice as long as wide; chambers comparatively few, thickest toward the middle; sutures indistinct, except near the apertural end, curved; periphery acute, sometimes slightly carinate; surface ornamented by a reticulate pattern, but very irregular, consisting of irregularly longitudinal costae, crossed or connected by other curved costae, not in any general direction; aperture narrow, elongate. Maximum length 0.5 millimeter.

This is one of the most common species of the genus in the Vicksburg deposits, occurring in the typical Marianna limestone especially, as well as in the Glendon limestone, the Byram marl, and the Red Bluff clay. It is related to *B. reticulata*, as figured by Brady in the *Challenger* report. He states that the best recent specimens of this species came from the south Pacific.

Bolivina caelata n. sp. occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Jackson, Miss., 7373*a*.
Glendon limestone.—Vicksburg, Miss., 6446; Robinson's quarry, Miss., 6548; Tiger Hill, Miss., 7735; McGowans Bridge, Ala., 6749.
Typical Marianna limestone.—Castleberry, Ala., 7238; Claiborne, Ala., 6729; Salt Creek, Ala., 7164; St. Stephens, Ala., 5649; Fail, Ala., 7214; Tallahala Road, Miss., 7375; Brandon, Miss., 7371.
Red Bluff clay.—St. Stephens, Ala., 6713 and 6714; Fail, Ala., 7213.

Bolivina caelata Cushman var. byramensis Cushman, n. var.

Plate I, figure 9.

Variety differing from the typical species by the more carinate form, surface rather coarsely punctate, sutures limbate, and the ornamentation characteristic of the typical form nearly or quite wanting. This variety seems largely to replace the typical form in the Byram marl.

Bolivina caelata var. *byramensis*, n. var., occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6449, 6454, and 6455; Vicksburg, Miss., 7372 and 8240; Leaf River, Miss., 7376; Woodward, Miss., 6648.

Bolivina cf. B. punctata D'Orbigny.

Plate II, figure 1.

Test small, elongate, slightly tapering, composed of about 20 chambers; periphery slightly rounded; sutures distinct; wall finely punctate. Length about 0.25 millimeter.

I have referred to this species specimens from but two stations. They are small and in their general characters like recent specimens from the Gulf of Mexico.

Bolivina cf. *B. punctata* occurs at the following U. S. G. S. stations:

Mint Spring calcareous marl member.—Vicksburg, Miss., 6451.

Red Bluff clay.—St. Stephens, Ala., 6713.

Bolivina mississippiensis Cushman.

Bolivina mississippiensis Cushman, U. S. Geol. Survey Prof. Paper 129, p. 92, pl. 15, fig. 5, 1922.

Test elongate, slender, gradually tapering from the subacute initial end to the broadly rounded apertural end; thickest in the median line; chambers numerous, wider than high, curved; sutures marked by limbate lines, broadly curved and somewhat broken near the inner end, not depressed; surface of test smooth and even. Length about 0.4 millimeter.

This is one of the species that seems to be confined to the Byram marl. It may be distinguished by the narrow, tapering form, the peculiarly marked sutures, and the very even, smooth surface.

Bolivina mississippiensis occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6455; Vicksburg, 6449; Brandon, Miss., 7389.

Bolivina vicksburgensis Cushman.

Bolivina vicksburgensis Cushman, U. S. Geol. Survey Prof. Paper 129, p. 126, pl. 29, fig. 2, 1922.

Test elongate, tapering, apical end bluntly pointed, gradually increasing in breadth for several chambers, after which the sides are nearly parallel during the remainder of the growth; chambers distinct; sutures excavated; proximal angle of the periphery of each chamber somewhat projecting beyond the general line of the test, forming a serrate edge; chambers distinctly triangular; sutures oblique; surface with numerous punctations, arranged generally in longitudinal lines. Length 0.45 millimeter.

This was originally described from material obtained in the Mint Spring marl member but has since been found at one station in the Glendon limestone. It can be distinguished by the peculiar serrate periphery and the ornamentation.

Bolivina vicksburgensis occurs at the following U. S. G. S. stations:

Glendon limestone.—Vicksburg, Miss., 6446.

Mint Spring calcareous marl member.—Vicksburg, Miss., 6451.

Bolivina cookei Cushman.

Bolivina cookei Cushman, U. S. Geol. Survey Prof. Paper 129, p. 126, pl. 29, fig. 1, 1922.

Test elongate, tapering, the early portion with the periphery slightly rounded, thick, the later portion with the periphery subacute, and the whole test broader and thinner; chambers numerous; sutures indistinct; surface of the earlier thickened portion ornamented by numerous fine longitudinal costae, later portion smooth, but finely punctate. Length 0.25–0.35 millimeter.

This species as originally described was obtained from the Mint Spring marl member, but it occurs also in the typical Marianna limestone. It is never common, so far as the records show. Young specimens do not show the complete adult characters but where found with the adults may be distinguished by the ornamentation of fine longitudinal costae.

Bolivina cookei occurs at the following U. S. G. S. stations:

Typical Marianna limestone.—St. Stephens, Ala., 6710 and 6711; Fail, Ala., 7214; Heidelberg, Miss., 6645.

Mint Spring calcareous marl member.—Vicksburg, Miss., 6447; Browns Cave, Miss., 7671; Boice, Miss., 6647.

Bolivina frondea Cushman.

Bolivina frondea Cushman, U. S. Geol. Survey Prof. Paper 129, p. 126, pl. 29, fig. 3, 1922.

Test much compressed, broad, composed of several chambers, those of the early portion elongate, forming a narrow test, those of the adult extending back, forming a broad test, similar to that seen in certain species of *Frondicularia;* sutures distinct; wall smooth; periphery broadly rounded. Length slightly more than 1 millimeter.

I described this peculiar species from material collected at a station in the Mint Spring marl member of the Marianna, but it has since been found at a number of stations in the Glendon limestone, the typical Marianna limestone, and the Red Bluff clay. Its peculiar shape will at once distinguish it. In general appearance it is somewhat like the young of *Frondicularia,* but the chambers are alternating, and the aperture is that of a *Bolivina.*

Bolivina frondea occurs at the following U. S. G. S. stations:

Glendon limestone.—Vicksburg, Miss., 6446; McGowans Bridge, Ala., 6749.

Typical Marianna limestone.—Brandon, Miss., 7371.

Mint Spring calcareous marl member.—Boice, Miss., 6647.

Red Bluff clay.—St. Stephens, Ala., 6712 and 6713.

Genus VERNEUILINA D'Orbigny, 1840.

Verneuilina spinulosa Reuss var. glabrata Cushman.

Verneuilina spinulosa Reuss var. *glabrata* Cushman, U. S. Geol. Survey Prof. Paper 129, p. 92, 1922.

Test pyramidal, three-sided, widest above the middle, generally triangular in transverse section, the sides somewhat concave; angles of the test bluntly angled or even rounded, without spines; surface smooth; aperture small, at the inner side of the last-formed chamber. Maximum length 0.75 millimeter.

This variety occurs at nearly all the stations in the Byram marl and at one station in the typical Marianna limestone. It differs from the typical form in its lack of spines, the edges often being rounded and thickened. No specimens approaching the typical form were found.

The species is very characteristic of shallow tropical and subtropical waters of the Indo-Pacific region.

Verneuilina spinulosa var. *glabrata* occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6454 and 6455; Vicksburg, Miss., 6449, 7372, and 8240; Haynes Bluff, Miss., 7385; Brandon, Miss., 7389; Leaf River, Miss., 7376; Woodward, Miss., 6648.

Typical Marianna limestone.—St. Stephens, Ala., 6710.

Verneuilina rectimargo Cushman.

Verneuilina rectimargo Cushman, U. S. Geol. Survey Prof. Paper 129, p. 127, pl. 29, figs. 4, 5, 1922.

Test elongate, triangular in cross section, early portion tapering, adult portion typical, with the sides nearly parallel and straight; chambers numerous, arranged triserially; sutures not depressed, often slightly limbate; sides of the test flattened or very slightly concave; peripheral angles rounded; aperture slightly elongate at the base of the inner margin of the last-formed chamber; wall finely punctate. Maximum length 1 millimeter.

This is a much longer species than *V. spinulosa* var. *glabrata*, which occurs in the Byram marl and can easily be distinguished from it. *V. rectimargo* was originally described from specimens found in the Mint Spring marl member, but it also occurs in the Glendon limestone, in the typical Marianna, and at one station in the Red Bluff clay. It was found at only one station in the Byram marl.

Verneuilina rectimargo occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Vicksburg, Miss., 6449.

Glendon limestone.—Robinson's quarry, Miss., 6548; Tiger Hill, Miss., 7735; McGowans Bridge, Ala., 6749.

Typical Marianna limestone.—Castleberry, Ala., 6733 and 7238; Perdue Hill, Ala., 6728; Millry, Ala., 6702; St. Stephens, Ala., 6710; Fail, Ala., 7214.

Mint Spring calcareous marl member.—Vicksburg, Miss., 6447, 6448, 6451, and 6452.

Red Bluff clay.—Hiwannee, Miss., 8752.

Genus GAUDRYINA D'Orbigny, 1839.

Gaudryina quadrangularis Bagg.

Plate III, figure 4.

Gaudryina quadrangularis Bagg, U. S. Nat. Mus. Proc., vol. 34, p. 133, pl. 5, fig. 1, 1908.
Cushman, U. S. Nat. Mus. Bull. 71, pt. 2, p. 64, fig. 103 (in text), 1911.

Test elongate, tapering abruptly at the initial end, composed of an early trihedral portion with acute angles made up of a triserial group of chambers and a later more or less quadrangular portion composed of chambers biserially arranged; wall coarsely arenaceous and rather roughly cemented; aperture an elongate orifice between the inner border of the chamber and the adjacent wall of the preceding chamber, with, in end view, a sort of rounded lip above and a depression at either side; in side view the aperture is in a depression of the abruptly truncated end of the test. Length slightly more than 1 millimeter.

This species, which was described by Bagg from material collected off the Hawaiian Islands and which I have recorded from the same region, occurs in the typical Marianna limestone and Red Bluff clay. The fossil specimens are smaller than the recent ones but have the same general characters, especially the quadrangular shape of the last-formed portion.

Gaudryina quadrangularis occurs at the following U. S. G. S. stations:

Typical Marianna limestone.—Castleberry, Ala., 7238; Fishers Creek, Ala., 7156; Millry, Ala., 6702.

Red Bluff clay.—Hiwannee, Miss., 8752.

Gaudryina triangularis Cushman.

Plate III, figure 5.

Gaudryina triangularis Cushman, U. S. Nat. Mus. Bull. 71, pt. 2, p. 65, figs. 104*a–c* (in text), 1911; Bull. 103, p. 56, pl. 20, fig. 3, 1918; Carnegie Inst. Washington Pub. 291, p. 35, 1919; U. S. Geol. Survey Prof. Paper 129, p. 127, 1922.

Test slightly longer than broad, for the most part triangular, the angles rather acute, com-

posed of a series of chambers triserially arranged, the later chambers rotund, biserially arranged, few; walls coarsely arenaceous, more or less smoothly finished; sutures plainly visible on the exterior; aperture narrow, between the inner border of the chamber and the preceding chamber; color gray. Length about 1 millimeter.

Gaudryina triangularis occurs at the following U. S. G. S. station:

Mint Spring calcareous marl member.—Browns Cave, Miss., 7671.

It was originally described from material collected off the Hawaiian Islands and is recorded from the vicinity of the Bonin Islands, southeast of Japan. I have also recorded it from the Miocene marl in the gorge of Yumuri River, Matanzas, Cuba, and from the later Oligocene (lower part of the Culebra formation) in the Canal Zone.

Gaudryina advena Cushman, n. sp.

Plate III, figure 1.

Test elongate, slightly tapering, early portion triserial, the main part of the test biserial; chambers rounded; sutures deeply depressed; wall smooth; aperture slightly above the base of the inner margin of the last-formed chamber. Maximum length 1.5 millimeters.

This species occurs only in the Byram marl and Marianna limestone at a few stations, and specimens are usually rare. It belongs to the group of *Gaudryina filiformis* Berthelin, but the number of chambers is smaller than in either *filiformis* or *pseudofiliformis*.

Gaudryina advena, n. sp., occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6455; Leaf River, Miss., 7376; Woodward, Miss., 6648.

Marianna limestone.—Millry, Ala., 6702; Tallahala Road, Miss., 7375.

Genus CLAVULINA D'Orbigny, 1826.

Clavulina byramensis Cushman.

Plate II, figure 3.

Clavulina byramensis Cushman, U. S. Geol. Survey Prof. Paper 129, p. 92, pl. 16, fig. 1, 1922.

Test elongate, subcylindrical, the early chambers triserial, forming but a small portion of the test, later ones uniserial, both portions rounded; sutures slightly depressed, often not very distinct otherwise; aperture terminal, central, rounded; wall coarsely arenaceous but smoothly finished. Maximum length 1 millimeter.

This is one of the common and characteristic species of the Byram marl. The early portion is small in proportion to the whole test and consists of a considerable number of rounded chambers in a triserial arrangement, but the resulting mass with rounded angles forms a bulbous tip to the otherwise tapering test. The sutures of this early portion are usually very indistinct.

This resembles certain tropical Pacific species and probably has its affinities in that region. It is quite likely that forms of the Pacific that have been referred by authors to *C. parisiensis* D'Orbigny are closer to this species.

Clavulina byramensis occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6454 and 6455; Vicksburg, Miss., 8240.

Clavulina byramensis Cushman var. extans Cushman, n. var.

Plate II, figure 6.

Variety differing from the typical form in the more elongate form and distinct chambers. Length of adult specimens 0.3 millimeter.

Clavulina byramensis var. *extans*, n. var., occurs at the following U. S. G. S. stations:

Marianna limestone.—Castleberry, Ala., 7238; Fail, Ala., 7214.

Red Bluff clay.—Hiwannee, Miss., 5264.

Clavulina byramensis Cushman var. turgida Cushman, n. var.

Plate II, figures 4, 5.

Variety differing from the typical species in the much larger and stouter form. Length between 2 and 3 millimeters.

This variety does not differ greatly from the typical form except in the points mentioned, but when the two are seen together it is not difficult to distinguish them. The variety seems to replace the typical form in the Glendon limestone, the typical Marianna, and the Red Bluff clay, but neither occurs in the Mint Spring marl member of the Marianna.

Clavulina byramensis var. *turgida*, n. var. occurs at the following U. S. G. S. stations:

Glendon limestone.—McGowans Bridge, Ala., 6749.

Typical Marianna limestone.—Salt Creek, Ala., 7164; Millry, Ala., 6702; St. Stephens, Ala., 5609; Heidelberg, Miss., 6645; Brandon, Miss., 7371.

Red Bluff clay.—Hiwannee, Miss., 5264, 6456, and 8752; St. Stephens, Ala., 6714.

Genus BULIMINA D'Orbigny, 1826.

Bulimina pupoides D'Orbigny.

Bulimina pupoides D'Orbigny, Foraminifères fossiles du bassin tertiaire de Vienne, p. 185, pl. 11, figs. 13, 14, 1846.

H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 400, pl. 50, figs, 15*a*, *b*, 1884.

Cushman, U. S. Nat. Mus. Bull. 71, pt. 2, p. 80, figs. 132*a–c* (in text), 1911; U. S. Geol. Survey Prof. Paper 129, p. 127, pl. 129, fig. 7, 1922.

Test ovate, broadest near the apertural end, apical end broadly pointed, tapering, end view nearly circular; visible chambers numerous, much inflated; sutures rather deeply depressed; wall smooth; aperture long and narrow, with a narrow platelike tooth; color white. Length about 1 millimeter.

These specimens of *B. pupoides* are much longer than *B. ovata*, which occurs in the Byram marl.

Bulimina pupoides occurs at the following U. S. G. S. stations:

Mint Spring calcareous marl member.—Browns Cave, Miss., 7671; Boice, Miss., 6647.

Bulimina ovata D'Orbigny (?).

Bulimina ovata D'Orbigny, Foraminifères fossiles du bassin tertiaire de Vienne, p. 185, pl. 11, figs. 13, 14, 1846.

H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 400, pl. 50, figs. 13*a*, *b*, 1884.

Cushman, U. S. Geol. Survey Prof. Paper, 29, p. 92, pl. 16, fig. 4, 1922.

This species is very rare in the Byram marl, and the correctness of the identification is very questionable.

Bulimina ovata (?) occurs at the following U. S. G. S. station:

Byram calcareous marl.—Byram, Miss., 6455.

Bulimina sculptilis Cushman, n. sp.

Plate III, figure 3.

Test elongate, tapering, subacute at the initial end, broadly rounded at the apertural end, or somewhat contracted; chambers numerous, distinct; sutures slightly depressed; surface ornamented by longitudinal costae, raised considerably above the general surface of the test, comparatively few and continuous from the apex nearly to the aperture; aperture elongate, comma-shaped. Maximum length 1 millimeter.

This species seems to be confined to the Red Bluff clay among the Vicksburg formations. It is apparently much more abundant in the upper Eocene. It is related somewhat to *B. buchiana* D'Orbigny, but the specimens are much more elongate, more evenly tapering, and fewer and have more prominent platelike costae and the apertural end, especially in adults, somewhat narrowed.

Bulimina sculptilis occurs at the following U. S. G. S. stations:

Red Bluff clay.—Hiwannee, Miss., 6456 and 8752; St. Stephens, Ala., 6714.

Bulimina sp. (?)

Single specimens from stations in the Glendon limestone and in the typical Marianna limestone are rather poorly preserved and show little beyond the generic characters, but the occurrence of the genus in these parts of the Oligocene should be noted.

Bulimina sp. (?) occurs at the following U. S. G. S. stations:

Glendon limestone.—Tiger Hill, Miss., 7735.

Typical Marianna limestone.—Fail, Ala., 7214.

Genus BULIMINELLA Cushman, 1911.

Buliminella contraria (Reuss) Cushman.

Plate III, figure 6.

Rotalina contraria Reuss, Deutsch. geol. Gesell. Zeitschr., vol. 3, p. 76, pl. 5, fig. 37, 1851.

Bulimina contraria (Reuss) H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 409, pl. 54, figs. 18*a–c*, 1884.

Buliminella contraria (Reuss) Cushman, U. S. Nat. Mus., Bull. 71, pt. 2, p. 89, figs. 143*a–c* (in text), 1911, U. S. Geol. Survey Prof. Paper 129, p. 128, 1922.

Test coiled in a depressed spire, umbilicate; chambers numerous, slightly inflated; sutures distinct, slightly depressed; wall smooth, calcareous; aperture distinctly bulimine, looplike, rather long and narrow, extending to the umbilicus; color white. Length 0.65 millimeter.

Buliminella contraria occurs at the following U. S. G. S. station:

Mint Spring calcareous marl member.—Boice, Miss., 6647.

The records for *B. contraria* are mostly from the south Pacific Ocean. Brady recorded one specimen from waters off the Azores, and I have recorded it from the vicinity of the Hawaiian Islands. Bagg records very small specimens from the Pliocene sands of San Pedro, Calif. This is another of the species that seems to show the relation of the Vicksburgian Oligocene of the Coastal Plain of the southeastern United States to the recent fauna of the Indo-Pacific region.

Buliminella subteres H. B. Brady var. angusta Cush

Buliminella subteres H. B. Brady var. *angusta* Cushman, U. S. Geol. Survey Prof. Paper 129, p. 127, pl. 29, figs. 8, 9, 1922.

Variety differing from the typical in the more elongate narrower shape of the test, and the larger number of chambers; aperture elongate, nearly in the long axis of the test; sutures not depressed, marked by darker lines of shell material.

Specimens of this variety were very rare in the Mint Spring marl. The typical form of the species occurs in the present oceans in the warmer parts of the Atlantic and in the Indo-Pacific. It has not been recorded as a fossil in the American Tertiary.

Buliminella subteres var. *angusta* occurs at the following U. S. G. S. stations:

Mint Spring calcareous marl member.—Vicksburg, Miss., 6447 and 6452; Browns Cave, Miss., 7671; Boice, Miss., 6647.

Buliminella declivis (Reuss) Cushman.

Bulimina declivis Reuss, Akad. Wiss. Wien Sitzungsber., vol. 48, p. 55, pl. 6, fig. 70; pl. 7, fig. 71, 1863.
H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 404, pl. 50, figs. 19*a*, *b*, 1884.

This species differs from *B. subteres* in its much broader form and the somewhat more regular spiral. The specimen in the present collection is much closer to Reuss's plate 7, figure 71, than to his other figure, and is somewhat like Brady's plate 50, figure 19, except that it has not nearly so deep a reentrant. Brady's specimens were from the south Pacific; those of Reuss were fossils from the Tertiary of Germany.

Buliminella declivis occurs at the following U. S. G. S. station:

Red Bluff clay.—Hiwannee, Miss., 5264.

Genus CASSIDULINA D'Orbigny, 1826.

Cassidulina crassa D'Orbigny.

Plate III, figure 7.

Cassidulina crassa D'Orbigny, Voyage dans l'Amérique méridionale, Foraminifères, p. 56, pl. 7, figs. 18–20, 1839.
H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 429, pl. 54, figs. 4, 5, 1884.
Cushman, U. S. Nat. Mus. Bull. 71, pt. 2, p. 97, figs. 151*a–c* (in text), 1911; U. S. Geol. Survey Prof. Paper 129, p. 128, 1922.

Outline subcircular or oval, biconvex, with a broadly rounded peripheral border; chambers rather few, short, and inflated; surface depressed at the sutures; wall calcareous, perforate, smooth; aperture a long, narrow slit, just below and nearly parallel to the periphery of the test. Diameter 0.4 millimeter.

The specimens from the Mint Spring marl and the Byram marl seem to be similar, but the specimens from the typical Marianna limestone are more like *C. laevigata* D'Orbigny. They are not keeled but are thinner and have an acute periphery.

Cassidulina crassa occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Woodward, Miss., 6648.
Typical Marianna limestone.—Castleberry, Ala., 6734.
Mint Spring calcareous marl member.—Vicksburg, Miss., 6447 and 6451.

Genus EHRENBERGINA Reuss, 1850.

Ehrenbergina glabrata Cushman.

Ehrenbergina glabrata Cushman, U. S. Geol. Survey Prof. Paper 129, p. 93, pl. 17, figs. 4a–4., 1922.

Test small, in front view broadly triangular; chambers numerous, distinct, low, and broad; sutures distinct, on the ventral side at the bottom of deep, rounded depressions, on the dorsal side but slightly depressed below the general surface; periphery lobulate; surface smooth; aperture elliptical at the base of the inner margin of the last-formed chamber. Length 0.4 millimeter.

This species is rare in the Byram marl. It differs from the widely distributed deep-water species *E. serrata* Reuss in the rounded chambers, smooth surface, and lack of spines or sharp angles.

A form that occurs in comparatively shallow water in the Australian region may be the same as this species, which would not be surprising in view of the relationships already noted for other forms. In its characters the Australian form is very similar to the species figured in the reference given above.

Ehrenbergina glabrata occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6455; Vicksburg, Miss., 7372; Leaf River, Miss., 7376.

Genus PAVONINA D'Orbigny, 1826.

Pavonina advena Cushman, n. sp.

Plate I, figure 10.

Test of comparatively few chambers, only the very early ones showing a trace of the

biserial arrangement; succeeding chambers rapidly increasing in width until an annular chamber is developed; wall thin, translucent, finely punctate, otherwise smooth. Diameter slightly less than 0.50 millimeter.

This somewhat resembles *P. flabelliformis*, which is characteristic of certain parts of the Indo-Pacific region in shallow water but which has much coarser pores. It is less closely like *P. atlantica*, which I have described from material obtained off the Florida coast.

Pavonina advena occurs at the following U. S. G. S. station:

Byram calcareous marl —Leaf River, Miss., 7376.

Family LAGENIDAE.

Genus LAGENA Walker and Boys, 1784.

Lagena laevigata (Reuss) Terrigi.

Plate III, figure 12.

Fissurina laevigata Reuss, Akad. Wiss. Wien Denkschr., vol. 1, p. 366, pl. 46, fig. 1, 1849.
Lagena laevigata (Reuss) Terrigi, Accad. pont nuovo Lincei Atti, vol. 33, p. 177, pl. 1, fig. 6, 1880.
H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 473, pl. 114, figs. 8*a*, *b*, 1884.
Cushman, U. S. Nat. Mus. Bull. 71, pt, 3, p. 7, pl. 2, fig. 1, 1913; U. S. Geol. Survey Prof. Paper 129, p. 128, 1922.

Test subglobose, compressed, somewhat pyriform in front view; in cross section elliptical; wall smooth, transparent in thin specimens or opaque in more thickened ones, along the lateral margins usually clear, even in thickened specimens; aperture elongate, fairly narrow, connecting with the interior by a fairly long entosolenian neck. Length, 0.45 millimeter.

There are two specimens in the Vicksburg material which can be referred to this species. They are small and have the characteristic shape.

Lagena laevigata occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Leaf River, Miss., 7376.
Mint Spring calcareous marl member.—Vicksburg, Miss., 6451.

Lagena sulcata (Walker and Jacob) Parker and Jones.

Plate III, figure 8.

Serpula (Lagena) striata sulcata rotundata Walker and Boys, Testacea minuta rariora, p. 2, pl. 1, fig. 6, 1784.
Serpula (Lagena) sulcata Walker and Jacob, Adams's Essays on the microscope, Kanmacher's ed., p. 634, pl. 14, fig. 5, 1798.
Lagena sulcata (Walker and Jacob) Parker and Jones, Philos. Trans., vol. 155, p. 351, 1865.
H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 462, pl. 57, figs, 23, 26, 33, 34, 1884.
Cushman, U. S. Nat. Mus. Bull. 71, pt. 3, p. 22, pl. 9, fig. 2, 1913.

Test flask-shaped, body portion subglobular, ornamented with numerous platelike costae running the length of the test, a few often more prominent than others, rather closely set and numerous, sometimes ending in spinose projections at the apical end; neck variously ornamented by costae or annular rings. Maximum length 0.45 millimeter.

Specimens that may be referred to this species occur in the Byram marl and the Marianna limestone but are rare.

Lagena sulcata occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6454.
Marianna limestone.—Fishers Creek, Ala., 7156; Calmar, Miss., 7445.

Lagena cookei Cushman, n. sp.

Plate III, figures 9, 10.

Test broader than long, base broadly truncate; apertural end tapering to a short cylindrical neck; surface smooth except for a slight granulation, dull. Length usually not exceeding 0.2 millimeter.

This species has been found to be common at one station in the Glendon limestone, and a similar specimen was found in the Byram marl. Its peculiar shape and surface ornamentation will distinguish it from others of the genus found in the lower Oligocene.

Lagena cookei occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6454.
Glendon limestone.—McGowans Bridge, Ala., 6749.

Lagena semistriata Williamson.

Plate III, figure 11.

Lagena striata (D'Orbigny) var. *semistriata* Williamson, Annals and Mag. Nat. Hist., 2d ser., vol. 1, p. 14, pl. 1, figs. 9, 10, 1848.

Lagena vulgaris Williamson var. *semistriata* Williamson, Recent Foraminifera of Great Britain, p. 6, pl. 1, fig. 9, 1858.

Lagena semistriata Williamson. Jones, Parker, and H. B. Brady, A monograph of the Foraminifera of the Crag, p. 34, pl. 4, fig. 6, 1866.

H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 465, pl. 57, figs. 14, 16, 17, 1884.

Test very elongate, slender, tapering toward the apertural end, with a distinct tapering neck, smooth except for the basal end, which has a few distant platelike costae. Length 0.4 millimeter.

This species was found in the Vicksburg deposits only at a single station in the Glendon formation. The specimen is fairly well preserved and shows a characteristic ornamentation.

Lagena semistriata occurs at the following U. S. G. S. station:

Glendon limestone.—McGowans Bridge, Ala., 6749.

Lagena striata (D'Orbigny) var. substriata Williamson.

Lagena substriata Williamson, Annals and Mag. Nat. Hist., 2d ser., vol. 1, p. 15, pl. 2, fig. 12, 1848.

Lagena vulgaris var. *substriata* Williamson, Recent Foraminifera of Great Britain, p. 7, pl. 1, fig. 14, 1858.

Lagena striata var. *substriata* Williamson. Cushman, U. S. Nat. Mus. Bull. 71, pt. 2, p. 20, pl. 8, figs. 1–3, 1913; U. S. Geol. Survey Prof. Paper 129, p. 128, pl. 129, fig. 10, 1922.

Variety differing from the typical form in the more elongate body, long tapering neck, and costulate surface extending up onto the neck, often to its end, and usually spirally arranged on the neck. Length 0.40–0.50 millimeter.

There is a single very typical specimen of this variety in the Vicksburg material. The neck is somewhat broken, but the general form of the test and the ornamentation is that of the variety.

Lagena striata var. *substriata* occurs at the following U. S. G. S. station:

Mint Spring calcareous marl member.—Browns Cave, Miss., 7671.

Lagena orbignyana (Seguenza) var. flintii Cushman.

Lagena castrensis Flint (not Schwager), U. S. Nat. Mus. Rept. for 1897, p. 308, pl. 54, fig. 5, 1899.

Lagena orbignyana (Seguenza) var. *flintii* Cushman, U. S. Geol. Survey Prof. Paper 129, p. 129, pl. 29, fig. 11, 1922.

Variety with a secondary keel at each side near the periphery and a series of two or three concentric lines of lacunae or pitted areas of uniform size inside the inner carina, the central part of the test having the pits less prominent. Length 0.45 millimeter.

This variety I described from material obtained from the Mint Spring marl member of the Marianna, but it is found also in the Byram marl and the Red Bluff clay. The specimens are somewhat similar to *L. castrensis* Schwager, but the ornamentation is made up of pits and not of raised knobs, and the pits are more numerous and very evenly placed compared to the form which I have referred to the variety *lacunata*.

Lagena orbignyana var. *flintii* occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6454; Leaf River, Miss., 7376.

Mint Spring calcareous marl member.—Vicksburg, Miss., 6447.

Red Bluff clay.—St. Stephens, Ala., 6713.

Lagena hexagona (Williamson) Siddall.

Entosolenia squamosa Montagu var. *hexagona* Williamson, Annals and Mag. Nat. Hist., 2d ser., vol. 1, p. 20, pl. 2, fig. 23, 1848; Recent Foraminifera of Great Britain, p. 13, pl. 1, fig. 31, 1858.

Lagena hexagona (Williamson) Siddall, Catalogue of recent British Foraminifera, p. 6, 1879.

H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 472, pl. 58, figs. 32, 33, 1884.

Cushman, U. S. Nat. Mus. Bull. 71, pt. 3, p. 17, pl. 6, figs. 2, 3, 1913; U. S. Geol. Survey Prof. Paper 129, p. 129, pl., 29, fig. 12, 1922.

Test subglobular, broadly rounded at the apical end, bluntly pointed at the apertural end; surface ornamentation consisting of a reticulate pattern, the areoles of which are hexagonal, either arranged in vertical rows or irregular. Length 0.5 millimeter.

Lagena hexagona occurs at the following U. S. G. S. station:

Mint Spring calcareous marl member.—Vicksburg, Miss., 6452.

The specimen is similar to the specimen I have figured in plate 6, figure 2, of Bulletin 71 of the National Museum.

Genus NODOSARIA Lamarck, 1812.

Nodosaria communis D'Orbigny.

Nodosaria (*Dentalina*) *communis* D'Orbigny, Annales sci. nat., vol. 7, p. 254, No. 35, 1826.

Nodosaria communis D'Orbigny. H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 504, pl. 62, figs. 19–22, 1884.

Cushman, U. S. Nat. Mus. Bull. 71, pt. 3, p. 54, pl. 28, figs. 1, 2, 1913; U. S. Geol. Survey Prof. Paper 129, p. 129, pl. 30, fig. 4, 1922.

Test elongate, slender, tapering, straight or more often slightly curved; composed of numerous chambers, slightly inflated toward the apical end but later ones becoming more inflated; sutures oblique; aperture radiate, somewhat eccentric, elongate somewhat; surface smooth. Maximum length 3 millimeters or more.

Nodosaria communis occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Leaf River, Miss., 7376.

Typical Marianna limestone.—Marianna, Fla., 6767.

Mint Spring calcareous marl member.—Vicksburg, Miss., 6451; Browns Cave, Miss., 7671.

Red Bluff clay.—Hiwannee, Miss., 6456 and 8752; St. Stephens, Ala., 6712, 6713, and 6714.

Nodosaria filiformis D'Orbigny.

Nodosaria filiformis D'Orbigny, Annales sci. nat., vol. 7, p. 253, No. 14, 1826.

H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 500, pl. 63, figs. 3–5, 1884.

Cushman, U. S. Nat. Mus. Bull. 71, pt. 3, p. 55, pl. 27, figs. 1–4, 1913; U. S. Geol. Survey Prof. Paper 129, p. 129, pl. 30, figs. 1–3, 1922.

Test elongate, slender, arcuate; chambers numerous, elliptical or ovate, elongate, tumid; sutures usually oblique; chambers increasing in length toward the apertural end; aperture radiate, slightly eccentric; wall smooth. Maximum length 0.5 millimeter.

The collections contain specimens showing a few chambers, which seem to belong to this species. They are elongate, cylindrical, and slightly contracted at the ends, and the apertural end, where shown, is long and tapering.

Nodosaria filiformis occurs at the following U. S. G. S. stations:

Typical Marianna limestone.—Fishers Creek, Ala., 7156.

Mint Spring calcareous marl member.—Vicksburg, Miss., 6448 and 6451; Browns Cave, Miss., 7671.

Red Bluff clay.—Hiwannee, Miss., 5264.

Nodosaria obliqua (Linné) Parker and Jones.

Nautilus obliquus Linné, Systema naturae, 12th ed., p. 1163, 1767; 13th (Gmelin's) ed., p. 3372, No. 14, 1788.

Nodosaria (*Dentalina*) *obliqua* (Linné) Parker and Jones, Annals and Mag. Nat. Hist., 3d ser., vol. 3, p. 482, 1859.

Nodosaria obliqua (Linné) Parker and Jones. H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 513, pl. 64, figs. 20–22, 1884.

Cushman, U. S. Nat. Mus. Bull. 71, pt. 3, p. 59, pl. 25, fig. 5, 1913; U. S. Geol. Survey Prof. Paper 129, p. 129, pl. 30, figs. 6, 7, 1922.

Test elongate, tapering, apical end often with a spine; chambers numerous, in the early portion not distinct, in the later portion the chambers tumid; sutures depressed; surface ornamented with numerous rounded costae, fairly broad, as many as 40 in the adult chambers of some of the specimens, costae continuous from the apical spine to the apertural end, additional ones added between those already formed; aperture radiate. Maximum length 0.10 millimeter when complete.

Large, coarsely costate specimens that are referred to this species have been found in all the divisions of the Vicksburg group. This is quite possibly the same as the species from the Byram marl noted as a "single broken specimen."

Nodosaria obliqua occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Vicksburg, Miss., 8240.

Glendon limestone.—Tiger Hill, Miss., 7735; McGowans Bridge, Ala., 6749.

Typical Marianna limestone.—St. Stephens, Ala., 5609.

Mint Spring calcareous marl member.—Vicksburg, Miss., 6452; Browns Cave, Miss., 7671; Boice, Miss., 6647.

Red Bluff clay.—Hiwannee, Miss., 6456.

Nodosaria vertebralis (Batsch) H. B. Brady.

Plate IV, figure 1.

Nautilus (*Orthoceras*) *vertebralis* Batsch, Conchylien des Seesandes, p. 3, No. 6, pl. 2, figs. 6*a*, *b*, 1791.

Nodosaria vertebralis (Batsch) H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 514, pl. 63, fig. 35; pl. 64, figs. 11–14, 1884.

Flint, U. S. Nat. Mus. Rept. for 1897, p. 312, pl. 57, fig. 5, 1899.

Cushman, U. S. Nat. Mus. Bull. 71, pt. 3, p. 60, pl. 32, fig. 1, 1913.

Test elongate, slender, tapering, straight or very slightly arcuate; chambers comparatively short, numerous, little inflated; sutures of clear shell material, appearing darker than the opaque portions; surface ornamented with

longitudinal costae, apical end usually with a short spine. Length not exceeding 0.4 millimeter.

Rather typical specimens of this species occur in all the formations of the Vicksburg group except the Byram marl. This is the same as the single specimen recorded in my paper on the Mint Spring marl[12] as *Nodosaria* sp.

Nodosaria vertebralis occurs at the following U. S. G. S. stations:

Glendon limestone.—Vicksburg, Miss., 6446; Robinson's quarry, Miss., 6548; McGowans Bridge, Ala., 6749.

Typical Marianna limestone.—St. Stephens, Ala., 5609 and 5649.

Red Bluff clay.—Hiwannee, Miss., 5264 and 8752; St. Stephens, 6713.

Nodosaria cf. N. pauciloculata Cushman.

Plate III, figure 13.

Nodosaria pauciloculata Cushman, U. S. Nat. Mus. Proc., vol. 51, p. 655, 1917; U. S. Nat. Mus. Bull. 100, vol. 4, p. 205, pl. 36, figs. 10–12, 1921.

Test nodose, composed of few chambers, usually not more than five, two or three closely set, later ones remote, inflated; sutures even in the early chambers much depressed, wall ornamented by longitudinal costae, few and large, usually limited to the middle portion of the chamber and becoming obsolete toward each end; neck long, swollen toward the top, then again rapidly contracted to the aperture; in the early chambers the neck with costae; in later ones with the costae limited to the last tapering portion near the aperture.

A single final chamber which from its peculiar shape and the few costae very strongly resembles a species that I have described from material obtained in the Philippine region.

Nodosaria cf. *N. pauciloculata* occurs at the following U. S. G. S. station:

Glendon limestone.—McGowans Bridge, Ala., 6749.

Nodosaria cf. N. obliqua Linné.

The material examined contains two somewhat broken specimens, which show a finely costate species of *Nodosaria*. The aperture is missing in both specimens, but in general this species resembles *N. obliqua*.

Nodosaria cf. *N. obliqua* occurs at the following U. S. G. S. station:

Marianna limestone.—Brandon, Miss., 7371.

[12] U. S. Geol. Survey Prof. Paper 129, p. 130, pl. 30, fig. 5, 1922.

Nodosaria catenulata H. B. Brady.

Plate III, figure 14.

Nodosaria catenulata H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 515, pl. 63, figs. 32–34, 1884.
Flint, U. S. Nat. Mus. Rept. for 1897, p. 312, pl. 58, fig. 2, 1899.
Cushman, U. S. Nat. Mus. Bull. 71, pt. 3, p. 57, pl. 25, fig. 3, 1913; U. S. Nat. Mus. Bull. 100, vol. 4, p. 198, pl. 35, fig. 7, 1921.

Test elongate, slender, straight or more often slightly arcuate, tapering, apical end bearing a well-developed spine; chambers numerous, elliptical or ovate, distinctly separated by deep sutures; wall smooth, ornamented by four or six equidistant longitudinal costae bridging the depressions between the chambers, but usually not continuous over the chambers; costae more or less rounded; aperture small at the end of a long tapering neck, the apertural end of which is costate, giving a stellate appearance in end view.

The Vicksburg group material contains a fragmentary specimen which shows the peculiar costae bridging the depression between two chambers. From this character and the shape of the chambers it seems to be distinctly this species, which is known from the Philippines, Torres Strait, and warm waters elsewhere.

Nodosaria catenulata occurs at the following U. S. G. S. station:

Marianna limestone.—Fishers Creek, Ala., 7156.

Genus CRISTELLARIA Lamarck, 1812.

Cristellaria convergens Bornemann.

Plate IV, figure 2.

Cristellaria convergens Bornemann, Deutsch. geol. Gesell. Zeitschr., vol. 7, p. 327, pl. 13, figs. 16, 17, 1855.
H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 546, pl. 69, figs. 6, 7, 1884.
Cushman, U. S. Nat. Mus. Bull. 71, pt. 3, p. 68, pl. 34, fig. 3, 1913; U. S. Geol. Survey Prof. Paper 129, p. 130, 1922.

Test oval, biconvex, close-coiled; chambers triangular, the last-formed one drawn out to a point at the apertural end; sutures hardly visible, the chambers embracing to the umbo; wall smooth and thick. Length about 1 millimeter.

Cristellaria convergens occurs at the following U. S. G. S. stations:

Typical Marianna limestone.—Fishers Creek, Ala., 7156; Millry, Ala., 6702.

Mint Spring calcareous marl member.—Browns Cave, Miss., 7671; Boice, Miss., 6647.

Red Bluff clay.—St. Stephens, Ala., 6713 and 6714; Hiwannee, Miss., 8752.

Cristellaria cultrata (Montfort) Parker and Jones.

Robulus cultratus Montfort, Conchyliologie systématique, vol. 1, p. 214, 54e genre, 1808.

Robulina cultrata (Montfort) D'Orbigny, Annales sci. nat., vol. 7, p. 287, No. 1, Modèles, No. 82, 1826; Foraminifères fossiles du bassin tertiaire de Vienne, p. 96, pl. 4, figs. 14, 15, 1846.

Cristellaria cultrata (Montfort) Parker and Jones, Philos. Trans., vol. 155, p. 344, pls. 13, 17, 18; pl. 16, fig. 5, 1865.

H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 550, pl. 70, figs. 4–6, 1884.

Cushman, U. S. Nat. Mus. Bull. 71, pt. 3, p. 64, pl. 29, fig. 5, 1913; U. S. Geol. Survey Prof. Paper 129, p. 130, pl. 31, fig. 8, 1922.

Test with a distinct keel; chambers with very oblique, curved sutures; surface smooth. Maximum diameter, 0.2 millimeter.

This species may be separated from that which is here referred to *C. rotulata* Lamarck by the large number of chambers and the very oblique, curved sutures, and usually a broader, more distinct keel. It is found in the typical Marianna limestone, the Mint Spring marl member, and the Red Bluff clay, but not so far as I have seen in either the Byram marl or the Glendon limestone.

Cristellaria cultrata occurs at the following U. S. G. S. stations:

Typical Marianna limestone.—St. Stephens, Ala., 5609.

Mint Spring calcareous marl member.—Browns Cave, Miss., 7671.

Red Bluff clay.—St. Stephens, Ala., 6713.

Cristellaria rotulata (Lamarck) D'Orbigny.

Lenticulites rotulata Lamarck, Annales Mus., vol. 5, p. 188, No. 3, 1804; vol. 8, pl. 62, fig. 11, 1806.

Cristellaria rotulata (Lamarck) D'Orbigny, Soc. géol. France Mém., 1st ser., vol. 4, p. 26, pl. 2, figs. 16–18, 1840.

H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 547, pl. 69, figs. 13*a*, *b*, 1884.

Cushman, U. S. Nat. Mus. Bull. 71, pt. 3, p. 66, pl. 35, fig. 3, 1913; U. S. Geol. Survey Prof. Paper 129, p. 130, pl. 32, fig. 1, 1921.

Test large, close-coiled,; chambers numerous, lenticular, biconvex; wall smooth, thick, peripheral margin rather acute but not distinctly carinate; apertures of all chambers of visible test usually apparent. Length 1.5–2 millimeters.

This species occurs in all the divisions of the Vicksburg except the Byram marl.

Cristellaria rotulata occurs at the following U. S. G. S. stations:

Glendon limestone.—McGowans Bridge, Ala., 6749.

Typical Marianna limestone.—Marianna, Fla., 6767; Perdue Hill, Ala., 6728; Millry, Ala., 6702; St. Stephens, Ala., 5649, 6710, and 6711.

Mint Spring calcareous marl member.—Vicksburg, Miss., 6452; Browns Cave, Miss., 7671.

Red Bluff clay.—Hiwannee, Miss., 5264 and 8752; St. Stephens, Ala., 6712 and 6714; Fail, Ala., 7213.

Cristellaria vicksburgensis Cushman.

Cristellaria vicksburgensis Cushman, U. S. Geol. Survey Prof. Paper 129, p. 130, pl. 31, figs. 6, 7, 1922.

Test composed of few chambers, seven to eight in the visible coil; surface generally smooth, except on the sutures, which are marked by rather broad, curved, raised ridges, those near the earlier part of the coil broken into rounded knobs, especially near the umbilical area, the later ones more continuous; periphery angled, the early portion carinate; apertural face smooth and somewhat concave, with acute projecting angles; aperture radiate at the angle of the chamber. Length 0.65–1 millimeter.

This species in its typical form occurs at numerous stations in the Mint Spring marl, Glendon limestone, and typical Marianna limestone and is replaced in the Byram marl and Red Bluff clay by the variety *aperta*, described below.

Cristellaria vicksburgensis occurs at the following U. S. G. S. stations:

Glendon limestone.—Vicksburg, Miss., 6446; McGowans Bridge, Ala., 6749.

Typical Marianna limestone.—Marianna, 6767; Castleberry, Ala., 6734; Fishers Creek, Ala., 7156; Millry, Ala., 6702; St. Stephens, Ala., 5609, 5649, and 6710; Fail, Ala., 7214.

Mint Spring calcareous marl member.—Browns Cave, Miss., 7671; Boice, Miss., 6647.

Cristellaria vicksburgensis Cushman var. aperta Cushman, n. var.

Plate IV, figure 4.

Cristellaria sp. Cushman, U. S. Geol. Survey Prof. Paper 129, p. 130, pl. 31, figs. 6, 7, 1922.

Variety differing from the typical form in the character of the sutures, which are broadly limbate, of clear shell material, and either not otherwise ornamented or with a single knob at the inner end; test otherwise smooth, often with a thin keel.

Cristellaria vicksburgensis var. *aperta* occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Vicksburg, Miss., 8240; Plain, Miss.?, 7373*a*.

Typical Marianna limestone.—St. Stephens, Ala., 5649.

Red Bluff clay.—St. Stephens, Ala., 6712 and 6713; Hiwannee, Miss., 8752.

Cristellaria submamilligera Cushman.

Plate IV, figures 5, 6.

Cristellaria mamilligera H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 553, pl. 70, figs. 17, 18, 1884 (not *C. mamilligera* Karrer).

Cushman, U. S. Nat. Mus. Bull. 71, pt. 3, p. 74, pl. 34, fig. 6*a* (not 6*b*, which should read 5*b*), 1913.

Cristellaria submamilligera Cushman, U. S. Nat. Mus. Proc., vol. 51, p. 657, 1917; U. S. Nat. Mus. Bull. 100, vol. 4, p. 235, 1921.

Test biconvex, close-coiled, periphery with a thin keel; sutures curved, limbate externally, ornamented by a raised ridge that ends near the umbilical region in a protuberant knob, often a distinct raised boss over the center of the umbilical region; keel entire and not denticulate in well-preserved specimens; wall between the raised ridges smooth; aperture radiate. Diameter as much as 3 millimeters but usually less.

A few specimens from the Marianna limestone are very close to this species, which I have described from material collected in the Philippine region, where it occurs at numerous stations in warm waters of medium depths.

Cristellaria submamilligera occurs at the following U. S. G. S. stations:

Typical Marianna limestone.—St. Stephens, Ala., 5609.

Red Bluff clay.—St. Stephens, Ala., 6713.

Cristellaria italica (Defrance) D'Orbigny.

Plate IV, figure 3.

Saracenaria italica Defrance, Dictionnaire des sciences naturelles, vol. 32, p. 177, 1824; vol. 47, p. 344, 1827.

Cristellaria (*Saracenaria*) *italica* (Defrance) D'Orbigny, Annales sci. nat., vol. 7, p. 293, No. 26, Modèles, Nos. 19 and 85, 1826.

Cristellaria italica (Defrance) D'Orbigny. Parker, Jones, and H. B. Brady, Annals and Mag. Nat. Hist., 3d ser., vol. 16, pp. 21, 32, pl. 1, figs. 41, 42, 1865.

H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 544, pl. 68, figs. 17, 18, 20-23, 1884.

Test stout, trihedral, triangular in cross section; early chambers close-coiled, later ones uncoiling but short, not extending back to the earlier volutions; sutures somewhat depressed; wall smooth; face of the last-formed chamber nearly triangular. Maximum length 1 millimeter.

This species is very rare in the Vicksburg group, but small specimens that may be referred to it occur in the Glendon limestone and Mint Spring marl member of the Marianna limestone.

Cristellaria italica occurs at the following U. S. G. S. stations:

Glendon limestone.—McGowans Bridge, Ala., 6749.

Mint Spring calcareous marl member.—Vicksburg, Miss., 6448.

Cristellaria cf. C. italica (Defrance.)

Rare specimens from several stations in the Marianna limestone and Red Bluff clay are similar to the specimen of *Cristellaria italica* here figured. They are all small, and none of them show the development which is typical of the species, but they are here referred provisionally.

Cristellaria cf. *C. italica* occurs at the following U. S. G. S. stations:

Typical Marianna limestone.—St. Stephens, Ala., 5609 and 5649; Perdue Hill, Ala., 6729.

Red Bluff clay.—St. Stephens, Ala., 6713 and 6714.

Cristellaria sp.?

Plate IV, figure 7.

A species which is very rare in the lower Oligocene, so far as the present collections show, is here figured. It has an elongate, uncoiled form. It was found in the Red Bluff clay.

Cristellaria sp.? occurs at the following U. S. G. S. station:

Red Bluff clay.—Hiwannee, Miss., 8752.

Genus VAGINULINA D'Orbigny, 1826.

Vaginulina legumen (Linnê) D'Orbigny var. elegans D'Orbigny.

Plate IV, figure 8.

Vaginulina elegans D'Orbigny, Annales sci. nat., vol. 7, p. 257, No. 1, Modèles, No. 54, 1826.

Parker, Jones, and H. B. Brady, Annals and Mag. Nat. Hist., 3d ser., vol. 16, p. 27, pl. 1, fig. 33, 1865.

Vaginulina legumen (Linné) var. *elegans* Fornasini, Soc. geol. ital. Boll., vol. 5, p. 25, pl. 1, figs. 1 (?), 2–8, 1886.

Cushman, U. S. Nat. Mus. Bull. 100, vol. 4, p. 258, pl. 41, fig. 4, 1921; U. S. Geol. Survey Prof. Paper 129, pp. 93, 131, pl. 17, fig. 1, 1922.

Test elongate, tapering, basal end with a stout spine; sutures very distinct, limbate, contour in end view less compressed than in the typical form; last-formed chambers

more distinct in outline than the earlier ones; wall smooth and transparent.

Specimens occur rarely at several stations in the lower Oligocene. They are usually not complete, as there is a line of weakness where the chambers are joined. From the series, however, the characters of the variety are distinctly shown. I have already recorded it from several stations in the Philippine area.

Vaginulina legumen var. *elegans* occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6455; Leaf River, Miss., 7376.

Mint Spring calcareous marl member.—Vicksburg, Miss., 6447.

Red Bluff clay.—Hiwannee, Miss., 5264 and 8752; Fail, Ala., 7213.

Vaginulina cf. V. linearis (Montagu) Goës.

A single specimen in the collections may be compared to *V. linearis*. It has fewer costae than the typical form and differs from it in other characters. It somewhat resembles specimens from the Philippine region, and further specimens may show it to be a distinct species.

Vaginulina cf. *V. linearis* occurs at the following U. S. G. S. station:

Red Bluff clay.—Hiwannee, Miss., 5264.

Genus POLYMORPHINA D'Orbigny, 1826.

Polymorphina gibba D'Orbigny.

"Polymorphina Subcordiformia vel Oviformia" Soldani, Testaceographia, vol. 1, pt. 2, p. 114, pl. 113, figs. *zz*, *C*. etc., 1791.

Polymorphina (*Globulina*) *gibba* D'Orbigny, Annales sci. nat., vol. 7, p. 226, No. 20, Modèles, No. 63, 1826.

Polymorphina gibba H. B. Brady, Parker, and Jones (part), Linnean Soc. London Trans., vol. 27, p. 216, pl. 39, figs. 2*a–d*, 1870.

H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 561, pl. 71, figs. 12*a*, *b*, 1884.

Cushman, U. S. Nat. Mus. Bull. 71, pt. 3, p. 85, pl. 41, fig. 4, 1913; U. S. Geol. Survey Bull. 676, p. 11, pl. 2, fig. 4; p. 52, pl. 11, fig. 5, 1918; U. S. Geol. Survey Prof. Paper 129, p. 93, pl. 17, fig. 3, 1922.

Test rotund, in front view nearly circular, in end view broadly oval; chambers few, distinct; sutures distinct, little if at all excavated; wall smooth and translucent; aperture slightly produced, radiate. Maximum length 0.75 millimeter.

I have referred to this species all the rotund specimens which are common in all the divisions of the Vicksburg group. There are different forms, however, but whether these are due to different stages in development the condition of the specimens does not show clearly. What seem to be the young of this species have a pointed apertural end in specimens consisting of two or three chambers only. Others seem to be rather rotund from the beginning, and it may be that these two represent different species.

Polymorphina gibba occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6454 and 6455; Vicksburg, 8240; Brandon, Miss., 7389; Leaf River, Miss., 7376; Woodward, Miss., 6648; Waynesboro, Miss., 6649.

Glendon limestone.—Vicksburg, Miss., 6446; Robinson's quarry, Miss., 6548; Tiger Hill, Miss., 7735; McGowans Bridge, Ala., 6749.

Typical Marianna limestone.—Castleberry, Ala., 6732 and 6734; Perdue Hill, Ala., 6729; Millry, Ala., 6702; St. Stephens, Ala., 6710 and 6711; Fail, Ala., 7214; Heidelberg, Miss., 6645; Tallahala Road, Ala., 7375; Brandon, Miss., 7371; Calmar, Miss., 7445.

Mint Spring calcareous marl member.—Vicksburg, Miss., 6447, 6448, and 6451; Browns Cave, Miss., 7671; Boice, Miss., 6647.

Red Bluff clay.—Hiwannee, Miss., 6456 and 8752; St. Stephens Bluff, Ala., 6713; Fail, Ala., 7213.

Polymorphina byramensis Cushman.

Plate V, figures 1–5.

Polymorphina byramensis Cushman, U. S. Geol. Survey Prof. Paper 129, pp. 94, 131, pl. 17, figs. 2a, 2b, 1922.

Test short and broad, triangular, composed of a few chambers, usually only four, all except a final fifth chamber extending back to the base of the proloculum, forming a truncate test; chambers inflated; sutures deep and distinct; surface smooth; aperture radiate, only slightly produced. Maximum length 0.75 millimeter.

This is one of the most common species in the Vicksburg, occurring at most of the stations, except in the typical Marianna limestone, in which it seems to be less abundant. The specimens are very typical. A large proportion of the specimens have three or four chambers with a triangular test, truncate at the base, the fifth chamber, if present, being added at a higher level.

Polymorphina byramensis occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6454 and 6455; Vicksburg, Miss., 7372 and 8240; Leaf River, Miss., 7376; Woodward, Miss., 6648.

Glendon limestone.—Vicksburg, Miss., 6446; Tiger Hill, Miss., 7735; Robinson's quarry, Miss., 6548; McGowans Bridge, Ala., 6749.

Typical Marianna limestone.—St. Stephens, Ala., 5609 and 5649; Castleberry, Ala., 6734; Perdue Hill, Ala., 6728; Fail, Ala., 7214; Tallahala Road, 7375.

Mint Spring calcareous marl member.—Vicksburg, Miss., 6447, 6448, 6451, and 6452; Browns Cave, Miss., 7671; Boice, Miss., 6647.

Red Bluff clay.—Hiwannee, Miss., 5264, 6456, and 8752; St. Stephens, Ala., 6712 and 6713; Fail, Ala., 7213.

Polymorphina amygdaloides Reuss.

Plate IV, figure 9; Plate V, figure 9.

Globulina amygdaloides Reuss, Deutsch. geol. Gesell. Zeitschr., vol. 3, p. 82, pl. 6, fig. 47, 1851.

Polymorphina amygdaloides Reuss, Akad. Wiss. Wien Sitzungsber., vol. 18, p. 250, pl. 8, fig. 84, 1855.

H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 560, pl. 71, fig. 13 (?), 1884.

Bagg, U. S. Nat. Mus. Proc., vol. 34, p. 148, 1908.

Cushman, U. S. Nat. Mus. Bull. 71, pt. 3, p. 85, pl. 41, fig. 5, 1913; U. S. Geol. Survey Prof. Paper 129, pp. 95, 132, pl. 18, figs. 2a, 2b, 1922.

Test elongate-oval, much compressed, composed of a few chambers which are elongate and narrow; sutures rather indistinct, not depressed; surface smooth; aperture somewhat produced. Maximum length 0.55 millimeter.

An examination of the figures referred to this species by various authors will show a very considerable range of form. It occurred in all the divisions of the Vicksburg group.

Polymorphina amygdaloides occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6455; Leaf River, Miss., 7376.

Glendon limestone.—McGowans Bridge, Ala., 6749.

Typical Marianna limestone.—Fishers Creek, Ala., 7156.

Mint Spring calcareous marl member.—Vicksburg, Miss., 6447, 6448, 6451, and 6452; Browns Cave, 7671.

Red Bluff clay.—St. Stephens, Ala., 6713.

Polymorphina equalis D'Orbigny.

Polymorphina equalis D'Orbigny, Annales sci. nat., vol. 7, p. 265, No. 13, 1826.

Cushman, U. S. Geol. Survey Prof. Paper 129, p. 132, pl. 31, fig. 3, 1922.

Polymorphina aequalis D'Orbigny, Foraminiferes fossiles du bassin tertiaire de Vienne, p. 227, pl. 13, figs. 11, 12, 1846.

Polymorphina gibba var. *aequalis* H. B. Brady, Parker, and Jones, Linnean Soc. London Trans., vol. 27, p. 216, pl. 39, figs. 2*c*, *d*, 1870.

Test compressed, broadly oval, periphery rather evenly curved, rounded, composed of few chambers; sutures distinct but very slightly depressed; wall smooth; aperture radiate. Length 0.70–0.80 millimeter.

Polymorphina equalis occurs at the following U. S. G. S. stations:

Typical Marianna limestone.—Calmar, Miss., 7445.

Mint Spring calcareous marl member.—Vicksburg, Miss., 6448 and 6451.

Polymorphina cuspidata H. B. Brady.

Polymorphina sororia var. *cuspidata* H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 563, pl. 71, figs. 17–9; pl. 72, fig. 4, 1884.

Polymorphina cuspidata Cushman, U. S. Geol. Survey Prof. Paper 129, p. 133, pl. 30, figs. 9, 10, 1922.

Test elongate, fusiform, composed of a few chambers, initial end with a prominent sharp, elongate spine, apertural end bluntly pointed, surface smooth; sutures somewhat depressed; aperture radiate. Maximum length 1.5 millimeters.

The Vicksburg specimens are very close to this form as figured by Brady in the *Challenger* report. The relation of this species to *P. sororia* Reuss seems very problematical, and I have given it specific rank. It is also represented in the Mint Spring marl member of the Marianna by the variety described below.

Polymorphina cuspidata occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Leaf River, Miss., 7376.

Mint Spring calcareous marl member.—Vicksburg, Miss., 6447.

Polymorphina cuspidata H. B. Brady var. costulata Cushman.

Polymorphina cuspidata H. B. Brady var. *costulata* Cushman, U. S. Geol. Survey Prof. Paper 129, p. 133, pl. 31, fig. 1, 1922.

Variety differing from the typical form in the surface ornamentation, which consists of a few longitudinal costae, rather widely separated from one another.

Polymorphina cuspidata var. *costulata* occurs at the following U. S. G. S. station:

Mint Spring calcareous marl member of Marianna limestone.—Vicksburg, Miss., 6452.

Polymorphina lanceolata Reuss.

Polymorphina lanceolata Reuss, Deutsch. geol. Gesell. Zeitschr., vol. 3, p. 83, pl. 6, fig. 50, 1851; K. Akad. Wiss. Wien Sitzungsber, vol. 62, p. 487, No. 12, 1870.

H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 564, pl. 72, figs. 5, 6, 1884.

Cushman, U. S. Nat. Mus. Bull. 71, pt. 3, p. 86, pl. 40, fig. 2, 1913.

Polymorphina fusiformis H. B. Brady, Parker, and Jones (part), Linnean Soc. London Trans. vol. 27, p. 219, pl. 39, figs. 5*b*, *c*, 1870.

Test elongate, compressed, cylindrical, fusiform, initial end rather acute, apertural end obtusely pointed; chambers several, smooth, elongate, tumid; sutures somewhat depressed; last-formed chamber rather more inflated; wall smooth. Length 0.75 millimeter.

Polymorphina lanceolata occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Leaf River, Miss., 7376.
Red Bluff clay.—St. Stephens, Ala., 6712.

Polymorphina problema D'Orbigny.

Plate V, figure 6.

Polymorphina (*Guttulina*) *problema* D'Orbigny, Annales sci. nat., vol. 7, p. 266, No. 14, Modèles, No. 61, 1826.
H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 568, pl. 72, fig. 20; pl. 73, fig. 1, 1884.
Cushman, U. S. Geol. Survey Prof. Paper 129, p. 94, pl. 18, fig. 1, 1922.
Guttulina problema D'Orbigny, Foraminifères fossiles du bassin tertiaire de Vienne, p. 224, pl. 12, figs. 26–28, 1846.

Test elongate, fusiform, composed of few chambers, tumid; sutures slightly depressed; apical end bluntly pointed, apertural end tapering; surface smooth; aperture radiate. Maximum length 1 millimeter.

The Vicksburgian form is not unlike that figured by Brady but is even more like recent specimens from the Philippine region, where it also attains a large size. This is by far the largest of the Byram species but is not so common as some of the others. The truncate apertural end is the usual character in both the fossil and recent material of this form. It occurred in all the divisions of the Vicksburg group.

Polymorphina problema occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6455; Vicksburg, Miss., 7372; Leaf River, Miss., 7376; Woodward, Miss., 6648.
Glendon limestone.—Vicksburg, Miss., 6446.
Typical Marianna limestone.—Fail, Ala., 7214; Tallahala Road, 7375.
Mint Spring calcareous marl member.—Vicksburg, Miss., 6452; Leaf River, Miss., 7671; Boice, Miss., 6647.
Red Bluff clay.—Hiwannee, Miss., 6456 and 8752; St. Stephens, Ala., 6713.

Polymorphina vicksburgensis Cushman.

Polymorphina vicksburgensis Cushman, U. S. Geol. Survey Prof. Paper 129, p. 133, pl. 31, fig. 2, 1922.

Test elongate, fusiform, broadest near the initial end, which is subcircular in transverse section, the later portion becoming compressed and more narrow, initial end bluntly pointed or with a short spine; chambers becoming shorter toward the apertural end in the adult; surface smooth or with very slight longitudinal costae; sutures not depressed but often standing out as clearer areas in side view; aperture radiate. Maximum length 1.5 millimeters.

This seems to be different from the other described species of this genus and may be distinguished especially by the cuspidate initial end and the peculiar change in shape from the rounded early portion to the narrow compressed last-formed portion.

Polymorphina vicksburgensis occurs at the following U. S. G. S. stations:

Mint Spring calcareous marl member of Marianna limestone.—Vicksburg, Miss., 6448 and 6451.

Polymorphina regina H. B. Brady, Parker, and Jones.

Polymorphina regina H. B. Brady, Parker, and Jones, Linnean Soc. London Trans., vol. 27, p. 241, pl. 41, figs. 32*a*, *b*, 1870.
H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 571, pl. 73, figs. 11–13, 1884.
Egger, K. bayer Akad. Wiss. München Abh., Cl. 2, vol. 18, p. 310, pl. 9, figs. 45, 50, 51, 1893.
Millett, Roy. Micr. Soc. Jour., p. 265, 1903.
Bagg, Maryland Geol. Survey, Miocene, p. 478, pl. 133, fig. 7, 1904; U. S. Nat. Mus. Proc., vol. 34, p. 149, 1908.
Chapman, Quekett Micr. Club Jour., 2d ser., vol. 10, p. 132, pl. 10, fig. 4, 1907 (1909); Roy. Soc. Victoria Proc., vol. 22, p. 281, 1910.
Cushman, U. S. Nat. Mus. Bull. 71, pt. 3, p. 91, pl. 41, figs. 6, 7, 1913; U. S. Geol. Survey Bull. 676, p. 54, pl. 11, figs. 3, 4, 1918; U. S. Nat. Mus. Proc., vol. 56, p. 619, 1919; U. S. Geol. Survey Prof. Paper 129, p. 94, pl. 18, fig. 4, 1921.
Heron-Allen and Earland, Zool. Soc. London Trans., vol. 20, p. 673, 1915.

Test elongate, fusiform; chambers tumid, distinct, especially in the later portion; sutures deep; wall ornamented by numerous longitudinal costae, usually continuing unbroken across several chambers; aperture radiate, somewhat produced. Maximum length 1 millimeter.

This is one of the species by which the foraminiferal fauna of the Vicksburg deposits of the Coastal Plain of the United States is correlated with the fauna of the Indo-Pacific region.

Polymorphina regina occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6455.

Mint Spring calcareous marl member.—Vicksburg, Miss., 6448 and 6452; Browns Cave, Miss., 7671.

Polymorphina regina H. B. Brady, Parker, and Jones var. rutila Cushman, n. var.

Plate V, figures 7, 8.

Variety differing from the typical species in the general form of the test, which is much more flattened and larger, is somewhat fusiform, and has fewer prominent, longitudinal costae. Maximum length, 0.80 millimeter.

Polymorphina regina var. *rutila* occurs at the following U. S. G. S. station:

Byram calcareous marl.—Leaf River, Miss., 7376.

Polymorphina spinosa (D'Orbigny) Egger.

Globulina spinosa D'Orbigny, Foraminifères fossiles du bassin tertiaire de Vienne, p. 230, pl. 13, figs. 23, 24, 1846.

Polymorphina spinosa Egger, Neues Jahrb., 1857, p. 292, pl. 14, figs. 9, 10.

H. B. Brady, Parker, and Jones, Linnean Soc. London Trans., vol. 27, p. 243, pl. 42, figs. 36*a*, *b*, 1870.

Cushman, U. S. Geol. Survey Prof. Paper 129, p. 133, pl. 31, fig. 5, 1922.

Test rounded, irregular; chambers few, surface covered with numerous short, projecting spines which seem to be hollow where broken. Maximum length, 1 millimeter.

The specimens that can be referred to this species are limited almost entirely to the Mint Spring marl member of the Marianna limestone and the Glendon limestone, being found elsewhere only at a single station in the Byram marl.

Polymorphina spinosa occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Leaf River, Miss., 7376.

Glendon limestone.—Vicksburg, Miss., 6446; McGowans Bridge, Ala., 6749.

Mint Spring calcareous marl member.—Vicksburg, Miss., 6447 and 6451; Browns Cave, Miss., 7671; Boice, Miss., 6647.

Genus UVIGERINA D'Orbigny, 1826.

Uvigerina pigmea D'Orbigny.

Uvigerina pigmea D'Orbigny, Annales sci. nat., vol. 7, p. 269, pl. 12, figs. 8, 9, Modèles, No. 67, 1826.

Cushman, U. S. Geol. Survey Prof. Paper 129, p. 134, pl. 32, fig. 2, 1922.

Uvigerina pygmaea D'Orbigny, Foraminifères fossiles du bassin tertiaire de Vienne, p. 190, pl. 11, figs. 25, 26, 1846.

H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 575, pl. 74, figs. 11–14, 1884.

Cushman, U. S. Nat. Mus. Bull. 71, pt. 3, p. 96, pl. 42, fig. 1; pl. 44, fig. 5, 1913; U. S. Nat. Mus. Bull. 103, p. 63, pl. 22, fig. 4, 1918; U. S. Geol. Survey Bull. 676, p. 55, 1918.

Test subcylindrical, triserially spiral; chambers numerous, inflated; sutures deep; wall ornamented by numerous longitudinal costae, those of each chamber usually independent of those of adjacent chambers; aperture with a short cylindrical neck and phialine lip. Length 0.75–1 millimeter.

Specimens that are very similar to the figures given by D'Orbigny in the Vienna Basin monograph are found in a large number of stations in all the divisions of the Vicksburg group except the Byram marl, but single specimens occur at two of the Byram marl stations.

Uvigerina pigmea occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6455; Vicksburg, Miss., 7372.

Glendon limestone.—Robinson's quarry, Miss., 6548; Vicksburg, Miss., 7735; McGowans Bridge, Ala., 6749.

Typical Marianna limestone.—Marianna, Fla., 6767; St. Stephens, Ala., 5609, 5649, 6710, and 6711; Castleberry, Ala., 6733 and 7238; Perdue Hill, Ala., 6728; Drewry, Ala., 6721; Fishers Creek, Ala., 7156; Millry, Ala., 6702; Heidelberg, Miss., 6645; Tallahala Road, Miss., 7375.

Mint Spring calcareous marl member.—Vicksburg, Miss., 6447 and 6452; Browns Cave, Miss., 7671; Boice, Miss., 6647.

Red Bluff clay.—Hiwannee, Miss., 5264, 6456, and 8752; St. Stephens, Ala., 6712, 6713, and 6714; Fail, Ala., 7213.

Uvigerina byramensis Cushman.

Plate IV, figures 10, 11.

Uvigerina byramensis Cushman, U. S. Geol. Survey Prof. Paper 129, pp. 95, 133, pl. 18, fig. 5, 1922.

Test minute, elongate, somewhat fusiform, initial end pointed; chambers numerous, dis-

tinct; sutures depressed; surface ornamented by longitudinal costae, rather thin and sharp; the last-formed chamber more distinct than the rest, the inner side concave, the other two sides slightly convex, giving a generally triangular section, the surface of the last-formed chamber smooth; the apertural end produced into a short cylindrical neck with a slight lip, the aperture circular. Length 0.25–0.40 millimeter.

In the best-developed specimens the later half of the test is composed of chambers rather remotely placed. These are triangular in section, with the flattened side toward the axis and the outer angle at the periphery. Although this species is found in all the divisions of the Vicksburg group, it occurs in its typical form mainly in the Byram marl and the Mint Spring marl member of the Marianna. In the typical Marianna limestone it develops a form which has not so many of the loosely placed chambers in the adult, and the earlier chambers are also more evenly placed at the surface.

Uvigerina byramensis occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6454 and 6455; Vicksburg, Miss., 7372 and 8240; Haynes Bluff, Miss., 7385; Leaf River, Miss., 7376; Woodward, Miss., 6648; Robinson's quarry, Miss., 6548.

Glendon limestone.—Vicksburg, Miss., 6446; McGowans Bridge, Ala., 6749.

Typical Marianna limestone.—St. Stephens, Ala., 5649 and 6710; Castleberry, Ala., 6734; Perdue Hill, Ala., 6728; Heidelberg, Miss., 6645; Tallahala Road, Miss., 7375; Brandon, Miss., 7371.

Mint Spring calcareous marl member.—Vicksburg, Miss., 6447, 6448, 6451, and 6452; Browns Cave, Miss., 7671; Boice, Miss., 6647.

Genus SIPHOGENERINA Schlumberger, 1883.

Siphogenerina irregularis (Bagg) Cushman.

Sagraina irregularis Bagg, U. S. Nat. Mus. Proc., vol. 34, p. 152, pl. 5, figs. 8–10, 1908.

Siphogenerina irregularis Cushman, U. S. Nat. Mus. Bull. 71, pt. 3, p. 109, pl. 47, figs. 6, 7, 1913.

Test elongate, subcylindrical; chambers somewhat irregular but becoming uniserial in the later-developed portion, variable as regards height of individual chambers; surface ornamented with very fine costae; wall thin and translucent, apertural end of the chamber depressed; aperture slightly excentric, with a long tubular neck and a slightly flaring lip. Maximum length 0.85 millimeter.

In the Red Bluff clay a very few specimens occur which, except for the very slight development of the surface ornamentation, are typical of this species. It is common in the region of the Hawaiian Islands at medium depths.

Siphogenerina irregularis occurs at the following U. S. G. S. station:

Red Bluff clay.—Fail, Ala., 7213.

Family GLOBIGERINIDAE.

Genus GLOBIGERINA D'Orbigny, 1826.

Globigerina bulloides D'Orbigny.

Globigerina bulloides D'Orbigny, Annales sci. nat., vol. 7, p. 277, No. 1, Modèles, Nos. 17, 76, 1826.

H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 593, pl. 77; pl. 79, figs. 3–7, 1884.

Cushman, U. S. Nat. Mus. Bull. 71, pt. 4, p. 5, pl. 2, figs. 7–9; pl. 9, 1914; Carnegie Inst. Washington Pub. 291, p. 38, 1919; U. S. Nat. Mus. Bull. 103, p. 64, 1918; U. S. Geol. Survey Bull. 676, p. 12, pl. 3, fig. 2; p. 56, pl. 3, figs. 4, 6, 1918; U. S. Geol. Survey Prof. Paper 129, pp. 95, 134, pl. 19, figs. 1–3, 1922.

Test subglobose, spiral, made up of a few inflated chambers, all visible from the dorsal side, three to four visible from the ventral side; sutures deep; surface reticulate.

Globigerina bulloides occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6454; Vicksburg, Miss., 7372; Leaf River, Miss., 7376.

Glendon limestone.—Vicksburg, Miss., 6446; Tiger Hill, 7735; McGowans Bridge, Ala., 6749.

Typical Marianna limestone.—Marianna, Fla., 7241; St. Stephens, Ala., 5609, 5649, and 6711; Castleberry, Ala., 7238; Salt Creek, Ala., 7165; Millry, Ala., 6702; Monroeville, Ala., 6716; Fail, Ala., 7214; Heidelberg, Miss., 6645; Tallahala, Miss., 7375; Brandon, Miss., 7371; Calmar, Miss., 7445.

Mint Spring calcareous marl member.—Vicksburg, Miss., 6447, 6448, 6451, and 6452; Browns Cave, Miss., 7671.

Red Bluff clay.—Hiwannee, Miss., 6456; St. Stephens, Ala., 6712, 6713, and 6714.

Globigerina triloba Reuss.

Globigerina triloba Reuss, Akad. Wiss. Wien Denkschr., vol. 1, p. 374, pl. 47, figs. 11*a–e*, 1849.

Cushman, U. S. Geol. Survey Prof. Paper 129, p. 95, 1922.

Globigerina bulloides D'Orbigny var. *triloba* H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 595, pl. 81, figs. 2, 3, 1884.

Specimens that are very similar to the species described by Reuss and figured by Brady in the references given were found at one station in the Byram marl. In all the specimens the three visible chambers make up the whole of

the exterior of the test. The walls are very thin and translucent.

Globigerina triloba occurs at the following U. S. G. S. station:

Byram calcareous marl.—Byram, Miss., 6455.

Globigerina dutertrei D'Orbigny.

Globigerina dutertrei D'Orbigny, in De la Sagra, Histoire physique, politique et naturelle de l'île de Cuba, Foraminifères, p. 95, pl. 4, figs. 19–21, 1839.
H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 601, pl. 81, figs. 1 *a–c*, 1884.
Cushman, U. S. Nat. Mus. Bull. 71, pt. 4, p. 8, 1914; U. S. Geol. Survey Prof. Paper 129, p. 134, 1922.

Test rounded, the dorsal side slightly, the ventral side more strongly convex, composed of about three whorls, the last one consisting of four to five chambers, much inflated, especially the later ones, umbilicate; aperture comparatively small, a single arched opening near the umbilical edge of the last-formed chamber. Maximum diameter 0.60 millimeter.

Specimens apparently of this species were found at the following U. S. G. S. stations:

Glendon limestone.—McGowans Bridge, Ala., 6749.
Typical Marianna limestone.—Marianna, Fla., 6767; St. Stephens, Ala., 6710; Fail, Ala., 7214.
Mint Spring calcareous marl member of Marianna.—Vicksburg, Miss., 6451; Browns Cave, Miss., 7671; Boice, Miss., 6647.
Red Bluff clay.—St. Stephens, Ala., 6712 and 6713; Hiwannee, Miss., 8752.

Genus PULLENIA Parker and Jones, 1862.

Pullenia quinqueloba (Reuss) H. B. Brady.

Nonionina quinqueloba Reuss, Deutsch. geol. Gesell. Zeitschr., vol. 3, p. 47, pl. 5, figs. 31*a*, *b*, 1851.
Pullenia quinqueloba H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 617, pl. 84, figs. 14, 15, 1884.
Balkwill and Wright, Roy. Irish Acad. Trans., vol. 28 (Science), p. 348, pl. 12, figs. 29*a*, *b*, 1885.
H. B. Brady, Parker, and Jones, Zool. Soc. Trans., vol. 12, p. 226, pl. 43, figs. 22, 23, 1888.
Goës, K. svenska Vet. Akad. Handl., vol. 25, p. 87, pl. 14, fig. 773, 1894; Mus. Comp. Zool. Bull., vol. 29, p. 68, 1896.
Flint, U. S. Nat. Mus. Rept. for 1897, p. 324, pl. 70, fig. 5, 1899.
Cushman, U. S. Nat. Mus. Bull. 71, pt. 4, p. 21, pl. 13, fig. 2, 1914.

Test bilaterally symmetrical, biconvex, composed of numerous chambers arranged in an involute coil, five chambers usually being present in each coil, compressed laterally, peripheral edge broadly rounded; surface smooth; sutures somewhat compressed; aperture a long, narrow curved slit at the base of the inner face of the chamber. Maximum diameter 0.75 millimeter.

Single specimens that seem to be distinctly this species were found at two stations in the Marianna limestone. This species was not found at any of the other divisions of the Vicksburg group. It is a widely distributed species in recent oceans and is also known from the Tertiary of Europe and perhaps also from the Upper Cretaceous.

Pullenia quinqueloba occurs at the following U. S. G. S. stations:

Typical Marianna limestone.—St. Stephens, Ala., 5649; Millry, Ala., 6702.

Family ROTALIIDAE.

Genus SPIRILLINA Ehrenberg, 1841.

Spirillina limbata H. B. Brady var. bipunctata Cushman.

Spirillina limbata H. B. Brady var. *bipunctata* Cushman, U. S. Geol. Survey Prof. Paper 129, p. 134, pl. 32, figs. 3–5, 1922.

Test very similar in general to that of *S. limbata* but differing in the character of the ornamentation, the area of the dorsal surface being ornamented in the adult of this variety by a double series of deep punctations inside the raised carina.

The species is characteristic of comparatively shallow water in the Indo-Pacific region, and this variety in the Vicksburg group is another link connecting the two areas. In the young there is usually but a single row of pits, but in the adult it becomes double.

Spirillina limbata var. *bipunctata* occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6454.
Mint Spring calcareous marl member of Marianna limestone.—Vicksburg, Miss., 6447, 6451, and 6452; Browns Cave, Miss., 7671; Boice, Miss., 6647.

Spirillina vivipara Ehrenberg.

Plate VI, figure 1.

Spirillina vivipara Ehrenberg, Akad. Wiss. Berlin Abh., p. 442, pl. 3, fig. 41, 1841.
Moebius, Beiträge zur Meeresfauna der Insel Mauritius, p. 88, pl. 8, figs. 1, 2, 1880.
H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 630, pl. 85, figs. 1–5, 1884.
Flint, U. S. Nat. Mus. Rept. for 1897, p. 326, pl. 71, fig. 4, 1899.
Millett, Roy. Micr. Soc. Jour., p. 693, 1903.
Rhumbler, Zool. Jahrb., Abt. Syst., vol. 24, p. 32, pl. 2, fig. 7, 1906.
Cushman, U. S. Nat. Mus. Bull. 71, pt. 5, p. 3, pl. 1, figs. 1, 2; fig. 1 (in text), 1915.

Test typically free, rarely adherent, planospiral, coils of early portion, at least in microspheric specimens, narrow, those of later coils much wider and of nearly uniform width, faces somewhat flattened but more often concave on both sides; sutures usually distinct and often considerably depressed; peripheral border rounded; wall marked by conspicuous perforations, irregularly scattered and most prominent on the last-formed volutions; aperture somewhat crescentic.

This species has been discussed at some length in my paper on the Tortugas shallow-water Foraminifera.[12]

Spirillina vivipara occurs at the following U. S. G. S. station:

Marianna limestone.—Castleberry, Ala., 6733.

Spirillina subdecorata Cushman.

Spirillina subdecorata Cushman, U. S. Geol. Survey Prof. Paper 129, p. 95, pl. 19, figs. 4, 5, 1922.

Test discoidal, much flattened, consisting of eight or more coils, slightly embracing, dorsal side slightly convex, ventral side strongly concave in the middle, chamber broad, the periphery with a broad, thin keel, the main surface of the chamber on the dorsal side granular, ventral side more nearly smooth; aperture at the end of the tube. Diameter about 0.5 millimeter.

This species is perhaps nearest to the Indo-Pacific species *S. decorata* H. B. Brady in its characters.

Several specimens of this same character were found in the Byram marl. One specimen is attached to a shell fragment by the ventral side.

Spirillina subdecorata occurs at the following U. S. G. S. station:

Byram calcareous marl.—Byram, Miss., 6455.

Genus PATELLINA Williamson, 1858.

Patellina advena Cushman.

Patellina advena Cushman, U. S. Geol. Survey Prof. Paper 129, p. 135, pl. 31, fig. 9, 1922.

Test plano-convex, early portion composed of chambers spirally arranged, later ones elongate and becoming nearly annular; chambers partly divided by numerous longitudinal internal septa, visible from the exterior, forming what seems to be a radiating pattern; ventral side with numerous radiating lines. Diameter 0.4 millimeter.

This species differs from *Patellina corrugata* Williamson in the much finer division by internal septa. The spire is low, making a broad, flaring test.

Patellina advena occurs at the following U. S. G. S. station:

Mint Spring calcareous marl member of Marianna limestone.—Vicksburg, Miss., 6452.

Genus DISCORBIS Lamarck, 1804.

Discorbis byramensis Cushman.

Discorbis byramensis Cushman, U. S. Geol. Survey Prof. Paper 129, p. 96, pl. 19, figs. 6–8, 1922.

Test pyramidal, low, octagonal, ventral surface slightly concave, peripheral margin subacute; eight chambers in each of the four or more coils, their margins uniting to form a series of eight ribs extending radially from the apex of the test to the periphery, the lateral sutures much less distinct, surface between the ridges concave but smooth; ventral surface composed of numerous radiating rounded costae broken up transversely to form a beaded surface; umbilical area hollow; aperture at the base of the last-formed chamber. Diameter 0.35–0.40 millimeter, height 0.10 millimeter.

Since the original publication of this species it has been found at several other stations in the Byram marl. It is very constant in its characters. It seems to be most nearly related to *D. corrugata* Millett, originally described from specimens collected in the Malay Archipelago and later recorded by Heron-Allen and Earland from the Kerimba Archipelago, off the eastern coast of Africa. *D. corrugata* differs from the Byram specimens, having but half the number of chambers to a coil and being much higher in proportion. The specimens from Kerimba show the line of the sutures, which is not apparent in the Malay specimens. Other records given by Heron-Allen and Earland are Sandoway, on the Arakan coast of Burma, and Rottnest Island, Western Australia, showing that it has a wide Indo-Pacific range. The characters of the ventral surface in both of these species show that they are related to *D. patelliformis* H. B. Brady and *D. tabernacularis* H. B. Brady, both of which are typical Indo-Pacific species and the first of

[12] Carnegie Inst. Washington Pub. 311, p. 37, 1922.

which is also found in the Vicksburg group of the Coastal Plain of the United States.

D. byramensis is another one of the species that very definitely connect the Vicksburg group of our Coastal Plain with the present fauna of the Indo-Pacific.

Discorbis byramensis occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6454 and 6455; Vicksburg, Miss., 6449 and 8240.

Discorbis patelliformis (H. B. Brady) Cushman.

Plate VI, figures 2–4.

Discorbina patelliformis H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 647, pl. 88, figs. 3*a–c;* pl. 89, figs. 1*a–c*, 1884.

Egger, K. bayer. Akad. Wiss. München Abh., Cl. 2, vol. 18, p. 390, pl. 15, figs. 48–50, 1893.

Rhumbler, Zool. Jahrb., Abt. Syst., vol. 24, p. 68, 1906.

Discorbis patelliformis (H. B. Brady) Cushman, U. S. Nat. Mus. Bull. 71, pt. 5, p. 17, pl. 5, fig. 5; fig. 19 (in text), 1915.

Test free, superior side conical, inferior flat, peripheral edge acute; in the adult state composed of fully three convolutions, of which the outermost has from five to seven segments; segments in their superior aspect long and narrow, the sutures and margin marked by broad lines of clear shell substance but not limbate externally, superior surface smooth, inferior ornamented either with faint riblets radiating from the umbilicus or with lines of closely set granules, sometimes with larger tubercles near the center. Diameter about 0.36 millimeter.

Specimens in the Vicksburg group, from both the Byram marl and the Mint Spring marl member of the Marianna limestone, seem identical with this species, described by Brady from material obtained in comparatively shallow water among the islands of the Pacific and recorded also from Ceylon, Madagascar, Mauritius, and the Mediterranean.

Discorbis patelliformis occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Vicksburg, Miss., 8240; Leaf River, Miss., 7376.

Mint Spring calcareous marl member.—Vicksburg, Miss., 6451.

Discorbis bertheloti (D'Orbigny) Cushman.

Rosalina bertheloti D'Orbigny, in Barker, Webb, and Berthelot, Histoire naturelle des îles Canaries, vol. 2, pt. 2, Foraminifères, p. 135, pl. 1, figs. 28–30, 1839.

Discorbina bertheloti (D'Orbigny), H. B. Brady, Linnean Soc. London Trans., vol. 24, p. 469, pl. 48, figs. 10*a, b*, 1864; *Challenger* Rept., Zoology, vol. 9, p. 650, pl. 89, figs. 10–12, 1884.

Discorbis bertheloti (D'Orbigny) Cushman, U. S. Nat. Mus. Bull. 71, pt. 5, p. 20, pl. 7, fig. 3, 1915; U. S. Geol. Survey Bull. 676, p. 58, pl. 15, figs. 1–3, 1918; U. S. Geol. Survey Prof. Paper 129, p. 135, pl. 32, fig. 7, 1922.

Test unequally biconvex, usually six to seven chambers in the last-formed coil, dorsal side usually flattened, ventral side more convex; sutures curved, fairly distinct on both sides, occasionally slightly limbate; aperture usually extending into the dorsal side so that a portion of the aperture is peripheral. Diameter 0.80 millimeter or less.

The only specimens of this species in the Vicksburg group were obtained from the Mint Spring marl member of the Marianna limestone. I have also recorded it from the Miocene of the Coastal Plain in the Choctawhatchee marl 1 mile south of Red Bay, Fla.; in the Duplin marl (?) of South Carolina (locality unknown); and in the Yorktown formation at Suffolk, Va.

Discorbis bertheloti occurs at the following U. S. G. S. stations:

Mint Spring calcareous marl member.—Vicksburg, Miss., 6451 and 6452.

Discorbis auracana (D'Orbigny) Cushman.

Rosalina auracana D'Orbigny, Voyage dans l'Amérique méridionale, Foraminifères, p. 44, pl. 6, figs. 16–18, 1839.

Discorbina auracana (D'Orbigny) Parker and Jones, Geol. Soc. London Quart. Jour., vol. 28, p. 115, 1872.

H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 645, pl. 86, figs. 10, 11, 1884.

Discorbis auracana (D'Orbigny) Cushman, U. S. Nat. Mus. Bull. 71, pt. 5, p. 15, pl. 9, fig. 3; fig. 15 (in text), 1915; U. S. Geol. Survey Prof. Paper 129. p. 135, pl. 32, fig. 6, 1922.

Test small, plano-convex, dorsal side slightly convex, ventral side flat or slightly concave, peripheral margin rather acutely rounded; chambers six to nine in the last-formed whorl;

sutures slightly depressed, often limbate with clear shell material; early chambers often carinate with similar material; wall finely punctate; aperture a narrow curved slit at the margin of the ventral side of the chamber; color brownish, especially in the earlier chambers. Diameter 0.30–0.50 millimeter.

There are but a few specimens that can be referred to this species, and these may not be identical. The sutures are limbate, and on the ventral side the last-formed chamber develops a projecting lip above the aperture.

Discorbis auracana occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Vicksburg, Miss., 8240.
Mint Spring calcareous marl member of Marianna limestone.—Vicksburg, Miss., 6447.
Red Bluff clay.—St. Stephens, Ala., 6713.

Discorbis orbicularis (Terquem) Berthelin.

Rosalina orbicularis Terquem, Essai sur la classement des animaux sur la plage de Dunkerque, p. 75, pl. 9, figs. 4*a*, *b*, 1876.
Discorbis orbicularis (Terquem) Berthelin, Liste des foraminifères de Borgneuf et Pornichet, p. 39, No. 63, 1878.
Cushman, U. S. Nat. Mus. Bull. 71, pt. 5, p. 16, pl. 11, fig. 1; figs. 18*a–c* (in text), 1915; U. S. Geol. Survey Prof. Paper 129, p. 96, pl. 19, figs. 9, 10, 1922.
Discorbina orbicularis (Terquem) H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 647, pl. 88, figs. 4–8, 1884 (and numerous subsequent authors).

The collections include specimens from both the Byram marl and the Marianna limestone of a broad, flat, scalelike *Discorbis* which are referred to this species of Terquem. The number of chambers is less than in the usual form of typical *D. orbicularis*, and a further examination may show that this Vicksburg species is distinct.

Discorbis orbicularis occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6454 and 6455; Vicksburg, Miss., 8240.
Marianna limestone.—Castleberry, Ala., 6733; Salt Mountain, Ala., 3296.

Discorbis eximius Cushman, n. sp.

Test rotaliform, thin, dorsally convex, ventrally concave, composed of about three coils; chambers numerous, 14 or more in the last-formed coil, the dorsal side with chambers somewhat concave; sutures limbate, projecting, with a decided angle toward the periphery of the test, which is acute and carinate, ventral side umbilicate. Diameter 0.40 millimeter.

This is a beautifully sculptured species, especially on the dorsal side, and with its very numerous chambers and peculiar oblique sutures it is easily distinguished from other species which occur in the Vicksburg group.

Discorbis eximius occurs at the following U. S. G. S. station:

Byram calcareous marl.—Byram, Miss., 6454.

Discorbis sp.?

Plate VI, figures 5, 6.

A rather rare species is here figured. It is unlike the other species described but should be recorded for future reference.

Discorbis sp.? occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Vicksburg, Miss., 8240.
Marianna limestone.—Perdue Hill, Ala., 6728.

Genus PLANORBULINA D'Orbigny, 1826.

Planorbulina larvata Parker and Jones.

Plate VI, figures 7, 8.

Planorbulina vulgaris D'Orbigny var. *larvata* Parker and Jones, Annals and Mag. Nat. Hist., 3d ser., vol. 5, p. 294, 1860.
Planorbulina larvata Parker and Jones, Philos. Trans., vol. 155, p. 379, pl. 19, figs. 3a, b, 1865.
H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 658, pl. 92, figs. 5, 6, 1884.
Heron-Allen and Earland, Zool. Soc. London Trans., vol. 20, p. 706, 1915.
Cushman, U. S. Nat. Mus. Bull. 71, pt. 5, p. 27, pl. 8, fig. 2; fig. 30 (in text), 1915.

Test typically attached, discoidal; chambers of the central portion hidden by the development of thick granules or tubercles on the test, which make the sutures indistinct; peripheral chambers arranged in annular rings, distinct; sutures somewhat depressed; apertures lipped. Maximum diameter 3 millimeters.

This species is typical of coral-reef conditions in the general Indo-Pacific region. It does not occur, so far as is known, in the West Indies at the present time. Its discovery in very typical form in all the divisions of the Vicksburg group except the Red Bluff clay is very interesting, as it forms another of the links connecting this fauna with the recent fauna of the Pacific.

Planorbulina larvata occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Vicksburg, Miss., 8240.
Glendon limestone.—Vicksburg, Miss., 6446; Tiger Hill, Miss., 7735.

Typical Marianna limestone.—Castleberry, Ala., 6734; Millry, Ala., 6702; Fail, Ala., 7214; Tallahala Road, Miss., 7375; Brandon, Miss., 7371.

Mint Spring calcareous marl member.—Vicksburg, Miss., 6452; Browns Cave, Miss., 7671.

Genus TRUNCATULINA D'Orbigny, 1826.

Truncatulina lobatula (Walker and Jacob) D'Orbigny.

Nautilus lobatula Walker and Jacob, Adams's Essays on the microscope, Kanmacher's ed., p. 642, pl. 14, fig. 36, 1798.

Truncatulina lobatula (Walker and Jacob) D'Orbigny, in Barker, Webb, and Berthelot, Histoire naturelle des îles Canaries, vol. 2, pt. 2, Foraminifères, p. 134, pl. 2, figs. 22–24, 1839; Foraminifères fossiles du bassin tertiaire de Vienne, p. 168, pl. 9, figs. 18–23, 1846.

H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 660, pl. 92, fig. 10; pl. 93, fig. 1, 1884.

Cushman, U. S. Geol. Survey Bull. 676, p. 16, pl. 1, fig. 10; p. 60, pl. 17, figs. 1–3, 1918; Carnegie Inst. Washington Pub. 291, p. 41, 1919; U. S. Geol. Survey Prof. Paper 129, pp. 96, 135, pl. 20, figs. 1–3, 1922.

Test plano-convex, flattened on the ventral face, moderately convex dorsally, peripheral margin rounded; chambers numerous, seven or eight in the last-formed whorl; sutures depressed, especially on the dorsal face; wall smooth, punctate.

Although referred to this species the specimens are not all typical, most of them having the last-formed coil at an angle with the earlier ones, giving a somewhat concave form to the dorsal surface of the test. In some of the specimens this is very strongly marked. It is one of the most common species in the Vicksburg group, occurring in all the divisions and at most of the stations. It has been recorded from the Pliocene Waccamaw formation at Cronley, N. C., from various Miocene formations in Maryland, Virginia, South Carolina, and Florida, and from the Miocene of Santo Domingo.

Truncatulina lobatula occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6454 and 6455; Vicksburg, Miss., 8240; Leaf River, Miss., 7376; Plain, Miss., 7373*a*; Woodward, Miss., 6648; Waynesboro, Miss., 6649.

Glendon limestone.—Vicksburg, Miss., 6446; Robinson's quarry, Miss., 6548; Tiger Hill, Miss., 7735; McGowans Bridge, Ala., 6749.

Typical Marianna limestone.—Marianna, Fla., 6767 and 7241; St. Stephens Bluff, Ala., 5649; Castleberry, Ala., 6732, 6733, and 7238; Perdue Hill, Ala., 6728; Fishers Creek, Ala., 7156; Millry, Ala., 6702; St. Stephens, Ala., 5609, 6710, and 6711; Heidelberg, Miss., 6645; Tallahala Road, Miss., 7375; Brandon, Miss., 7371; Calmar, Miss., 7445.

Mint Spring calcareous marl member of Marianna limestone.—Vicksburg, Miss., 6448, 6451, and 6452; Browns Cave, Miss., 7671; Boice, Miss., 6647.

Red Bluff clay.—Hiwannee, Miss., 6456; St. Stephens, Ala., 6712 and 6713; Fail, Ala., 7213.

Truncatulina pseudoungeriana Cushman.

Truncatulina ungeriana H. B. Brady *Challenger* Rept., Zoology, vol. 9, pl. 94, figs. 9*a–c*, 1884 (not *Rotalina ungeriana* D'Orbigny).

Cushman, U. S. Nat. Mus. Bull. 103, p. 69, pl. 24, fig. 1, 1918.

Truncatulina pseudoungeriana Cushman, U. S. Geol. Survey Prof. Paper 129, pp. 97, 136, pl. 20, fig. 9, 1922.

Test almost equally biconvex, periphery subacute; chambers nine to eleven in the last-formed whorl, those of the earlier whorls not showing on either the ventral or the dorsal side, being hidden on the dorsal side by the roughness of the surface and on the ventral side by the involute character; periphery lobulate; sutures distinct above the last whorl and very distinct below, as they are somewhat tumid on the ventral side; umbilical region filled nearly flush with the chambers by clear shell material, last few chambers on the dorsal side slightly above the surface on the inner margin; surface dorsally with coarse punctae, below smooth and more finely punctate; aperture at the periphery. Diameter 1 millimeter or less.

In the Vicksburg group the same form appears that is figured by Brady as *T. ungeriana*. Brady says of his figure "The drawing (pl. 94, fig. 9) is not a good illustration of the species, the specimen being relatively thicker and altogether more stoutly built than the typical form." A comparison of Brady's figure with that of D'Orbigny in the Vienna Basin monograph will show the numerous differences in the two. Brady does not give the locality for the specimen from which the drawing was made, but I have seen identical material from the Philippine and Australian regions. The occurrence of this same form in the lower Oligocene seems to show that the species is distinct and that discrimination will show it to have a definite geographic range in the present ocean. Material I have referred to *T. ungeriana* from the later Oligocene Culebra formation of the Canal Zone may be this species.

This is a very common species in all the divisions of the Vicksburg group and occurs in great numbers at some of the stations.

Truncatulina pseudoungeriana occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6454 and 6455; Vicksburg, Miss., 7372 and 8240; Plain, Miss., 7373*a*; Woodward, Miss., 6648.

Glendon limestone.—Tiger Hill, Miss., 7735; McGowans Bridge, Ala., 6749.

Typical Marianna limestone.—Marianna, Fla., 6767 and 7241; St. Stephens, Ala., 5649; Castleberry, Ala., 6732 and 7238; Perdue Hill, Ala., 6728; Fishers Creek, Ala., 7156; Millry, Ala., 6702; Monroeville, Ala., 6716; St. Stephens Bluff, Ala., 5609, 6710, and 6711; Fail, Ala., 7214; Heidelberg, Miss., 6645; Tallahala Road, Miss., 7375.

Mint Spring calcareous marl member of Marianna.—Vicksburg, Miss., 6447 and 6451; Browns Cave, Miss., 7671; Boice, Miss., 6647.

Red Bluff clay.—Hiwannee, Miss., 5264 and 6456; St. Stephens, Ala., 6712, 6713, and 6714; Fail, Ala., 7213.

Truncatulina vicksburgensis Cushman.

Truncatulina vicksburgensis Cushman, U. S. Geol. Survey Prof. Paper 129, p. 136, pl. 35, figs. 7, 8, 1922.

Test plano-convex, dorsal side with the sutures very obscure, low-spired, periphery subacute, ventral side with a central raised area and the inner angle of each chamber ending in a raised knob, ventral side of the chambers somewhat irregularly granular, especially toward the inner margin, otherwise the chambers are not distinct from one another. Diameter 0.50–0.60 millimeter.

This differs from the other species of the genus found in the Vicksburg group, in its form, its indistinct chambers, and the peculiar ornamentation of the ventral side.

Truncatulina vicksburgensis occurs at the following U. S. G. S. station:

Mint Spring calcareous marl member of Marianna limestone.—Vicksburg, Miss., 6448.

Truncatulina byramensis Cushman.

Truncatulina byramensis Cushman, U. S. Geol. Survey Prof. Paper 129, pp. 96, 136, pl. 20, figs. 4–6, 1922.

Test plano-convex, dorsal side slightly convex, ventral side flattened, peripheral margin subcarinate; about eight chambers in the last-formed whorl, chambers on the ventral side failing to reach the center of the test, leaving a definite umbilical area which is filled with clear shell material; on the dorsal side each chamber at its inner border has the angles somewhat produced and a broad, rounded reentrant near the middle; on the ventral side the inner half of the chamber is rather intricately lobed, the chambers themselves of lighter color; the sutures darker, of clear shell material; surface finely granular; aperture an elongate opening at the base of the last-formed chamber near its inner ventral border. Diameter 0.35–0.75 millimeter.

In the form of the lobed chambers this species is related to two Miocene species which I have described—*T. basiloba*, from South Carolina, and *T. concentrica*, from the Choctawhatchee marl of Florida. In the peculiar labyrinthic form of the chamber it is not unlike some forms of *Pulvinulina elegans* D'Orbigny, but in the shape of the test, chambers, and aperture it is different. This species was originally described from specimens found in the Byram marl, but it occurs in all the divisions of the Vicksburg group except the Red Bluff clay.

Truncatulina byramensis occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6454 and 6455; Vicksburg, Miss., 6449, 7372, and 8240; Leaf River, Miss., 7376.

Glendon limestone.—Vicksburg, Miss., 6446.

Typical Marianna limestone.—Marianna, Fla., 6767; Castleberry, Ala., 6733, 6734, and 7238; Perdue Hill, Ala., 6728; St. Stephens, Ala., 5609, 6710, and 6711.

Mint Spring calcareous marl member.—Vicksburg, Miss., 6447, 6448, and 6451.

Truncatulina americana Cushman.

Truncatulina americana Cushman, U. S. Geol. Survey Bull. 676, p. 63, pl. 20, figs. 2, 3; pl. 21, fig. 1, 1918; U. S. Nat. Mus. Bull. 103, p. 68, pl. 23, figs. 2*a–c*, 1918; U. S. Geol. Survey Prof. Paper 129, p. 97, pl. 20, figs. 7, 8, 1922.

Test plano-convex, dorsal side nearly flat, ventral side slightly convex; chambers numerous, ten to fifteen in the last-formed coil, rather rapidly increasing in size, peripheral margin subangular, dorsal side with the last few chambers failing to meet the umbilicus, ventral side similar in this respect in most specimens; sutures distinct, slightly limbate on the dorsal side, depressed on the ventral side; wall smooth, punctate; aperture peripheral with a slight lip. Diameter 0.75 millimeter or less.

This species is common in the Vicksburg group, occurring in all the divisions except the Mint Spring marl member of the Marianna limestone. It is known also from the Miocene

of various American deposits and from the upper Oligocene of the Canal Zone.

Truncatulina americana occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6454 and 6455; Vicksburg, Miss., 6449, 7372, and 8240; Waynesboro, Miss., 6649.

Glendon limestone.—Vicksburg, Miss., 6446; McGowans Bridge, Ala., 6749.

Typical Marianna limestone.—St. Stephens, Ala., 5649; Castleberry, Ala., 6732, 6733, and 7238; Fail, Ala., 7214; Tallahala Road, Miss., 7375; Brandon, Miss., 7371; Calmar, Miss., 7445; Monroeville, Ala., 6716.

Red Bluff clay.—Hiwannee, Miss., 6456; St. Stephens, Ala., 6712 and 6713.

Truncatulina americana Cushman var.

Truncatulina americana Cushman var., U. S. Geol. Survey Prof. Paper 129, p. 136, 1922.

A variety differing from the typical species in the broader form.

Truncatulina americana var. occurs at the following U. S. G. S. stations:

Mint Spring calcareous marl member.—Vicksburg, Miss., 6447, 6448, 6451, and 6452.

Truncatulina wuellerstorfi (Schwager) H. B. Brady.

Anomalina wuellerstorfi Schwager, *Novara*-Exped., Geol. Theil, vol. 2, p. 258, pl. 7, figs. 105, 107, 1866.

Truncatulina wuellerstorfi (Schwager) H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 662, pl. 93, figs. 8, 9, 1884.

Cushman, U. S. Nat. Mus. Bull. 71., pt. 5, p. 34, pl. 12, fig. 3, fig. 36 in text, 1915.

Planorbulina wuellerstorfi (Schwager) Goës, K. svenska Vet. Akad. Handl., vol. 25, No. 9, p. 89, pl. 15, fig. 777, 1894.

Test usually free, much compressed, dorsal side slightly convex, ventral side flattened; chambers numerous, elongate, curved, nine or ten in the last-formed coil; sutures limbate; periphery usually bluntly rounded; wall very coarsely punctate; aperture a curved, arched opening at the periphery of the chamber. Maximum diameter 1.40 millimeters.

A very few specimens from the Marianna and Glendon limestones appear to belong to this species, although they are not typical.

Truncatulina wuellerstorfi occurs at the following U. S. G. S. stations:

Marianna limestone.—Millry, Ala., 6702.

Glendon limestone.—Robinson's quarry, Miss., 6548.

Genus SIPHONINA Reuss, 1849.

Siphonina advena Cushman.

Siphonina advena Cushman, U. S. Geol. Survey Prof. Paper 129, pp. 98, 137, pl. 22, figs. 1, 2, 1922.

Test unequally biconvex, dorsal side usually less convex than the ventral; periphery subacute; chambers in three or more coils, four chambers making up the last-formed coil; sutures distinct, on the dorsal side flush with the surface, on the ventral side slightly depressed, on the dorsal side somewhat broadened and limbate, ventrally narrow; surface smooth but punctate; aperture with a short neck, compressed, with a phialine lip and elliptical aperture; color even in the fossil specimens somewhat brownish; wall thin and translucent. Maximum diameter 0.50 millimeter.

This is one of the most abundant species of the Vicksburg group, occurring at most of the stations in all the divisions and commonly in very considerable numbers. It is most closely related to *S. pulchella* Cushman, from the Miocene of Yumuri River gorge, near Matanzas, Cuba, but differs in the size and shape of the chambers and the character of the sutures.

Siphonina advena occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6454 and 6455; Vicksburg, Miss,, 6449, 7372, and 8240; Leaf River, Miss. 7376; Plain, Miss., 7373*a*; Woodward, Miss., 6648.

Glendon limestone.—Vicksburg, Miss., 6446; Tiger Hill, Miss., 7735; McGowans Bridge, Ala., 6749.

Typical Marianna limestone.—Marianna, Fla., 6767 and 7241; St. Stephens, Ala., 5609, 5649, 6710, and 6711; Castleberry, Ala., 6732, 6733, 6734, and 7328; Perdue Hill, Ala., 6728; Fishers Creek, Ala., 7156; Millry, Ala., 6702; Fail, Ala., 7214; Heidelberg, Miss., 6645; Tallahala Road, 7375; Brandon, Miss., 7371; Calmar, Miss., 7445.

Mint Spring calcareous marl member.—Vicksburg, Miss., 6447, 6448, 6451, and 6452; Browns Cave, Miss., 7671; Boice, Miss., 6647.

Red Bluff clay.—Hiwannee, Miss., 6456; St. Stephens Ala., 6712, 6713, and 6714; Fail, Ala., 7213.

Genus ANOMALINA D'Orbigny, 1826.

Anomalina bilateralis Cushman.

Anomalina bilateralis Cushman, U. S. Geol. Survey Prof. Paper 129, pp. 97, 137, pl. 21, figs. 1, 2, 1922.

Test of about four coils, bilateral or nearly so, composed of numerous chambers, ten or

more in the last-formed whorl, umbilical region on both sides with a knob of clear shell material, more pronounced on the dorsal side; chambers smooth but coarsely punctate, more coarsely so on the ventral side; sutures broad and somewhat limbate with clear shell material; aperture a narrow curved opening at the base of the final chamber. Maximum diameter, 1 millimeter.

This species is close to *A. ammonoides* Reuss but differs from that species as figured by Reuss. It is very close to the form figured in the *Challenger* report by Brady (pl. 94, fig. 2). Brady's records were almost entirely from the south Pacific, and it may be predicted that a study of the rather shallow-water material from that region will show that the species there is closely related to this from the Byram marl if not identical with it. Reuss's original material was from the Cretaceous of Europe. A critical study of the various figures assigned to *A. ammonoides* will show that there are several forms under the one name.

This has proved to be a common species in all the divisions of the Vicksburg group.

Anomalina bilateralis occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6454 and 6455; Vicksburg, Miss., 7372; Leaf River, Miss., 7376; Woodward, Miss., 6648.

Glendon limestone.—McGowans Bridge, Ala., 6749.

Typical Marianna limestone.—St. Stephens, Ala., 5609, 5649, and 6710; Castleberry, Ala., 6733, 6734, and 7238; Fisher's Creek, Ala., 7156; Fail, Ala., 7214; Heidelberg, Miss., 6645; Tallahalla Road, Miss., 7375; Brandon, Miss., 7371.

Mint Spring calcareous marl member.—Vicksburg, Miss., 6448 and 6451; Browns Cave, Miss., 7671; Boice, Miss., 6647.

Red Bluff clay.—Hiwannee, Miss., 6456; St. Stephens, Ala., 6712 and 6713; Fail, Ala., 7213.

Anomalina mississippiensis Cushman.

Anomalina mississipiensis Cushman, U. S. Geol. Survey Prof. Paper 129, pp. 98–137, pl. 21, figs. 6–8, 1922.

Test small, plano-convex, of about two and one-half coils, periphery slightly lobulate, bluntly rounded, dorsal side very much flattened, even slightly concave, ventral side very convex; chambers comparatively few, six to eight in the last-formed coil; sutures curved, on the dorsal side broad and limbate, even with the surface of clear shell material, on the ventral side narrower and depressed; the last-formed two or three chambers on the inner margin on the dorsal side slightly above the general surface; wall thin and translucent, especially on the dorsal side, smooth, on the ventral finely punctate and not so clear; aperture a curved opening at the inner margin at the periphery. Length 0.25–0.35 millimeter, breadth 0.20–0.30 millimeter.

This small species occurs in all the divisions of the Vicksburg group, most abundantly in the upper ones and rarely in the Red Bluff clay. It is very constant in its characters and in some respects it has affinities with *Truncatulina americana* Cushman, and in others with *Anomalina grosserugosa* (Gümbel) Brady? var., but it is very distinct from either.

Anomalina mississippiensis occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6454 and 6455; Vicksburg, Miss., 6449, 7372, and 8240.

Glendon limestone.—Vicksburg, Miss., 6446; Tiger Hill, Miss., 7735; McGowans Bridge, Ala., 6749.

Typical Marianna limestone.—Marianna, Fla., 6767; St. Stephens, Ala., 5649 and 6710; Castleberry, Ala., 6728, 6732, and 7238; Fishers Creek, Ala., 7156; Millry, Ala., 6702; Fail, Ala., 7214; Heidelberg, Miss., 6645; Tallahala Road, Miss., 7375; Brandon, Miss., 7371.

Mint Spring calcareous marl member.—Vicksburg, Miss., 6447, 6448, 6451, and 6452; Browns Cave, Miss., 7671; Boice, Miss., 6647.

Red Bluff clay.—St. Stephens, Ala., 6712 and 6713.

Anomalina vicksburgensis Cushman.

Anomalina vicksburgensis Cushman, U. S. Geol. Survey Prof. Paper 129, p. 137, pl. 35, figs. 5, 6, 1922.

Test equally biconvex, dorsal side more flattened than the ventral; chambers numerous, 10 to 12 in the last-formed coil; sutures slightly limbate; periphery rounded, not lobulate; wall between the sutures finely granular or punctate, ventral side with a clear mass of shell material at the umbilicus. Diameter 0.35 millimeter.

This is a peculiar species of the genus and is rare, having been found at but one station.

Anomalina vicksburgensis occurs at the following U. S. G. S. station:

Mint Spring calcareous marl member.—Vicksburg, Miss., 6452.

Anomalina grosserugosa (Gümbel) Brady?

A form in the Byram calcareous marl may questionably be referred to this species. It is very close to the form figured by Brady in the *Challenger* report (pl. 94, fig. 4), which is very different from the original of Gümbel, as a comparison of the two will show.

Millett records this species with *A. ammonoides* as widely distributed in the Malay Archipelago, and as both are recorded from a number of stations off the Hawaiian Islands, a review of tropical Pacific material should be made to see just what forms are really present there.

Anomalina grosserugosa (?) occurs at the following U. S. G. S. station:

Byram calcareous marl.—Byram, Miss., 6455.

Genus PULVINULINA Parker and Jones, 1862.

Pulvinulina byramensis Cushman.

Pulvinulina byramensis Cushman, U. S. Geol. Survey Prof. Paper 129, pp. 99, 138, pl. 22, figs. 4, 5, 1922.

Test small, biconvex, rotaliform, consisting of about three coils, seven to eight chambers in the last-formed one; on the dorsal side sutures oblique and at a considerable angle with the periphery, somewhat limbate; on the ventral side the chambers extend in to the center, which is usually not umbilicate; sutures nearly straight; surface polished, punctations appearing as light tubules against the translucent wall; aperture near the inner end of the chamber on the ventral side, with a definite valvular lip, the aperture hidden below but when examined found to be composed, in the adult, of several adjacent small rounded openings. Maximum diameter 1.5 millimeters.

This species, which was originally described from the Byram marl collections, has been found in all the divisions of the Vicksburg group, but most abundantly in the Red Bluff clay and the Mint Spring marl member of the Marianna limestone. It is related to species of the genus found in the comparatively shallow water of the general Indo-Pacific region and may be identical with some of those forms which are now passing under various names.

Pulvinulina byramensis occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6454 and 6455; Vicksburg, Miss., 6449, 7372, and 8240; Leaf River, Miss., 7376; Woodward, Miss., 6648.

Glendon limestone.—Vicksburg, Miss., 6446; Tiger Hill, Miss., 7735; McGowans Bridge, Ala., 6749.

Typical Marianna limestone.—Marianna, Fla., 6767; Castleberry, Ala., 6732 and 7238; Perdue Hill, Ala., 6728; Fishers Creek, Ala., 7156; St. Stephens, Ala., 6710; Fail, Ala., 7214; Heidelberg, Miss., 6645; Tallahala Road, 7375; Brandon, Miss., 7371.

Mint Spring calcareous marl member.—Vicksburg, Miss., 6447, 6448, 6451, and 6452; Browns Cave, Miss., 7671; Boice, Miss., 6647.

Red Bluff clay.—Hiwannee, Miss., 5264 and 6456; St. Stephens, Ala., 6712, 6713, and 6714; Fail, Ala., 7213.

Pulvinulina mariannensis Cushman, n. sp.

Plate VII, figures 1–3.

Test unequally biconvex, the dorsal side nearly flat; chambers with a keel and slightly limbate sutures, obliquely curved, ventral side somewhat convex, sutures deeply depressed, with a deep umbilical central opening; aperture elongate at the base at the inner margin of the last-formed chamber; surface smooth. Maximum diameter 1.5 millimeters.

This species is found only in the Marianna limestone, but it occurs at several stations, and the specimens have rather constant characters. The main variation seems to be in the convexity of the ventral side of the test. In some of the specimens that have a very convex form the inner side of the chambers shows numerous wrinkled lines.

Pulvinulina mariannensis occurs at the following U. S. G. S. stations:

Typical Marianna limestone.—Marianna, Fla., 6767; Castleberry, Ala., 6732 and 7238; Perdue Hill, Ala., 6728; Fishers Creek, Ala., 7156; St. Stephens, Ala., 5609 and 6710.

Pulvinulina advena Cushman.

Pulvinulina advena Cushman, U. S. Geol. Survey Prof. Paper 129, p. 99, pl. 22, fig. 8, 1922.

Test minute, plano-convex, composed of two and a half coils, periphery deeply lobulate; chambers few, elongate, broadest at the outer end, six to seven in the last-formed whorl, periphery of the chambers somewhat tubulate, remainder of surface slightly papillose on the dorsal side, which is flat, ventral side with each chamber more tumid; sutures depressed and distinct, the surface granulose with coarse, almost spinose projections, chambers continuing in to the umbilicus, where they meet; aperture near the periphery of the test at the base of the last-formed chamber. Diameter 0.20 millimeter.

Pulvinulina advena occurs at the following U. S. G. S. station:

Byram calcareous marl.—Byram, Miss., 6455.

Pulvinulina menardii (D'Orbigny) Owen.

Rotalia menardii D'Orbigny, Annales sci. nat., vol. 7, p. 273, No. 26, Modèles, No. 10, 1826.

Pulvinulina menardii (D'Orbigny) Owen, Linnean Soc. London Jour. (Zoology), vol. 9, p. 148, pl. 5, fig. 6, 1867.

H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 690, pl. 103, figs. 1, 2, 1884.

H. B. Brady, Parker, and Jones, Zool. Soc. London Trans., vol. 12, p. 228, pl. 46, fig. 3, 1888.

Flint, U. S. Nat. Mus. Rept. for 1897, p. 329, pl. 73, fig. 3, 1899.

Cushman, U. S. Nat. Mus. Bull. 71, pt. 5, p. 55, pl. 22, fig. 2, 1915.

Test plano-convex, compressed, dorsal side slightly convex, ventral side flat or somewhat concave, umbilicate; peripheral margin thin, slightly lobulate, carinate; chambers usually six in the last-formed coil; sutures somewhat depressed, especially below, on the dorsal side limbate and curved, ventrally simply depressed, straight, in a radial position; wall usually smooth and punctate but sometimes slightly granular; aperture a rather well developed opening at the umbilical end of the chamber, with a projecting valvular lip. Maximum diameter 1.27 millimeters.

A few specimens that can be referred to this species occurred at a single station in the Marianna limestone. At the present time it is one of the most widely distributed of all the Foraminifera.

Pulvinulina menardii occurs at the following U. S. G. S. station:

Typical Marianna limestone.—Salt Mountain, Ala., 3296.

Pulvinulina sagra (D'Orbigny) Cushman.

Plate VI, figures 9, 10.

Rotalina sagra D'Orbigny, in De la Sagra, Histoire physique, politique et naturelle de l'île de Cuba, Foraminifères, p. 77, pl. 5, figs. 13–15, 1839.

Pulvinulina sagra (D'Orbigny) Cushman, U. S. Geol. Survey Bull. 676, p. 65, pl. 22, fig. 3; pl. 23, fig. 1, 1918; U. S. Nat. Mus. Bull. 103, p. 70, pl. 24, figs. 6*a*, *b*, 1918; Carnegie Inst. Washington Pub. 291, p. 44, 1919.

Test longer than broad, biconvex, the ventral side more convex than the dorsal; chambers few, six to seven in the last-formed coil, increasing rapidly in size as added; sutures slightly if at all depressed on the dorsal side, ventral side decidedly depressed; chambers slightly carinate above in some specimens; wall smooth; aperture a narrow slit on the umbilical region on the ventral side. Diameter 0.50 millimeter.

The material from one station in the Glendon limestone contained a few specimens that may be referred to this species. It has already been recorded from the Miocene of Jamaica and Cuba, from the Coastal Plain of Florida and Virginia, and from Panama. It is probable that at least some of the specimens referred to *P. auricula* from the Indo-Pacific region may be identical with this species.

Pulvinulina sagra occurs at the following U. S. G. S. station:

Glendon limestone.—Vicksburg, Miss., 6446.

Pulvinulina glabrata Cushman.

Plate VI, figures 11, 12.

Pulvinulina glabrata Cushman, U. S. Geol. Survey Prof. Paper 129, pp. 99, 138, pl. 22, figs. 6, 7, 1922.

Test biconvex, elongate, somewhat lobulate, composed of about two coils, seven chambers in the last-formed one, dorsal side convex; sutures depressed, curved; chambers convex between, rapidly increasing in size as added; dorsal side very coarsely punctate, the sutures somewhat limbate, ventral side umbilicate; surface smooth and with very fine punctations; sutures distinct; last-formed chamber with a long, straight valvular lip across the whole of the depressed umbilicus; aperture beneath the lip. Length 0.5 millimeter.

This is one of the most striking species in the Vicksburg group Foraminifera. The last-formed chamber especially can be identified even in fragments. In the very smooth surface with the deeply indented aperture it is different from any other species in the genus. It is most nearly related to the species described and figured by Brady in the *Challenger* report as *Discorbina ventricosa*. The species is limited to the Byram marl and the Mint Spring marl member of the Marianna limestone.

Pulvinulina glabrata occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6454 and 6455; Leaf River, Miss., 7376; Woodward, Miss., 6648.

Mint Spring calcareous marl member.—Vicksburg, Miss., 6448, 6451, and 6425; Browns Cave, Miss., 7671.

Genus ROTALIA Lamarck, 1804.

Rotalia byramensis Cushman.

Rotalia byramensis Cushman, U. S. Geol. Survey Prof. Paper 129, pp. 99, 138, pl. 23, fig. 1, 1922.

Test unequally biconvex, rotaliform, in the last-formed coils six to seven chambers, dorsally with the chambers somewhat triangular; sutures oblique, limbate, broad, of clear shell material; ventral side with a large circular mass in the umbilical region, with the sutures deep and ending in a depressed ring about it; aperture with a somewhat valvular lip often divided into several teeth; surface on the dorsal side somewhat roughened, on the ventral side scrobiculate near the periphery, smoother near the center. Maximum diameter 2 millimeters.

This species, which is limited to the Byram and Mint Spring marls, is somewhat closely related to certain forms of tropical waters referred to *R. calcar*. The spines, of which there is but one to a chamber, are at the angle and obliquely placed. Typical *R. calcar* and its various related forms are characteristic of comparatively shallow water in tropical regions, especially the Indo-Pacific.

Rotalia byramensis occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6454 and 6455; Vicksburg, Miss., 6449 and 7372; Leaf River, Miss., 7376.

Mint Spring calcareous marl member of Marianna limestone.—Vicksburg, Miss., 6447 and 6448.

Rotalia advena Cushman, n. sp.

Plate VII, figures 4–6.

Test rotaliform, composed of about three coils, nearly as high as broad, the last coil consisting of five or six chambers, umbonal region elevated, periphery broadly rounded, ventral side somewhat more convex than the dorsal; sutures slightly if at all depressed, only those of the last-formed coil distinct; aperture an elongate slit, several times as long as wide, the ends curved, on the ventral side at the inner margin of the last-formed chamber; wall finely punctate, smooth, somewhat shiny. Diameter 0.80 millimeter or less.

This species somewhat resembles *R. schroeteriana* but is larger, has fewer chambers and less oblique sutures, and is more convex on the ventral side. It also somewhat resembles *R. soldanii* and *R. vicksburgensis* but lacks the shallow depressed area on the dorsal side. Specimens are fairly numerous, and the characters are constant.

Rotalia advena occurs at the following U. S. G. S. stations:

Typical Marianna limestone.—St. Stephens Bluff, Ala., 5649; Fishers Creek, Ala., 7156.

Red Bluff clay.—St. Stephens, Ala., 6713.

Rotalia vicksburgensis Cushman.

Rotalia vicksburgensis Cushman, U. S. Geol. Survey Prof. Paper 129, p. 139, pl. 35, figs. 3, 4, 1922.

Test spiral, dorsal side flattened, ventral side strongly convex, umbilicate, about eight chambers in the last-formed coil; chambers distinct, inflated; sutures distinct, slightly depressed; surface smooth, finely punctate. Maximum diameter 0.75 millimeter.

This species was originally described from specimens collected in the Mint Spring marl member of the Marianna limestone but has since been found in all the divisions of the Vicksburg group. It is apparently related to *R. soldanii* D'Orbigny, but it does not have nearly so great a height, the line between adjacent whorls is not channeled, and in general it has a much more primitive form.

Rotalia vicksburgensis occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6454; Vicksburg, Miss., 8240.

Glendon limestone.—Vicksburg, Miss., 6446; McGowans Bridge, Ala., 6749.

Typical Marianna limestone.—Marianna, Fla., 7241; St. Stephens, Ala., 5649; Castleberry, Ala., 6734; Fishers Creek, Ala., 7156; Heidelberg, Miss., 6645; Brandon, Miss., 7371.

Mint Spring calcareous marl member.—Vicksburg, Miss., 6448, 6451, and 6452; Browns Cave, Miss., 7671; Boice, Miss., 6647.

Red Bluff clay.—Hiwannee, Miss., 6456; St. Stephens, Ala., 6712 and 6713; Fail, Ala., 7213.

Rotalia dentata Parker and Jones.

Rotalia dentata Parker and Jones, Philos. Trans., vol. 155, p. 387, pl. 19, fig. 13, 1865.

Cushman, U. S. Geol. Survey Prof. Paper 129, p. 100, pl. 23, fig. 2, 1922.

Several specimens from one station in the Byram marl are very close to this species from Bombay figured by Parker and Jones. They are also close to the figure given by Brady in the *Challenger* report, plate 108, figure 4. It is a different species from *R. calcar*, although probably included under that name by various authors.

As shown in the figure of the type the sutures are limbate with clear shell material and the outer border of each whorl is marked in a like manner. The spinose projections from the edge are very much like those in the figure given by Brady and seem to be different from those ordinarily seen in *R. calcar*.

Rotalia dentata occurs at the following U. S. G. S. station:

Byram calcareous marl.—Byram, Miss., 6455.

Rotalia dentata Parker and Jones var. parva Cushman.

Rotalia dentata Parker and Jones var. *parva* Cushman, U. S. Geol. Survey Prof. Paper 129, p. 139, pl. 35, figs. 1, 2, 1922.

Variety differing from the typical form in the size and the number of chambers, having usually but five chambers in the last-formed coil, each with a single spine from the periphery at the center of each chamber. Diameter 0.65 millimeter.

This small variety is fairly common in the Byram and Mint Spring marls and at one station in the typical Marianna limestone. It is often found in considerable numbers. It has a spine near the center of each chamber extending out in a radial direction rather than obliquely, as in *R. byramensis*.

Rotalia dentata var. *parva* occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6454 and 6455; Vicksburg, Miss., 6449 and 8240.

Typical Marianna limestone.—Calmar, Miss., 7445.

Mint Spring calcareous marl member.—Vicksburg, Miss., 6447, 6448, 6451, and 6452.

Genus GYPSINA Carter, 1877.

Gypsina rubra (D'Orbigny) Heron-Allen and Earland.

Planorbulina rubra D'Orbigny, Annales sci. nat., vol. 7, p. 280, No. 4, 1826.

Fornasini, Accad. sci. Ist. Bologna Mem., 6th ser., vol. 5, p. 44, pl. 2, fig. 3, 1908.

Gypsina rubra (D'Orbigny) Heron-Allen and Earland, Zool. Soc. London Trans., vol. 20, p. 725, pl. 53, figs. 35–37, 1915.

Cushman, U. S. Geol. Survey Prof. Paper 129, pp. 98, 138, pl. 22, fig. 3, 1922.

This is an Indo-Pacific species recorded by D'Orbigny from the South Seas and Sarawak. Heron-Allen and Earland note its occurrence at the Kerimba Archipelago, off the southeastern coast of Africa. They also record it in shore sands from Fremantle, Western Australia; from Lord Howe Island, east of Australia; and from Apia Beach and the Lufilufi reef, Samoa, and note that "it is probably widely distributed in shallow water across the Indo-Pacific region."

Although in the fossil specimens the color is of course lacking, nevertheless the characteristic secondary growth seems to be developed in these specimens.

The species has been found in all the divisions of the Vicksburg group except the Glendon limestone.

Gypsina rubra occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6454 and 6455.

Typical Marianna limestone.—Fishers Creek, Ala., 7156; Heidelberg, Miss., 6645; Brandon, Miss., 7371.

Mint Spring calcareous marl member.—Vicksburg, Miss., 6448, 6451, and 6452; Browns Cave, Miss., 7671; Boice, Miss., 6647.

Red Bluff clay.—Hiwannee, Miss., 6456; St. Stephens, Ala. 6712 and 6713; Fail, Ala., 7213.

Genus ASTERIGERINA D'Orbigny, 1839.

Asterigerina subacuta Cushman.

Asterigerina subacuta Cushman, U. S. Geol. Survey Prof. Paper 129, p. 100, pl. 24, figs. 1–3, 1922.

Test plano-convex or unequally biconvex, composed of about three and a half coils, the dorsal side slightly convex, smooth, the chambers all visible in well-preserved specimens, even those of the earlier coils showing through the layer of transparent shell material covering them; chambers about ten in the last-formed coil; sutures oblique and curved backward but not depressed below the surface, slightly thickened and clear, joining at the periphery with the slight keel; from below only the chambers of the last coil visible, sutures ending about one-third of the way in from the periphery, from which point a secondary chamber is developed to the umbilical region, where the sutures come together in a central boss of clear shell material; aperture elongate, curved, at the base of the inner margin on the ventral side. Diameter about 1 millimeter.

This species is clearly related to *Asterigerina carinata* D'Orbigny and *A. angulata* Cushman. From the former it differs in the larger number of chambers and the more narrow coils, and from the latter in the smaller number of the chambers, simpler aperture, and narrower coils. *A. subacuta* is nearer *A. carinata* than *A. angulata* but is very constant in its characters. From above it has the appearance of a *Pulvinulina*, but an examination of the ventral

side shows the typical characters of *Asterigerina*. It shows traces of granules on the ventral side near the aperture.

The species has proved to be abundant and widely distributed in the Byram marl, occurring at nearly all the stations, but is limited to that formation.

Asterigerina subacuta occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6454 and 6455; Vicksburg, Miss., 6449, 7372, and 8240; Leaf River, Miss., 7376; Woodward, Miss., 6648; Waynesboro, Miss., 6649.

Family NUMMULITIDAE.

Genus POLYSTOMELLA Lamarck.

Polystomella poeyana D'Orbigny.

Plate VIII, figure 1.

Polystomella poeyana D'Orbigny, in De la Sagra, Histoire physique, politique et naturelle de l'île de Cuba, Foraminifères, p. 55, pl. 6, figs. 25, 26, 1839.
Cushman, Carnegie Inst. Washington Pub. 311, p. 55, 1922.

Test equally biconvex, composed of numerous chambers, eight to twelve in the last-formed coil, each inflated; the periphery somewhat lobulate, especially in the last-formed portion, periphery in apertural view broadly rounded, retral processes small and numerous, in the depressed sutural lines; umbilical region depressed but without any secondary development of shell material; wall thin, translucent, finely punctuate; aperture a row of small pores at the base of the apertural face of the chamber. Diameter usually not over 0.60 millimeter.

This species was described by D'Orbigny from shore sands in the West Indies. I have found it to be common in such localities in the West Indies and in the Gulf of Mexico.

Polystomella poeyana occurs at the following U. S. G. S. station:

Byram calcareous marl.—Vicksburg, Miss., 7372.

Genus LEPIDOCYCLINA Gümbel, 1868.

Lepidocyclina supera (Conrad) H. Douvillé.

Orbitolites supera Conrad, Acad. Nat. Sci. Philadelphia Proc., [vol. 17], No. 2, p. 74, 1865.
Orbitoides supera Conrad, Am. Jour. Sci., 2d ser., vol. 43, p. 31, 1867.
Lepidocyclina supera (Conrad) H. Douvillé, Compt. Rend., 1918, pp. 263, 264, figs. 6–8, 11.
Cushman, U. S. Geol. Survey Prof. Paper 125, p. 69, pl. 26, figs. 5–7, 1920; U. S. Geol. Survey Prof. Paper 129, p. 101, 1922.

Test flattened or slightly sellaeform, typically circular in outline but occasionally irregular with lobes at one side or elongated oval; thickest in the central region but not distinctly umbonate, gradually decreasing in thickness to the periphery; surface apparently smooth but with slight enlargement becoming papillate; the papillae, which are the ends of the pillars, rounded and projecting above the general surface slightly, or where the test is eroded becoming more prominent. The horizontal section shows the chambers of the equatorial band to be irregularly hexagonal, the chambers with thick walls, the annuli irregular, occasionally much crowded, the chambers then compressed and elongate oval, embryonic chambers not seen. The vertical section shows the equatorial band to be unusually thin, increasing somewhat in thickness toward the periphery, where the height of the chambers is two to two and one-half times the radial width; lateral chambers numerous, ten to twelve in a column in the thickest portion of the test, thence decreasing gradually in number toward the periphery; chambers very much compressed, six to eight times as wide as high, elliptical, the walls thick, usually much thicker than the chamber itself; pillars very numerous, increasing rapidly in diameter toward the surface, most numerous in the thicker central portion but in lesser numbers scattered over the surface well toward the periphery. Diameter as much as 18 millimeters in adult specimens; thickness about 2 millimeters.

Conrad describes this species from specimens obtained in the upper bed at Vicksburg (hence probably the specific name *supera*) in the following words:

> Smaller than the preceding [*L. mantelli*] and comparatively thicker without the raised central point. Diameter thirteen-twentieths of an inch. This species is readily distinguished by the convex center and is limited to the Oligocene strata.

Lepidocyclina supera seems to be an index fossil for the Byram calcareous marl. It is not found in any of the other formations of the Vicksburg group except the Glendon limestone.

Lepidocyclina supera occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 5623, 6454, and 6455; Vicksburg, Miss., 2664, 3722, 3729, and 6449; Haynes Bluff, Miss., 7385.

Glendon limestone.—Robinson's quarry, Miss., 6548.

Lepidocyclina mantelli (Morton) Gümbel.

Nummulites mantelli Morton, Am. Jour. Sci., vol. 23, p. 291, pl. 5, fig. 9, 1833; Synopsis of organic remains of the Cretaceous group, p. 45, pl. 5, fig. 9, 1834.

Orbitoides (*Lepidocyclina*) *mantelli* (Morton) Gümbel, K.-bayer. Akad. Wiss. Abh., vol. 10, p. 718, 1868 (1870).

Orbitoides mantelli D'Orbigny, in Lyell, Geol. Soc. London Quart. Jour., vol. 4, p. 11, 1847 (1848); Prodrome de paléontologie, vol. 2, p. 406, No. 1296, 1850.

Carpenter, Geol. Soc. London Quart. Jour., vol. 6, p. 32, pl. 6, figs. 20, 21, 31, 1850.

Carpenter, Parker, and Jones, Introduction to the study of the Foraminifera, pp. 298, 300, pl. 20, figs. 5, 6, 7, 11, 1862.

Bütschli, in Bronn, Klassen und Ordnungen des Thier-Reichs, p. 215, pl. 12, fig. 22, 1880; in Steinmann, Elemente de Paläontologie, vol. 1, p. 36, fig. K, 1888.

De Gregorio, Annales géol. paléont., vol. 8, p. 261, pl. 46, figs. 16, 17, 1890.

Lepidocyclina mantelli Lemoine and R. Douvillé, Soc. géol. France Mém., Paléontologie, No. 32, p. 10, pl. 1, fig. 4; pl. 2, fig. 18; pl. 3, figs. 7, 12, 1904.

Cushman, U. S. Geol. Survey Prof. Paper 125, p. 57, pls. 12–14, 1920.

Orbitoides mantelli mut. *umbrellopsis* De Gregorio, Annales géol. paléont., vol. 8, p. 262, pl. 46, figs. 21–26, 1890.

Test thin, flattened, circular, often slightly undulate; adults from 25 to 35 millimeters in diameter, in exceptional specimens 41 millimeters; central region slightly protuberant on both sides of the test, the umbo thus formed being limited to the central portion and only 2 to 3 millimeters in diameter; surface smooth in well-preserved specimens, or slightly pustulate, owing to the irregular elevation of the outer walls of adjacent lateral chambers; in eroded specimens irregularly scrobiculate; young specimens with the central umbonal protuberance more marked than in adults.

This species which I have discussed at some length in the paper cited above, as is shown by the records, is characteristic of certain definite horizons near the base of the Vicksburg in Alabama, parts of Mississippi, and northwestern Florida. From all the material examined it seems to occur usually alone, without other species of its group, a peculiarity that distinguishes it from certain species of similar size in the upper Eocene.

Lepidocyclina mantelli occurs at the following U. S. G. S. stations:

Glendon limestone.—Robinson's quarry, Miss., 6548.

Typical Marianna limestone.—Salt Mountain, Ala., 3296; St. Stephens, Ala., 5609, 6710, and 6711; Drewry, Ala., 6721; Perdue Hill, Ala., 6728 and 6729; Castleberry, Ala., 6732 and 6733; McGowan's Bridge, Ala., 6748; Marianna, Fla., 6767; Salt Creek, Ala., 7164; Castleberry, Ala., 7238; Heidelberg, Miss., 6648; and Millry, Ala., 6702.

Genus NONIONINA D'Orbigny, 1826.

Nonionina umbilicatula (Montagu) Parker, Jones, and Brady.

Nautilus umbilicatulus Montagu, Testacea Britannica, p. 191, 1803; Suppl., p. 78, pl. 18, fig. 1, 1808.

Nonionina umbilicatula (Montagu) Parker, Jones, and Brady, Annals and Mag. Nat. Hist., 4th ser., vol. 8, p. 242, pl. 12, fig. 157, 1871.

H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 726, pl. 109, figs. 8, 9, 1884.

Cushman, U. S. Geol. Survey Prof. Paper 129, p. 139, pl. 23, figs. 3, 4, 1922.

Test biconvex, peripheral margin rounded; chambers ten or more in the last-formed coil; sutures limbate but not depressed, deep, umbilicate; wall smooth, punctate toward the periphery; aperture a very narrow, curved opening at the base of the chamber, peripheral. Diameter 0.50–0.60 millimeter.

Nonionina umbilicatula occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Leaf River, Miss., 5615.

Mint Spring calcareous marl member of Marianna limestone.—Vicksburg, Miss., 6447, 6448, and 6452; Bcice, Miss., 6647; Browns Cave, Miss., 7671.

Nonionina scapha (Fichtel and Moll) Parker and Jones.

Nautilus scapha Fichtel and Moll, Testacea microscopica, p. 105, pl. 19, figs. *d–f*, 1803.

Nonionina scapha (Fichtel and Moll) Parker and Jones, Annals and Mag. Nat. Hist., 3d ser., vol. 5, p. 102, No. 4, 1860.

H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 730, pl. 109, figs. 14, 15, 16?, 1884.

Cushman, U. S. Nat. Mus. Bull. 103, p. 73, pl. 25, figs. 6*a*, *b*, 1918; U. S. Geol. Survey Prof. Paper 129, p. 139, pl. 23, figs. 5, 7, 1922.

Test in side view longer than wide, about ten chambers in the last-formed coil, rapidly increasing in length as added; sutures evenly curved, slightly depressed; periphery broadly rounded, in apertural view the face of the last-formed chamber making up a large part of the visible surface; wall smooth, finely punctate, somewhat umbilicate; aperture an arched slit at the base of the chamber. Length 0.60 millimeter.

Nonionina scapha occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Leaf River, Miss., 5615.

Mint Spring calcareous marl member.—Vicksburg, Miss., 6447, 6448, 6451, and 6452; Browns Cave, Miss., 7671.

Nonionina advena Cushman.

Nonionina advena Cushman, U. S. Geol. Survey Prof. Paper 129, p. 139, pl. 32, fig. 8, 1922.

Test small, circular in side view, biconvex; periphery rounded, nine to eleven chambers in the last-formed coil, inflated; sutures curved, slightly sigmoid, the inner portion excavated and broadened; umbilical region at each side of the test occupied by a large projecting knob of clear shell material; aperture at the base of the last-formed chamber. Maximum length 0.75 millimeter.

This is an unusual form and may perhaps not belong to this genus. It looks more like some species of *Polystomella*, but there seem to be no retral processes. It is apparently confined entirely to the Mint Spring marl member of the Marianna limestone.

Nonionina advena occurs at the following U. S. G. S. stations:

Mint Spring calcareous marl member.—Vicksburg, Miss., 6447; Boice, Miss., 6647.

Family MILIOLIDAE.

Genus CORNUSPIRA Schultze, 1854.

Cornuspira involvens (Reuss) Reuss var.

Operculina involvens Reuss, Akad. Wiss. Wien Denkschr., vol. 1, p. 370, pl. 45, fig. 30, 1849.

Cornuspira involvens (Reuss) Reuss, Akad. Wiss. Wien Sitzungsber., vol. 48, p. 39, pl. 1, fig. 2, 1863 (1864).

H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 200, pl. 11, figs. 1–3, 1884.

Cushman, U. S. Nat. Mus. Bull. 71, pt. 6, p. 25, pl. 1, fig. 2; pl. 2, fig. 2, 1917; U. S. Geol. Survey Prof. Paper 129, pp. 101–140, pl. 25, fig. 1, 1922.

The lower Oligocene specimens that are referred to this species differ from the typical recent form in having the last coil somewhat broadened and flattened. In this they somewhat resemble *C. carinata* (Costa). The specimens from the Byram marl are small and are probably young specimens, not having the flattened character. Recent specimens from the West Indian region are usually small, but in the Indo-Pacific region specimens reach a large size, especially in shallow water under conditions similar to those which prevailed in Vicksburg time in our Coastal Plain region.

Cornuspira involvens occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6455.

Mint Spring calcareous marl member of Marianna limestone.—Vicksburg, Miss., 6447, 6451, and 6452.

Red Bluff clay.—Hiwannee, Miss., 5264.

Genus SPIROLOCULINA D'Orbigny, 1826.

Spiroloculina grateloupi D'Orbigny.

Spiroloculina grateloupi D'Orbigny, Annales sci. nat., vol. 7, p. 298, 1826.

Terquem, Soc. géol. France Mém., 3d ser., vol. 1, p. 52, pl. 5, figs. 5, 6, 1878.

Weisner, Archiv Protistenkunde, vol. 25, p. 203, 1912.

Cushman, U. S. Nat. Mus. Bull. 71, pt. 6, p. 31, pl. 4, figs. 4, 5, 1917; U. S. Geol. Survey Prof. Paper 129, p. 101, pl. 25, fig. 2, 1922.

Spiroloculina excavata H. B. Brady (not D'Orbigny), *Challenger* Rept., Zoology, vol. 9, p. 151, pl. 9, figs. 5, 6, 1884.

This species is the most common one of the genus in the Vicksburg group but is restricted in its typical form to the Byram marl. Although the specimens are not as well developed as most of the recent ones—those of the Philippine region, for example—they show well the characteristic form, with the sides of the test deeply excavated, each chamber usually having a strong keel at the outer edge and the surface smooth, the apertural end somewhat produced, with a cylindrical neck. Microspheric specimens often have a series of openings at either end of each coil, where the new chamber failed to fill in the area next to the produced apertural end. Specimens are much smaller than the common shallow-water Indo-Pacific form, measuring not more than 0.65 millimeter. A single specimen from the Glendon limestone (U. S. G. S. station 7735) somewhat resembles this species, but the characters are not well developed, and further specimens may show that it is a different species.

Spiroloculina grateloupi occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6454 and 6455; Vicksburg, Miss., 6449, 7372, and 8240; Leaf River, Miss., 7376.

Spiroloculina antillarum D'Orbigny.

Spiroloculina antillarum D'Orbigny, in De la Sagra, Histoire physique, politique et naturelle de l'île de Cuba, Foraminifères, p. 166, pl. 9, figs. 3, 4, 1839.

H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 155, pl. 10, fig. 21, 1884.

Cushman, U. S. Geol. Survey Bull. 676, p. 21, pl. 8, fig. 2, 1918; U. S. Geol. Survey Prof. Paper 129, p. 140, pl. 33, fig. 1, 1922.

Spiroloculina grata Terquem, Soc. géol. France Mém., 3d ser., vol. 1, p. 55, pl. 5, figs. 14*a*–15*b*, 1878; and subsequent authors.

Test elongate, twice as long as broad; chambers subtriangular, peripheral margin broadly

rounded, ornamented by numerous longitudinal costae; apertural end extended. The costae are distinct and continue from one end to the other of the chambers without any trace of branching or anastomosing. Maximum length 1 millimeter.

As noted in a paper on the recent Foraminifera from the shallow water of Jamaica[14] this species described by D'Orbigny from specimens obtained in Cuba and other West Indian localities is *S. antillarum*. It is very similar to Terquem's *S. grata*, if not identical, and therefore the earlier name should be used.

Specimens very close to this form now living in the West Indies occurred at two stations in the Mint Spring calcareous marl member of the Marianna limestone:

Mint Spring calcareous marl member.—Vicksburg, Miss., 6451 and 6452.

Spiroloculina byramensis Cushman.

Spiroloculina byramensis Cushman, U. S. Geol. Survey Prof. Paper 129, p. 101, pl. 25, figs. 3a, 3b, 1922.

Test compressed, broadly rounded in side view, peripheral margin squarely truncate, sides of the chambers sloping in somewhat toward the center, surface with a beautiful ornamentation consisting of fine hexagonal depressed areas with very narrow, thin ridges between, covering the entire surface. Length 0.85 millimeter.

This species is rare in the Byram marl, but its beautifully ornamented surface is very distinctive. It resembles that shown in Terquem's figures of *Quinqueloculina variolata* D'Orbigny, from the Pliocene of the Isle of Rhodes.

Spiroloculina byramensis occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6455; Vicksburg, Miss., 8240.

Glendon limestone.—Robinson's quarry, Miss., 6548.

Typical Marianna limestone.—Millry, Ala., 6702.

Spiroloculina imprimata Cushman.

Spiroloculina imprimata Cushman, U. S. Geol. Survey Prof. Paper 129, pp. 101–140, pl. 25, figs. 3a, 3b, 1922.

Test broad and flat, complanate, nearly circular in outline, composed of numerous chambers, those of the last-formed coil failing to extend to the base of the preceding chamber, leaving a gap; periphery square, lateral faces nearly flat; the surface ornamented by a series of pits in a more or less linear arrangement. Length about 1 millimeter.

Spiroloculina imprimata occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6454; Vicksburg, Miss., 8240.

Mint Spring calcareous marl member of Marianna limestone.—Vicksburg, Miss., 6451.

Genus VERTEBRALINA D'Orbigny, 1826.

Vertebralina advena Cushman.

Vertebralina advena Cushman, U. S. Geol. Survey Prof. Paper 129, p. 102, pl. 25, figs. 5, 6, 1922.

Test compressed, in the adult with three chambers in the final whorl, the chamber angled, surface with numerous strong longitudinal costae, aperture elongate, with a flaring everted lip. Diameter 1 millimeter.

It may be that some of the specimens that have been assigned to *Articulina sulcata*, based on the figure given by Brady, should be referred to this species. Heron-Allen and Earland record *A. sulcata* from the Kerimba Archipelago. Sidebottom records the species from the Mediterranean, but from his figures his specimens were evidently *Articulina*. The figure of Brady, Parker, and Jones from the Abrolhos Bank is apparently not the same.

Forms similar to this should be looked for in the tropical Indo-Pacific. A specimen I have figured as *Articulina sulcata*[15] is very close to if not identical with this species.

Vertebralina advena occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6454 and 6455; Leaf River, Miss., 7376.

Vertebralina sp.

In the Byram calcareous marl was found a single specimen of a very thin, complanate species with numerous anastomosing costae as a surface ornamentation. It is very distinct from *Vertebralina advena*, but the single specimen is not enough for specific determination and description.

Vertebralina sp. (?) occurs at the following U. S. G. S. station:

Byram calcareous marl.—Byram, Miss., 6455.

[14] U. S. Nat Mus. Proc., vol. 59, p. 63, 1921.

[15] U. S. Nat. Mus. Bull. 71, pt. 6, pl. 22, figs. 5*a*, *b*, 1917.

Vertebralina sp.

A single specimen from the Mint Spring marl member of the Marianna limestone is evidently the young of a species of this genus, but the specimen is worn and can not be specifically identified.

Vertebralina sp. (?) occurs at the following U. S. G. S. station:.

Mint Spring calcareous marl member.—Vicksburg, Miss., 6451.

Genus QUINQUELOCULINA D'Orbigny, 1826.

Quinqueloculina bicostata D'Orbigny, var.

Quinqueloculina bicostata D'Orbigny, in De la Sagra, Histoire physique, politique et naturelle de l'île de Cuba, Foraminifères, p. 195, pl. 12, figs. 8–10, 1839.
Cushman, U. S. Nat. Mus. Bull. 71, pt. 6, p. 47, pl. 13, fig. 1, 1917; U. S. Geol. Survey Prof. Paper 129, pp. 102–141, pl. 26, figs. 2–4, 1922.
Miliolina bicostata Heron-Allen and Earland, Zool. Soc. London Trans., vol. 20, p. 572, pl. 42, figs. 42–45, 1915.

The specimens from the Mint Spring marl member of the Marianna limestone referred to this species are considerably longer than D'Orbigny's type figures and resemble more the specimens from the Byram marl which I have referred to this species.

Quinqueloculina bicostata occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6454 and 6455; Vicksburg, Miss., 6449, 7372, and 8240; Leaf River, Miss., 7376.
Glendon limestone.—Tiger Hill, Miss., 7735.
Typical Marianna limestone.—Salt Mountain, Ala., 3296.
Mint Spring calcareous marl member.—Vicksburg, Miss., 6448 and 6451.

Quinqueloculina vicksburgensis Cushman.

Quinqueloculina venusta Karrer (?) var. Cushman, U. S. Geol. Survey Prof. Paper 129, p. 102, pl. 26, fig. 5, 1922.
Quinqueloculina vicksburgensis Cushman, U. S. Geol. Survey Prof. Paper 129, p. 141, pl. 34, fig. 6, 1922.

Test much elongate, narrow; chambers distinct; basal end broadly rounded, projecting, apertural end also projecting, forming a cylindrical neck and rounded aperture; periphery of the test subacute; surface smooth, dull. Length nearly 2 millimeters, width 0.50 millimeter.

This is probably the same as the form recorded from the Byram marl as *Q. venusta* Karrer (?) var. It is a long, narrow species of peculiar form, as shown in the figures referred to above.

Quinqueloculina vicksburgensis occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6455; Vicksburg, Miss., 6449.
Glendon limestone.—Vicksburg, Miss., 6446.
Mint Spring calcareous marl member of Marianna limestone.—Vicksburg, Miss., 6447.

Quinqueloculina glabrata Cushman.

Quinqueloculina glabrata Cushman, U. S. Geol. Survey Prof. Paper 129, p. 141, pl. 34, fig. 8, 1922.

Test elongate, elliptical in side view, basal end of the chambers somewhat rounded; aperture slightly extending beyond the preceding chamber; aperture ovate with a simple tooth, tending to become bifid toward the tip; periphery of the test with an outside carina, the sides slightly concave; sutures distinct; surface smooth but not shiny. Length 1.5 millimeters, breadth 0.75 millimeter.

This species is very constant in its characters, and several specimens occur at each station.

Quinqueloculina glabrata occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6454; Vicksburg, Miss., 8240.
Typical Marianna limestone.—Leaf River, Miss., 7371.
Mint Spring calcareous marl member of Marianna limestone.—Vicksburg, Miss., 6451 and 6452.

Quinqueloculina lamarckiana D'Orbigny.

Plate VIII, figure 4.

Quinqueloculina lamarckiana D'Orbigny, in De la Sagra, Histoire physique, politique et naturelle de l'île de Cuba, Foraminifères, p. 187, pl. 11, figs. 14, 15, 1839.
Cushman, U. S. Geol. Survey Prof. Paper 129, p. 142, 1922.

Test short and broad; chambers with a sharp peripheral angle, sides slightly convex; aperture not produced; sutures distinct; surface smooth and shiny. Length 1 millimeter.

Quinqueloculina lamarckiana occurs at the following U. S. G. S. station:

Mint Spring calcareous marl member.—Vicksburg, Miss., 6447.

Quinqueloculina crassa D'Orbigny?

Quinqueloculina crassa D'Orbigny, Annales sci. nat., vol. 7, p. 301, No. 14, 1826.
Terquem, Soc. géol. France Mém., 3d ser., vol. 2, pt. 3, p. 186, pl. 20 (28), figs. 20, 21, 1882.
Fornasini, Accad. sci. Ist. Bologna Mem., 6th ser., vol. 2, p. 65, pl. 3, fig. 5, 1905.
Miliolina crassa Heron-Allen and Earland, Zool. Soc. London Trans., vol. 20, p. 572, pl. 42, figs. 37–41, 1915.

A fairly common species in the Byram marl is rather close to *Q. crassa* as figured by Heron-

Allen and Earland from their Kerimba material and is referred questionably to that species. The Byram specimens have perhaps a little finer costae but are otherwise similar to the Kerimba material.

Quinqueloculina crassa occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6454 and 6455; Leaf River, Miss., 7376.

Quinqueloculina seminulum (Linné) D'Orbigny

Serpula seminulum Linné, Systema naturae, 10th ed., p. 786, 1758; 13th (Gmelin's) ed., pp. 37, 39, 1788.
Quinqueloculina seminulum (Linné) D'Orbigny, Annales sci. nat., vol. 7, p. 303, No. 44, 1826.
Cushman, U. S. Nat. Mus. Bull. 71, pt. 6, p. 44, pl. 11, fig. 2, 1917; U. S. Geol. Survey Prof. Paper 129, p. 142, 1922.
Miliolina seminulum (Linné) Williamson, Recent Foraminifera of Great Britain, p. 85, pl. 7, figs. 183–185, 1858.
H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 157, pl. 5, figs. 6*a–c*, 1884.

Test somewhat longer than broad, smooth, peripheral margins rounded; sutures distinct; apertural end not exserted; aperture fairly large, oval, with a simple tooth becoming bifid at the free end. Maximum length 1.5 millimeters.

Quinqueloculina seminulum occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6454 and 6455; Vicksburg, Miss., 6449, 7372, and 8240.
Mint Spring calcareous marl member.—Vicksburg, Miss., 6448, 6451, and 6452.

Quinqueloculina vulgaris D'Orbigny.

Quinqueloculina vulgaris D'Orbigny, Annales sci. nat., vol. 7, p. 302, No. 23, 1826.
Cushman, U. S. Nat. Mus. Bull. 71, pt. 6, p. 46, pl. 11, fig. 3, 1917; U. S. Geol. Survey Prof. Paper 129, p. 142, pl. 32, figs. 9, 16, 1922.
Miliolina vulgaris Heron-Allen and Earland, Zool. Soc. London Trans., vol. 20, p. 569, 1915.

Test short and stout, about as long as wide, in front view orbicular; chambers in transverse section roughly triangular, the periphery bluntly angled, sides straight or slightly convex; sutures distinct, wall smooth; apertural end not contracted or produced, aperture elongate, narrow, with a tooth bifid at the tip, in front view projecting slightly above the border of the aperture. Length about 0.75 millimeter.

Quinqueloculina vulgaris occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Vicksburg, Miss., 6449 and 8240; Haynes Bluff, Miss., 7385; Waynesboro, Miss., 6649.
Mint Spring calcareous marl member of Marianna limestone.—Vicksburg, Miss., 6447, 6451, and 6452.

Quinqueloculina cuvieriana D'Orbigny.

Quinqueloculina cuvieriana D'Orbigny, in De la Sagra, Histoire physique, politique et naturelle de l'île de Cuba, Foraminifères, p. 164, pl. 11, figs. 19–21, 1839.
Cushman, U. S. Geol. Survey Prof. Paper 129, pp. 102, pl. 26, 141, fig. 1, 1922.

Test slightly longer than wide; chambers sharply angled, those of the adult with a secondary carina at each side of the periphery of the chamber; remainder of the surface smooth; aperture somewhat elongated with a simple tooth. Maximum length 1 millimeter.

Quinqueloculina cuvieriana occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6455.
Mint Spring calcareous marl member of Marianna limestone.—Vicksburg, Miss., 6448 and 6451.

Quinqueloculina contorta D'Orbigny.

Quinqueloculina contorta D'Orbigny, Foraminifères fossiles du bassin tertiaire de Vienne, p. 298, pl. 20, figs. 4–6, 1846.
Cushman, U. S. Geol. Survey Prof. Paper 129, p. 142, pl. 34, figs. 2, 3, 1922.

Test elongate, oval; chambers narrow, of uniform width; periphery flattened, especially in the middle,, sides flat or slightly concave, very slightly if at all extended at the apertural end; aperture rounded with a simple tooth; sutures distinct; surface smooth, flattened, periphery dull, sides somewhat glossy. Maximum length 1 millimeter.

This species was found in the Mint Spring calcareous marl member of the Marianna limestone. The specimens are very similar to those figured by D'Orbigny.

Quinqueloculina contorta occurs at the following U. S. G. S. stations:

Mint Spring calcareous marl member.—Vicksburg, Miss., 6447, 6448, 6451, and 6452.

Quinqueloculina lustra Cushman.

Quinqueloculina lustra Cushman, U. S. Geol. Survey Prof. Paper 129, p. 141, pl. 33, fig. 6, 1922.

Test broadly elliptical, somewhat compressed; chambers broadly curved, of uniform width, at the basal end slightly projecting, the apertural end only slightly extending beyond the outline of the chamber; surface smooth,

shiny; sutures not very distinct; aperture nearly circular with a short, simple tooth. Length 1.25 millimeters, breadth 1 millimeter.

This species has a peculiar rounded form and the periphery is slightly angled.

Quinqueloculina lustra occurs at the following U. S. G. S. station:

Mint Spring calcareous marl member of Marianna limestone.—Vicksburg, Miss., 6448.

Quinqueloculina cookei Cushman.

Quinqueloculina cookei Cushman, U. S. Geol. Survey Prof. Paper 129, p. 141, pl. 33, figs. 2, 3, 1922.

Test much elongate, somewhat fusiform; chambers narrow, widest near the base, rounded, apertural end extended, forming a subcylindrical neck with a simple tooth and slight lip; periphery of the test broad, carinate at each angle, slightly concave between the carinae; sutures distinct; surface smooth, shiny, except for the carinae, which are dull. Maximum length 1.5 millimeters, diameter 0.35 millimeter.

This species in some ways resembles *Q. bicostata*, but it is very elongate and slender, and the general form is entirely different from that species.

Quinqueloculina cookei occurs at the following U. S. G. S. station:

Mint Spring calcareous marl member of Marianna limestone.—Vicksburg, Miss., 6451.

Quinqueloculina limbata D'Orbigny.

Plate VIII, figure 2.

Quinqueloculina limbata D'Orbigny, Annales sci. nat., vol. 7, p. 302, No. 20, 1826.
Fornasini, R. Accad. sci. Ist. Bologna Mem., 6th ser., vol. 2, p. 66, pl. 3, fig. 9, 1905.
Miliolina limbata Heron-Allen and Earland, Zool. Soc. London Trans., vol. 20, p. 577, pl. 44, figs. 5–8, 1915.

Test elongate, about twice as long as broad; chambers distinct, periphery broadly rounded, ornamented by comparatively few, large, distinct costae, slightly irregular; apertural end produced into a short neck, opposite end broadly rounded, somewhat projecting. Maximum length 0.5 millimeter.

This species was originally described by D'Orbigny from material collected in the Red Sea and has been recorded by Heron-Allen and Earland from the Kerimba Archipelago. The specimen from the Byram calcareous marl is very similar to this species as figured by them.

Quinqueloculina limbata occurs at the following U. S. G. S. station:

Byram calcareous marl.—Byram, Miss., 6454.

Quinqueloculina byramensis Cushman, n. sp.

Plate VIII, figure 5.

Test quinqueloculine, slightly longer than broad; chambers with a reticulate pattern, made up of strong longitudinal costae between which are weaker transverse ridges, periphery rounded, apertural end slightly extended. Length 0.40 millimeter.

This differs from all the other species in the Byram calcareous marl in its peculiar ornamentation of the exterior of the test.

Quinqueloculina byramensis n. sp. occurs at the following U. S. G. S. station:

Byram calcareous marl.—Leaf River, Miss., 7376.

Quinqueloculina tessellata Cushman.

Quinqueloculina tessellata Cushman, U. S. Geol. Survey Prof. Paper 129, p. 142, pl. 33, fig. 8, pl. 34, fig. 1, 1922.

Test elongate, fusiform, in transverse section much angled, periphery rather sharply angled, sides flat and very slightly convex, apertural end very little extended; sutures not very distinct; surface ornamented by longitudinal rows of rather large pits, five or six rows on each side of the largest chamber. Length 1.25 millimeters, breadth 0.50 millimeter.

This is a peculiarly ornamented species, resembling somewhat the pattern found in some of the Miliolidae of the Paris Basin Eocene.

Quinqueloculina tessellata occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6454; Vicksburg, Miss., 6449 and 8240; Leaf River, Miss., 7376.
Glendon limestone.—Vicksburg, Miss., 6446.

Quinqueloculina sp.?

A few specimens from the Byram marl are large (1.50–1.75 millimeters) and have much the form of *Triloculina oblonga* (Montagu) D'Orbigny but are quinqueloculine. In most of them the surface is worn and smooth, but in one of the largest, best-preserved specimens there is a faint longitudinal striation. In this connection the note which Heron-Allen and Earland give under *Miliolina oblonga* in their Kerimba work (p. 567) is interesting.

At stations 9 and 12 the specimens were large and showed signs of superficial markings, linking the species with *M. striata*.

Quinqueloculina sp.? occurs at the following U. S. G. S. station:

Byram calcareous marl.—Byram, Miss., 6455.

Genus MASSILINA Schlumberger, 1893.

Massilina crusta Cushman.

Massilina crusta Cushman, U. S. Geol. Survey Prof. Paper 129, p. 104, pl. 28, fig. 1, 1922.

Test elliptical, compressed, periphery carinate; early chambers quinqueloculine, later ones 180° from one another, making a flat test; sutures distinct, central portion of each chamber elliptical in transverse section; surface with a slight secondary thickening, the test itself ornamented by a series of very short longitudinal pits, apertural and basal ends of each chamber strongly projecting, the basal end rounded, the aperture rounded with a bifid tooth, surface dull. Maximum length 1.60 millimeters.

This species in some ways resembles the figures given by Heron-Allen and Earland [16] of *Spiroloculina planissima* (Lamarck), from the Kerimba Archipelago. Our specimens are much more involute, however, and belong to *Massilina*. The shape of the apertural end and the carinate periphery are very similar in the two forms.

Massilina crusta occurs at the following U. S. G. S. station:

Byram calcareous marl.—Byram, Miss., 6455.

Massilina occlusa Cushman.

Massilina occlusa Cushman, U. S. Geol. Survey Prof. Paper 129, p. 104, pl. 28, fig. 2, 1922.

Test elongate, narrowly elliptical in face view, involute, the peripheral margins squarely truncate, initial end of the chamber projecting backward beyond the former aperture, rounded, apertural end somewhat produced, whole chamber nearly square in transverse section; sutures distinct; aperture rounded, neck square; surface dull, smooth. Maximum length 0.75 millimeter.

The involute form of the last-formed chambers hides the early chambers almost completely. The whole test has a squarish form that is continued even to the apertural neck. The shape of the initial end of the last-formed chamber is also very constant and characteristic.

Massilina occlusa occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6454 and 6455; Vicksburg, Miss., 7372 and 8240; Leaf River, Miss., 7376.

Massilina occlusa Cushman var. costulata Cushman.

Plate VIII, figure 3.

Massilina occlusa Cushman var. *costulata* Cushman, U. S. Geol. Survey Prof. Paper 129, p. 104, 1922.

Variety differing from the typical form in the surface, which instead of being smooth and polished has an ornamentation of several longitudinal, more or less irregular costae, running out on the neck of the last-formed chamber, the angles of the chambers sharp and carinate, the periphery of the test concave.

This may be compared to such forms as *Spiroloculina costigera* Terquem, *S. costata* Terquem, *S. striata* Terquem, and *S. semiovata* Terquem, from the Paris Basin Eocene. It is unlike any of these, however.

This form is rare in the Byram calcareous marl and seems to be either a distinct species or a variety of *M. occlusa*.

Massilina occlusa var. *costulata* occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6455; Leaf River, Miss., 7376.

Massilina decorata Cushman.

Massilina decorata Cushman, U. S. Geol. Survey Prof. Paper 129, p. 143, pl. 34, fig. 7, 1922.

Test much flattened, elliptical or oval, slightly longer than wide, basal and apertural ends projecting, the apertural end narrowing to a small cylindrical neck, nearly in the longitudinal axis of the test; sutures rather indistinct; surface dull white; periphery rounded, the sides ornamented by very fine pits, giving a finely granular appearance to the test. Maximum length 1 millimeter.

This in some ways resembles some of the specimens referred by Brady to *Spiroloculina tenuis* (Czjzek).

Massilina decorata occurs at the following U. S. G. S. stations:

Glendon limestone.—Vicksburg, Miss., 6446; Robinson's quarry, Miss., 6548; Tiger Hill, Miss., 7735.

Typical Marianna limestone.—Fishers Creek, Ala., 7156; St. Stephens, Ala., 5609 and 5649; Heidelberg, Miss., 6645; Tallahala Road, Miss., 7375; Brandon, Miss., 7371.

[16] Zool. Soc. London Trans., vol. 20, pl. 41, figs. 1-5, 1915.

Mint Spring calcareous marl member.—Vicksburg, Miss., 6452; Browns Cave, Miss., 7671; Boice, Miss., 6647.

Red Bluff clay.—Hiwannee, Miss., 5264; St. Stephens, Ala., 6714.

Genus ARTICULINA D'Orbigny, 1826.

Articulina byramensis Cushman.

Articulina byramensis Cushman, U. S. Geol. Survey Prof. Paper 129, pp. 103–143, pl. 27, figs. 5, 6, 1922.

Test of two portions, a basal triloculine portion followed by a single linear chamber, the earlier portion with the lip of the antepenultimate chamber standing out free at the base, that of the penultimate chamber covered by the base of the last-formed one, the last chamber rounded in transverse section or slightly compressed, with a broadly flaring, slightly downward curved lip; aperture rounded, slightly longer than wide; surface of the test with numerous longitudinal costae, sharp, sometimes, especially in the final chamber, anastomosing. Length 1.25 millimeters.

Articulina byramensis occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6455; Vicksburg, Miss., 7372 and 8240; Leaf River, Miss., 7376.

Mint Spring calcareous marl member of Marianna limestone.—Vicksburg, Miss., 6451 and 6452.

Genus HAUERINA D'Orbigny, 1846.

Hauerina fragillissima (H. B. Brady) Millett.

Spiroloculina fragillissima H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 149, pl. 9, figs. 12–14, 1884.

Hauerina fragillissima (H. B. Brady) Millett, Roy. Micr. Soc. Jour., p. 610, pl. 13, figs. 8–10, 1898.

Heron-Allen and Earland, Zool. Soc. London Trans., vol. 20, p. 587, pl. 46, figs. 1, 2, 1915.

Cushman, U. S. Nat. Mus. Bull. 71, pt. 6, p. 64, pl. 24, fig. 4, 1917; U. S. Geol. Survey Prof. Paper 129, p. 103, pl. 27, fig. 3, 1922.

The test of this species is very thin and of a peculiar opalescent character, the surface smooth or slightly pitted, the sutures usually appearing as whitish lines in the test.

All the known records for this species are Indo-Pacific. Brady's original records are: Off Tahiti, Society Islands, 420 and 620 fathoms; off Kandavu, Fiji Islands, 255 fathoms; New Guinea, south coast 3 to 28 fathoms, north coast 16 to 25 fathoms. Heron-Allen and Earland record it from the Kerimba Archipelago, off the southeastern coast of Africa. I have recorded the species from waters off the Hawaiian Islands in 271 fathoms.

This record from the Byram calcareous marl confirms the Indo-Pacific relations of this fossil fauna.

Hauerina fragillissima occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6454 and 6455.

Hauerina sp.?

A single specimen, somewhat broken, which appears in the Byram calcareous marl belongs to this genus. It differs from the species just described in the sharp edge to the peripheral borders of the chambers, even carinate, and the character of the wall, which, though thin and transparent, seems to have deep pits or possibly perforations at wide but regular intervals in a single irregular line down the curved part of the chamber.

Hauerina sp.? occurs at the following U. S. G. S. station:

Byram calcareous marl.—Byram, Miss., 6455.

Genus TRILOCULINA D'Orbigny, 1826.

Triloculina peroblonga Cushman.

Triloculina peroblonga Cushman, U. S. Geol. Survey Prof. Paper 129, p. 143, pl. 34, figs. 4, 5, 1922.

Test much elongate, periphery rounded; chambers rounded at the base, the apertural end coming to or extending slightly beyond the base of the previous chamber; aperture rounded with a simple tooth and a slightly thickened lip; sutures distinct; wall dull white, smooth. Maximum length 1.5 millimeters.

One of the specimens shows the aperture at each end, the last-formed chamber evidently having failed to cover the aperture of the preceding chamber, an unusual occurrence in this group.

Triloculina peroblonga occurs at the following U. S. G. S. station:

Mint Spring calcareous marl member.—Vicksburg, Miss., 6451.

Triloculina oblonga (Montagu) D'Orbigny.

Vermiculum oblongum Montagu, Testacea Britannica, p. 522, pl. 14, fig. 9, 1803.

Triloculina oblonga (Montagu) D'Orbigny, Annales sci. nat., vol. 7, p. 300, No. 16, Modèles, No. 95, 1826; in De la Sagra, Histoire physique, politique et naturelle de l'île de Cuba, Foraminifères, p. 155, pl. 10, figs. 3–5, 1893.

Cushman, U. S. Nat. Mus. Bull. 71, pt. 6, p. 69, pl. 26, fig. 3, 1917; U. S. Geol. Survey Prof. Paper 129, p. 104, pl. 28, figs. 3, 4, 1922.

Miliolina oblonga (Montagu) H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 160, pl. 5, figs. 4*a*, *b*, 1884.
Millett, Roy. Micr. Soc. Jour., p. 267, pl. 5, fig. 14, 1898.
Heron-Allen and Earland, Zool. Soc. London Trans., vol. 20, p. 566, 1915.

A few small but otherwise typical specimens of this species were found in the Byram marl and Mint Spring marl member of the Marianna limestone. They are widest near the base, thence taper to the narrower apertural end, the surface smooth and polished. Length about 0.35 millimeters.

The specimen figured by Brady seems to be a *Quinqueloculina* and to lack the characteristic shape of the tropical specimens in shallow water. It may be that the present specimens and that I have figured from waters off the Hawaiian Islands, together with that figured by Millett, really constitute a tropical species different from that of British waters.

Triloculina oblonga occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6455; Vicksburg, Miss., 6449.
Mint Spring calcareous marl member.—Vicksburg, Miss., 6452.

Triloculina trigonula (Lamarck) D'Orbigny.

Miliolites trigonula Lamarck, Annales du Muséum, vol. 5, p. 351, No. 3, 1804; Animaux sans vertèbres, vol. 7, p. 612, No. 3, 1822.
Triloculina trigonula (Lamarck) D'Orbigny, Annales sci. nat., vol. 7, p. 299, No. 1, pl. 16, figs. 5–9, Modèles, No. 93, 1826.

A single specimen only of this species was found in the Vicksburg group. It is a short, rather rotund form.

Triloculina trigonula occurs at the following U. S. G. S. station:

Byram calcareous marl.—Byram, Miss., 6455.

Triloculina rotunda D'Orbigny.

Plate VIII, figures 6, 7.

Triloculina rotunda D'Orbigny, Annales sci. nat., vol. 7, p. 299, No. 4, 1826.
Schlumberger, Soc. zool. France Mém., p. 64, pl. 1, figs. 48–50, figs. 11, 12 (in text), 1893.
Cushman, U. S. Geol. Survey Prof. Paper 129, p. 104, 1922.

Several specimens from the Byram calcareous marl are here referred to this species. They are triloculine, smooth, nearly as broad as long, and the chambers rounded. The longest are about 0.75 millimeter in length.

The species is recorded from widely separated localities, but there are various forms, as noted in the literature on the species.

Triloculina rotunda occurs at the following U. S. G. S. station:

Byram calcareous marl.—Byram, Miss., 6455.

Triloculina sculpturata Cushman.

Triloculina sculpturata Cushman, U. S. Geol. Survey Prof. Paper 129, p. 143, pl. 33, figs. 4, 5, 1922.

Test about twice as long as wide; periphery rounded or truncate; sutures indistinct; surface peculiarly sculptured, in general formed of longitudinal costae with broad surfaces, together with irregular connections, forming areolae; aperture rounded, with a simple tooth. Length 0.50 millimeter.

In its quinqueloculine stage this species has a neck somewhat extended, but in its adult character the aperture does not usually extend beyond the base of the previously formed chamber.

Triloculina sculpturata occurs at the following U. S. G. S. stations:

Mint Spring calcareous marl member of Marianna limestone.—Vicksburg, Miss., 6447 and 6451.

Genus BILOCULINA D'Orbigny, 1826.

Biloculina inornata D'Orbigny.

Biloculina inornata D'Orbigny, Foraminifères fossiles du bassin tertiaire de Vienne, p. 266, pl. 16, figs. 7–9, 1846.
Cushman, U. S. Geol. Survey Prof. Paper 129, p. 143, pl. 33, fig. 7, 1922.

Test slightly longer than wide, each chamber broadest toward the basal end; aperture broadly rounded, the tooth somewhat bifid; surface smooth, dull. Length 0.40 millimeter.

Biloculina inornata occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6455; Vicksburg, Miss., 6449; Leaf River, Miss., 7376.
Mint Spring calcareous marl member.—Vicksburg, Miss., 6451 and 6452.

Biloculina sp.?

A very few specimens of a small rotund *Biloculina* were found in the Byram calcareous marl. They are smooth, with a large aperture and a tooth very small in comparison.

Biloculina sp.? occurs at the following U. S. G. S. stations:

Byram calcareous marl.—Byram, Miss., 6455; Vicksburg, Miss., 8240.

PLATES I–VIII.

PLATE I.

Ammobaculites agglutinans (D'Orbigny) Cushman (p. 15).

FIGURE 1. Side view, × 80. U. S. G. S. station 6455.

Textularia recta Cushman, n. sp. (p. 17).

FIGURE 2. Front view, × 80. U. S. G. S. station 6456.

Textularia recta Cushman, var. (p. 18).

FIGURE 3. Front view, × 80. U. S. G. S. station 6456.

Textularia mississippiensis Cushman var. alabamensis Cushman, n. var. (p. 17).

FIGURE 4. Front view, × 80. U. S. G. S. station 6749.

Textularia conica D'Orbigny (p. 16).

FIGURE 5. Front view, × 80. U. S. G. S. station 7238.
FIGURE 6. End view, × 80. U. S. G. S. station 7238.

Textularia subhauerii Cushman, var. (p. 16).

FIGURE 7. Front view, × 80. U. S. G. S. station 7214.

Textularia porrecta H. B. Brady (p. 16).

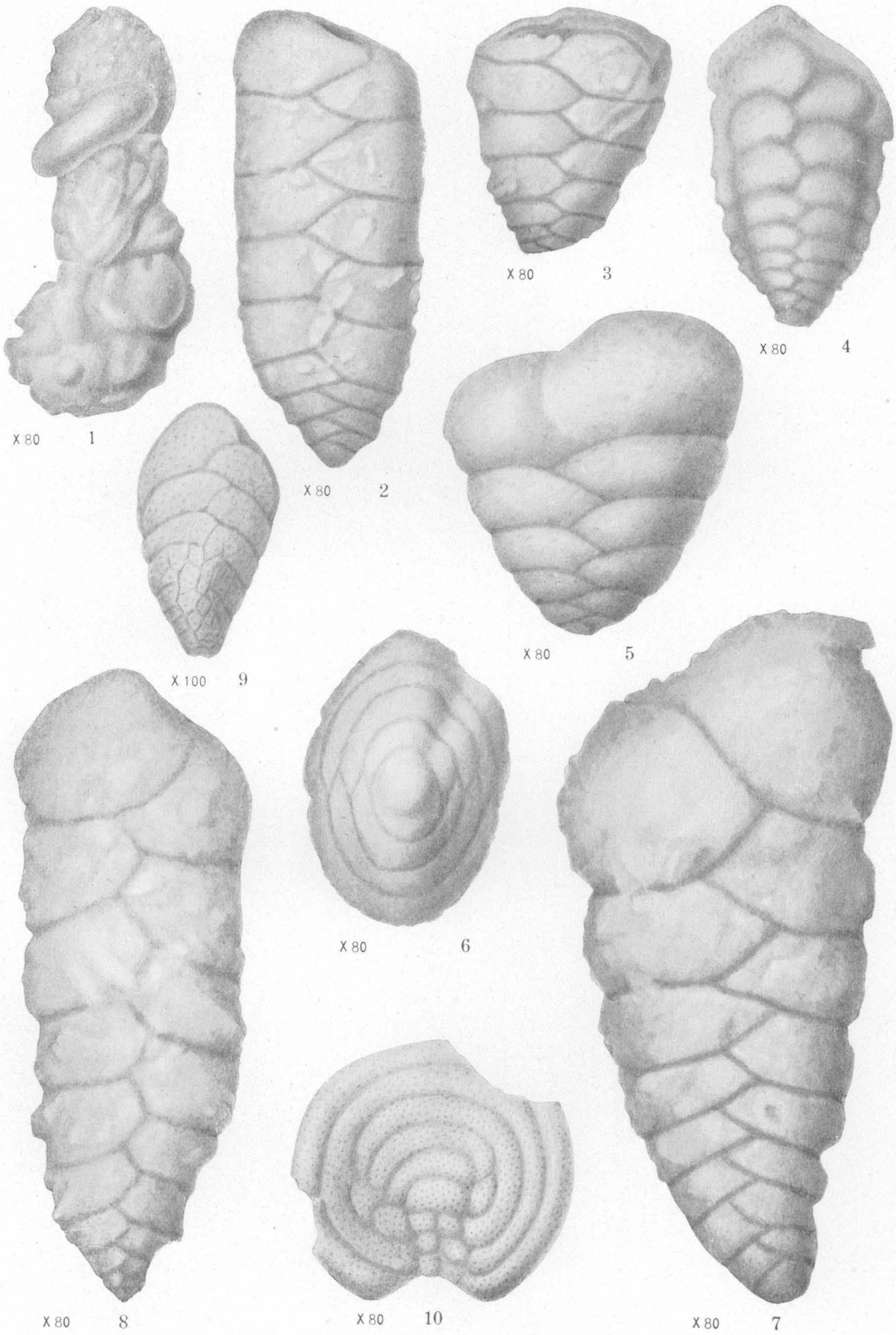
FIGURE 8. Front view, × 80. U. S. G. S. station 6733.

Bolivina caelata Cushman var. byramensis Cushman, n. var. (p. 19).

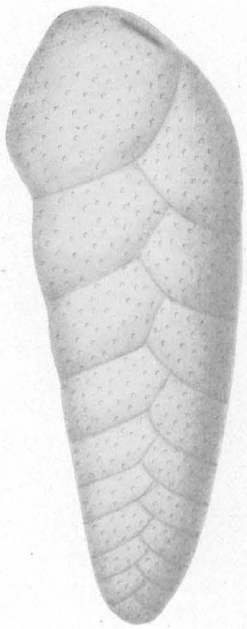
FIGURE 9. Front view, × 100. U. S. G. S. station 6455.

Pavonina advena Cushman, n. sp. (p. 24).

FIGURE 10. Front view, × 80. U. S. G. S. station 7376.



FORAMINIFERA OF THE VICKSBURG GROUP.



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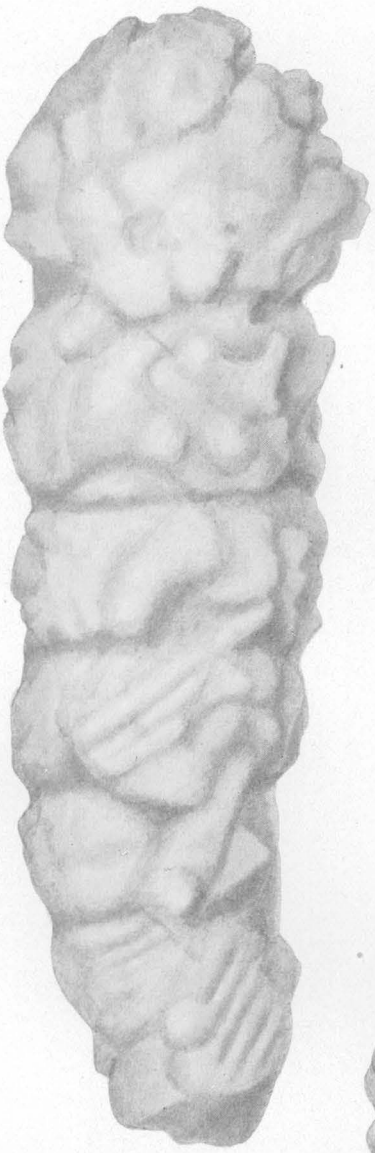

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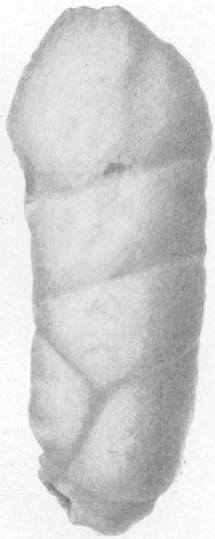

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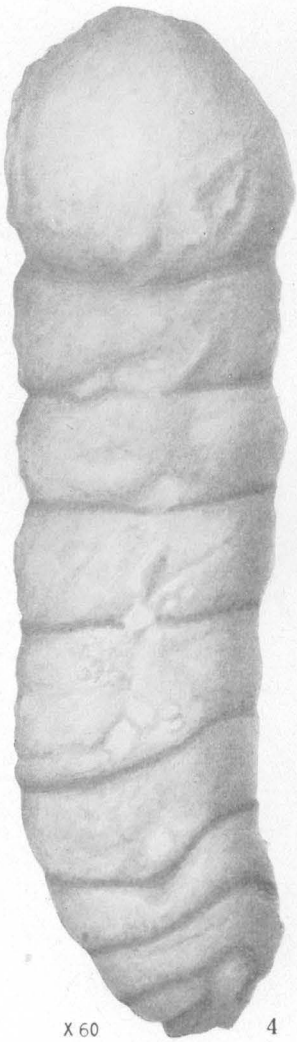


X 60 4

X 100 2

X 60 5

FORAMINIFERA OF THE VICKSBURG GROUP.

PLATE II.

Bolivina cf. B. punctata D'Orbigny (p. 19).

FIGURE 1. Front view, × 200. U. S. G. S. station 6451.

Bolivina caelata Cushman, n. sp. (p. 19).

FIGURE 2. Front view, × 100. U. S. G. S. station 7213.

Clavulina byramensis Cushman (p. 22).

FIGURE 3. Front view, × 60. U. S. G. S. station 6455.

Clavulina byramensis Cushman var. turgida Cushman, n. var. (p. 22).

FIGURE 4. Front view of microspheric form, × 60. U. S. G. S. station 5264.
FIGURE 5. Front view of megalospheric form, × 60. U. S. G. S. station 5264.

Clavulina byramensis Cushman var. extans Cushman, n. var. (p. 22).

FIGURE 6. Front view, × 60. U. S. G. S. station 7238.

PLATE III.

Gaudryina advena Cushman, n. sp. (p. 22).

FIGURE 1. Front view, × 100. U. S. G. S. station 7376.

Bolivina sp. ? (p. 19).

FIGURE 2. Front view, × 140. U. S. G. S. station 6713.

Bulimina sculptilis Cushman, n. sp. (p. 23).

FIGURE 3. Front view, × 100. U. S. G. S. station 6452.

Gaudryina quadrangularis Bagg (p. 21).

FIGURE 4. Front view, × 60. U. S. G. S. station 7238.

Gaudryina triangularis Cushman (p. 21).

FIGURE 5. Front view, × 140. U. S. G. S. station 7671.

Buliminella contraria (Reuss) Cushman (p. 23).

FIGURE 6. Apertural view, × 140. U. S. G. S. station 6647.

Cassidulina crassa D'Orbigny (p. 24).

FIGURE 7. Apertural view, × 140. U. S. G. S. station 6447.

Lagena sulcata (Walker and Jacob) Parker and Jones (p. 25)

FIGURE 8. Front view, × 125. U. S. G. S. station 6454.

Lagena cookei Cushman, n. sp. (p. 25).

FIGURE 9. Front view, × 125. U. S. G. S. station 6749.
FIGURE 10. Apertural view, × 125. U. S. G. S. station 6749.

Lagena semistriata Williamson (p. 26).

FIGURE 11. Front view, × 125. U. S. G. S. station 6749.

Lagena laevigata (Reuss) Terrigi (p. 25).

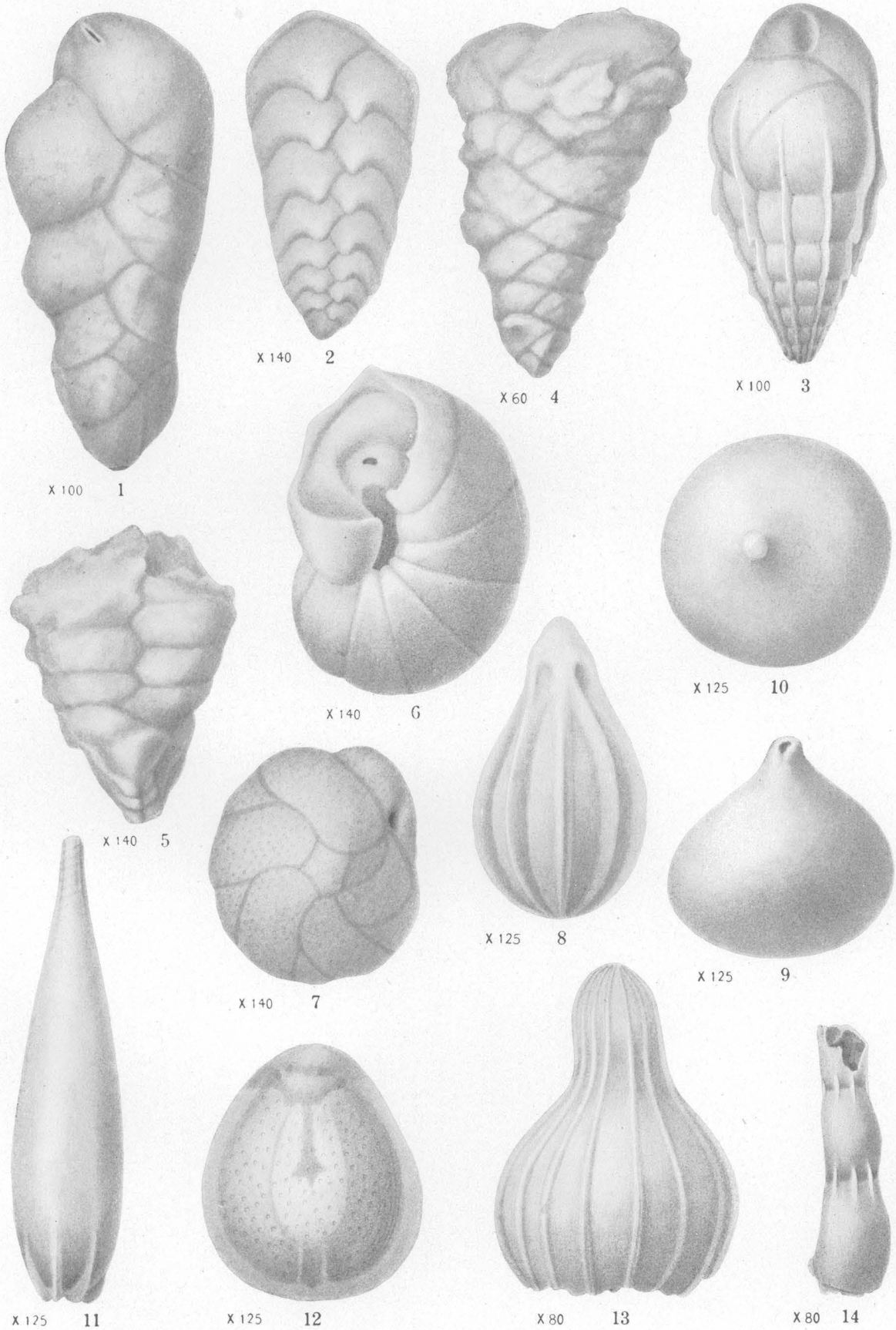
FIGURE 12. Front view, × 125. U. S. G. S. station 7376.

Nodosaria cf. N. pauciloculata Cushman (p. 28).

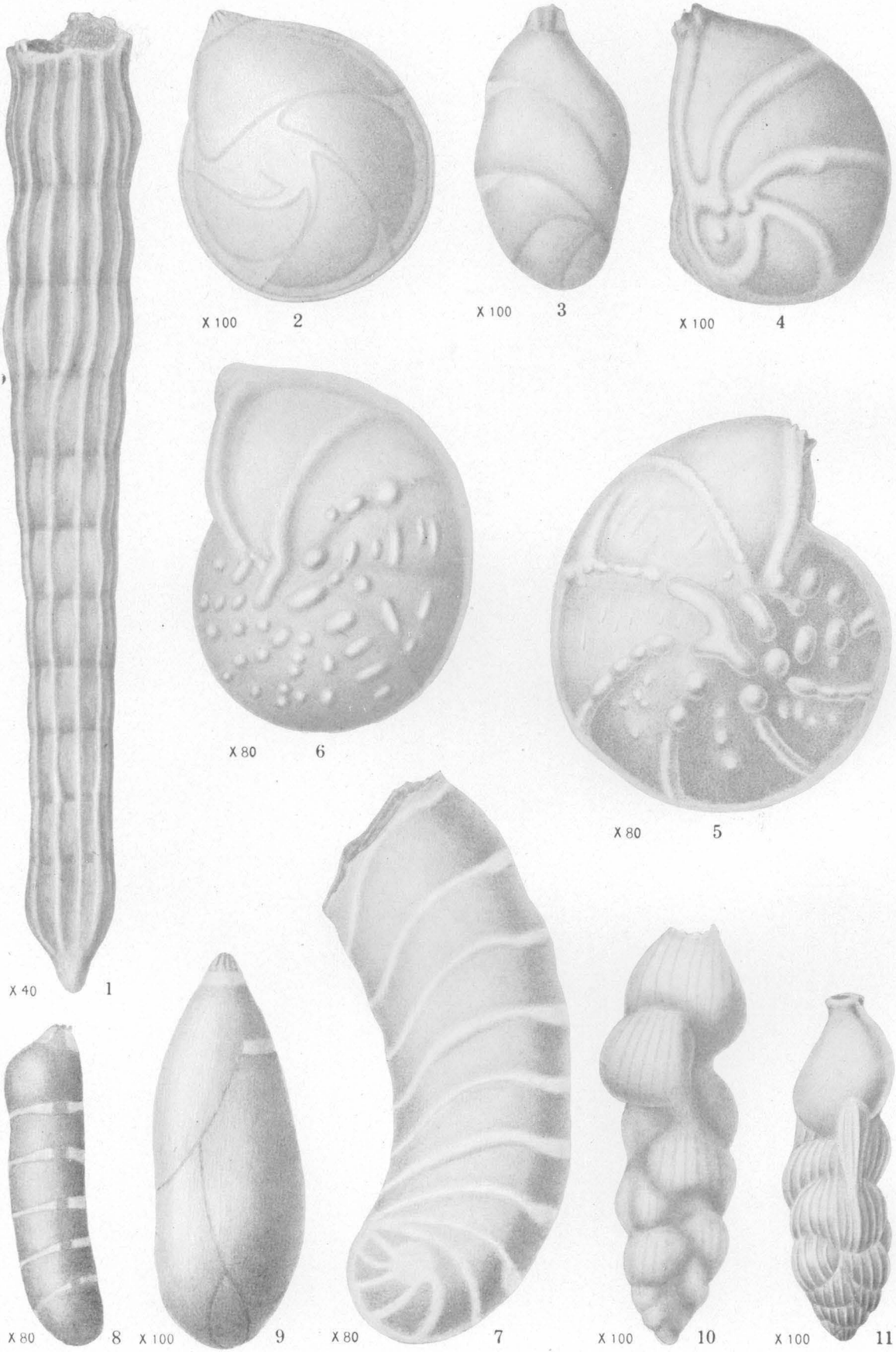
FIGURE 13. Front view of last chamber, × 80. U. S. G. S. station 6749.

Nodosaria catenulata H. B. Brady (p. 28).

FIGURE 14. Front view of broken specimen, showing two chambers and costae above the connecting area, × 80. U. S. G. S. station 7156.



FORAMINIFERA OF THE VICKSBURG GROUP.



FORAMINIFERA OF THE VICKSBURG GROUP.

PLATE IV.

Nodosaria vertebralis (Batsch) H. B. Brady (p. 27).

FIGURE 1. Front view, × 40. U. S. G. S. station 5264.

Cristellaria convergens Bornemann (p. 28).

FIGURE 2. Side view, × 100. U. S. G. S. station 8752.

Cristellaria italica (Defrance) D'Orbigny (p. 30).

FIGURE 3. Side view, × 100. U. S. G. S. station 6749.

Cristellaria vicksburgensis Cushan mvar. aperta Cushman, n. var. (p. 29).

FIGURE 4. Side view, × 100. U. S. G. S. station 8240.

Cristellaria submamilligera Cushman (p. 30).

FIGURE 5. Side view, × 80. U. S. G. S. station 6713.
FIGURE 6. Side view, × 80. U. S. G. S. station 5609.

Cristellaria sp. ? (p. 30).

FIGURE 7. Side view, × 80. U. S. G. S. station 8752.

Vaginulina legumen (Linné) D'Orbigny var. elegans D'Orbigny (p. 30).

FIGURE 8. Side view, × 80. U. S. G. S. station 7213.

Polymorphina amygdaloides Reuss (p. 32).

FIGURE 9. Side view, × 100. U. S. G. S. station 6448.

Uvigerina byramensis Cushman (p. 34).

FIGURE 10. Side view, × 100. U. S. G. S. station 7376.
FIGURE 11. Side view, another specimen, × 100. U. S. G. S. station 7376.

PLATE V.

Polymorphina byramensis Cushman (p. 31).

FIGURE 1. Apertural view, × 80. U. S. G. S. station 8752.
FIGURE 2. Front view, × 80. U. S. G. S. station 8752.
FIGURE 3. Front view, × 80. U. S. G. S. station 8752.
FIGURE 4. Front view of young specimen, × 125. U. S. G. S. station 8752.
FIGURE 5. Young specimen viewed from opposite side, × 125. U. S. G. S. station 8752.

Polymorphina problema D'Orbigny (p. 33).

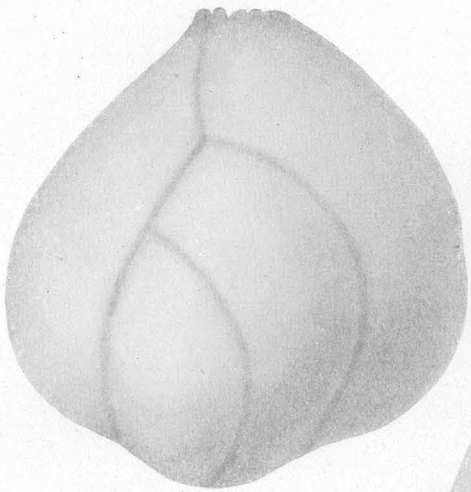
FIGURE 6. Front view, × 80. U. S. G. S. station 7372.

Polymorphina regina H. B. Brady, Parker, and Jones var. rutila Cushman, n. var. (p. 34).

FIGURE 7. Front view, × 100. U. S. G. S. station 7376.
FIGURE 8. Front view, × 100. U. S. G. S. station 7376.

Polymorphina amygdaloides Reuss (p. 32).

FIGURE 9. Front view, × 100. U. S. G. S. station 7156.



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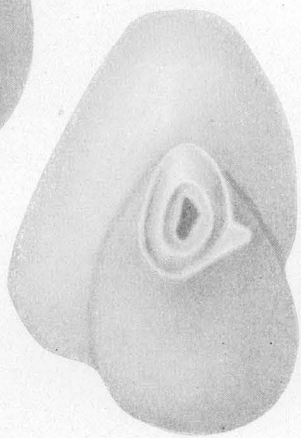

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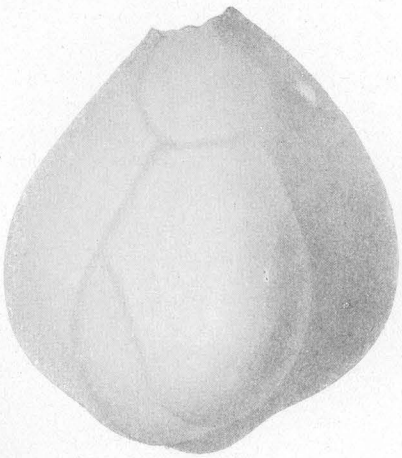

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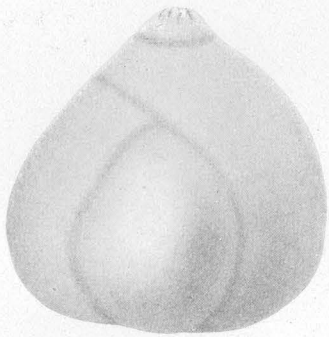

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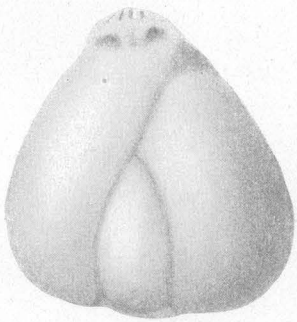

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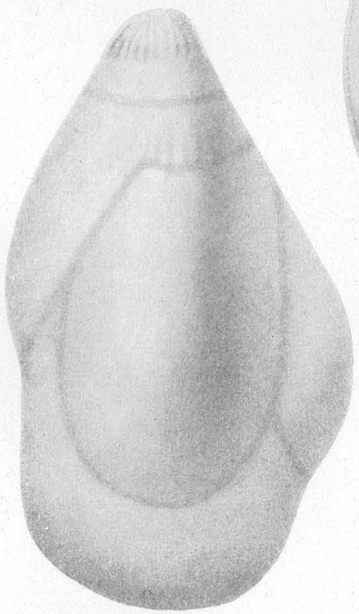

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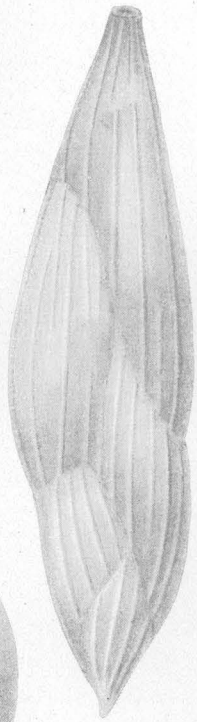

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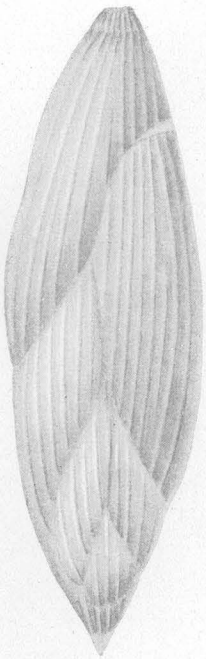

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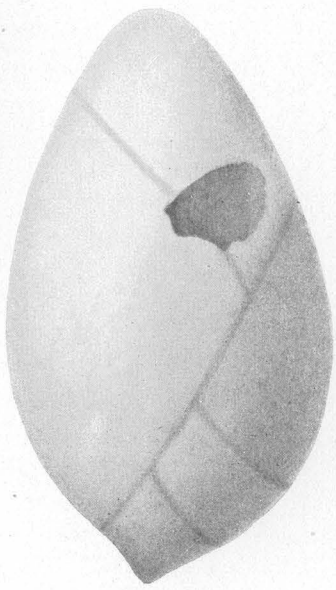

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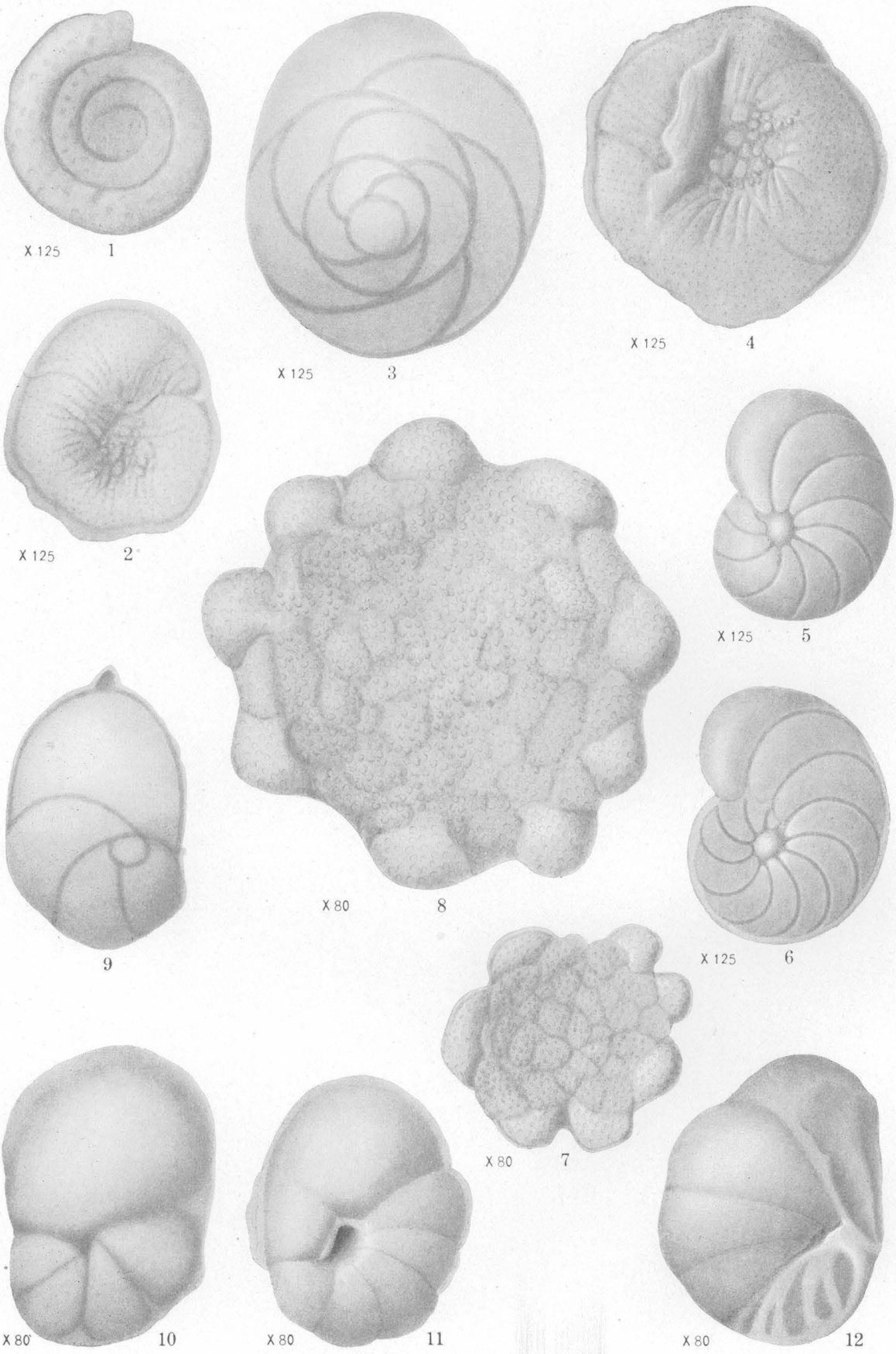
FORAMINIFERA OF THE VICKSBURG GROUP.



FORAMINIFERA OF THE VICKSBURG GROUP.

PLATE VI.

Spirillina vivipara Ehrenberg (p. 36.)

FIGURE 1. Dorsal view, × 125. U. S. G. S. station 6733.

Discorbis patelliformis (H. B. Brady) Cushman (p. 38).

FIGURE 2. Ventral view of young specimen, × 125. U. S. G. S. station 7376.
FIGURE 3. Dorsal view of adult, × 125. U. S. G. S. station 7376
FIGURE 4. Ventral view of adult, × 125. U. S. G. S. station 7376.

Discorbis sp.? (p. 39).

FIGURE 5. Ventral view, × 125. U. S. G. S. station 8240.
FIGURE 6. Dorsal view of another specimen, × 125. U. S. G. S. station 8240.

Planorbulina larvata Parker and Jones (p. 39).

FIGURE 7. Ventral view of young specimen, × 80. U. S. G. S. station 6446.
FIGURE 8. Dorsal view of adult, × 80. U. S. G. S. station 6446.

Pulvinulina sagra (D'Orbigny) Cushman (p. 45).

FIGURE 9. Dorsal view, × 80. U. S. G. S. station 6446.
FIGURE 10. Ventral view of another specimen, × 80. U. S. G. S. station 6446.

Pulvinulina glabrata Cushman (p. 45).

FIGURE 11. Ventral view, × 80. U. S. G. S. station 6448.
FIGURE 12. Dorsal view of another specimen, × 80. U. S. G. S. station 6448.

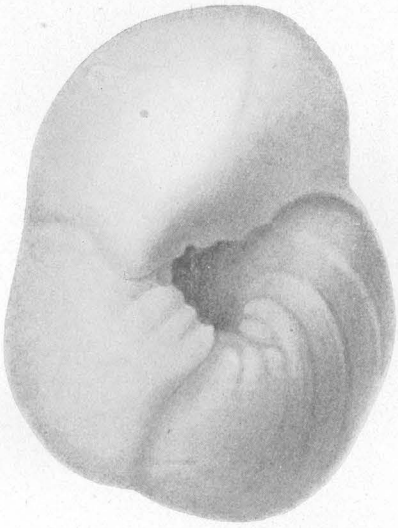
PLATE VII.

Pulvinulina mariannensis Cushman, n. sp. (p. 44).

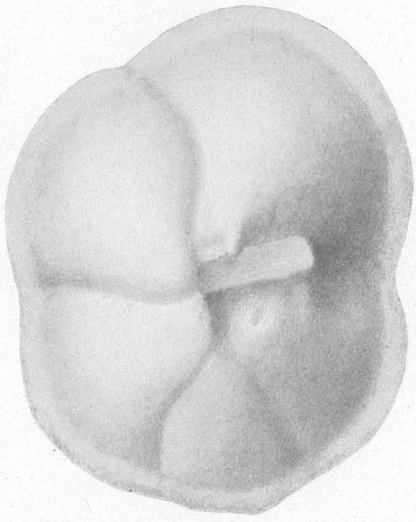
FIGURE 1. Ventral view, × 80. U. S. G. S. station 7156.
FIGURE 2. Ventral view of another specimen, × 80. U. S. G. S. station 7156.
FIGURE 3. Dorsal view, × 60. U. S. G. S. station 7156.

Rotalia advena Cushman, n. sp. (p. 46).

FIGURE 4. Apertural view, × 80. U. S. G. S. station 7156.
FIGURE 5. Ventral view, × 80. U. S. G. S. station 7156.
FIGURE 6. Dorsal view of another specimen, × 80. U. S. G. S. station 7156.



X 80 1



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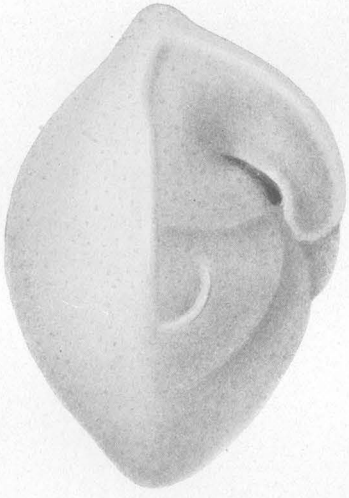

X 80 4

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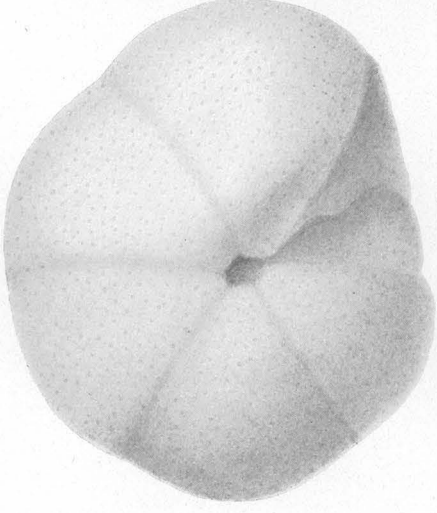

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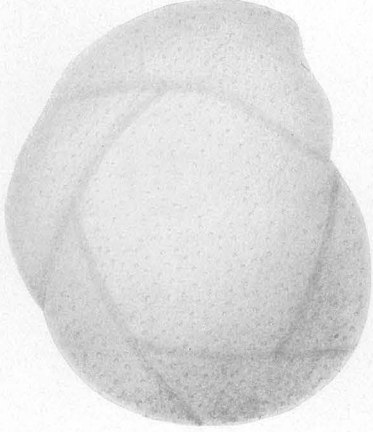
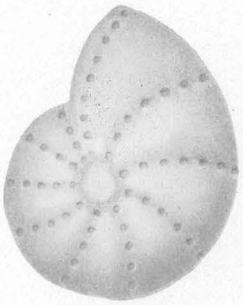


X 80 6

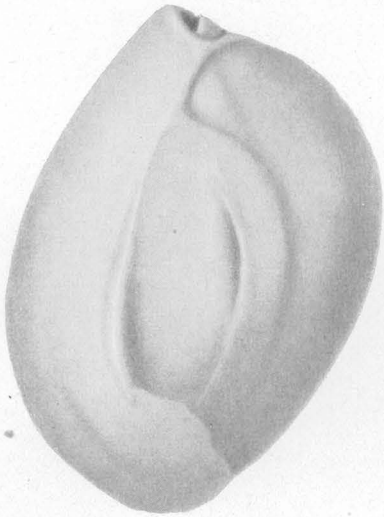
FORAMINIFERA OF THE VICKSBURG GROUP.



X 125 1

X 125 2

X 125 3



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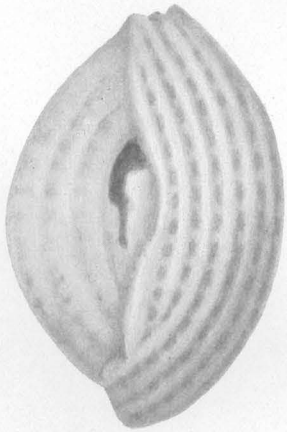

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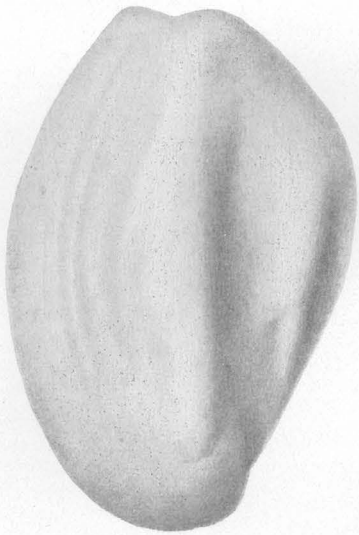

X 125 7

FORAMINIFERA OF THE VICKSBURG GROUP.

PLATE VIII.

Polystomella poeyana D'Orbigny (p. 48).

FIGURE 1. Side view, × 125. U. S. G. S. station 7372.

Quinqueloculina limbata D'Orbigny (p. 54).

FIGURE 2. Side view, × 125. U. S. G. S. station 6454.

Massilina occlusa Cushman var. costulata Cushman (p. 55).

FIGURE 3. Side view, × 125. U. S. G. S. station 7376.

Quinqueloculina lamarckiana D'Orbigny (p. 52).

FIGURE 4. Side view, × 100. U. S. G. S. station 6447.

Quinqueloculina byramensis Cushman, n. sp. (p. 54).

FIGURE 5. Side view, × 125. U. S. G. S. station 7376.

Triloculina rotunda D'Orbigny (p. 57).

FIGURE 6. Side view, × 125. U. S. G. S. station 6455.

FIGURE 7. Side view of another specimen, × 125. U. S. G. S. station 6455.

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