Gastropods from the Coffee Sand (Upper Cretaceous) of Mississippi

GEOLOGICAL SURVEY PROFESSIONAL PAPER 331-C

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By NORMAN F. SOHL

LATE CRETACEOUS GASTROPODS IN TENNESSEE AND MISSISSIPPI

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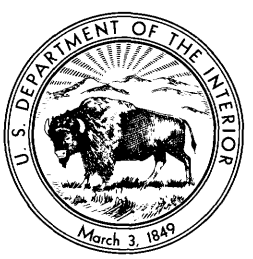
Descriptions of Upper Cretaceous gastropods from the Mississippi embayment of the Gulf Coastal Plain



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GASTROPODS FROM THE COFFEE SAND (UPPER CRETACEOUS) OF MISSISSIPPI

By NORMAN F. SOHL

ABSTRACT

The Coffee Sand in Mississippi consists of a body of massive to crossbedded calcareous glauconitic sand about 200 feet thick. To the south in Lee County, Miss., it interfingers with the more calcareous Demopolis and Mooreville Chalks.

The Coffee Sand occupies the lower and middle parts of the *Exogyra ponderosa* zone up to and including beds equivalent to the *Diploschiza cretacea* zone (=lower and middle Campanian of Europe). The lower part of the Coffee Sand correlates with the Mooreville Chalk and Blufftown Formation of Alabama and Georgia, the Black Creek Formation (in part) of North Carolina, and the Merchantville Formation of New Jersey. The upper part of the Coffee Sand, including the Tupelo Tongue, correlates with the Wolfe City Sand and Pecan Gap Chalk Members of the Taylor Marl of Texas and with the lower part of the Demopolis Chalk and basal part of the Cusseta Sand of Alabama and Georgia.

The invertebrate fauna of the Coffee Sand is dominated by mollusks. Of these, the pelecypods are commonly more abundant and diverse than either the gastropods, cepalopods, or scaphopods. The fauna of the lower part of the Coffee Sand is a normal marine Upper Cretaceous sand-facies assemblage typical of the level-bottom shelf area. It is characterized by its variety of gastropods and numerous burrowing pelecypods. In contrast the fauna of the upper part of the Coffee Sand is dominated by surface-dwelling and attached pelecypods that resemble the fossil assemblages of the chalk facies.

The gastropod fauna of the Coffee Sand consists of 63 species that are assigned to 53 genera. Twenty-one of the species are described as new. Unlike the pelecypods, which are geographically widespread, the gastropods of the Coffee Sand have an endemic aspect, with most species restricted to the Mississippi embayment area. Interestingly, these gastropods, although geographically restricted, are ancestral to widespread species found in the younger beds of the *Exogyra costata* zone.

INTRODUCTION

Aside from the faunal lists provided by Stephenson and Monroe (1940), only scattered references indicate the nature of the invertebrate fauna of the Coffee Sand of Mississippi. In 1955, L. W. Stephenson of the U.S. Geological Survey guided me to an exposure of the Coffee Sand about 2 miles west of Ratliff in Lee County, Miss. This exposure had yielded an especially well preserved and diversified fauna that shows considerable affinities to the younger and much better known faunas of the Ripley Formation of Tennessee and Mississippi. The collections that were made during this visit and later (1956) form the principal basis for the taxonomic part of the present paper.

Only the gastropod part of the Coffee Sand fauna is described herein, but tentative identifications of the remainder of the mollusks are included as aids in correlation and determination of the affinities of the fauna.

Grateful acknowledgment is made to Dr. L. W. Stephenson, who guided me to the Coffee Sand exposures in Lee County, Miss. My colleagues of the U.S. Geological Survey, D. W. Taylor and R. W. Imlay, are due special thanks for reviewing the manuscript. The photographs were made by R. H. McKinney.

OUTLINE OF COFFEE SAND STRATIGRAPHY

Safford (1869, p. 361) first applied the name Coffee Sand to what he considered the lowest Cretaceous deposits in Tennessee. The name is derived from typical exposures at Coffee Landing on the Tennessee River, Hardin County, Tenn. Stephenson (1914, p. 14) proved the Coffee Sand to be the lateral equivalent of the lower parts of the Selma Chalk of Mississippi and not, as Safford supposed, the equivalent of that part of the Eutaw Formation below the Tombigbee Sand Member.

TENNESSEE

In Tennessee both the Eutaw Formation and the overlying Coffee Sand consist of massive to crossbedded micaceous glauconitic sands and clays. Because the two formations are so similar, most authors (Jewell, 1931; Whitlach, 1940) have found it impossible to map them separately. Wade (1920, 1926) also considered the Coffee Sand as an upper member of the Eutaw Formation. More recently, however, Pryor

(1960) considered the Coffee Sand as a distinct formation.

The Coffee Sand in the type area of Hardin County is somewhat more than 200 feet thick, but it thins rapidly northward (Glenn, 1904; Wade, 1920). In Tennessee the Coffee Sand has yielded fossil plants (Berry, 1919). Also, lignitized logs and lenses of carbonaceous clay are common. Except for wood-boring mollusks and an insect preserved in amber (Wade 1920, p. 56), invertebrates are unknown.

MISSISSIPPI

The most comprehensive account of the Coffee Sand in Mississippi was published by Stephenson and Monroe (1940, p. 143–175), who provided numerous measured stratigraphic sections, local details, and a summary of the fauna. Various county reports of the Mississippi Geological Survey contain additional details (Vestal, 1946; Parks, 1960). Mellen (1958) discussed the downdip character of the formation.

The formation crops out only in the more northerly counties (fig. 20), where it is about 200 feet thick. To the south in Mississippi, the lower part of the Coffee Sand interfingers with the Mooreville Chalk in southern Lee County (fig. 19), and the upper part interfingers with the Demopolis Chalk. This upper part has been designated by Stephenson and Monroe as the Tupelo Tongue (see below).

Stephenson and Monroe stated (1940, p. 144)

> The deposits in Mississippi are, in general, like the typical materials except that from the Tennessee line southward the bedding in parts of the formation becomes more massive until in the valley of Old Town Creek in Lee County the Tupelo tongue of the formation * * * presents a massive uniform structure similar to that of the Tombigbee sand member of the Eutaw. These more massive facies were deposited in deeper water than the typical deposits and in places yield marine fossils.
>
> The Tupelo tongue of the Coffee sand [fig. 19] is a body of dark-gray mostly massive calcareous, glauconitic sand extending southward from the Coffee sand of northern Lee County into the main body of the Selma chalk, being underlain by a corresponding tongue of the Selma chalk, the Mooreville tongue [fig. 19], which extends northward from the basal part of the Selma * * *. The exposure in an abandoned portion of the Fulton road, 1.5 miles east of Tupelo is considered the type section.
>
> The thickness of the Tupelo tongue, as shown by logs of wells at and near Tupelo, is approximately 100 feet.

DESCRIPTION OF COLLECTION LOCALITIES

In the following descriptions the geographic position of each locality is followed by the U.S. Geological Survey Mesozoic locality number, name of collector, and date of collection. At some localities

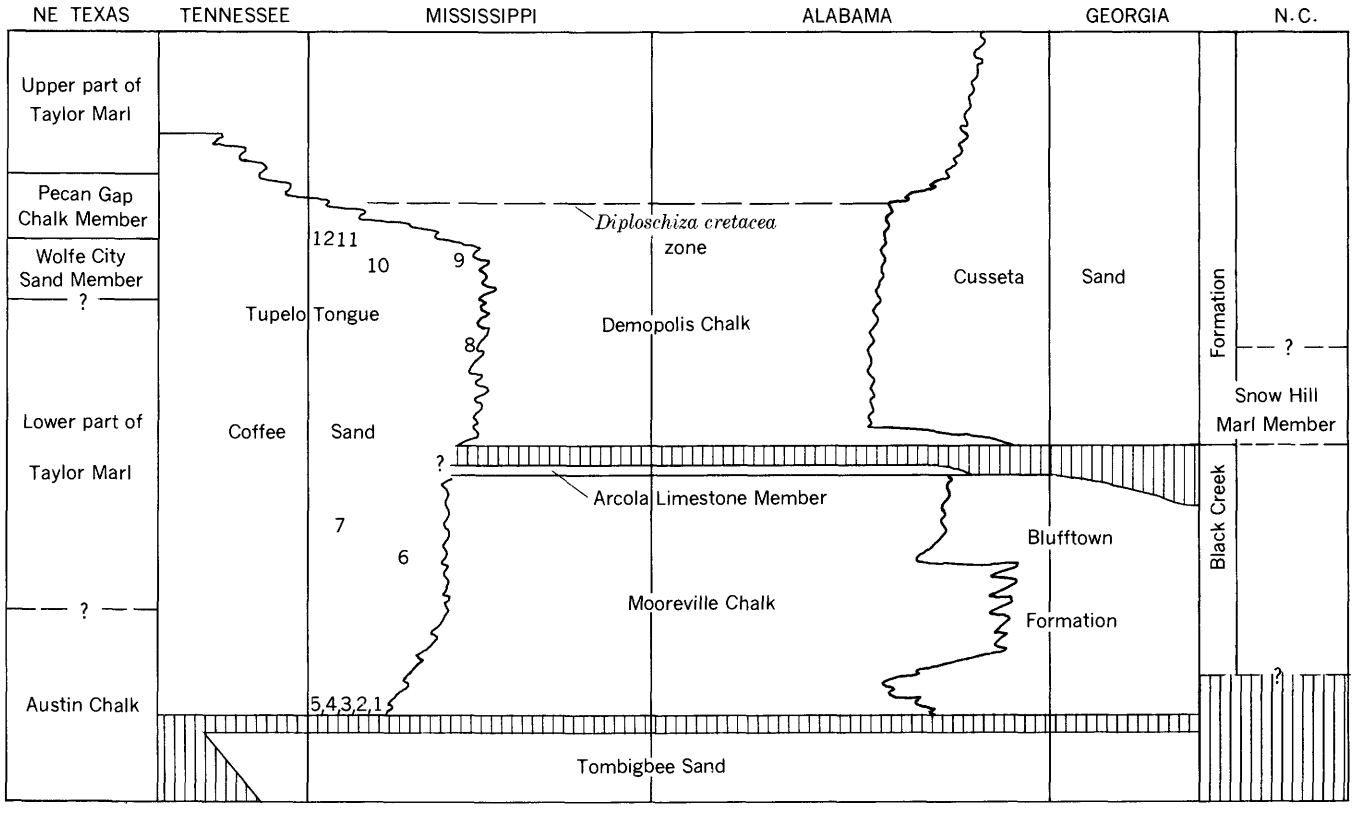

FIGURE 19.—Correlation of the Upper Cretaceous rocks of the *Exogyra ponderosa* zone of the Gulf Coastal Plain and North Carolina. (Modified from Monroe, 1947). Numbers indicate approximate stratigraphic level of collection localities.

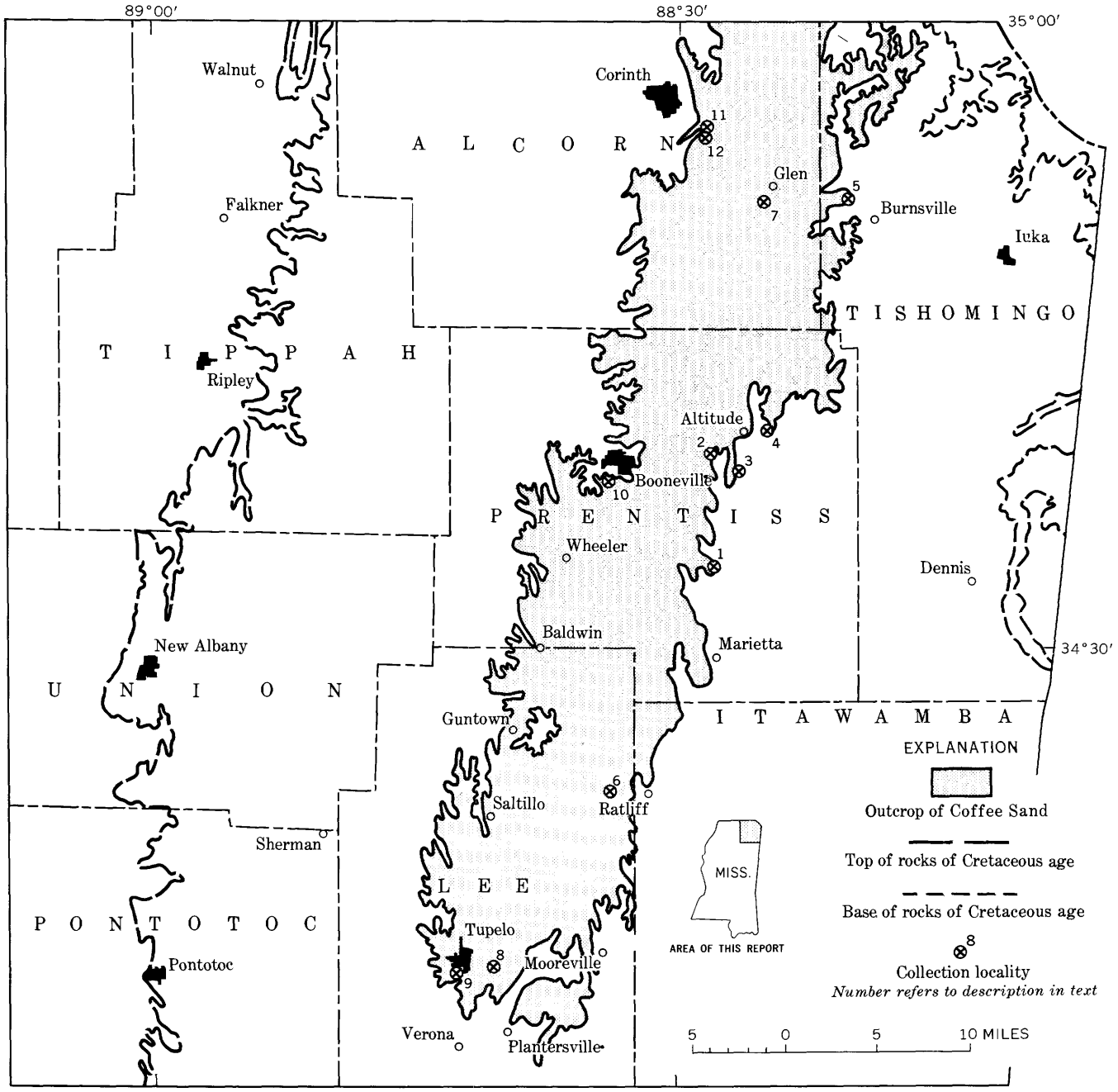

FIGURE 20.—Map of northeastern Mississippi showing distribution of the Coffee Sand and collection localities.

several collections were made and separate numbers have been assigned. Published measured sections are available for most localities, and therefore only short notations as to stratigraphic position have been appended.

Locality 1.—Roadcut on the northeast-facing slope of Young's Creek valley (sec. 9, T. 6 S., R. 8. E.), Prentiss County, Miss., USGS 17783, W. H. Monroe, 1938; USGS 19080–19082, W. H. Monroe, 1940. Stephenson and Monroe (1940, p. 159) have given a measured section at this locality. Collection USGS 17783 came from 8 to 10 feet above the contact of the Coffee Sand and the Tombigbee Sand Member of the Eutaw Formation and USGS 19080–82 came from about 20 feet above the contact.

Locality 2.—Six miles east of Booneville on road to Hare's old mill site, Prentiss County, Miss. USGS 6454, L. W. Stephenson, 1909; USGS 6909, L. W. Stephenson, 1910; USGS 9501, L. W. Stephenson, 1915.

Stephenson and Monroe (1940, p. 159) noted a 45-foot section of micaceous glauconitic sand of the Coffee Sand with well-preserved fossils in the lower 5 feet. These beds are in the lower part of the Coffee Sand and are probably equivalent in position to the fossiliferous beds of the Hare's old mill site locality to the east (loc. 4).

Locality 3.—Cuts on east-facing slope of hill, just below curve in road, 2.1 miles south of Altitude, near center, SE¼, sec. 8, T. 5 S, R. 8 E., Prentiss County, Miss. USGS 20304, W. H. Monroe, D. H. Eargle, L. C. Conant, 1946.

According to the accompanying field label, this collection is from two sandstone beds that are 7 feet apart and about 8–15 feet above a unit of dark gray shaley clay. These sands appear to belong in the basal part of the Coffee Sand.

Locality 4.—Hare's old mill site on Big Brown Creek, 9 miles east of Booneville, Prentiss County, Miss., USGS 6458, L. W. Stephenson, 1909; USGS 6910, L. W. Stephenson, 1910; USGS 9502, L. W. Stephenson, 1915.

At this locality Stephenson and Monroe (1940, p. 159) noted

> * * * the upper 30 feet of the 80-foot exposure on the steep hill east of the creek is referred to the Coffee sand * * * An 8-foot ferruginous layer with its base about 50 feet above the bed of the creek contains numerous internal and external molds of fossil shells * * *

The base of the section is assigned to the Tombigbee Sand Member of the Eutaw Formation. The contact is not exposed at this section, but Tombigbee fossils are noted from 20 feet above the base of the section. The Coffee fossils are therefore from near the base of the formation.

Locality 5.—Cut of Southern Railway, 2 miles northwest of Burnsville, Tishomingo County, Miss. USGS 6461, L. W. Stephenson, 1909.

Stephenson collected fossils from concretionary masses of sandstone about 22 feet above the base of the exposed section. Considering that some cuts on the same railroad a little east of this locality expose sands of the Tombigbee Sand Member of the Eutaw Formation, locality 6461 must be in the basal part of the Coffee Sand.

Locality 6.—Roadcut on north-facing slope of Mantachie Creek Valley, S½, sec. 9, T. 8 S., R. 7 E., 2 miles due west of Ratliff, Lee County, Miss. USGS 17254, W. H. Monroe, 1936; USGS 17809, L. W. Stephenson and W. H. Monroe, 1938; USGS 25483, L. W. Stephenson and N. F. Sohl, 1955; USGS 26338, N. F. Sohl and H. I. Saunders, 1956.

Fossils occur abundantly at this locality in the lower few feet of a 35-foot section of massive dark-colored micaceous glauconitic clayey sand. This locality affords the most diverse fauna yet found in the formation. The exposed beds appear to lie at about the middle of the lower part of the Coffee Sand, stratigraphically higher than localities 1–5 and lower than localities 7–10.

Locality 7.—Cut on Illinois Central Railroad 10.25 miles southeast of Corinth, Alcorn County, Miss. USGS 9498, L. W. Stephenson, 1915.

Stephenson and Monroe (1940, p. 165) noted

> * * * 10 to 15 feet of reddish-brown massive ferruginous sand with an irregular concretionary layer of fossiliferous ferruginous sandstone about 8 feet above the base, overlain by 4 to 6 feet of pebbly surficial deposit.

The collection (USGS 9498) comes from the above-mentioned ferruginous sandstone. This section is estimated to be some 60–70 feet above the base of the Coffee Sand and approximately at the same, or at a slightly higher level than that at locality 6.

Locality 8.—Abandoned cut of Tupelo-Fulton road on westward-facing slope of Old Town Creek (sec. 33, T. 9 S., R. 6 E.), 1½ miles east of Tupelo, Lee County, Miss. USGS 6453, L. W. Stephenson, 1909; USGS 6900, L. W. Stephenson, 1910.

This locality is at the type section of the Tupelo Tongue of the Coffee Sand. Stephenson and Monroe (1940, p. 150) noted 80 feet of sand and calcareous sandstone here. Collections 6453 and 6900 are from 25 to 40 feet above the base of the section.

Locality 9.—Cut on U.S. Highway 45 on north-facing slope of Kings Creek valley (sec. 31, T. 9 S., R. 6 E.), half a mile south of St. Louis-San Francisco Rail-

way at west edge of Tupelo, Lee County, Miss. USGS 17260, W. H. Monroe, 1936.

Stephenson and Monroe (1940, p. 155) described a 64-foot measured section at this locality that includes beds of the Tupelo Tongue of the Coffee Sand overlain by chalk of the Demopolis. The collection came from the uppermost unit of the Coffee Sand.

Locality 10.—Bluff of small branch of Boyer Creek, three-fourths of a mile south of Boonville, Prentiss County, Miss. USGS 6907, L. W. Stephenson, 1910.

This collection came from float concretions probably derived from unit 2 in the lower part of a 35-foot section of Coffee Sand measured by Stephenson and Monroe (1940, p. 161). This unit is probably within the uppermost 50 feet of the formation.

Locality 11.—Cut of Southern Railway, 3 miles southeast of Corinth, Alcorn County, Miss. USGS 64606, L. W. Stephenson, 1909.

According to L. W. Stephenson's field notes, this collection came from the very top of the Coffee Sand immediately below the base of the Demopolis Chalk.

Locality 12.—Stevenson's cut on Illinois Central Railroad, 2½ miles southeast of the station at Corinth, Alcorn County, Miss. USGS 9497. L. W. Stephenson, 1915.

This collection came from the upper 6 to 9 feet of the Coffee Sand (Stephenson and Monroe, 1940, p. 172).

CORRELATION OF THE COFFEE SAND

General statement.—These notes on the regional correlation of the Coffee Sand are preliminary. Certain probable discrepancies of previous correlations are pointed out, but many of the problems involved cannot be solved until the faunas of other critical areas have been studied.

The Coffee Sand includes beds of the lower and middle parts of the *Exogyra ponderosa* zone as defined by Stephenson (1914). Compared to the Cretaceous section of the Chattahoochee River region, Georgia, it is in part equivalent to the Blufftown Formation and in part equivalent to the lower part of the Cusseta Sand. As yet the mollusks offer only a general correlation with the Texas Cretaceous section. The upper part (Tupelo Tongue) of the Coffee Sand is equivalent in part to the Annona Chalk and and to the Pecan Gap Chalk and Wolfe City Sand Members of the Taylor Marl. Correlation of the lower part of the Coffee Sand with the Texas section is in doubt, but the common occurrence of *Delawarella danei* Young in Mississippi, Arkansas, and Oklahoma indicates partial equivalence of the lower part of the Coffee Sand with parts of the Gober Chalk (of Young, 1963) of Texas.

Mississippi.—The Coffee Sand unconformably overlies the Tombigbee Sand Member of the Eutaw Formation from the southern Tennessee State line to the northwestern part of Itawamba County, Miss. From this point south it interfingers with and overlies a thin northward extending tongue of the Mooreville Chalk. It is conformably overlain by the Demopolis Chalk and interfingers with the lower part of that formation in Lee County. Therefore, it includes beds equivalent to all of the Mooreville Chalk and the lower part of the Demopolis. In terms of zones this involves the lower and medial parts of the *Exogyra ponderosa* zone, with the upper limit somewhat above the *Diploschiza cretacea* zone (fig. 19).

The change in facies between the chalky rocks of the Mooreville and Demopolis and the sand facies of the Coffee is such that there is great difficulty in comparing the faunas. *Diploschiza cretacea* is a fine example of this phenomenon. Through the chalk facies from central Alabama to Texas this diminutive clam is used as a zonal marker. Its occurrence in Mississippi can be traced at presumably the same stratigraphic position from the Alabama-Mississippi State line to within a few miles south of Tupelo. Here the Demopolis Chalk interfingers with the sands of the Tupelo Tongue. With the change from chalk to sand, *Diploschiza cretacea* disappears and is not to be found to the north.

Oysters serve as a second example. In general they are the most abundant identifiable molluscan element in the chalk, but in the Coffee Sand, except for the uppermost beds, they are rare and thin shelled and are associated with a more diversified molluscan fauna. Such facies changes in Mississippi hamper precise paleontological correlations.

Texas.—General agreement that the Tupelo Tongue of the Coffee Sand is correlative with the Annona Chalk of Arkansas and the Pecan Gap Chalk Member of the Taylor Marl of northeastern Texas is based on the common occurrence of *Diploschiza cretacea* (Stephenson, 1942). The remainder of the upper Coffee Sand faunas resemble those of the Wolfe City Sand Member of the Taylor.

Stephenson and others (1942) correlated the lower part of the Coffee Sand with the lower part of the Taylor Marl and the upper part of the Austin Chalk. This correlation agrees with a statement by Monroe (1947) that both Austin and Taylor Foraminifera are present in the Coffee Sand. Aside from ammonites the molluscan fauna of the lower part of the Taylor and Austin is poorly known and affords little basis at present for exact comparison.

The best basis for comparison is the common occurrence of *Delawarella danei* Young in the Coffee Sand at locality 3, in the Ozan Formation of Arkansas (Dane, 1929, pl. 10) and "from a formation equivalent to the Gober Chalk" (Young, 1963, p. 114) in Oklahoma. Young believed *D. danei* to be "no more than a coarsely ornamented geographic subspecies of *Delawarella delawarensis* (Morton)." The best preserved specimen from the Coffee Sand is only a fragment but is closely similar in character to Dane's (1929, pl. 10) figured specimen from Arkansas. Young (1963) accepted the Gober Chalk as of formation rank, but Stephenson (1942) considered it as a tongue in the upper part of the Austin Chalk.

Therefore, in terms of the Texas section, the Coffee Sand of Mississippi includes stratigraphic equivalents of at least the Gober Tongue of the Austin Chalk and all but perhaps the uppermost part of the Taylor Marl.

Georgia-Alabama.—Stephenson and others (1942) and Monroe (1947) have correlated the lower part of the Coffee Sand with the Blufftown Formation and the Tupelo Tongue of the Coffee Sand with the lower parts of the Cusseta Sand of the Chattahoochee River region of Georgia and Alabama. Preliminary study of the Upper Cretaceous mollusks of these areas suggests that some adjustment of these correlations is necessary.

The pelecypods from the lowest parts of the Coffee Sand (locs. 1–5) are most similar to those of the medial part rather than of the basal beds of the Blufftown Formation. The pelecypods from a somewhat higher position in the lower part of the Coffee Sand (locs. 6, 7) are closer to those of the upper beds of Blufftown Formation. A correlation with those beds is supported by the common occurrence of a gastropod, *Potamides cowickeensis*, at locality 6 and in the upper beds of the Blufftown Formation.

The fauna from the upper part of the Coffee Sand, especially that of locality 10, resembles the younger fauna of the Ripley Formation of Tennessee more than it resembles the older faunas from the lower part of the Coffee Sand. Correlation of the upper part of the Coffee Sand with the lower part of the Cusseta Sand of Alabama is not firmly established but is suggested by stratigraphic succession and by the presence of a few species in common, such as *Aphrodina regia.*

North Carolina.—The Coffee Sand of Mississippi can be correlated with the Upper Cretaceous section of North Carolina only indirectly by the way of the Chattahoochee River region section. For correlation, the most significant fauna in North Carolina is that of the Snow Hill Marl Member of the Black Creek Formation. The Snow Hill was proposed as the uppermost fossiliferous member of the Black Creek Formation by Stephenson (1923). More recently Brett and Wheeler (1961) placed the Snow Hill in the Peedee. Stephenson (1942) correlated the Snow Hill Member with the uppermost part of the Cusseta Sand of Alabama and the upper part of the Demopolis Chalk of Alabama and Mississippi. According to his correlation, none of the Snow Hill Member would be equivalent to any part of the Coffee Sand.

In terms of common species the fauna of the type Snow Hill Member described by Stephenson (1923) bears a striking similarity to the basal rather than to the upper beds of the Cusseta Sand of Georgia and Alabama. A few of the more important species common to the basal Cusseta and type Snow Hill are:

Ostrea blackensis Stephenson
Ostrea pratti Stephenson
Trigonarca maconensis Conrad
Trigonia bartrami Stephenson
Veniella mullinensis Stephenson
Crassatella roodensis Stephenson
Aphrodina regia Conrad

In addition, *Ostrea* sp. (Stephenson 1923, p. 141) from North Carolina is conspecific with an undescribed species from the basal Cusseta of Alabama and Georgia.

If the type Snow Hill is a correlative of the basal Cusseta, then the upper part of the Coffee Sand probably is correlative also.

New Jersey.—Ammonites (table 1) are the most significant fossils for correlation found in common in the Coffee Sand and the New Jersey section. *Menabites* (*Delawarella*) sp. from the Coffee Sand (locs. 4, and 6) may be conspecific with *M.* (*D.*) *delawarensis* Morton of the Merchantville Formation. Likewise, *Placentriceras* sp. from the Coffee Sand is similar to the species *P. placenta* from the Merchantville. Additional evidence of correlation of the lower part of the Coffee Sand with the Merchantville Formation of New Jersey is the common occurrence of *Scaphites hippocrepis* in New Jersey and in the middle and upper parts of the Blufftown Formation of Alabama and Georgia. These parts of the Blufftown correspond to the lower part of the Coffee Sand.

ANALYSIS OF THE COFFEE SAND FAUNA

Mollusca dominate the invertebrate fauna of the Coffee Sand both in abundance of individuals and in diversity. Foraminifera and ostracodes are present but are not especially abundant (Cushman, 1946, Mellen, 1958). Sponges are represented by *Cliona* and

worms by the calcareous tubes of *Longitubus*, *Hamulus*, and *Serpula*. Fossil echinoids in the Coffee Sand are recorded by a few spines. Although corals are locally common in other Upper Cretaceous units of the Mississippi embayment, none has been found in the Coffee Sand.

The Mollusca (table 1) are represented by 42 genera of pelecypods, 53 genera and subgenera of gastropoda, 2 genera of scaphopods, and 4 genera of cephalopods. With the exception of locality 6, near Ratliff in Lee County, where gastropods are especially diverse, pelecypods dominate the molluscan fauna.

TABLE 1.—*Geographic and stratigraphic distribution of the molluscan species of the Coffee Sand of Mississippi*

Collection	Lower							Upper				
	Collection localities											
	1	2	3	4	5	6	7	8	9	10	11	12
Acmaea sp						×						
Calliomphalus (*Calliomphalus*) *paucispirilus* Sohl, n. sp						×						
(*C.*) sp	×			×								
(*Planolateralus*) *tuberculosus* Sohl, n. sp						×						
Urceolabrum mantachieensis Sohl, n. sp						×						
Teinostoma cf. *T. clara* Sohl						×						
Architectonica (*Granosolarium*) *coffea* Sohl, n. sp						×						
Laxispira lumbricalis Gabb						×						
Laxispira? sp		×										
Haustator trilira (Conrad)	×			×		×	×					
quadrilira (Johnson)	×	×		×		×						
Turritella n. sp							×					
Gegania sp						×						
Potamides cowickeensis Sohl, n. sp						×						
Seila meeki (Wade)						×						
Cerithiella n. sp				?		×						
Acirsa (*Plesioacirsa*?) *gravida* Sohl, n. sp						×						
(*Plesioacirsa*) *culmosa* Sohl, n. sp						×						
Epitoniid? gastropods spp						×						
Thylacus cretaceus Conrad						×						
Anchura aff. *A. substriata* Wade						×						
Graciliala johnsoni Stephenson?						×						
Arrhoges (*Latiala*?) sp		×				×						
Tundora cf. *T. tuberculata* Stephenson						×						
Pterocerella sp						×						
Pugnellus aff. P. *densatus* Conrad										×		
Gyrodes major Wade	?					×	?					
spillmani Gabb	×					×						
Euspira rectilabrum (Conrad)		×				×						
Pseudamaura lepta Sohl, n. sp						×						
Sargana stantoni (Weller)?						×						
Morea corsicanensis depressa Sohl, n. subsp						×						
Lowenstamia funiculus Sohl, n. sp						×						
Stantonella sp						×						
Buccinopsis aff. *B. crassus* (Wade)										×		
Buccinopsis? sp						×						
Cantharus (*Cantharulus*) *lemniscatus* Sohl n. sp					?	×	?					
Lomirosa carinata Sohl, n. sp						×						
Pyrifusus sinuocostatus Sohl, n. sp						×						
Bellifusus sp						×						
Drilluta cf. *D. major* Wade						×						
Hercorhyncus (*Haplovoluta*) *bicarinatus* (Wade)						×						
Remera stephensoni Harbison?						×						
Fusinus? cf. *F. macnairyensis* (Wade)						×						
Lupira disparila Sohl, n. sp						×						
Pyropsis sp. a						×						
sp b		×										
Napulus cf. *fragilis* Sohl						×						
Fulgerca compressilirata Sohl, n. sp						×						
Longoconcha imbricatus Sohl, n. sp		?				×						

TABLE 1.—*Geographic and stratigraphic distribution of the molluscan species of the Coffee Sand of Mississippi*—Continued

Collection	Lower							Upper				
	Collection localities											
	1	2	3	4	5	6	7	8	9	10	11	12
Volutomorpha splendida Sohl, n. sp						×						
Liopeplum spiculatum Sohl, n. sp						×						
Mataxa leioderma Sohl						×						
Paladmete cancellaria (Conrad)?						×						
Mitrinae sp						×						
Amuletum aff. *A. fasceolatum* (Wade)						×						
sp						×						
costata Sohl, n. sp						×						
Beretra preclara Sohl, n. sp						×						
Eoacteon ithyocheilus Sohl, n. sp						×						
Nonacteonina sp						×						
Cylichna? sp						×						
Cylichna (*Cylichnopsis*?) sp						×						
Nucula cf. *N. stantoni* Stephenson		×										
cf. *N. amica* Gardner										×		
n. sp						×						
Nuculana cf. *longifrons* (Conrad)												
cf. *N. tarensis* Stephenson						×						
"*Perissonata*" n. sp						×						
Barbatia lintea (Conrad) small	×											
sp. (large)	×											
Barbatia? sp										×		
Nemodon brevifrons Conrad						×						
cf. *N. neusensis* Stephenson		×				×						
sp				×								
sp. (large)										×		
Glycymeris whiteleyensis Stephenson						×	×					
sp		×										
Breviarca umbonata (Conrad)						×						
Idonearca n. sp	?					×						
cf. *I. carolinensis* (Gabb)		×										
sp				×		×						
wadei Imlay?										×		
Pseudoptera sp						×						
Gervilliopsis sp												×
Pinna? sp						×				?		
Ostrea pulmosa Morton		×						×	×	×		
sloani Stephenson								×			×	
? sp						×						
Exogyra ponderosa Roemer	×	×				×		×	×		×	×
ponderosa erraticostata Stephenson						×						
sp										×		
Gryphaea mutabilis Morton											×	×
convexa (Say)								×	×		×	×
Gryphaeostrea vomer (Morton)								×			×	×
Scabrotrigonia aff. *S. bartrami* (Stephenson)	×	×	×	×								
n. sp							×					
Trigonia sp		×										
Camptonectes berryi (Stephenson)	×					×						
burlingtonensis (Gabb)		×										
bellisculptus (Conrad)				×								
Lima reticulata Forbes						×					×	
aff. *L. reticulata* Forbes		×							×			
Lima? sp							×					×
Anomia argentaria Morton						×		×			×	
Paranomia scabra (Morton)	×	×		?		×			×		×	×
Plicatula? sp				×								
Crenella serica Conrad?						×						
Pholadomya										×		
Anatimya aff. *A. anteradiata* Forbes						×						
Cymella ironensis Stephenson?						×						

TABLE 1.—*Geographic and stratigraphic distribution of the molluscan species of the Coffee Sand of Mississippi*—Continued

Collection	Lower							Upper				
	Collection localities											
	1	2	3	4	5	6	7	8	9	10	11	12
Veniella conradi (Morton)												×
cf. *V. conradi* (Morton)		×			×	×						?
Etea cf. *E. carolinensis* Stephenson						×						
n. sp	×	×		×								
Crassatella aff. *C. roodensis* Stephenson						×						
cf. *C. neusensis* Stephenson							×					
n. sp	×	×		×		×						
Trachycardium carolinensis (Conrad)						×						
n. sp						×						
sp			×							×		
Granocardium dumosum (Conrad)		?		×		×						
sp		×		×								
Pachycardium stantoni (Wade)?										×		
Lucina cf. *L. parva* Stephenson						×	×					
Aphrodina regia Conrad										×		
n. sp						×						
Cyprimeria cf. *C. alta* Conrad	×	×				×						
Leptosolen cf. *L. biplicata* (Conrad)						×						
Legumen ellipticum Conrad						×						
Linearia cf. *L. metastriata* Conrad		×				×						
Caesticorbula crassiplica (Gabb)		×			×	×						
Caryocorbula? sp		×										
Parmicorbula sp						×						
Panope sp				×		×						
Solyma sp						×						
Kummelia sp						×						×
Dentalium sp. (ribbed)						×						
sp. (smooth)						×						
Cadulus sp		×				×						
Baculites sp		×				×						
Placenticeras cf. *P. placenta* (De Kay)	×	×	×	×								
sp						×	?					
Delawarella cf. *D. delawarensis* (Morton)				×		×						
Delawarella danei Young			×									
Eutrephoceras sp						×						

In all respects the fauna of the lower part of the Coffee Sand is more varied than that of the upper part. The fauna contains no pronounced brackish-water elements and consists of genera common in the shallow waters of the shelf area on a mixed sand-silt bottom. Both burrowing pelecypods and those of attached habit are numerous. Both herbivorous and carnivorous gastropods are present.

The reasons for the unusually large number of species at locality 6 as compared with the other localities are not clear. Such diversity may be partly related to the large size of the collections. Nevertheless, the collections from other localities (such as 1–4) are representative and appear to reflect an originally smaller fauna. Preservation is not a major factor because fossils are equally well preserved at other localities. More favorable ecologic conditions for locality 6 remains the most likely major factor in explaining the differences in faunal diversity. An appeal to environmental conditions alone is contradicted, however, by the lithologic similarities of the beds at locality 6 with the beds at localities 1–5.

The fauna of the upper part of the Coffee Sand is less diverse than that of the lower part of the Coffee Sand. It is similar to the fauna found in the chalky phases of units such as the Demopolis Chalk and is dominated by pelecypods. Ostreids, Limas, and anomids, are the common pelecypods, and all are animals that live attached or nestled on the bottom. The fauna of locality 10, near Boonville (fig. 19), is the only apparent exception. The fauna of this locality appears to be more typically a sand-facies fauna, including some clams of burrowing habit as well as a few gastropods.

The fauna from near the top of the Coffee Sand is transitional between the typical sand facies of the Coffee Sand and the overlying Demopolis Chalk. Con-

centrations of *Gryphaea* and ostreid elements at this level are harbingers of a return to deposition of chalk.

GASTROPOD FAUNA

The gastropod fauna of the Coffee Sand consists of 35 definitely assigned species; 28 others are compared to described species or assigned only to genus. These species represent 53 genera and subgenera and form the largest assemblage of gastropods yet reported from a single formation in the *Exogyra ponderosa* zone.

FAUNAL AFFINITIES

The gastropod fauna of the Coffee Sand is a typical gulf coast late Late Cretaceous assemblage. Its closest affinities are with younger faunas of the *Exogyra costata* zone, as can be readily shown by the following comparisons.

The Cenomanian Woodbine fauna of Texas (Stephenson, 1952) has a gastropod fauna consisting of 48 genera and subgenera. Of that total only eight, or about 17 percent, are common to both the Woodbine and Coffee Formations. These genera are: *Acmaea*, *Euspira*, *Gyrodes*, *Turritella*, *Anchura*, *Bellifusus*, *Aliofusus*, and questionably *Paladmete*. The first five are long ranging and have little significance in terms of affinities. Even including such genera, the similarities between the Woodbine and Coffee faunas are not marked.

A much closer comparison can be made with beds of the Eutaw Formation of Alabama that are only slightly older than those of the Coffee Sand. For example, collections from one locality in the Eutaw Formation near Uchee in Russell County, Ala., have yielded a gastropod fauna of 50 genera, of which 31 are common to both the Eutaw Formation and Coffee Sand. This is a much greater similarity than that shown by the Woodbine fauna.

The closest faunal comparisons are, however, between the Coffee Sand and younger formations of the *Exogyra costata* zone from which, between Texas and Georgia, more than 100 genera and close to 400 species of gastropods are known (Wade, 1926; Stephenson, 1941; and Sohl, 1960) and these include species of all the 53 gastropod genera and subgenera that are present in the Coffee Sand.

The greater similarity of the Coffee Sand fauna to the younger than to the older faunas is shown also by a comparison of the relative abundance of the three orders Archaeogastropoda, Mesogastropoda, and Neogastropoda in the various formations under discussion (see table as follows).

Composition of Streptoneura in four gulf coast Upper Cretaceous gastropod faunas

[Numbers indicate percent of all Streptoneura genera in three orders]

	Archaeogastropoda	Mesogastropoda	Neogastropoda
Ripley Formation	6	41	53
Coffee Sand	9	43	48
Eutaw Formation	4	46	50
Woodbine Formation	7	66	27

As seen in the table above, the Archaeogastropoda compose less than 10 percent of the total Streptoneuran gastropods in all the faunas. The Woodbine is distinctive in having a dominance of Mesogastropod genera. The three younger faunas are all similar in having more neogastropods than mesogastropods. In this respect the Eutaw, Coffee, and Ripley gastropod faunas are allied in being close to the Tertiary faunas, whereas the Woodbine fauna is similar to the Lower Cretaceous faunas. (See Sohl, 1964.)

Considered taxonomically, the Coffee Sand gastropods are closely related to the later Cretaceous faunas of the East Gulf Coastal Plain. Many are ancestral to the species found in the *Exogyra costata* zone. Considered geographically, however, the gastropods of the Coffee Sand exhibit a decidedly endemic aspect as few of them are known outside northern Mississippi.

The endemic aspect of the Coffee Sand gastropod fauna probably is more apparent than real and may be explained by a combination of factors. First, the gastropod fauna of the *Exogyra ponderosa* zone is poorly known taxonomically and stratigraphically. The literature is virtually confined to Stephenson's (1923) description of 28 species from the Black Creek Formation of North Carolina and to Weller's (1907) description of 55 species from the Merchantville, Woodbury, Marshalltown, and Wenonah Formations in New Jersey. Stephenson's species are from a high level in the *E. ponderosa* zone. All but a few of the Coffee Sand gastropods, described herein, are from a low position within this zone. Weller's New Jersey gastropod species apparently represent the entire zone, but they are based either on indeterminable internal molds or on specimens too poorly preserved for close comparison. Some of the described species may be common to North Carolina and New Jersey, but comparisons are limited by the type of preservation.

A second factor influencing the endemic aspect of the Coffee Sand gastropod fauna is that of facies. The Coffee Sand consists of dark-colored fossiliferous clayey sands, which are uncommon elsewhere in equivalent beds of the *Exogyra ponderosa* zone. For instance, in southern Mississippi and in Alabama the

equivalent beds are of the chalk facies whose faunas are dominated by well-preserved ostreids, whereas most of the other associated mollusks are represented by specifically indeterminable phosphatic internal molds. Conceivably, some species of the Coffee Sand gastropods may be represented in the chalk but, if so, are unrecognizable because of their poor state of preservation. On the other hand, the diversity of molds in the chalk is not great, indicating that the more calcareous environment represented by the chalk was not as favorable for development of a diversified snail fauna as the sand facies.

In Texas no fauna stratigraphically comparable to that of the Coffee Sand has been described. Nevertheless, to my knowledge, the only extensive gastropod fauna present comes from the Wolfe City Sand Member of the Taylor Marl at a higher position in the *Exogyra ponderosa* zone than those of the lower part of the Coffee Sand. The following list has been prepared from a preliminary examination of a collection from the type section of the Wolfe City Member (USGS 9710) in a railroad cut about 1 mile east of Wolfe City, Tex.

Acmaea sp.
Calliomphalus (*Calliomphalus*) *americanus* Wade
Urceolabrum mantachieensis Sohl?
Turritella macnairyensis Wade
Haustator trilira (Conrad)
Laxispira lumbricalus Gabb
Xenophora sp.
Achura cf. *A. substriata* Wade
Graciliala cf. *G. calcaris* (Wade)
Graciliala johnsoni Stephenson?
Pterocerella poinsettiformis Stephenson
Pugnellus densatus Conrad
Gyrodes major Wade
Euspira rectilabrum (Conrad)
Sargana sp.
Ecphora proquadricostata Wade
Morea marylandica Gardner?
Morea aff. *M. cancellaria* Conrad
Schizobasis sp.
Buccinopsis crassus (Wade)
Bellifusus sp.
Haplovoluta bicarinata Wade
Pyrifusus sp.
?*Cantharus* (*Cantharulus*) sp.
Lirosoma cretacea (Wade)
Liopeplum cf. *L. leiodermum* Conrad
Beretra sp.
Paladmete gardnerae Wade
Acteon sp.
Nonacteonina sp.
Ringicula (*Ringicula*) *pulchella* Shumard?
Anisomyon sp.

Judging from the above list of species, the Wolfe City Member is equivalent to the upper part of the Coffee Sand and, likewise, has a closer faunal link with the fauna of the Coon Creek Tongue of the Ripley Formation than with the lower Coffee Sand fauna. Unfortunately for purposes of faunal comparisons with Texas, no significant gastropod faunas have as yet been found in the lower part of the Taylor Marl or the upper part of the Austin Chalk.

Faunas outside the coastal plain province show even less similarity to that of the Coffee Sand. The more common genera present in the Coffee Sand are represented in the western interior faunas, but, as known, there is little similarity at the specific level.

In summary, the endemic aspect of the lower Coffee Sand gastropod fauna is due apparently to overall lack of knowledge of the gastropod fauna of equivalent units of other areas. Where gastropods are known elsewhere, they are generally too poorly preserved for close comparison. To document the assertion that the Coffee gastropods form a restricted fauna, other localities of similar facies should be found and tested.

STREPTONEURA

The Archaeogastropoda are the most poorly represented of the three streptoneuran (prosobranch) orders in the Coffee Sand fauna. The species assigned to *Acmaea*, *Calliomphalus*, and *Urceolabrum*, however, all belong to lineages that can be traced through the higher beds of the *Exogyra costata* zone of the gulf coast.

The mesogastropods are well represented by species of most of the common late Late Cretaceous genera of the coastal plains. Of special note in this group is the occurrence of *Architectonica* (*Granosolarium*) *coffea*. Architectonicids are rare in the Upper Cretaceous, and this species appears to be ancestral to *Architectonica voragiformis* Stephenson, of the Nacatoch Sand of Texas. Another species with affinities to a Texas Nacatoch Sand species is *Tundora* cf. *T. tuberculata* Stephenson. The Coffee Sand representative is only the second known occurrence of this peculiar and poorly known genus. This additional material has enabled the placement of the genus in the Aporrhaidae. Except for *Gegania* (sp.), the remainder of the species all have close relatives that occur in the younger beds of the *Exogyra costata* zone. The *Gegania* (sp.) finds its closest relative in an undescribed species from the upper part of the Eutaw Formation in Alabama.

Among the neogastropods, most of the Coffee Sand species appear to be ancestral to species that occur in the Ripley Formation of the Mississippi embayment region. The exception to this rule is *Cantharus* (*Cantharulus*) *lemniscatus* Sohl whose affinities appear

to be with species from the Late Cretaceous of the western interior. Although the occurrence of many of these species in the Coffee Sand extends their range downward, this is not their earliest recorded occurrence. Preliminary studies have shown that almost all genera are represented in the fauna of the Eutaw Formation in Alabama.

EUTHYNEURA

An unusual feature of the gastropod fauna of the Coffee Sand is the general lack of euthyneuran species. The Ripley fauna, with which this fauna compares in composition so favorably, possesses numerous cephalaspids (as much as 14 percent of all genera). In most sand facies faunas of the Upper Cretaceous of the East Gulf Coastal Plain and in Texas as well, genera such as *Ringicula*, *Cylichna*, and *Acteon* are common elements. In the Coffee Sand, *Ringicula* is totally absent, and the cephalaspid species that are present are represented by only a few specimens. This sparsity is real and not due to collecting failure, for care was taken to wash much matrix and search the residue for such species.

PRESERVATION OF SHELLS

In the Coffee Sand of Mississippi, fossils are preserved as original shell material, as internal or external molds, and as replacements by crystalline calcite or iron oxide.

Virtually unaltered shells are found commonly in the lower part of the formation in dark gray clayey silty sands ("marls" of some authors). Such is the case at locality 6, near Ratliff, Lee County, and locality 2, near Hare's old mill site in Prentiss County. At these places gastropods, pelecypods, and other organisms still retain strong aragonitic shells, and some shells retain their color pattern. Except for a few worn or weathered specimens, the finest details of structure and sculpture are preserved. The brown callus glaze of volutes, such as *Volutomorpha* and *Liopeplum*, is still present. Shreds of hinge ligament are common on the small shells of the pelecypod *Breviarca*. Other clams, such as *Inoceramus* and the ammonites *Placenticeras* and *Baculites*, possess shells that glow with the varicolored iridescence of the nacreous layers.

In state of preservation these specimens from the lower part of the Coffee Sand rival those from the best Cretaceous and Tertiary collecting localities. Their fine state of preservation is most probably due to their being protected from percolating ground water by a rather impermeable matrix.

At other localities, such as locality 4, 9 miles east of Boonville, Prentiss County, the shell material has been leached out, but the fine-grained sand faithfully retains the impression of the shell surface sculpture. At several other localities internal and external molds are retained in ferruginous sandstone. At one of these localities (loc. 9) some of the pelecypods and gastropods have been replaced by what appears to be amorphous iron oxide. Another form of preservation is found at locality 10, where a well-cemented fossiliferous calcareous sandstone shows evidence of differential leaching. As a result, the calcitic shells of the ostreids, such as *Exogyra*, are well preserved, whereas the aragonitic-shelled mollusks are preserved only as molds that have some chalky shell material adhering to their surface.

Stephenson and Monroe (1940) and Parks (1960) noted the presence of mollusks preserved as phosphatic internal molds in both the upper and lower parts of the Coffee Sand. Their abundance at certain levels may indicate minor intraformational diastems.

PROPOSED NEW SPECIES AND SUBSPECIES

Calliomphalus (Calliomphalus) paucispirilus
(Planolateralus) tuberculosus
Urceolabrum mantachieensis
Architectonica (Granosolarium) coffea
Laxispira monilifera
Potamides cowickecnsis
Acirsa (Plesioacirsa?) gravida
(Plesioacirsa) culmosa
Pseudamaura lepta
Morca corsicanensis depressa
Lowenstamia funiculus
Cantharus (Catharulus) lemniscatus
Lomirosa carinata
Pyrifusus sinuocostatus
Lupira disparila
Fulgerca compressilirata
Longoconcha imbricatus
Volutomorpha splendida
Liopeplum spiculatum
Mataxa leioderma
Amuletum costatum
Beretra preclara
Eoacteon ithyocheilus

CHANGES IN GENERIC OR SPECIFIC ASSIGNMENTS

The following are the changes in generic or specific assignment of previously described species.

Old assignment	*New assignment*
Vermiculariide:	
Laxispira lumbicalis Wade (not Gabb)	*Laxispira monilifera* Sohl
Vermetus libycus Wanner	*Laxispira*
libycus Trechmann (not Wanner)	*Laxispira*
Turritellidae:	
Turritella trilira Conrad	*Haustator*
quadrilira Johnson	*Haustator*

Old assignment	New assignment
Mathildidae:	
Callonema Conrad	*Gegania*
Cerithiopsidae:	
Cerithium nodoliratum Wade	*Cerithiella*
semirugatum Wade	*Cerithiella*
Aporrhaidae:	
Tundora Stephenson	from Strombidae
Magilidae:	
Hippocampoides liratus Wade	*Lowenstamia*
Straparolus subplanus Gabb	*Lowenstamia*

SYSTEMATIC DESCRIPTIONS

The arrangement of families and the grouping of genera follows the classification of Taylor and Sohl (1962). Only partial synonomies are given for some described species. For these, references are given to recent publications having full synonomies. Morphological terminology conforms to that used in the "Treatise on Invertebrate Paleontology."

Abbreviations are as follows:

USNM, U.S. National Museum.

ANSP, Academy of Natural Sciences of Philadelphia.

USGS, U.S. Geological Survey Mesozoic locality.

Class GASTROPODA
Order ARCHAEOGASTROPODA
Superfamily PATELLACEA
Family ACMAEIDAE
Subfamily ACMAEINAE

Genus ACMAEA Eschscholtz, 1830

Type by subsequent designation (Dall, 1871, p. 238), *Acmaea mitra* Eschscholtz.

Discussion.—*Acmaea* occurs rarely in the Upper Cretaceous rocks of the Gulf Coastal Plain. Only three species are known: *Acmaea? occidentalis* (Hall and Meek) of Stephenson, from the Kemp Clay of Texas; *A. pilleolus* Stephenson, from the Woodbine Formation of Texas; and *A. galea* Sohl, from the Ripley Formation of Tennessee. The fragile nature of the subconical shells makes their recovery difficult and may account for their scarcity in these deposits.

Acmaea sp.

Plate 53, figure 18

Discussion.—One small incomplete and distorted specimen of 1.7 mm in maximum diameter and about 4.0 mm in height has been discovered in the Coffee Sand. The musculature of this specimen is not known, but its subcentral apex, steep anterior slope, smooth shell surface, and subovate apertural outline are characteristic of *Acmaea*.

Compared with *Acmaea galea* Sohl (1960, p. 52), from the Ripley Formation of Tennessee, this form possesses a less circular apertural outline, is larger, lower, and less conical in profile, has less pronounced concentric growth lines, and has a less centrally placed apex. It appears to be most closely related both in size, shape, and position of the apex to the specimens from the Kemp Clay of Texas assigned by Stephenson (1941, p. 256) to *Acmaea? occidentalis* (Hall and Meek). Further comparison of these poorly preserved forms is impracticable.

Types: Figured specimen USNM 131592.
Occurrence: Mississippi: Coffee Sand.

Superfamily TROCHACEA
Family ANGARIIDAE

Genus CALLIOMPHALUS Cossmann, 1888

Type by original designation, *Turbo squamulosus* Lamarck, 1804.

Discussion.—The genus *Calliomphalus* is represented on the Gulf and Atlantic Coastal Plains by more than 10 species that range in age from Coniacian through Maestrichtian (Sohl, 1960, p. 54, 55). These species are placed in two subgenera which are represented in the Coffee Sand of Mississippi by one species each. *Calliomphalus* (*Calliomphalus*) differs from *Planolateralus* by nuclear character (contrast figs. 29 and 30 on pl. 53). The former has larger more rapidly expanding whorls, and the earliest sculpture is of transverse riblets that die out below the shoulder. The initial whorls of *Planolateralus* are not so prominent as those of *C.* (*Calliomphalus*), and the transverse riblets develop earlier, are closer spaced, sharper, and extend from suture to suture. The typical subgenus has subsuturally flattened whorls with rounder sides than *Planolateralus*. In addition, the shell is generally proportionally broader, lacks transverse sculpture on the base, and the umbilical nodes are stronger.

Subgenus CALLIOMPHALUS Cossmann, 1888
Type species, Turbo squamulosus Lamarck, 1804
Calliomphalus (Calliomphalus) paucispirilus Sohl, n. sp.

Plate 53, figures 23, 24

Diagnosis.—Spiral cords of upper and peripheral surfaces wide spaced for genus, with tuberculations diminishing greatly in strength between subsutural and peripheral cords.

Description.—Shell trochiform, moderately small, and with a nacreous shell layer. Protoconch small but not completely known. Pleural angle 70°–75°. Suture impressed. Whorls five to six in number, early whorls with a flattened ramplike upper whorl surface; body whorl well rounded over periphery, upper surface steeply sloping between suture and third spiral cord, base rounded. Sculpture dominated

by spiral elements. Upper three cords strongly tuberculate where crossed by thin growth lines; periphery with two wide-spaced strong spiral cords that bear weaker tuberculations; cords of lower whorl sides closer spaced, and in turn these give way to many closely spaced lirae on base that diminish in vigor as umbilicus is approached. Growth lines gently prosocline over whorl sides, becoming stronger and closer spaced on base at they converge on umbilicus and lending a subcancellate sculpture pattern. Aperture round in outline; outer lip rounded and thinning at edge; inner lip rounded with a slight angulation at intersection of umbilical rib. Umbilicus broad open, a little less than one-third shell width and bordered by a band of 14 to 16 elongate but sharp nodes; inner surface of umbilicus covered by growth lines and a few spiral lirae with a strong spiral rib about two-thirds the distance between the umbilical rim and suture.

Measurements.—The holotype measures 8.8 mm in height and has a maximum diameter of 8.2 mm. An incomplete paratype (USNM 131683) that lacks part of the spire has a maximum diameter of 9.8 mm.

Discussion.—*Calliomphalus* (*C.*) *paucispirilus* is scarce in the Coffee Sand of Mississippi. In specimens the size of the holotype, there is a general lack of secondary spiral lirae interpolated between the primary cords of the periphery, but one paratype (USNM 131594) shows that at the latest developmental stages a secondary lira may appear between each of the primary peripheral cords. Decreased strength of the two subsutural cords and an increased inclination of the upper whorl surface are other gerontic developments.

Calliomphalus (*C.*) *americanus* Wade, from the Ripley Formation of Tennessee and Mississippi, differs by the consistent presence of secondary spirals on the whorl sides, by having a flatter subsutural area, and by possessing weaker tuberculations. In addition, the Ripley species has more numerous spiral elements on the penultimate whorl, coarser umbilical nodes, and weaker transverse elements on the base.

Types: Holotype USNM 131593; paratypes USNM 131594, 131683.

Occurrence: Mississippi: Coffee Sand.

Subgenus PLANOLATERALUS Sohl, 1960

Type by original designation, Calliomphalus argenteus Wade, 1926

Calliomphalus (Planolateralus) tuberculosus Sohl, n. sp.

Plate 53, figures 26–28, 30, 31, 35

Diagnosis.—Small trochiform shells with surface covered by tuberculations; whorls lack basal carination or spines; umbilical margin poorly defined.

Description.—Small rather flat sided trochiform shells with a nacreous shell layer. Protoconch of about 1½ smooth round-topped low whorls that are followed by half a convex whorl bearing thin transverse riblets; beyond this point, whorls develop a noded spiral cord at suture and an angulate noded shoulder with riblets persistent from suture to suture. Pleural angle about 64°. Suture impressed; whorls broadly rounded to a subacute peripheral angulation; lower part of whorls rounded sharply to the base. Sculpture of crowded spiral lirae over whorl sides and base; lirae noded where crossed by finer spiral threads giving surface a pustulose appearance. Aperture entire, subrounded, outer lip thin at edge, slightly crenulated at intersection of spiral sculpture; inner lip attached over short part of parietal lip and rounded. Umbilicus open, a little less than one-quarter as wide as shell; umbilicus bounded generally by a poorly defined noded spiral band; umbilical walls steep but gently rounded and marked by a continuation of growth lines and a few faint spiral lines.

Measurements. — The holotype (USNM 131594) measures about 6 mm in height by 6 mm in width. A somewhat larger topotype measures 7.2 mm in height by 7 mm in diameter.

Discussion.—Shells of this species are common at the type locality but are difficult to obtain entire as the outer surface exfoliates and the shells break easily during washing.

Variation in the available suite of specimens is primarily displayed in the strength of sculpture. All have the same basic sculptural pattern and essentially agree in terms of numbers and spacing of the spiral cords, but the strength of both the spiral cords and the nodes may vary moderately. The greatest range of difference appears to be in the strength of the noded spiral band that margins the umbilicus. In several specimens this band consists of strong and moderately sharp rather wide spaced nodes, but in others the rim is well rounded and only a very faintly noded band occurs on the rounded sides.

Compared to *Calliomphalus* (*P.*) *argenteus* Wade, from the Ripley Formation of Tennessee, *C.* (*P.*) *tuberculosus* has less flat sided whorls, lacks a strong basal carination, has a narrower umbilicus, and a more rounded base. It appears to approach more closely *C.* (*P.*) *conanti* Sohl, from the Ripley Formation of Mississippi, by its more subdued sculpture and by its umbilical characters, but it has a greater pleural angle and rounder whorls and base.

Types: Holotype USNM 131594; paratypes USNM 131595, 131596, 131684.

Occurrence: Mississippi: Coffee Sand.

Family TURBINIDAE

Genus URCEOLABRUM Wade, 1916

Type by original designation, *Urceolabrum tuberculatum* Wade, 1916.

Discussion.—Distribution and development of this genus on the gulf coast and its confusion with *Eucycloscala* Cossmann has been discussed by Sohl (1960, p. 59).

Urceolabrum mantachieensis Sohl, n. sp.

Plate 53, figures 1–3

Diagnosis.—Small high trochiform phaneromphalous shells with four coarsely noded spiral cords on the whorl sides and a heavily reinforced flaring aperture.

Description.—Shell small, trochiform, phaneromphalous, with about five teloconch whorls. Protoconch unknown, scar small. Suture abutting, trace regular. Body whorl with well-rounded sides and a steeply inclined flattened base. Sculpture of body whorl dominated by transverse ribs that are accentuated to nodes where they intersect the spiral lirae. Spiral cords four in number. Upper lira forms strongest nodes slightly upturned; second lira also forms strong nodes, just above midwhorl; third and fourth lirae closer spaced than upper two, form lower nodes but are distinguishable in the rib interspaces and essentially delimit base from whorl sides. Base free of scuplture between marginal lira and the nodose umbilical rim. Growth lines faint, gently prosocline over whorl sides. Aperture circular with lips heavily reinforced by a flaring reflected and inclined rim composed of shell lamellae. Umbilicus broad, open, and bounded by six to seven strong nodes.

Measurements. — The holotype (USNM 131589) measures 5 mm in height by 4 mm in diameter. No available specimens exceed 6 mm in height.

Discussion.—This species is moderately common at its type locality. Remarkably little variation is to be seen in shape or sculpture in the type lot. A faint suggestion of a few spiral lines was seen on the base of one specimen. On all others the base is smooth.

Compared to the type species, *Urceolabrum tuberculatum* Wade, from the Coon Creek Tongue of the Ripley Formation of Tennessee, this species is smaller, has four not five spiral lirae, the suture is straight not undulatory, lacks secondary spiral elements, and has only six to seven umbilical nodes as opposed to nine to eleven. *U. tuberculatum callistum* Harbison from a higher level in the Ripley Formation of Mississippi (Sohl, 1960, p. 60) is larger, has stronger spiral cords, has secondary spiral lirae on the whorl sides and base, and more numerous umbilical nodes.

Type: Holotype USNM 131589; paratypes USNM 131588.
Occurrence: Mississippi: Coffee Sand; Texas: Wolfe City Sand Member of Taylor Marl.

Order MESOGASTROPODA
Superfamily RISSOACEA
Family VITRINELLIDAE

Genus TEINOSTOMA H. and A. Adams, 1853
Type by subsequent designation (Cossmann, 1888, pt. 3, p. 48)
Teinostoma politum A. Adams, 1853

Teinostoma cf. T. clara Sohl

Plate 53, figures 4–6

1960. *Teinostoma clara* Sohl, U.S. Geol. Survey Prof. Paper 331–A, p. 62, pl. 6, figs. 2–6.

Discussion.—Two small specimens from the collections from the Coffee Sand are assignable to *Teinostoma.* They possess a shape, degree of whorl overlap, and spiral sculpture (pl. 53, figs. 4, 6) of the base and upper whorl surface very similar to those of *T. clara* from the Ripley Formation of Mississippi. Their small size, degree of overlap, and incomplete umbilical filling may be reflection of immaturity. If so they may represent a growth stage of *T. clara.* On the other hand if they represent mature specimens they are probably a related but new species. The available material is insufficient to form a definite conclusion.

The only other described Upper Cretaceous gulf coast species for comparison is *Teinostoma prenanum* Wade from Coon Creek, Tenn. That species has more completely overlapped whorls and a smooth unornamented surface.

Types: Figured specimens USNM 131590, 131591.
Occurrence: Mississippi: Coffee Sand.

Superfamily ARCHITECTONICACEA
Family ARCHITECTONICIDAE

Genus ARCHITECTONICA (Bolten) Röding 1798

Type by subsequent designation (Gray, 1847, p. 151, error *Architectoma*), *Trochus perspectivus* Linné.

Discussion.—Although several North American Cretaceous species have been assigned to *Architectonica* proper, none appear to belong to the typical subgenus and most do not belong to the genus. *Architectonica voragiformis* Stephenson, from the Neylandville Marl of Texas belongs in *A.* (*Granosolarium*) Sacco. The other Navarro Group species which Stephenson assigned to *Architectonica* spp. (1941, p. 271) belong to several different genera, none to this genus. They are as follows: *Margaritella* sp., USNM 76821;

Margaritella? sp., USNM 76820; *Pseudomalaxis* sp., USNM 76823–76827; *Pseudomalaxis?* sp., USNM 76821. *Architectonica(?) veatchi* Gabb from the "Chico group" at Tuscan Springs, Calif., as indicated by Stewart (1926, p. 344) is entirely too incomplete for identification. As figured it could as easily be assigned to the Trochacea. "*Solarium*" *planorbis* Roemer (1888, p. 15) from the Lower Cretaceous of Texas, Oklahoma, and Venezuela has been assigned to *Architectonica* by Osten (1957, p. 584). It is a planispiral shell that can only doubtfully be assigned to the same family and does not display any of the features of the genus *Architectonica*. In general shape and in umbilical character it may be allied with *Omalaxis* Deshayes.

Subgenus GRANOSOLARIUM Sacco, 1892

Type by original designation, *Solarium milligranus* Lamarck, 1822.

Diagnosis.—Shell with strong and noded spiral carina, base flat to slightly rounded. Body whorl ½–⅔ total shell height. Umbilicus moderately broad with a noded margin that is not separated by a groove from remainder of base; umbilical wall with a spiral cord between margin and suture. Surface sculpture granular.

Discussion.—*Solariaxis* Dall (1892) is, according to Palmer (1937, p. 163), a synonym of *Granosolarium*.

The subgenus is represented in the Upper Cretaceous of the Gulf Coastal Plain by two species, *Architectonica voragiformis* Stephenson from the Neylandville Marl of Texas and *Architectonica* (*Granosolarium*) *coffea* Sohl from the Coffee Sand of Mississippi. The subgenus ranges from the Upper Cretaceous to the Recent.

Architectonica (Granosolarium) coffea Sohl, n. sp.

Plate 53, figures 19–22

Diagnosis.—An architectonicid with peripheral angulation bearing two strong spiral cords.

Description.—Trochiform moderately small shells; spire flat sided, evenly tapering; suture narrowly channeled. Protoconch of about 1½ well-rounded whorls with first whorl somewhat submerged and at an angle to the axis of teloconch coiling; junction with teloconch whorls abrupt. Whorls five to six in number, with a flat sloping upper whorl surface, an angulated periphery, and an almost flat base. Spiral sculpture dominant, beginning with a strong nodose cord that borders sutural channel and a second at the periphery; after about one-fifth of a turn, secondary spirals appear on upper whorl surface between these two. On body whorl, six spiral cords occur on upper whorl surface; first and sixth strongest, the fifth introduced at a late stage. Peripheral carination changes to two strong proportionally broad spiral ribbons; on base, spiral cords numerous, upper and basal surfaces beaded where crossed by growth lines; peripheral spiral ribbons bear thin elongate and sharp-crested costae at intersection of growth lines. Growth lines prosocline on periphery and arcuately prosocline on base. Umbilicus broad, open, and bounded by a noded rim. Umbilical wall with strong transverse lirae and a spiral cord placed a little more than half way between umbilical rim and suture.

Measurements.—The holotype (USNM 131597) measures 9 mm in width. A paratype (USNM 131597) measures 6 mm in width and 3.8 mm in height.

Discussion.—This species is represented by three specimens in the collections from the Coffee Sand of Mississippi. Inasmuch as they represent different stages of growth, it it difficult to determine the amount of variation present.

Compared to the only other similar Cretaceous species. *Architectonica voragiformis* Stephenson (1941, p. 271), this species possesses fewer spiral cords on the upper whorl face and has two, not one, peripheral ribbons. In addition, *A. voragiformis* has a sharp, not a blunt periphery.

Types: Holotype USNM 131597; paratypes USNM 131598, 131687.

Occurrence: Mississippi: Coffee Sand.

Superfamily CERITHIACEA
Family VERMICULARIIDAE

Genus LAXISPIRA Gabb, 1877

Type by monotypy, *Laxispira lumbricalis* Gabb, 1877.

Diagnosis.—Shell loosely but regularly coiled in the manner of *Vermicularia;* surface ornament dominated by spiral lirae, aperture round to teardrop shaped.

Discussion.—Keen (1961) removed the vermiculariids from the family Vermetidae and suggested a closer relationship to the Turritellidae. *Laxispira* appears to be more closely related to the vermiculariids than vermetids.

The genus as known is confined to the Upper Cretaceous. Sohl (1960, p. 69) cited species as occurring on the Gulf and Atlantic Coastal Plains and in Germany. To these occurrences should be added *Vermetus libycus* Wanner (1902, p. 25) from the Maestrichtian of the Libyan desert of North Africa; *Vermetus* cf. *libycus* Wanner of Trechmann (1927, p. 38) from the Maestrichtian of Jamaica, and an undescribed species in the collections of the Geological Survey from the Upper Cretaceous of Puerto Rico and Cuba.

Laxispira lumbricalis Gabb

Plate 53, figures 25, 34

1877. *Laxispira lumbricalis* Gabb, Acad. Nat. Sci. Philadelphia Proc. for 1876, p. 301, pl 17, figs. 6–7.
1883. *Laxispira lumbricalis* Gabb, Tryon, Structural and Systematic Conchology, v. 2, p. 309, pl. 79, fig. 14.
1892. *Laxispira lumbricalis* Gabb. Whitfield, U.S. Geol Survey Mon. 18, p. 148, pl. 18, fig. 25.
1892. *Siliquaria lumbricalis* Gabb. Dall, Wagner Free Inst. Sci. Trans. v. 3, pt. 2, p. 307.
1907. *Laxispira lumbricalis* Gabb. Weller, New Jersey Geol. Survey, Paleontology, v. 4, 706, pl, 81, figs. 1, 2.
1912. *Vermicularia lumbricalis* (Gabb). Cossmann, Essais Paléoconchologie comparée, v. 9, p. 143.
1939. *Vermicularia lumbricalis* (Gabb). Wenz, Gastropoda. *in* Handbuch der Paläozoologie, v. 6, pt. 3, p. 679.

Diagnosis.—Shell open but regularly coiled; surface sculpture of close-spaced spiral lirae.

Description.—Shell an open coiled spiral with whorls in contact only in earliest nuclear stage. Early whorls circular in cross section becoming teardrop shaped in the later stages with inner side less curved than outer surface. Sculpture of raised spiral lirae that are numerous and close-spaced over upper, outer, and lower part of whorl but are faint over inner whorl surface. Growth lines faint. Apertures slightly longer than wide, with thin uninterrupted lips; outer lip more curved than inner lip.

Measurements.—Specimens generally are less than half an inch in length and one-quarter inch in diameter.

Discussion.—This is one of the most abundant gastropod species in the Coffee Sand. These specimens occur at about the same stratigraphic position as do the type specimens from the Woodbury Clay of New Jersey (Weller, 1907, p. 707). Unfortunately the type specimen is lost, but specimens from the nearby Lorilard locality agree well with the Coffee Sand specimens.

Wade (1926, p. 159) and Sohl (1960, p. 69) described and figured specimens they assigned to this species from a higher stratigraphic position in the Ripley Formation of Tennessee and Mississippi. These specimens differ from *Laxispira lumbricalis* Gabb by having more tightly coiled whorls and beaded rather than smooth spiral lirae (compare figs. 33, 34 on pl. 53). In addition there is a greater tendency for development of secondary spiral lirae between the primaries on the lower part of the whorl on the Ripley species. These differences appear constant, and I hereby name the Ripley species *Laxispira monilifera* and designate Wade's (1926, pl. 55, figs. 5, 8) figured specimen (USNM 32950) as holotype.

Types: Holotype ANSP lost (New Jersey); hypotype USNM 131599, 131600.

Occurrence: Mississippi: Coffee Sand; New Jersey: Woodbury and Merchantville Clays; Delaware: Crosswicks Clay.

Family TURRITELLIDAE
Subfamily TURRITELLINAE

Genus HAUSTATOR Montfort, 1810

Type by original designation, *Turritella imbricataria* Lamarck (1804) = *Haustator gallicus* Montfort.

Discussion.—The genus *Haustator* Montfort is represented in the Upper Cretaceous of the Gulf Coastal Plain by a group of three distinctive and widespread species: *H. quadrilira*, *H. trilira*, and *H. bilira*. They are first found in the Eutaw Formation represented by *quadrilira* and range through the remainder of the Cretcaeous. They are not only morphologically distinctive but in terms of individual abundance they are the most common turritellids in the area. Their placement in *Haustator* is based on ontogenetic development of sculpture and conformity to the growth line of the type species as defined by Marwick (1957, p. 154). In some respects they resemble *Zaria* Gray closely but lack the weak spiral ridge of the columella, and the basal growth line sinus is abapertural instead of adapertural.

Haustator trilira (Conrad)

Plate 54, figure 15

1860. *Turritella trilira* Conrad, Acad. Nat. Sci. Philadelphia Jour., 2d ser., v. 4, p. 285.
For synonymy through 1960 see Sohl, 1960, page 71.

Diagnosis.—Medium to large turriculate shells with three prominent ribs on the whorl sides, a basal carination, and a flat unornamented base.

Discussion.—In size the specimens from the Coffee Sand of Mississippi compare well with representatives of the species from the higher stratigraphic units of the Gulf and Atlantic Coastal Plains. The few specimens available for study from the Coffee Sand are uniform in their strong and shelflike spiral carinae and do not appear to be as variable in sculpture as those from the Ripley Formation.

Haustator trilira is easily distinguished from *H. quadrilirata* in lacking the fourth primary spiral carina.

Analogous species from other areas of this long ranging and common species have been discussed by Sohl, 1960 (p. 72).

Types: Holotype ANSP, lost (Mississippi: Ripley Formation); hypotypes USNM 76865, 76866 (Texas); USNM 128422–128428, 131601 (Mississippi); USNM 32957 (Tennessee); USNM 73637 (Alabama).

Occurrence: Mississippi: Coffee Sand, Ripley Formation, Owl Creek Formation, Prairie Bluff Chalk; Texas: Taylor Marl, Navarro Group; Arkansas: Brownstown Marl, Saratoga Chalk, Nacatoch Sand; Alabama: Blufftown Forma-

tion, Cusseta Sand, Ripley Formation, Providence Sand, and Prairie Bluff Chalk; Georgia: Blufftown Formation, Ripley Formation, and Providence Sand; North Carolina: Black Creek and Peedee Formations; Maryland: Matawan and Monmouth Formations; New Jersey: Wenonah Formation.

Haustator quadrilira (Johnson)

Plate 54, figures 13, 14

1898. *Turritella quadrilira* Johnson, New Jersey Geol. Survey, Ann. Rept. for 1897, p. 264.
1898. *Turritella quadrilira* Johnson, Acad. Nat. Sci. Philadelphia, Proc., v. 50, p. 463.
1905. *Turritella quadrilirata* Johnson, Acad. Nat. Sci. Philadelphia, Proc., v. 57, p. 21.
1907. *Turritella quadrilira* Johnson, Weller, New Jersey Geol. Survey, Paleontology, v. 4, p. 695, pl. 78, fig. 7.
1923. *Turritella quadrilira* Johnson, Stephenson, North Carolina Geol. & Econ. Survey Bull., v. 5, p. 363, pl. 90, figs. 10, 11.
1940. *Turritella quadrilirata* Johnson, Stephenson, and Monroe, Mississippi Geol. Survey Bull. 40, pl. 4, fig. 61.

Diagnosis.—Medium-sized turriculate shells with four primary prominent ribs on the whorl sides, a basal carination, and a flat unornamented base.

Discussion.—All the specimens present in the collections from the Coffee Sand of Mississippi are small for the species, but all possess the diagnostic four spiral ribs.

Turritella trilira differs by possessing only three primary spiral ribs.

Turritella quadrilira appears first in the Eutaw Formation in the *Exogyra upatoiensis* zone and ranges upward through most of the *E. ponderosa* zone. It is the first representative of the lirate *Haustator* lineage so well developed on the coastal plains. It is succeeded by *Haustator trilira* which first appears at about the middle of the *E. ponderosa* zone and ranges up through the *E. costata* zone. At the top of the latter zone the last Cretaceous successor (*T. bilira*) makes its appearance. All three species appear to be directly derived from one another. All three develop their sculpture from two primary spiral carinae.

Haustator quadrilira, like its successors, is abundant and widely distributed from New Jersey to Arkansas.

Stephenson and Monroe (1940) figured another specimen of this species from the Coffee Sand of Prentiss County, Miss.

Types: Cotypes ANSP (New Jersey); hypotypes ANSP (New Jersey); hypotype USNM 31849 (North Carolina), USNM 76243, 131602 (Mississippi).

Occurrence: Mississippi: Eutaw Formation, Coffee Sand; Arkansas: Brownstown Marl; Alabama: Eutaw and Blufftown Formations; Georgia: Eutaw and Blufftown Formations; North Carolina: Black Creek Formation; New Jersey: Magothy Formation, Woodbury Clay.

Turritella n. sp.

Discussion.—One small incomplete turritellid from locality 7 does not appear to belong to a previously described species. It has flat-sided whorls that bear five equal strong spiral cords. Two secondary cords occur on the upper surface between the suture and the upper lira with a third cord between the lower two primaries. The whorl sides are flatter and the suture is almost flush in contrast to *Haustator*, the only other turritellid in the Coffee Sand.

The specimen is preserved in ironstone and does not exhibit a growth line. It is therefore impossible to place, but the sculpture is most similar to species assigned to *Turritella harbisoni* of the Ripley Formation (Sohl, 1960, p. 73).

Type: Mentioned specimen USNM 131603.
Occurrence: Mississippi: Coffee Sand loc. 7.

Position uncertain
Family MATHILDIDAE

Genus GEGANIA Jeffreys, 1884
(Callonema Conrad, 1875, nomen oblitum)

Type by original designation, *Gegania pinquis* Jeffreys, 1884.

Discussion.—The genus *Gegania* as here used, incudes *Tuba* Lea. Although much more abundant in the Tertiary, additional species are constantly being discovered in the Cretaceous. In addition to the gulf coast Cretaceous species already described from the *Exogyra costata* zone (Sohl, 1960, p. 134), the genus is now known to range through the *Exogyra ponderosa* zone and is represented by an undescribed species from the Eutaw Formation of Alabama (Coniacian).

Callonema Conrad, 1875, is a name applicable to this group but has been overlooked by subsequent authors. Under the 50-year rule of the International Code of Zoological Nomenclature (1961, Article 238, p. 23), it should be invalidated for the well known and commonly used name *Gegania*. Conrad (1875, p. 12) described *Callonema* as follows:

> Conoidal, with spiral prominent lines, sutural space channeled, columella, direct, thin, reflexed, projecting over the subbase and rounded at base, labrum thin.
> *Tuba? bella*, Conrad is a representative of this genus * * *

Conrad also included *Turritella ventricosa* Forbes, as well as a newly described species from the Upper Cretaceous of North Carolina, *Callonema carolinensis*, in his *Callonema*. *Tuba? bella* Conrad has subsequently been assigned to *Gegania* by Sohl (1960, p. 134, 135). No subsequent worker has used the name *Callonema carolinensis*. Stephenson (1923), in an exhaustive treatment of the Upper Cretaceous faunas of the Carolinas, made no mention of the species, and the holo-

type (Conrad, 1873, pl. 2, fig. 27) was evidently not present among Conrad's types. The figure, however, can very reasonably be ascribed to the species of *Gegania* of the gulf coast Cretaceous and Eocene.

Meek (1876, p. 341) subsequently assigned *Callonema* as a questionable junior synonym to *Spironema* Meek (1864). Subsequent authors have followed suit. In my opinion, both by comparison of Conrad's figures and in the identity of *Tuba? bella*, *Callonema* is a senior synonym of *Gegania*, but its lack of use allows the invoking of the laws for conservation of names.

The species from the Coffee Sand discussed below is somewhat aberrant and not closely related to most of the other gulf coast species. Of two groups in *Gegania*, the first and most common has strong spiral cords and a narrow shelflike subsutural area. The second group typified by an undescribed species from the Eutaw Formation and the species discussed below from the Coffee Sand, has fine spiral sculpture and lacks the subsutural shelf.

The placement of the Mathildidae in the Cerithiacea is conventional but without conviction. The deviated heterostrophic protoconch of members of this family may indicate relationship with the Euthyneura.

Gegania sp.

Plate 55, figures 9, 10, 11

Diagnosis.—A *Gegania* with an inclined ramplike upper whorl surface and fine beaded spiral sculpture.

Description.—Shell moderately small; whorls with a flattened steeply inclined upper face; sides and base well rounded. Suture grooved. Sculpture dominated by spiral elements that are proportionally stronger and sharper on early whorls; late whorls covered by rather widely spaced beaded primary spiral cords with closely spaced secondary and tertiary lira in interspaces. Transverse sculpture of fine raised growth threads that are accentuated to elongate nodes or beads where they cross the strongest spiral elements; growth lines opisthocyrt in trend. Aperture subcircular, inner lip reflexed, covering umbilical fissure.

Discussion.—Only two incomplete specimens are known of this species, and a full description and formal name should await better preserved material.

Species such as *Gegania parabella* (Wade), *Gegania bella* (Conrad), and *Gegania manzanetti* (Stephenson), from the Ripley and equivalent formations of the Gulf Coastal Plain, all are larger, possess much stronger spiral scupture, and have more smoothly rounded whorls, as well as a more deeply grooved suture.

The type of sculpture, the reflexed inner lip, and rounded whorls relate this species to *Gegania*, but unfortunately the character of the protoconch is unknown.

Types: Figured specimens USNM 131605, 131689.
Occurrence: Mississippi: Coffee Sand.

Family POTAMIDIDAE
Subfamily POTAMIDINAE

Genus POTAMIDES Brongniart, 1810

Type by monotypy, *Potamides lamarcki* Brongniart.

Discussion.—To my knowledge the species described below is the first specimen from the Cretaceous of the gulf coast to be assigned to *Potamides*. The apertural features are not completely known, precluding subgeneric assignment. In sculpture, however, it possesses noded spirals similar in character to certain Eocene Paris Basin species that are generally assigned to the subgenus *Ptychopotamides*.

Potamides cowickeensis Sohl, n. sp.

Plate 53, figures 10–16

Diagnosis.—A potamidid bearing many strongly noded spiral cords over whorl sides and base that are generated from two primary noded cords of the earlier whorls.

Description.—Shell of medium size, slender, turriculate, multiwhorled. Pleural angle 18°–22°. Protoconch worn. On early whorls suture at base of narrow channel almost imperceptibly incised on later whorls. Whorls broadly rounded; basal periphery angulated and base smooth on early whorls; on later whorls basal periphery subangulate on body, and base covered by strong spiral sculpture. Sculpture of earliest whorls begins with two primary spiral cords that are noded where intersected by less strong transverse ribs; ribs weaken close to sutures. Secondary spiral lirae next appear between the two primary cords and between them and the sutures. A third noded spiral cord develops subsuturally after about five whorls and by the seventh whorl even secondary lirae develop beads. Accompanying change of spirals of earliest whorls, ribs become depressed until by the seventh whorl they are little more than collabral swellings. With growth, additional noded spiral cords may develop until seven or eight may be discerned, but the first three generally remain dominant. Sculpture of shell base consists of about five noded spiral cords. Growth lines variable in strength, opisthocyrt over whorl sides, flexed over basal periphery and procyrt on base. Aperture incompletely known; posteriorly with a round based notch about as wide as deep; anteriorly columella diagonally truncate

at base with an inclined canal. Outer lip unknown, presumably with a broad sinus above midheight. Inner lip arched, parietal lip with a well-margined moderately heavy callus; columellar lip with callus extending out of aperture and diagonally truncate below.

Measurements.—No complete specimens are known. The largest nearly complete specimen (USNM 131690) measures about 13 mm in height and has a maximum diameter of about 4.3 mm. This width is similar to that of the holotype. Other incomplete specimens indicate the species to have reached a size in excess of 15 mm and maximum diameter of 5 mm.

Discussion.—The type locality of *Potamides cowickeensis* is in the Blufftown Formation, on the North Fork of Cowickee Creek under and downstream from the bridge of a secondary road 3 miles southwest of Glenville on the county line between Russell and Barbour Counties, Ala. (NE¼NE¼ sec. 26, T. 13 N., R. 28 E. [USGS 26980]). Specimens are quite abundant here but are fragile and difficult to recover.

The specimens from the Coffee Sand figured herein are all incomplete and represent only the early growth stages. The relationship between the specimens from the two widely separated localities, however, is unmistakable.

In the type lot of more than 100 specimens, variation in sculpture affects both the strength of the spiral elements and their numbers, but the two primary noded cords of the periphery and the subsutural cord are almost always dominant.

The Coffee Sand specimen figured (pl. 53, fig. 11) shows the virtually smooth shell base typical of early growth stages as contrasted with the mature whorls exhibited by the holotype (pl. 53, fig. 14). The ontogenetic development of the sculpture can be followed through from the earliest stage (pl. 53, fig. 16) to the medial stage (pl. 53, fig. 12), to the mature individual (pl. 53, fig. 15).

Types: Holotype USNM 131606; paratype USNM 131607; figured specimens USNM 131691–131693.

Occurrence: Alabama: Blufftown Formation; Mississippi: Coffee Sand.

Family CERITHIOPSIDAE

Genus SEILA A. Adams, 1861

Type by subsequent designation (Dall, 1889, p. 250), Triphorus dextroversus Adams and Reeve, 1850

Seila meeki (Wade)

Plate 53, figures 7, 8

1926. *Cerithiopsis meeki* Wade, U.S. Geol. Survey Prof. Paper 137, p. 155, pl. 54, figs. 23, 24.

1960. *Seila meeki* (Wade.) Sohl, U.S. Geol. Survey Prof. Paper 331–A, p. 84, pl. 9, figs. 17–19, 21.

Diagnosis.—Small aciculate flat-sided shells with three raised strong spiral ribbons on the whorl sides and one on the base; fine transverse threads are present in interspiral spaces.

Discussion.—This species is represented in the collections from the Coffee Sand by two incomplete small specimens (pl. 53, figs. 7, 8). They compare closely with the specimens from the type locality in the Ripley Formation on Coon Creek, McNairy County, Tenn., except that the three spiral ribbons of the whorl sides appear thinner and therefore wider spaced. However, it is impossible to determine how constant this character is on the basis of the available material.

Types: Holotype and paratype USNM 32946 (Tennessee). Hypotypes 128467–128468 and 131608, 131694 (Tennessee and Mississippi).

Occurrence: Mississippi: Coffee Sand and Ripley Formation; Tennessee: Ripley Formation.

Genus CERITHIELLA Verrill, 1882

Type by original designation, *Cerithium metula* Lovèn.

Discussion.—Several species from the Upper Cretaceous of the Gulf Coastal Plain heretofore assigned to *Cerithium* appear to be more closely related to *Cerithiella*. *Cerithium nodoliratum* Wade and *Cerithium semirugatum* Wade, from the Ripley Formation of Mississippi and Tennessee (Wade 1926, Sohl, 1960), and the specimen from the Coffee Sand discussed below possess the basally truncate columella, whorl outline, and noded intersecting transverse and spiral sculpture of the genus. They also appear to have descendants of similar character in the Eocene of the gulf coast in such a similar species as *Cerithiella heckscheri* Palmer (1937, p. 227).

Cerithiella n. sp.

Plate 53, figures 9, 17

Diagnosis.—Small slender turriculate cerithiopsids with sculpture of four spiral ribbons; upper ribbon smooth, lower three ribbons noded where they override broader, lower, transverse ribs.

Description.—Shells small, slender, and flat-sided; pleural angle about 10°. Protoconch unknown. Suture at the base of a shallowly incised groove. Whorl sides only very broadly rounded. Sculpture of four strong spiral cords; lower three are strongest, are of about equal spacing, and are noded where they override weaker collabral transverse ribs; upper spiral ribbon is immediately below suture and lacks nodings. Base of whorl side angulated by a basal spiral cord. Base of shell flat with very faint spiral threads and growth lines and a thin sulcuslike raised spiral lirae. Growth lines slightly opisthocyrt on whorl sides; on

base growth lines procyrt between whorl angulation and raised spiral lirae then flexed to opisthocyrt on the short pillar. Aperture incompletely known.

Measurements.—The specimen figured on plate 53, figure 17, measures 9.5 mm in height and 1.5 mm in diameter.

Discussion.—These little shells are especially distinguished by the peculiar growth line trend on the base of the shell. Although not previously noticed by the author (1960, p. 82), a reexamination of specimens of *Cerithium nodoliratum* indicates that they have the same feature. Although closely related and probably an ancestor of this species, *C. nodoliratum* lacks the fourth spiral ribbon. *Cerithium semirugatum* Wade has four spiral ribbons, but they are all noded, and the third ribbon from the suture is weak and undergoes a different sculpture ontogeny.

I am convinced that this is a new species, but formal naming should await better preserved material which would afford some idea of specific variability.

Types: Figured specimens USNM 131609, 131610.
Occurrence: Mississippi: Coffee Sand.

Superfamily EPITONIACEA
Family EPITONIIDAE
Subfamily ACIRSINAE

Genus ACIRSA Morch, 1857

Type by monotypy, *Scalaria costulata* Mighels and Adams 1842 (=*Scalaria borealis* Beck).

Subgenus PLESIOACIRSA de Boury, 1909

Type by monotypy, *Scalaria decussata* Cantraine, 1837.

Acirsa (Plesioacirsa?) gravida Sohl, n. sp.

Plate 54, figures 11, 12

Diagnosis.—Shell very slender, whorls round sided, sculpture of transverse ribs and spiral cords with secondary lirae in interspaces.

Description.—Moderately small very slender acicular shells. Pleural angle about 13°. Suture impressed, whorls broadly rounded on sides; body with well-rounded basal periphery and convex base. Sculpture of rather thin collabral transverse cords that are separated by interspaces as wide or wider than cords; spiral sculpture consists of uniform primary spiral cords about 0.2 mm in width separated by interspaces of twice the cord width; secondary spiral lirae occur in interspaces and like cords override transverse elements; subdivisions of interspaces by secondary elements of sculpture lend surface a punctate appearance where well preserved. On base spiral cords dominate, are close spaced, and transverse elements are very obscure. Growth lines arcuately prosocline on upper half of whorl, becoming virtually orthocline over lower half. Aperture subovate, subangulated posteriorly, rounded anteriorly. Outer lip rounded, smooth, thinning somewhat medially with a faint notch developing at suture; inner lip with thin but well-margined callus and flattened over parietal surface, columellar lip callus thin, somewhat reflexed, but thin at edge.

Measurements.—The holotype lacks 2–3 mm of its apical lip and measures 12.3 mm in height and 3.4 mm in diameter.

Discussion.—This rare species is closely related to *Acirsa (Plesioacirsa) implexa* Sohl (1963) from the Ripley Formation of Mississippi. Compared therewith it is more slender (pleural angle 13° as against 18°), has more rounded, and proportionately more elongate whorls. The suture is more impressed and the base is more rounded. The callus of the inner lip is thinner in *A. (P.?) gravida*, the transverse ribs are more flexed near the upper suture, and secondary spirals are well developed on the body whorl.

Types: Holotype USNM 131611.
Occurrence: Mississippi: Coffee Sand.

Acirsa (Plesioacirsa?) culmosa Sohl, n. sp.

Plate 54, figures 1, 10

Diagnosis.—Slender shells with broadly rounded whorls bearing close-spaced spiral cords that override the rather broad round-topped transverse ribs.

Description.—Moderately small slender very elongate many whorled shells. Pleural angle 11°. Suture slightly impressed. Whorls only broadly rounded on sides; body with a well-rounded basal periphery. Sculpture of early whorls dominated by sharp-crested strong straight transverse ribs; ribs become more widely spaced, lower, and round topped on later whorls and diminish in vigor greatly on body whorl. Spiral sculpture consists of many rather fine and close-spaced lirae that override transverse sculpture; lirae unequal in strength; spiral interspaces very narrow. Growth lines are very fine; they override spiral elements and are emplaced on ribs but are most noticeable in spiral interspaces where they simulate a punctate surface; in trend growth lines virtually orthocline on whorl sides. Aperture incompletely known, auriform in outline with callus thin over inner lip.

Measurements.—The holotype (USNM 131612) measures 13 mm in height and has a maximum diameter of 3.8 mm.

Discussion.—This species is difficult to place on a subgeneric level as it possesses characters that appear to be intermediate between *Plesioacirsa* and *Hemiacirsa*. Its slender form, well-rounded basal periph-

ery, and tendency for suppression of transverse sculpture relate it to the former. On the other hand, the presence of strong transverse sculpture over most of the whorls is suggestive of the latter.

The only other *Acirsa* in the Coffee Sand fauna is *A.* (*Plesioacirsa*?) *gravida* which lacks the strong transverse ribs and has transverse and spiral sculpture of almost equal strength. In addition, its cancellate surface is truly punctate. Compared to other Cretaceous species of *Acirsa*, *A. culmosa* approaches *Acirsa microstriata* Wade (1926, p. 168), from the Ripley Formation on Coon Creek, Tenn., in its close-spaced spiral sculpture but is more slender, has a well-rounded basal periphery, and strong transverse sculpture. *Acirsa* (*Plesioacirsa*) *wadei* Cossmann, from the same locality, has weaker and more arcuate transverse ribs, more widely spaced spiral sculpture and a punctate surface.

Types: Holotype USNM 131612; paratype USNM 131613.
Occurrence: Mississippi: Coffee Sand.

Subfamily EPITONIINAE

Epitoniid? gastropods

Plate 54, figures 6–9

Discussion.—Several fragments of epitoniid gastropods of questionable affinities are present in the collections from the Coffee Sand. They do not correspond to the immature stages of any of the more fully known species of Epitoniacea known in the fauna.

The smooth nuclear whorls preserved on the small specimen figured on plate 54, figure 6, in some ways is reminiscent of *Aciculiscala* Sohl but lacks the carinate nuclear whorls of that genus.

The other two specimens (pl. 54, figs. 8, 9) appear to represent immature stages of some type of epitoniid, perhaps *Epitonium* or conceivably *Opalia*. None of the specimens belong to the most common of the gulf coast Cretaceous Epitoniacea: *Striaticosta* Sohl, a cirsostremid.

Types: Figured specimens USNM 131614–131616.

Superfamily CALYPTRAEACEA
Family CAPULIDAE

Genus THYLACUS Conrad, 1860
Type by monotypy, Thylacus cretaceus Conrad, 1860

Thylacus cretaceus Conrad

Plate 54, figures 16–18

1860. *Thylacus cretaceus* Conrad, Acad. Nat. Sci. Philadelphia Jour. 2d ser., v. 4, p. 290, pl. 46, fig. 22.

For synonymy through 1960 and description see Sohl, 1960, page 94.

Discussion.—This little capuliform gastropod is characterized by the development of raised bladelike horseshoe-shaped muscle supports that are free at their distal ends (pl. 54, fig. 17). *Thylacus* evidently lived attached to the columella of gastropod shells (pl. 54, fig. 18) that lay free on the bottom (Sohl, 1960, p. 94–95). All shells as yet found in living position (pl. 54, fig. 18) have the same orientation relative to the columella of the host shell. They always rest with their apex toward the anterior of the host shell.

The specimens from the Coffee Sand compare closely in all characters to the specimens from the Ripley and Owl Creek Formations of Mississippi. Their presence in the Coffee Sand marks the oldest known occurrence of the genus.

Types: Holotype lost; hypotypes USNM 31958 (North Carolina), USNM 73028 (Tennessee), USNM 128483–128485, 131617, 131618 (Mississippi).

Occurrence: Mississippi: Coffee Sand, Ripley Formation, Owl Creek Formation; Tennessee: Ripley Formation, Clayton Formation (reworked Cretaceous material at base); Alabama: Ripley Formation. Georgia: Ripley Formation; North Carolina: Snow Hill Marl Member of the Black Creek Formation.

Superfamily STROMBACEA
Family APORRHAIDAE

Genus ANCHURA Conrad, 1860
Type of monotypy, Anchura abrupta Conrad, 1860

Anchura aff. A. substriata Wade

Plate 54, figures 2, 3

1926. *Anchura substriata* Wade, U.S. Geol. Survey Prof. Paper 137, p. 149, p. 52, fig. 10.
1960. *Anchura substriata* Wade, Sohl, U.S. Geol. Survey Prof. Paper 331–A, p. 106, pl. 12, figs. 2, 3, 10, 11, 13 [1961].

Discussion.—Fragments consisting of wings, spires, and parts of whorls of a species assignable to *Anchura* are quite common in the collections from the Coffee Sand of Mississippi. The shape of the outer lip wing fragments (pl. 54, fig. 2) with their thin broad blunt lateral edge, posterior extension to a spike, and the lobelike blunted anterior extension are typical of *Anchura*. The secondary spike at about midlength of the upper or posterior edge of the wing, on these fragments, is similar to that of *Anchura substriata* Wade but is a feature lacking on the type species, *A. abrupta* Conrad. The sculpture of the body and trend of transverse ribs of the Coffee Sand specimens are also similar to Wade's Coon Creek species, but perhaps the ornament is somewhat more subdued.

The presence of accessory spikes on the posterior edge of the gulf coast species of *Anchura* appears to have stratigraphic significance. All the species known from above the *Exogyra cancellata* zone lack the

spikes, whereas those from and below that zone all appear to possess them.

The available material does not allow for closer comparison.

Types: Figured specimens USNM 131619, 131620.
Occurrence: Mississippi: Coffee Sand.

Genus GRACILIALA Sohl, 1960

Graciliala johnsoni (Stephenson)?

Plate 54, figure 23

1875. *Anchura rostrata* Morton. Conrad, *in* North Carolina Geol. Survey Rept., v. 1 (by W. C. Kerr), app. A., p. 12, pl. 2, fig. 28.
1876 *Anchura pennata* Morton. Conrad, Acad. Nat. Sci. Philadelphia Proc. p. 275.
1898. *Anchura* sp. Johnson, Acad. Nat. Sci. Philadelphia Proc., v. 50, p. 463, text fig. 3 (questionably referred).
1923. *Anchura johnsoni* Stephenson, North Carolina Geol. and Econ. Survey Bull., v. 5, p. 370, pl. 92, figs. 1, 4.
1960. *Graciliala johnsoni* (Stephenson). Sohl, U.S. Geol. Survey Prof. Paper 137, p. 47, 97 [1961].

Discussion.—One specimen from the Coffee Sand of Mississippi (pl. 54, fig. 23) closely approaches *Graciliala johnsoni* (Stephenson), from the Snow Hill Marl Member of the Black Creek formation of North Carolina. I have no reservation in assigning it to Stephenson's species except that the extended outer lip wing is lacking as is part of the body whorl. In size this specimen is almost a replica of a topotype figured by Stephenson (1923, pl. 42, fig. 3). In trend and in number of transverse ribs it is very close to another topotype figured by that author on plate 42, figure 4. In addition the Coffee Sand specimens also lack varices and possess an inner lip like that of *A. johnsoni*.

The figure of the Coffee Sand specimen given here accentuates the suppression of the transverse ribs of the body whorl. The ribs increase in strength over the remainder of the body.

This species has also been cited as occurring in the Merchantville Formation of Delaware (Groot and others, 1954, p. 51).

Types: Figured specimen USNM 131622.
Occurrence: North Carolina: Snow Hill Marl Member of Black Creek Formation; Mississippi: Coffee Sand.

Genus ARRHOGES Gabb, 1868
Type by monotypy, Chenopus occidentale Beck, 1847
Subgenus LATIALA Sohl, 1960
Type by original designation, Anchura lobata Wade

Arrhoges (Latiala?) sp.

Plate 54, figures 19, 24–26

Discussion.—The most common aporrhaid in the collections from the Coffee Sand is represented only by small immature specimens lacking the extended apertural wing. The outer lip on several specimens is preserved (pl. 54, fig. 25), and they appear to represent the earliest stage of the development of the wing. In profile the upper edge is beginning to thicken and is bowing out with a decided procyrt trend over most of its length. The inner lip callus is rather thick and well margined and extends out onto the body over both the columellar and parietal surface (pl. 54, figs. 24, 26). The protoconch is worn on all specimens. The whorls are ornamented by strong generally sharp-crested transverse ribs that number 24–27 per whorl. Round topped varices occur periodically, and the transverse ribs diminish in vigor until they are entirely lost on the body whorl. Spiral sculpture when present is variable and confined to thin spiral threads.

These specimens appear to be allied to *Arrhoges* (*Latiala*) in generally having poorly developed spiral sculpture, sharp-crested ribs, varices, and subdued transverse sculpture in later growth stages. Small species of this genus are known in the Cretaceous of this same area (Sohl, 1960, pl. 11, fig. 10).

Compared to the type species *Arrhoges* (*Latiala*) *lobata* (Wade), from the Ripley Formation on Coon Creek, McNairy County, Tenn., this species is smaller, has less rounded whorls and grooved suture, and loses all trace of transverse ribs early in development. It more closely resembles the form Stephenson (1941, p. 300) described as *Anchura? cibolensis*, from the Kemp Clay of Texas. Although larger than the Coffee Sand specimens, this species loses its transverse sculpture well before the mature growth stage is reached.

Until the character of the fully developed outer lip is known, the generic assignment of this species must remain in doubt.

Types: Figured specimens USNM 131621, 131623.
Occurrence: Mississippi: Coffee Sand.

Genus PTEROCERELLA Meek, 1864
Type by original designation, Harpago tippana Conrad, 1858

Pterocerella sp.

Plate 54, figures 4, 5

Discussion.—Only fragments of a spire and a wing (pl. 54, figs. 4, 5) indicate the presence of the genus in the collections from the Coffee Sand. The type species as well as other species from the embayment region has been discussed and figured by Sohl (1960, p. 108–110). Stephenson (1941, p. 309) figured other species from the Navarro Group of Texas.

The spire fragment (pl. 54, fig. 4) shows smooth whorl surfaces that are angulated above midheight by a carination. In this character and in general shape it parallels *Pterocerella poinsettiformis* Stephenson.

The broken part of the outer lip wing (pl. 54, fig. 5) consists of only the basal part of two of the digital blades. They are probably the anterior wing digitations.

These fragments may belong to an undescribed species that occurs in the Blufftown Formation of Alabama and Georgia. The Blufftown species also possesses carinations on the whorls of the spire and occurs at approximately the same stratigraphic level.

Types: Figured specimens USNM 131624, 131625.
Occurrence: Mississippi: Coffee Sand.

Genus TUNDORA Stephenson, 1941

Type by original designation, Tundora tuberculata Stephenson

Tundora cf. T. tuberculata Stephenson

Plate 54, figures 20, 21, 22, 27

Discussion.—The material from the Coffee Sand of Mississippi discussed below represents the second recorded occurrence of this genus. *Tundora tuberculata* was described by Stephenson (1941, p. 313) from the Neylandville Marl of Navarro County, Tex.

This material consists of one specimen lacking the outer lip and anterior tip of the shell, one fragment of a body whorl of another individual, and several parts of expanded outer lips. The specimen figured on plate 54, figure 27, is more complete than Stephenson's holotype and displays well a number of features only suggested by the type lot. The Coffee Sand material consists only of adult shells whose surface is covered by callus, and the fine spiral lirae of the early growth stages noted by Stephenson are not displayed. The mature shell (pl. 54, fig. 27) is rather rotund in outline. Spiral sculpture consisting of nodose spiral cords is well displayed on the anterior slope but is covered over by a smooth coating of callus on the upper part of the body whorl. This callus continues up over the spire obscuring the preceding whorls. The posterior part of the outer lip is drawn out into an elongate siphonal groove that is bounded on the inner side by the callus that covers the spire. On the outer side there is another callus ridge that dies out rapidly on the surface of the preceding whorls. This posterior canal is adnate to the spire but continues above the tip of the shell as a groove incised in a curving spike about 8–9 mm long. From the base of the posterior canal spike another high narrow round-topped ridge of callus begins and trends straight down the side of the spire ending at the periphery of the body whorl. The fragment illustrated on plate 54, figure 20, shows the end of this ridge at the upper right side. This specimen also indicates that the heavy callus cover over the ventral suface of the spire and upper body whorl does not continue onto the dorsal surface but is delimited by the thick *Calyptraphorus*-like callus ridge and the posterior siphonal canal. The inner lip of the aperture is lightly callused and smooth. During the cleaning of the more complete specimen, the anterior extremity was broken; it has been restored in the illustration (pl. 54, fig. 27). Although the character of the outer lip was not known, Stephenson (1941, p. 313) assumed that it was expanded. One discrete outer lip recovered from the Coffee Sand and figured herein (pl. 54, fig. 21) belongs to this species. There are indications that the individual from which it was broken had tuberculate spiral sculpture. Judging by the shape of the wing, *Tundora* is more aptly placed in the Aporrhaidae or possibly in the Struthiolaridae than in the Strombidae where Stephenson placed it.

The specimens from the Coffee Sand may well represent a new species. No name is here proposed, because of the incomplete nature of the specimens. Compared to the Texas material, from a higher stratigraphic level, these specimens are larger in size, and the tuberculations on the spirals are less coarse. Due to the state of preservation other comparisons are impracticable.

Types: Figured specimens USNM 131626.
Occurrence: Mississippi: Coffee Sand; Texas: Neylandville Marl.

Family STROMBIDAE
Genus PUGNELLUS Conrad

Pugnellus aff. P. densatus Conrad

1858. *Strombus densatus* Conrad, Acad. Nat. Sci. Philadelphia Jour., 2d ser., v. 3, p. 330, pl. 25, fig. 14.
For all synonymy see Sohl, 1960, page 112.

Discussion.—The collection from the Coffee Sand at locality 10 contains one poorly preserved sandstone mold of a *Pugnellus* with some of the shell material adhering. In both size and wing characters the specimen may be Conrad's species. In addition there are impressions of short transverse ribs at the shoulder of the body whorl.

This specimen, although poorly preserved, is the only record of the presence of this genus in the Coffee Sand. This is somewhat unusual in view of the fact that *Pugnellus* is a moderately common element in both the sand and chalk facies in other formations of the same area.

Types: Mentioned specimen USNM 131627.
Occurrence: Mississippi: Coffee Sand at loc. 10.

Superfamily NATICACEA
Family NATICIDAE
Subfamily GYRODINAE

Genus GYRODES Conrad, 1860

Type by monotypy, *Rapa supraplicata* Conrad, 1858 (=*Natica* (*Gyrodes*) *crenata* Conrad, 1860).

Discussion.—The low globose broadly umbilicate shells of this genus are among the most widely dispersed gastropods in the Cretaceous deposits of the world. Three species are present in the Coffee Sand of Mississippi, all with closely related forms in the stratigrapically higher Ripley and Owl Creek Formations of the same area.

Gyrodes major Wade

Plate 54, figures 32, 35–37

1926. *Gyrodes major* Wade, U.S. Geol. Survey Prof. Paper 137, p. 164, pl. 57, figs. 4, 7, 11.

For synonymy through 1960 see Sohl, 1960, page 118.

Diagnosis.—Medium- to large-size shell; whorls flattened subsuturally and crenate, umbilicus margined by noncrenate carination in early stages that rounds off in late growth stages.

Measurements.—A somewhat distorted hypotype measures 26 mm in diameter and 19.7 mm in height.

Discussion.—This is the most common species of *Gyrodes* in the Coffee Sand and is closely related to the type species *Gyrodes supraplicatus* Conrad of the Ripley and Owl Creek Formations and equivalents. Compared with that species, at maturity, the umbilical carination is rounder (Sohl, 1960, pl. 16, figs. 7, 11), and the umbilicus is narrower. In early stages the umbilical margin lacks crenulations (pl. 54, fig. 32) and the shoulder crenulations are also weaker. The crenulate shoulder and sharp umbilical carination also serve to distinguish this species from other species of *Gyrodes* in the fauna.

The Coffee Sand specimens described here evidently are immature as they possess a sharp umbilical carination. All are smaller than the type specimen (Wade 1926, pl. 57, fig. 4) but resemble closely a tototype figured by Sohl (1960, pl. 16, fig. 15). Most of the available specimens are somewhat compressed or are incomplete but appear to be somewhat less globose than the Coon Creek specimens. On the other hand, no uniform differences can be noted, and besides the umbilical features the Coffee Sand specimens are similar in their rate of whorl expansion, width of shoulder sutural groove, and height of spire.

Types: Holotype USNM 73077; hypotype USNM 73076, 128547, and 128548 (Tennessee); USNM 31845 (North Carolina); and USNM 131628, 131695 (Mississippi).

Occurrences: Tennessee: Ripley Formation; Mississippi: Coffee Sand; North Carolina: Snow Hill Marl Member of Black Creek Formation.

Gyrodes spillmani Gabb

Plate 54, Figures 28–31, 33, 34

1860. *Natica* (*Gyrodes*) *alveata* Conrad, Acad. Nat. Sci. Philadelphia Jour., 2d ser., v. 4, p. 289, pl. 46, fig. 45.

1861. *Gyrodes spillmani* Gabb, Acad. Nat. Sci. Philadelphia Proc. v. 13, p. 320.

For synonymy through 1960 and description see Sohl, 1960, p. 118.

Diagnosis.—Shell thin and small for genus; suture in a narrow channel; whorls with a narrow subsutural platform that is bounded by a raised rather sharp carina.

Measurements.—A laterally compressed hypotype (pl. 54, fig. 33) measures 18.5 mm in height and 15.5 mm in diameter. A second hypotype (pl. 54, fig. 28), compressed dorsoventrally, measures 11.5 mm in height and 14 mm in diameter.

Discussion.—The specimens from the Coffee Sand here assigned to *Gyrodes spillmani* appear to show the same range of variability that Sohl (1960, p. 18) noted for specimens from the Ripley Formation of Mississippi and Tennessee. The suture in most specimens rests at the base of a narrow rather deep channel (pl. 54, figs. 29, 31). This channel is deeper in the figured specimens from the Coffee Sand than on those from the Ripley Formation (Sohl 1960, pl. 16, fig. 17). Another specimen (pl. 54, fig. 34) has the nuclear characters and early whorls of this species; it possesses a subsutural area that lacks the deeply channeled suture but does have a weltlike rim below a flattened upper whorl face as if the bounding carination had been flattened out. Similar varieties can be seen in specimens collected from the Ripley Formation. The differences in body proportions between the specimens figured on plate 54, figures 28 and 33, can, for the most part be ascribed to dorsalventral compression in one specimen and lateral compression in the other.

Types: "Cotypes" ANSP 15162, hypotypes USNM 131628–131630 (Mississippi); hypotypes USNM 128551, 73079, 128549 (Tennessee); hypotype (New Jersey).

Occurrence: Mississippi: Coffee Sand, Ripley Formation, Owl Creek Formation, Prairie Bluff Chalk; Tennessee: Ripley Formation; Texas: Nacatoch Sand and Corsicana Marl; Alabama: Prairie Bluff Chalk; New Jersey: Navesink Formation.

Subfamily NATICINAE

Genus EUSPIRA Agassiz (in Sowerby), 1842

Type by subsequent designation (Dall, 1915), *Natica glaucinoides* Sowerby, 1812.

Discussion.—Historically the shells here assigned to *Euspira* have generally been assigned to the synonym

Lunatia Gray (1847), to *Polinices*, or to *Natica*. Sohl (1960, p. 122) discussed the problem in detail.

Included species are among the most abundant gastropods in the Upper Cretaceous rocks of the Atlantic and Gulf Coastal Plains.

Euspira rectilabrum (Conrad)

Plate 55, figures 1, 2, 7, 8

1858. *Natica* (*Lunatia*) *rectilabrum* Conrad, Acad. Nat. Sci. Philadelphia Jour., 2d ser., v. 3, p. 334, pl. 35, fig. 28. See Sohl, 1960, page 122 for complete synonymy to that date.

Diagnosis.—Medium-sized globose shell with impressed suture; surface smooth and glazed; parietal lip generally with a thick pad of callus merging below into a straight moderately thick columellar lip. Umbilicus moderately narrow, partly covered by callus.

Measurements.—The hypotype (pl. 55, fig. 8, USNM 131632) measures 13.2 mm in height and 11.4 mm in diameter. The largest available specimen meaures 16.1 mm in height and 15 mm. in diameter.

Discussion.—This is one of the most abundant gastropods found in the Coffee Sand. Individual variation is well shown by a comparison of the two specimens figured on plate 55, figures 2 and 7. Figure 2 represents the common form with a well-rounded upper whorl surface and a very thick parietal callus pad that hardly invades the umbilicus at all. The second specimen figured (pl. 55, fig. 7) shows much thinner parietal callus that invades the umbilicus slightly and has a flattened upper whorl surface. This latter specimen is the extreme of variation in the population and may represent a deformity or pathologic condition.

Compared with specimens from the *Exogyra costata* zone of Mississippi and Tennessee, the Coffee Sand specimens average somewhat smaller in size. In apertural and umbilical characters they are very close but are somewhat proportionally more obese. Variations similar to those noted for the Coffee Sand specimens are noted among the collections from the Ripley Formation and from the type locality in the Owl Creek Formation on Owl Creek in Tippah County, Miss.

Types: Holotypes ANSP (Lost); hypotypes USNM 73074 (Tennessee), USNM 131631, 131632, Coffee Sand (Mississippi); USNM 3197 (North Carolina).

Occurrence: Mississippi: Owl Creek and Ripley Formations and Coffee Sand; Tennessee: Ripley Formation; Texas: San Miguel Formation, Neylandville Marl, Nacatoch Sand, Corsicana Marl, and Kemp Clay; Georgia and Alabama: Blufftown Formation, Cusseta Sand, Ripley Formation, Providence Sand; North Carolina: Snow Hill Marl Member, Black Creek Formation.

Subfamily AMPULLININAE

Genus PSEUDAMAURA Fischer, 1885
Type by monotypy, Natica bulbiformis Sowerby, 1832

Pseudamaura lepta Sohl, n. sp.

Plate 55, figures 3–5

Diagnosis.—Medium-sized shells with a proportionally high spire, a narrowly channeled suture, and a surface covered with fine impressed spiral lines.

Description.—Broadly naticiform shells of medium size with proportionally high spire a little less than half total shell height. Protoconch unknown. Suture impressed deeply, lying at the base of a narrow channel that widens somewhat near aperture. Body whorl greater in length than in breadth, with well rounded sides. Sculpture of many incised spiral lines which are fine and much narrower over the whorl sides and base but near suture are coarser with some being broader than the interspaces. Growth lines distinct, gently prosocline over channel rim and upper whorl and becoming holocline over whorl side and base. Aperture subovate somewhat angulated posteriorly, well rounded anteriorly. Outer lip thin at edge; inner lip straight; parietal lip thin at edge, columellar lip slightly patulous and rounded below. Umbilical slit partly covered by inner lip.

Discussion.—This is a common species in the Coffee Sand of Mississippi and has also been recognized in the Blufftown Formation of the Chattahoochee River region of Georgia and Alabama. Variation is primarily limited to strength of sculpture, in other respects the available specimens all show a considerable uniformity in characters.

The only other closely comparable described species is *Pseudamaura lirata* (Wade) from the Coon Creek Tongue of the Ripley Formation of Tennessee. Compared to Wade's species, *Pseudamaura lepta* is larger, proportionally stouter, has coarser spiral sculpture, and a stronger sutural channel.

Types: Holotype USNM 131633; paratypes 131634, 131635.
Occurrence: Mississippi: Coffee Sand; Georgia and Alabama: Blufftown Formation.

Order NEOGASTROPODA
Suborder STENOGLOSSA
Superfamily MURICACEA
Family MURICIDAE
Subfamily RAPANINAE

Genus SARGANA Stephenson, 1923
Type by original designation, Rapana stantoni Weller, 1907

Sargana stantoni (Weller)?

Plate 55, figures 18, 19

1907. *Rapana stantoni* Weller, New Jersey Geol. Survey, Paleontology, v. 4, p. 754, pl. 89, figs. 1–3.
1923. *Sargana stantoni* (Weller). Stephenson, North Carolina Geol. and Econ. Survey Bull., v. 5, p. 377, pl. 93, figs. 1–5.

1926. *Sargana stantoni* (Weller). Wade, U.S. Geol. Survey Prof. Paper 137, p. 136, pl. 46, figs. 7, 8.
1940. *Sargana stantoni* (Weller). Stephenson and Monroe, Mississippi Geol. Survey Bull. 40, pl. 9, figs. 6, 7, 8.
1941. *Sargana stantoni* (Weller). Stephenson, Texas Univ. Bull. 4101, p. 325, pl. 60, figs. 15 to 17.

Discussion.—Two specimens from the Coffee Sand are assignable to *Sargana*.

The holotype of *Sargana stantoni* (Weller) comes from the Nacatoch Sand of Texas. Large suites from the same level in the Ripley Formation of Mississippi and from a lower level in the *Exogyra cancellata* zone of the Ripley Formation of Tennessee (Sohl, 1963) are available for comparison. In ornament the Coffee Sand specimens agree well with those from the Ripley in having two spinose spiral cords between the suture and the peripheral carination and in having four similar spinose spiral cords on the whorl sides between the peripheral carination and the basal constriction. Differences can be noted, however, in that the two spiral cords of the upper whorl face develop at an earlier stage. In addition, the Coffee Sand form has a more deeply impressed basal constriction and the serrate umbilical keel is more highly abaxially inclined. These differences accompanied by the fact that in profile the outer lip is more highly inclined would lead one to differentiate the Coffee Sand specimens from those of the *Exogyra costata* zone. On the other hand the material available for study from the Coffee Sand is inadequate to determine whether the observed differences are constant. Until more material is available it is at present thought best to include these forms in *Sargana stantoni* but with question.

Types: Figured specimen USNM 131636.
Occurrence: Mississippi: Coffee Sand.

Subfamily MOREINAE

Genus MOREA Conrad, 1860

Type by monotypy, *Morea cancellaria* Conrad.

Two stocks of *Morea* are present in the gulf coast Upper Cretaceous sediments, the *M. marylandica* and *M. cancellaria* types (Sohl, 1963). The Coffee Sand species belongs to the latter.

Morea corsicanensis depressa Sohl, n. subsp.
Plate 55, figures 12–15

Diagnosis.—A *Morea* of the *cancellaria* type with a low spire.

Discussion.—From *Morea corsicanensis* (Stephenson) from the Nacatoch Sand of Texas, this subspecies differs in its lower spire and more rounded whorls. In general there is a lesser tendency for shouldering of the whorl and the subsutural excavation is less deeply impressed. In addition, this little *Morea* shows only a minor tendency for noding of the spiral elements. Only one or two spiral cords are to be seen on the whorls of the spire, whereas in both *M. cancellaria* and *M. corsicanensis corsicanensis* there are three spiral cords visible. Finally the inclination of the growth lines and outer lip is greater than for any other species.

This form is one of the more common and better preserved gastropod species present in the Coffee Sand.

Type: Holotype USNM 131637; paratype USNM 131638.
Occurrence: Mississippi: Coffee Sand.

Family MAGILIDAE

Genus LOWENSTAMIA Sohl, n. gen.

Type species.—*Lowenstamia funiculus* Sohl, n. sp.

Etymology.—The genus is named in honor of H. A. Lowenstam who has significantly contributed to the knowledge of the Upper Cretaceous paleoecology of the Mississippi embayment area.

Diagnosis.—Medium-sized very low to flat-spired broadly phaneromphalus shells; protoconch erect consisting of several smooth rounded whorls that possess a flattened upper whorl face, a peripheral carination, and whorl sides that slope adaxially to a sharply acute umbilical margin. Sculpture of fine spiral lirae covering entire shell surface with spiral cords generally on whorl sides. Aperture flaring with a short open V-shaped siphonal canal.

Discussion.—This genus is proposed to include *Lowenstamia funiculus* Sohl, from the Coffee Sand of Mississippi; *Hippocampoides liratus* Wade, from the Ripley Formation of Mississippi, Tennessee, Georgia, and Alabama; and an undescribed species from the Owl Creek Formation of Mississippi. In addition, internal molds occurring in the Prairie Bluff Chalk of Mississippi and Alabama of the type named *Straparolus subplanus* Gabb (1861, p. 300) may also represent members of this genus. In Texas the genus may be represented by the specimen from the Corsicana Marl figured by Stephenson (1941, pl. 47, figs. 14, 25) as *Hippocampoides* sp.

Hippocampoides Wade, to which several forms here included in *Lowestamia* have previously been assigned, has a narrow twisted canal and lacks the flared aperture of *Lowestamia*.

Lowenstamia shows a distinct developmental trend through time. There is a distinct reduction in the number of spiral cords on the whorl sides from its lowest to its uppermost occurrence. The earliest species, *L. funiculus*, possesses two primary cords, the Ripley species, only one cord, and the Owl Creek species has none.

Lowenstamia funiculus Sohl, n. sp.

Plate 55, figures 20, 24

Diagnosis.—A *Lowenstamia* bearing two nodose to spinose spiral cords upon the whorl sides between the peripheral and umbilical carinations.

Description.—Medium-sized very low spired phaneromphalus shells. Suture impressed with an irregular trace. Flat upper whorl surface develops welts and bumps in later developmental stages; whorls peripherally angulated by a strong nodose to subspinose carina; whorl sides slope adaxially but are broadly concave. Sculpture coarse; spiral ornament of fine flat-topped irregular spiral lirae that cover surface and override the two strong spiral cords on the whorl sides. Transverse elements restricted to broad swellings on whorl sides of early whorls but develop into rugose imbrications near aperture. Growth lines prosocline, more inclined on upper whorl face than on sides. Aperture subovate and flaring, interrupted anteriorly by a somewhat curved broad V-shaped siphonal canal. Outer lip thin, faintly crenulate at intersection of carinations and spiral cords; inner lip thin, flexed anteriorly and loosening in latest growth stage. Umbilicus broad and deep and bordered by a serrate to subspinose carinate margin.

Measurements.—The holotype measures 33.7 mm in diameter and 26 mm in height.

Discussion.—The holotype is the only known specimen of the species. The thin fragile lips of the aperture are retained primarily due to the support afforded by an attached worm tube. The photographs (pl. 55, figs. 20, 24) have been retouched to opaque out the distracting distortion of the tube.

Compared to *Lowenstamia liratus* (Wade), from the Ripley Formation, this species is larger and has two instead of one primary cord on the whorl side.

Types: Holotype USNM 130216.
Occurrence: Mississippi: Coffee Sand.

Superfamily BUCCINACEA
Family BUCCINIDAE

Genus STANTONELLA Wade, 1926
Type by original designation, Stantonella subnodosa Wade

Stantonella sp.

Plate 55, figure 6

Discussion.—Several fragments referable to the genus *Stantonella* have been recovered from the Coffee Sand, but none are in a sufficiently good state of preservation to warrant the assignment of a specific name. *Fasciolaria? rugosa* Stephenson from the Snow Hill Marl Member of the Black Creek Formation of North Carolina, is close but is from a slightly higher position within the *Exogyra ponderosa* zone. It is similar in possessing thin transverse ribs on the sutural collar but lacks visible spiral sculpture in the intercostal spaces. Such sculpture is present on the Coffee Sand specimen figured on plate 55, figure 6. Another fragment from the Coffee Sand that has part of a body whorl preserved shows wide-spaced low spiral cords that override the transverse ribs on the periphery and that become stronger on the anterior slope. *Stantonella rugosa* (Stephenson) has strong ribs that are nodose at the shoulder, but only the faintest microscopic spiral lirae could be found near the shoulder of the body whorl of the holotype. *Stantonella subnodosa* Wade from the *Exogyra cancellata* zone of Tennessee is also similar in its possession of fine transverse ribs on the subsutural collar, but it has more closely spaced and continuous transverse ribs, more closely spaced spiral cords, and flatter sided whorls. Among other differences, the species such as *Stantonella ripleyana* (Conrad) and *S. interrupta* (Conrad), from the Ripley and Owl Creek Formations and equivalents, possess a distinctive subsutural welt that is noded in harmony with the transverse ribs rather than having thin close-spaced transverse riblets on the welt.

Types: Figured specimen USNM 131639. Mentioned specimen USNM 131640.
Occurrence: Mississippi: Coffee Sand.

Genus BUCCINOPSIS Conrad, 1857
Type by monotypy, Buccinopsis perryi Conrad

Buccinopsis? sp.

Plate 56, figure 19

Discussion.—One fragment from the Coffee Sand of Mississippi appears to indicate the presence of a large buccinid species most probably belonging to *Buccinopsis*. The fragment under consideration consists of only the anterior extremity of the body whorl. The deeply impressed sulcus at the base of the body is preserved. This sulcus on well-preserved specimens terminates in a tooth on the outer lip. In addition there is a strong broad corrugated siphonal fasciole that terminates in a broad moderately deep siphonal notch. On the gulf coast, representatives of *Buccinopsis* range through both the *Exogyra ponderosa* and *E. costata* zones (Santonian(?)-Maestrichtian). This form, in both ornament and in estimated size, most closely approximates *B. crassa* Wade. It differs from that species, however, by having a much wider separation of the basal sulcus and siphonal fasciole.

Types: Figured specimen USNM 131641.
Occurrence: Mississippi: Coffee Sand.

Buccinopsis aff. B. crassus (Wade)

Discussion.—Several internal and external molds from the upper part of the Coffee Sand at locality 10

conform closely to *Buccinopsis crassus* (Wade). Compared with Wade's (1926, p. 145) species from the Ripley Formation of Tennessee, these specimens differ only by having somewhat more widely spaced transverse ribs and coarser spiral cords.

The fragment of a specimen assigned to this genus from the lower part of the Coffee Sand shows no sign of transverse ribbing and has finer and much closer spaced spiral sculpture.

Types: Mentioned specimens: USNM 131642.
Occurrence: Mississippi: Coffee Sand at loc. 10.

Genus CANTHARUS ("Bolten") Röding, 1798
Type by subsequent designation (Cossmann 1889), Cantharus globularis ("Bolten") Röding=Buccinum tranquebaricus Gmelin

Subgenus CANTHARULUS Meek, 1876

Type by original designation, *Fusus vaughani* Meek and Hayden.

Discussion.—Meek (1876, p. 380) noted that the type specimen of *C. vaughani* was distorted and that his illustration was poor. Better illustrations have been provided by Stanton (1921, pl. 7, figs. 7a, b) and by Cossmann (1901, pl. 7, fig. 1). Stanton (1921, p. 40), in addition, noted that the type specimen came from the Paleocene Cannonball Member of the Lance Formation instead of the Fox Hills as believed by Meek. Stanton believed the Cannonball was of Cretaceous age, but we now accept it as of Paleocene age. To my knowledge no other North American Cretaceous species have been assigned to the subgenus. Cossmann (1901, p. 173) placed two Cretaceous species in *Cantharulus*, one from India and the other from the Gosau beds of Austria. The latter, *Tritonium gosauicium* Zekeli (1852, pl. 15, fig. 1), is quite similar in many respects to the specimen from the Coffee Sand described below but has a narrow siphonal slit. If, like Meek's holotype, this specimen has been compressed it may belong here, but otherwise the siphonal canal is too narrow. The Indian species *Pollia pondicherriensis* (Forbes) of Stoliczka (1867, pl. 11, figs. 10–12) is suggestive of *Cantharulus* but is too incomplete for confident placement.

Cantharulus lemniscatus, from the Coffee Sand of Mississippi, compares very favorably with the type species in the shape and callus of the inner lip and in the profile and internal crenulations of the outer lip. Neither species appears to have a well-defined basal notch. The type specimen of the genotype is somewhat compressed, thus giving the appearance of a narrow siphonal canal. In shell outline the Mississippi species is more obese, has a higher shoulder, and in sculpture is closer to the Gosau and Indian species.

If these species are accepted in *Cantharulus*, its range is Turonian through Paleocene.

Cantharus (Cantharulus) lemniscatus Sohl, n. sp.

Plate 55, figures 16, 17, 21, 22

Diagnosis.—Whorls with high well-rounded periphery, strong rounded transverse ribs and covered by many spiral ribbons.

Description.—Medium size bucciniform shells, spire a little more than one-third total shell length, pleural angle 57°–62°. Protoconch erect, bulbous, of 2–2½ smooth whorls, the first of which is partly submerged and essentially flush with the upper surface of plane of coiling of the second; junction with teleconch and gradual addition on the round-sided whorls of four thin sharp spiral lirae with lower lira at lower suture. Whorls swollen above well-rounded periphery, tapering rapidly below to the pillar; suture impressed. Sculpture on earliest whorls consists of four thin sharp spiral threads on rounded whorl sides that continue for 1¼ whorls with an angulation gradually developing at upper thread; first transverse ribs now appear and are weak swellings above upper spiral but are strong round-topped ribs on whorl sides; as ribs appear, spiral threads strengthen to four rather broad raised spiral ribbons that override collabral ribs; with growth secondary lirae may be added. Body whorl bears 11–12 transverse ribs that are continuous from suture across periphery dying on anterior slope; spiral elements cover surface but diminish in vigor anteriorly. Growth lines sigmoidal, sharply opisthocline near suture, prosocline over periphery and upper anterior slope, swinging back to gently opisthocline low on base. Aperture subovate, siphonal canal short, broad, inclined and slightly twisted; aperture with a shallow posterior notch that extends forward well beyond limit of remainder of lip. Outer lip sinuate in profile, shallowly crenulate interiorly, thinning anteriorly; inner lip with a well margined but thin callus that extends out of aperture over parietal wall a short distance, columellar lip smooth, almost straight.

Measurements.—The holotype (USNM 131643) lacks an estimated 4 mm of its spire and measures 22.2 mm in height and 14 mm in diameter. Other specimens in the type lot indicate that some specimens reached a size in excess of 33 mm in height with a maximum diameter of about 18 mm.

Discussion.—This species is represented in the collections from the Coffee Sand by more than 15 specimens, none of which are complete. The holotype (pl. 55, fig. 21) is somewhat less than average size. It lacks the apical tip, but a paratype (USNM 131644) on which the protoconch and early growth stages are pre-

served, served as the basis for the description of the protoconch and ontogeny of sculpture.

Variation in size, shape, or sculpture is not great. The number of transverse ribs per whorl is constant at 11 or 12 at maturity, but the number of spiral elements varies. Some shells show an almost total lack of secondary spiral lirae, others have them in almost all interribbon spaces. On some specimens the ribs are crowned with subnodes. These form where the spiral ribbons are accentuated. In other cases such nodings are obscure.

Types: Holotype USNM 131643; paratypes USNM 131644, 131645.
Occurrence: Mississippi: Coffee Sand.

Genus ALIOFUSUS Stephenson, 1941
Type by original designation, Aliofusus reagani Stephenson
Aliofusus? sp.

Plate 56, figure 24

Discussion.—An incomplete specimen from the Coffee Sand (figured on pl. 56, fig. 24) is here questionably assigned to *Aliofusus* on the basis of its having a nonplicate columella, posteriorly constricted whorls, strong transverse ribs, and a growth line trend like that of the genus.

Compared to other known species of *Aliofusus* (Sohl, 1963), it is much larger and the spiral sculpture is much coarser. In addition, compared with the type species, the transverse ribs are much coarser and the subsutural constriction stronger. In terms of size and strength of ribbing this species is closer to some species of *Deussenia* but the spiral sculpture is weaker, and more importantly the growth line is much more inclined on the posterior collar as it is in *Aliofusus*.

Type: Figured specimen USNM 131646.
Occurrence: Mississippi: Coffee Sand.

Family MELONGENIDAE

Genus LOMIROSA Stephenson, 1941
Type by original designation, Lirosoma cretacea Wade, 1926

Lomirosa carinata Sohl, n. sp.

Plate 55, figures 23, 25

Diagnosis.—A *Lomirosa* with a carinate periphery and an almost smooth upper whorl surface.

Description.—Medium-size subfusiform shells, spire about two-thirds total shell height, pleural angle 60°–65°. Protoconch low, blunt, consisting of about 2½ round-sided whorls. Whorls three to four in number; suture impressed. Whorls of spire rounded, body whorl develops a peripheral carination above which upper whorl surface forms a smooth ramp; below periphery, body whorl first flatly inclined then sharply constricted to a somewhat twisted pillar. Very fine microscopic spiral lirae cover surface of shell but sculpture dominated by flat-topped spiral ribbons and rounded spiral cords; uppermost cord thin, bounding a narrow subsutural platform; inclined ramp bears one thin ribbon; strongest cords or ribbons develop at peripheral carination and between carination and basal constriction; spiral elements closer spaced but weaker over the anterior slope and pillar. Transverse sculpture restricted to a few weak varices and to elongate subnodose swellings near aperture. Growth lines fine, close spaced, forming a distinctive filose sculpture; growth lines gently opisthocline on the ramp, sinused at the peripheral carination, prosocline between the carination and constriction, and opisthocline over the anterior shape and pillar. Aperture incompletely known, produced anteriorly to an elongate and twisted siphonal canal; outer lip sinused at carina; inner lip lightly callused above; columellar lip thin, sharp, flexed and thus forming a slit above.

Measurements.—The holotype (USNM 131647) lacks a few millimeters of its anterior extremity; measures 28 mm in height and 18.6 mm in diameter.

Discussion.—*Lomirosa carinata* differs from *L. cretacea* (Wade), from the Coon Creek Tongue of the Ripley Formation of Tennessee by its development of a peripheral carination, by its ramplike upper whorl face, by its less strong spiral sculpture, by having finer and more flexuous growth lines and by its general lack of transverse ribs, nodes, or varices.

This occurrence in the Coffee Sand is the earliest record of the genus. In general, shells of *Lomirosa* are fragile, and well-preserved specimens are rare. The few specimens available of *Lomirosa carinata* indicate little noticeable variation in sculpture or form.

Types: Holotype USNM 131647.
Occurrence: Mississippi: Coffee Sand.

Genus PYRIFUSUS Conrad, 1858
Type by monotypy, Pyrifusus subdensatus Conrad
Pyrifusus sinuocostatus Sohl, n. sp.

Plate 56, figures 22, 23

Diagnosis.—Shell small for genus, secondary spiral lirae on excavated band and impressed on primary spiral ribbons; body strongly constricted below periphery.

Description.—Medium-size pyriform shells; spire about one-fourth total shell height; pleural angle about 77°. Suture impressed, irregular in trace, bordered below by a subsutural welt. Body bears a broad

and excavated band or collar above a narrow shoulder, periphery well rounded, sloping steeply below to an elongate tapering pillar. Sculpture ornate; about 15 prominent strongly curved collabral transverse ribs cross inflated periphery but die out on excavated band above and on anterior slope below. Spiral sculpture of wide-spaced flat-topped ribbons that are strongest on periphery; subsutural welt and excavated band lack primary ribbons but bear several faint secondary lirae low on periphery and on anterior slope; other secondary spiral lirae top spiral ribbons. Growth lines strong and sinuous, highly opisthocline over subsutural collar and excavated band, arcuately proscline over periphery and flexed back to opisthocline over anterior slope; growth lines develop broad sinus between each of the primary ribbons. Aperture subovate, narrowly notched posteriorly and anteriorly produced to an elongate narrow adaxially inclined siphonal canal. Outer lip incompletely known; inner lip excavated, with a heavy callus that extends out onto parietal surface a short distance, columellar lip slightly flattened, sharp at lower end and free, leaving an open umbilical chink.

Measurements.—The holotype (USNM 131648) lacks a small part of its spire but measures 28 mm in height and 22.2 mm in height.

Discussion.—The holotype is the only specimen available for comparison. It is almost complete, and the strength of the growth lines near the aperture indicates that it is a virtually mature individual. Compared with all other species of *Pyrifusus*, except the type species, *P. subdenstatus* Conrad from the Owl Creek Formation, *P. sinuocostatus* reaches maturity at a smaller size and has a proportionally higher spire. *Pyrifusus subdenstatus* has more direct growth lines and transverse ribs, more numerous spiral elements which consist of round-topped cords and not flat-topped ribbons, has a less constricted body, and has less callus on the inner lip. *Pyrifusus crassus* Sohl from the Ripley Formation of Mississippi has a heavier more expanding inner lip callus, lacks the umbilical slit, has a lower spire, and has round-topped spiral cords. *Pyrifusus subliratus* Wade, from the Coon Creek Tongue of the Ripley Formation of Tennessee, is perhaps the most closely related species, but it is larger, has a higher pleural angle, has round-topped spiral cords, and a less slender pillar.

Types: Holotype USNM 131648.
Occurrence: Mississippi: Coffee Sand.

Family FASCIOLARIIDAE
Subfamily FASCIOLARIINAE
Genus BELLIFUSUS Stephenson, 1941

Type by original description, Odontofusus curvicostatus Wade, 1926

Bellifusus sp.

Plate 56, figures 16, 17; plate 57, figure 13

Discussion.—Several incomplete fusiform specimens in the collections under study bear a subsutural collar, rounded whorls, and columellar plait arrangement typical of the genus *Bellifusus*. Their incomplete nature does not warrant a full description of formal name.

With the exception of one questionably assigned species from the Woodbine Formation of Texas, all the described species of *Bellifusus* occur in the zone of *Exogyra costata*. Compared with these species, the Coffee Sand form most closely approximates *B. angulicostatus* Sohl. Like that species the spiral sculpture is fine, consisting of many spiral lirae that override the transverse elements and are narrower than their interspaces. The transverse ribbing is also similar with the crest of the ribs angulated by a thin raised extra strong growth line. The ribs are less truncate on the early whorls and develop a sinuous trend at an earlier stage of growth. In addition, the Coffee Sand species has a collar with crenulations that appears to be lacking in *B. angulicostatus*. For these reasons these specimens appear to represent a new species related to *B. angulicostatus* Sohl.

The specimens available from the Coffee Sand collections show some variation. Spiral sculpture is fainter and weaker on the specimen figured on plate 56, figure 17, than that displayed by other specimens (USNM 131650). Similarly, strength of the transverse ribs and the development of a curved trend also appears to vary.

Types: Figured specimens USNM 131649, 131650, 131707.
Occurrence: Mississippi: Coffee Sand.

Genus DRILLUTA Wade, 1916

Type by original designation, *Drilluta communis* Wade.

Discussion.—It is indeed strange that stout fusiform shells of *Drilluta* are so poorly represented in the Coffee Sand as they are among the most common gastropods at higher levels. Perhaps even more significant than their scarcity is the type of *Drilluta* represented. The species discussed below is related to that group of *Drilluta* typified by *D. major* Wade that

reached the largest size attained by any member of the genus. The Coffee Sand specimen discussed below, however, is of small size.

Drilluta cf. D. major Wade

Plate 56, figure 15

Discussion.—Although lacking the apex and a goodly part of the body whorl, the specimen from the Coffee Sand (figured on pl. 56, fig. 15) appears to be related to *Drilluta major* Wade. Neither this specimen nor any related fragments indicate a size approaching that attained by the type specimens of *D. major*. On the other hand, when the figured specimen is compared with the early whorls of *D. major* (Wade 1926, pl. 38, figs. 2, 3; Sohl, 1963), a great similarity in whorl shape and sculpture is to be seen. The whorls of both the Coffee Sand and the Ripley Formation specimens are strongly constricted posteriorly to a subsutural weltlike collar that is crossed by thin sinused growth incrementals. Both the transverse ribs and the spiral elements have a similar strength and trend. The only noteworthy difference appears to lie in the tendency for the ribs to restrict themselves to the shoulder and periphery at an earlier developmental stage.

Types: Figured specimen USNM 131651.
Occurrence: Mississippi: Coffee Sand.

Subfamily FUSININAE

Genus HERCORHYNCUS Conrad, 1868
Type by monotypy, Fusus tippana Conrad, 1860
Subgenus Haplovoluta Wade, 1918
Type by original designation, Haplovoluta bicarinata Wade

Hercorhyncus (Haplovoluta) bicarinatus (Wade)

Plate 56, figures 21, 25, 26

1917. *Scobina bicarinata* Wade, Acad. Nat. Sci. Philadelphia Proc., v. 69, p. 287, pl. 18, figs. 1, 2.
1918. *Haplovoluta bicarinata* Wade, Am. Jour. Sci., 4th ser., v. 45, p. 334.
1920. *Brucia bicarinata* (Wade) Cossmann, Rev. critique de paléozoologie et paléophytologie, v. 21, p. 137.
1925. *Parafusus bicarinata* (Wade). Cossmann, Essais de paléoconchologie comparée, v. 13, p. 249, pl. 10, figs. 35, 36.
1926. *Haplovoluta bicarinata* Wade, U.S. Geol. Survey Prof. Paper 137, p. 138, pl. 47, figs. 3, 7.
1943. *Euthriofusus (Haplovoluta) bicarinata* (Wade). Wenz, Gastropoda, *in* Handbuch der Paläozoologie, v. 6, p. 1247, fig. 3555.

Diagnosis.—A *Haplovoluta* bearing a bicarinate periphery with the upper spiral carination developing spines at intersection of the transverse ribs.

Measurements.—One hypotype (pl. 56, fig. 25) from the Coffee Sand lacks part of both extremities; it measures 24.5 mm in height (estimated length 30 mm if complete) and has a maximum diameter of 19.5 mm.

Discussion.—The specimens here recorded from the Coffee Sand of Mississippi represent the earliest occurrence of *Haplovoluta* yet known. Compared with specimens from the type locality in the Coon Creek Tongue of the Ripley Formation of Coon Creek, McNairy County, Tenn., these forms are somewhat smaller in size. However, some fragments of body whorls from the Coffee Sand that probably represent this species indicate that the maximum size attained is commensurate with the Coon Creek specimens. The height of spire and pleural angle is uniformly lower than the average topotype, but a few topotypes have an equally low spire. The Coffee Sand specimens possess four or five primary spiral cords. On topotypes from Coon Creek generally there are only three cords, but on a few a fourth cord is visible. Other features of form and sculpture are so similar that the Coffee Sand specimens must be considered conspecific with those from the Coon Creek beds.

One specimen from the Coffee Sand (pl. 56, fig. 25) has the complete upper part of the outer lip preserved. The lip thins at the edge, is crenulated where intersected by the spiral elements of the body sculpture, and is produced to a slightly upcurving spinose protrusion at the intersection of the strong upper whorl carination.

Types: Holotype USNM 32889; hypotype (Tennessee) USNM 130378; hypotypes (Mississippi) USNM 131652, USNM 131653.
Occurrence: Tennessee: Coon Creek Tongue of Ripley Formation; Mississippi: Coffee Sand.

Genus REMERA Stephenson, 1941
Type by original designation, Remera microstriata Stephenson

Remera stephensoni Harbison?

Plate 56, figure 14

1962. *Anchura? pergracilis* Johnson. Wade, U.S. Geol. Survey Prof. Paper 137, p. 151, pl. 53, figs. 1, 2.
1945. *Remera stephensoni* Harbison, Acad. Nat. Sci. Philadelphia Proc., v. 97, p. 85, pl. 5, figs. 35, 36.

Discussion.—This species is represented in the collections from the Coffee Sand by only one specimen (pl. 56, fig. 14). In size, shape, pleural angle, and convexity of whorls it compares well with typotypic material that comes from a higher level in the Ripley Formation at Union County Lake, near Pleasant Ridge, Union County, Miss. (Harbison, 1945). In other respects it differs in that the spiral ribbons are narrower and the incised interspaces finer on the Coffee Sand specimen. Although the transverse ribs are as numerous and as strong as those of the topotype material, the ribs appear more flexed and in this respect are more similar to specimens from the *Exogyra cancellata* zone

of the Coon Creek Tongue of Tennessee. Compared with *Anchura? pergracilis* Johnson (1898, p. 463) as figured, this form is not so slim, has transverse ribs that are more highly inclined and more widely spaced. This species is common at some localities in the Ripley Formation of Mississippi and is also present as low as the *Exogyra cancellata* zone of Tennessee (Sohl 1964, p. 223).

Types: Holotype ANSP 16217 (Mississippi); hypotypes USNM 130389, 130390, and 131654 (Mississippi).

Occurrence: Mississippi: Coffee Sand and Ripley Formation; Tennessee: Ripley Formation; Georgia: Ripley Formation; Alabama: Ripley Formation.

Genus FUSINUS Rafinesque, 1815
Type by monotypy, Murex colus Linnaeus, 1758

Fusinus? cf. F? macnairyensis (Wade)

Plate 56, figure 9–11

1926. *Fusus? McNairyensis* Wade, U.S. Geol. Survey Prof. Paper 137, pl. 43, figs. 13, 14.

Discussion.—Several incomplete specimens closely related to *Fusinus? macnairyensis* (Wade) have been noted in the collections from the Coffee Sand. Wade's species is known from the lower part of the Ripley Formation of both Mississippi and Tennessee.

The generic placement of the species in *Fusinus* is provisional. The holotype of *F.? macnairyensis* shows a knife-edged columellar lip, but all other specimens including those from the Coffee Sand lack the anterior extremity of the shell.

In the possession of strong spiral ribbons, broad but strong transverse ribs, and in the character of the growth line, these specimens from the Coffee Sand agree well with the Ripley specimens. On the other hand the Coffee Sand specimens are not quite so slender in outline, the transverse ribs are more prominent, and the whorl sides are more rounded than on the Ripley forms. If these features are constant, specific distinction is feasible but should await better preserved material.

Types: Figured specimens USNM 131655, 131656.

Occurrence: Mississippi: Ripley Formation and Coffee Sand; Tennessee: Ripley Formation.

Family VASIDAE

Genus LUPIRA Stephenson, 1941

Type by original designation, *Xancus variabilis* Wade, 1926.

The specimens described below represent an extension in range of the genus down in to the *Exogyra ponderosa* zone. The presence of plaits on the parietal lip serve to distinguish *Lupira* from *Pyrifusus* Conrad which is similar both in shape and sculpture.

Lupira disparila Sohl, n. sp.

Plate 56, figures 1, 8

Diagnosis.—Shell small for genus, lacking a fasciolar band on the anterior slope of the body, and bearing very few spiral ribbons on the whorl sides.

Description.—Medium-sized pyriform shells with a spire of about one-third total shell height. Pleural angle about 84°. Suture impressed, irregular in trace as it conforms to sculpture of preceding whorl. Body whorl inflated above midheight, constricted anteriorly to an elongate siphonal canal, and posteriorly constricted to a subsutural collar. Sculpture of strong rather wide-spaced spiral ribbons that number about 11 on body with several secondary spiral lirae above the shoulder and on the collar. Transverse ribs round topped, strong on periphery, dying out on collar above and on anterior slope below. Growth lines of the body very gently prosocline over upper slope of body, almost orthocline over periphery, openly sinused on upper part of anterior slope, virtually orthocline on pillar. Aperture broadly subovate, notched posteriorly, produced anteriorly to an elongate curving siphonal canal; outer lip thin at edge, crenulate where intersected by major spiral ribbons; inner lip callus with a well-defined margin and extending out only a short distance over parietal surface. Near junction of parietal and columellar lips are two strong folds, followed posteriorly by one weak and one very faint plait.

Measurements.—The holotype measures 23.4 mm in height and 14 mm in diameter.

Discussion.—The size attained by the holotype is average for the species. There is a moderate amount of variability in the strength of the ribs but they are rather uniform in number, 12 or 13 per whorl. Spiral sculpture is consistently widespaced, but on a few of topotypes fine secondary spiral lirae are emplaced on the tops of the spiral ribbons, a feature not displayed on the holotype.

Compared to other species of *Lupira*, *L. disparila* has wider spaced spiral elements and is smaller. In addition, both *Lupira variabilis* (Wade) from the Ripley Formation of Tennessee and *L. pyriformis* Stephenson from a slightly higher level in Mississippi and Texas have spiral cords instead of ribbons, and most importantly they possess a flat fasciolelike band slightly below the periphery. *Lupira turbinea* Sohl from the *Exogyra cancellata* zone of Tennessee appears to be the most closely related species but possess close-spaced spiral cords, lacks spiral ribbons, and the inner lip plaits are lower.

Types: Holotype USNM 131657; paratype USNM 131658.

Occurrence: Mississippi: Coffee Sand.

Subfamily VASINAE

Genus PYROPSIS Conrad, 1860

Type by monotypy, Tudicla (Pyropsis) perlata Conrad, 1860

Pyropsis sp. A

Plate 56, figure 7

Several fragments in the collections under study indicate the presence of an ornate species of *Pyropsis* in the Coffee Sand. Insofar as shape can be determined this species belongs to the *P. perlata* Conrad-*P. proxima* Wade lineage of the *Exogyra costata* zone of the East Gulf Coastal Plain. The body is not so strongly constricted and the spiral sculpture is finer and closer spaced than in these species. The Coffee Sand fragments represent a distinct species, but better preserved material is necessary before defining it.

Types: Figured specimen USNM 131659.
Occurrence: Mississippi: Coffee Sand.

Pyropsis sp. B

Discussion.—One internal mold from the basal beds of the Coffee Sand at locality 2 is assigned to *Pyropsis*. Fragments of shell adhere to the surface of the mold. The specimen has the low flat spire and carinate shoulder typical of the genus.

The specimen from a slightly higher stratigraphic position discussed herein as *Pyropsis* sp. A (pl. 56, fig. 7) has a spinose shoulder angulation and highly ornate spiral sculpture. *Pyropsis* sp. B is too poorly preserved to show the nature of the whorl carination but has wide-spaced fine smooth spiral lirae and a broad low poorly delimited spiral cord about 1 cm below the angulation.

Types: Mentioned specimen USNM 131660.
Occurrence: Mississippi: Coffee Sand at loc. 2.

Genus NAPULUS Stephenson, 1941

Type by original designation, Napulus reesidei Sohl [1960] (=Perissolax whitfieldi (Weller) of Wade, 1926)

Napulus cf. N. fragilis Sohl

Plate 56, figures 18, 20

1964. *Napulus fragilis* Sohl. U.S. Geol. Survey Prof. Paper 331–B, p. 243, pl. 35, figs. 12, 21–23.

Discussion.—The specimens from the Coffee Sand here discussed are all small, crushed, distorted, or incomplete, and a full description should await better preserved material. In spite of state of preservation their assignment to *Napulus* is assured, and they appear to represent a new species most similar to *N. fragilis* from the Ripley Formation of Mississippi. As can be seen from a comparison of figures 18 and 20 on plate 56, the slope of the upper whorl face may vary from decidedly drooping (pl. 56, fig. 18) to almost flat (pl. 56, fig. 20). The almost flat face is the most common. Similarly, one specimen shows only three primary wide-spaced spiral ribbons on the rounded whorl sides, whereas the other specimen exhibits at least five over the same area.

The number of specimens available for study is inadequate to indicate whether this variation is normal or if more than one species is present. Judging by the other described species this is more variation than is typical for species of the genus.

Compared to the type species, *Napulus reesidei*, from the Ripley Formation of Coon Creek, McNairy County, Tenn., this species has suppressed transverse sculpture and lacks any strong nodings of the spiral ribbons. In addition the type species has more numerous spiral ribbons, and the growth lines are more strongly curved. *Napulus fragilis*, like this species, lacks strong transverse sculpture and is similar to the figured specimen (USNM 131662), but it has more numerous spiral ribbons and has a flatter whorl face.

Types: Figured specimen USNM 131661, 131662.
Occurrence: Mississippi: Coffee Sand.

Superfamily VOLUTACEA
Family OLIVIDAE
Subfamily PSEUDOLIVINAE

Genus FULGERCA Stephenson, 1941

Type by original designation, *Fulgerca venusta* Stephenson (=*Pseudoliva attenuata* Wade, 1926).

Discussion.—Stephenson (1941, p. 372) proposed this genus to include the two species *Fulgerca venusta* Stephenson from the Neylandville Marl of Texas and *Pseudoliva attenuata* Wade from the Coon Creek Tongue of the Ripley Formation of Tennessee. Both of these species came from approximately the same stratigraphic level, and, as pointed out previously (Sohl, 1964, p. 247), there is a possibility the two are synonyms. Differentiation by Stephenson was based upon strength of sculpture, slimness of the Tennessee species, and the larger size of the Texas form. On the basis of the new species described below, the degree of difference cited between the two mentioned species appears to be quite small, and they should be considered as synonyms.

The discovery of *Fulgerca compressilirata* in the Coffee Sand of Mississippi extends the range of the genus down into the *Exogyra ponderosa* zone. In addition, during preliminary studies of collections from the Chattahoochee River region of Georgia and Alabama, I have discovered undescribed species of *Fulgerca* as low in the section as the lower part of the Blufftown Formation and as high as the Providence

Sand. The range of the genus *Fulgerca* thus extends through all but the lowest part of the *Exogyra ponderosa* zone up through all of the Exogyra *costata* zone.

Fulgerca compressilirata Sohl, n. sp.

Plate 56, figures 12, 13

Diagnosis.—A *Fulgerca* with many close-spaced spiral cords and weak transverse elements.

Description.—Small apically blunted subfusiform shells; spire of about half total shell length; pleural angle about 25°. Protoconch incompletely known, proportionally large and consisting of about three round-sided smooth whorls, junction with conch abrupt, accompanied by the addition of thin transverse riblets and by the flattening and lengthening of the whorl sides. Whorls elongate, with rather flat to broadly rounded sides, tapering anteriorly to the fasciolar band. Sculpture of fine crowded spiral lirae of rather constant spacing that covers the whorl surface. Transverse elements weak, sinuously collabral in trend, consisting of rather fine cords, strongest near the suture but dying out on the periphery. Growth lines opisthocline near suture, bending back to gently prosocline over the periphery, then becoming gently opisthocline again over the anterior slope and adaperturally sinused on the fasciolar band. Aperture sublenticular, siphonal canal broad and open; outer lip thin, probably bearing a tooth at intersection with fasciolar band, inner lip excavated above, lightly callused along length. Columella smooth.

Measurements.—The holotype (USNM 131663) measures 7.0 mm in height and has a maximum diameter of 2.2 mm. A paratype (USNM 131664) measures 5.4 mm in height and has a maximum diameter of 1.8 mm.

Discussion.—Compared to *Fulgerca attenuata* (Wade) from the *Exogyra cancellata* zone of the Ripley Formation of Tennessee, *F. compressilirata* is more slender, has a proportionally longer aperture, and a more highly inclined fasciolar band. In addition, the transverse cords are weaker and less continuous and the spiral lirae are more numerous and close spaced. In *F. attenuata*, a decided cancellate sculpture is developed, whereas in *F. compressilirata* the spiral lirae are so close spaced that the spiral interspaces are reduced to mere furrows.

Fulgerca compressilirata is of rare occurrence as are the other species of the genus.

Types: Holotype USNM 131663; paratype USNM 131664.
Occurrence: Mississippi: Coffee Sand.

Family VOLUTIDAE
Subfamily VOLUTODERMATINAE
(emendation Volutoderminae Pilsbry and Olsson, 1954)

Genus LONGOCONCHA Stephenson, 1941

Type by original designation, *Volutoderma tennesseensis* Wade, 1926.

Discussion.—Stephenson (1941, p. 357) proposed *Longoconcha* as a subgenus of *Volutoderma*. Sohl (1964, p. 253) subsequently raised it to generic rank based on its slimmer body and spire, its possession of an anteriorly flaring aperture, and in the development of a subsutural welt or collar as well as in details of ornament.

The earliest representatives of this genus occur as an undescribed species from the upper part of the Tombigbee Sand Member of the Eutaw formation in Russell County, Ala. (USGS 27065). Although most of the species are found on the Atlantic and Gulf Coastal Plains, their Upper Cretaceous distribution reached Europe and possibly Africa.

Judging by the described species there appear to be several distinct trends displayed in the gulf coast species of *Longoconcha*, from the Coffee Sand to the higher Ripley and then Owl Creek Formations. These trends are as follows:

1. Overall increase in size from the Coffee Sand to the Ripley Formation.
2. Increase in slimness accompanied by a decrease in pleural angle.
3. Posterior whorl constriction becomes stronger and spiral sculpture is added thereon.
4. Decrease in prominence and number of columellar folds.

Longochoncha imbricatus Sohl, n. sp.

Plate 57, figures 23, 24

Diagnosis.—Shell small for genus; spiral sculpture on whorls of spire consists of two strong cords followed above by one rather weak spiral cord on subsutural constriction.

Description.—Shell of medium size, elongate, slender in outline; spire a little more than one-third total shell length; pleural angle 45°–50°. Suture impressed, slightly channeled on later whorls. Whorls gently constricted posteriorly, broadly rounded over the periphery, grading to a straight-sided gradual taper on anterior slope. Sculpture dominated by spiral cords of which there are two strong and one weak cord visible on the penultimate whorl and 11–13 primary cords on the body; cords become spinose near aperture where crossed by strong foliate or imbricate

growth lines. Transverse sculpture restricted to about eight broad swellings on body that are strongest on periphery but that die out above and below; ribs increase in strength on whorls of spire and may become rather sharp crested and continuous on earliest whorls.

Growth lines most conspicuous on later whorls; they form a distinct and strong subsutural sinus where they are raised to thin imbricate incremental flanges or spines; growth lines continue with an overall orthocline trend over constriction, periphery, and anterior slope but are sinused between each pair of spiral cords; foliaceous or imbricate nature of growth lines develops with growth stage first at sinus, then later over constricted band; imbrications increase in length until near aperture the raised imbricate growth lines are continuous across whorl and commonly are produced to spines as they override the spiral cords. Aperture elongate lenticular, strongly and deeply notched posteriorly in harmony with the reflected growth line sinus and anteriorly produced to an elongate but rather broad siphonal canal; outer lip thin at edge, may develop spines where intersected by spiral cords; inner lip broadly excavated, medially callused, with callus extending as a thin cover well out onto body. Columella bears four strong oblique plications all in the posterior half of the columellar surface.

Measurements.—The holotype (USNM 131665) is virtually complete and measures 56.7 mm in height and 19.0 mm in diameter.

Discussion.—The holotype is the only well-preserved specimen. The stage of development of the imbricate growth lines and suppression of transverse sculpture indicate that it represents the shell of a mature individual.

Longoconcha imbricatus is small in size compared with other species such as *Longoconcha tennesseensis* (Wade) (*E. cancellata* zone) which attains a size of about 1 foot in length. Despite the size discrepancy, Wade's Coon Creek species is the most closely allied species but differs by possession of four columellar plications that have a more oblique trend. Even on specimens of a comparable size, the number of primary spiral cords on the whorls of the spire is greater in *L. tennesseensis*, and the shell is proportionally slimmer. In addition it has a more attenuate spire (pleural angle of only 30°–40° as opposed to 45°–50°). On later whorls the transverse ribs are restricted to a subsutural welt and are absent over excavated subsutural band but begin again at the shoulder and carry down to the suture of the next whorl. On the body whorl, the excavated band broadens and the subsutural nodes are lost. Although on the largest specimens the growth lines may become imbricated near the aperture, they do not develop spines. *Longoconcha quadrilirata* Sohl from the Ripley Formation of Mississippi (post-*Exogyra cancellata* zone) again is larger but not as large as the Tennessee form. In addition it has an even more attenuate spire (pleural angle 20°–25°), has four strong spiral cords on the whorls of the spire, plus numerous minor spirals on the more strongly constricted posterior portion of the whorl, and possesses only three strong columellar plications.

Types: Holotype USNM 131665; paratype USNM 131666.
Occurrence: Mississippi: Coffee Sand.

Genus VOLUTOMORPHA Gabb, 1877
Type by original designation, Volutilithes conradi Gabb, 1877

Volutomorpha splendida Sohl, n. sp.

Plate 57, figures 14, 15, 21, 22

Diagnosis.—Shell slender and proportionally high for genus; pleural angle about 45°; sculpture of strong transverse ribs overridden by strong spiral cords.

Description.—Shell moderately large, elongate, slim, thick, and glazed; spire about one-third total shell height and turreted. Pleural angle about 45° at maturity and increasing to 50° or more on immature specimens. Protoconch unknown. Whorls constricted posteriorly to an excavated subsutural band; shoulder pronounced, but not broad; periphery broadly rounded and body whorl roundly tapering anteriorly. Sculpture consisting of strong transverse ribs numbering 17–18 on body; ribs present from suture to suture on early whorls; near aperture, ribs develop as slight swelling low on sloping excavated area; these increase in strength on shoulder and carry down over periphery onto basal slope with diminished vigor. Spiral sculpture absent or obscured by callus glaze on earliest whorls but develops to strong closely spaced round-topped cords that override transverse elements on body whorl; spiral cords, like transverse ribs, are absent on subsutural collar. Growth lines faint, partly obscured by callus, raised on subsutural welt, strongly opisthocline over subsutural collar, virtually orthocline on periphery and very slightly prosocline on anterior slope. Aperture elongate lenticular, developing an acute posterior sinus; siphonal canal moderate in length, straight, and rather broad and terminating in a shallow wide notch. Outer lip unknown, inner lip broadly excavated, columellar with a strong anterior fold followed posteriorly by a weaker secondary fold not visible at the aperture.

Measurements.—The holotype measures 79.3 mm in height and 33.1 mm in diameter. A slightly larger incomplete paratype measures 36.3 mm in diameter.

Discussion.—Only one complete mature specimen is present in the collections under study. Fragments, especially those consisting of almost complete spires, are rather common. Individual variation, in so far as can be determined, does not appear to be great. Variation in strength of sculpture can generally be laid to variability in the thickness of the obscuring callus cover. The change in strength and in type of sculpture with growth can easily be ascertained by comparing figures 15 and 21 on plate 57. The former, an immature paratype, shows a weak development of spiral cords, whereas, at maturity, as represented by the holotype, the spiral elements are quite strong. Figure 21, plate 57, also exhibits the gradual diminishment in strength of the shoulder with growth. This tendency is accompanied by widening of the subsutural excavated area due to the retraction of the upper ends of the ribs and to the suppression of the uppermost spiral cord.

Compared with the species to be found in the *Exogyra costata* zones, *Volutomorpha splendida* is consistently smaller, commonly reaching only half or less the length of the species present in the Ripley and Owl Creek Formations and their equivalents. In shape, sculpture, and number of columellar plications, *V. splendida* most closely approaches *V. mutabilis* and *V. gigantea* Wade from the Ripley Formation of Mississippi. These Ripley species not only reach a considerably greater size but also have a proportionally lower spire. One may note on the holotype of *V. mutabilis*, as illustrated by Wade (1926, pl. 40, fig. 6), a tendency for the subsutural welt to broaden near the aperture of the mature individual and a general suppression of the shoulder. This excavated band or posterior constriction bears sculpture that is not evident in *V. splendida*. Nonetheless, the similarities with *V. mutabilis* appear to indicate that *V. splendida* is the most likely predecessor of the ornate Coon Creek species. *Volutomorpha valida* Sohl, from the Ripley Formation of Mississippi, is similar in its slimness and in its high spire, but it lacks spiral sculpture on the body and has only one columellar plication. All the other known species differ by one or more of these characters.

Types: Holotype USNM 131667; paratypes USNM 131668, 131696.

Occurrence: Mississippi: Coffee Sand.

Subfamily ATHLETINAE

Genus LIOPEPLUM Dall, 1890
Type by original designation, Volutilithes (Athleta) leioderma Conrad, 1860

Liopeplum spiculatum Sohl, n. sp.

Plate 57, figure 8

Diagnosis.—Shell slender for genus, with a smooth rather evenly tapering spire and no callus ridges.

Description.—Medium-sized slender substrombiform shell, with an evenly tapering spire a little more than one-third total shell height; pleural angle about 43°. Protoconch unknown, suture obscured by callus. Shell surface smooth with only a very faint suggestion of a posterior whorl constriction, periphery broadly rounded. Growth lines gently prosocline from suture to periphery, swinging back to a gentle opisthocline trend on anterior slope until they become flexed and corrugated over the fasciole. Aperture lanceolate, posteriorly notched, anteriorly developing a short siphonal canal terminating in a broad and shallow notch; outer lip unknown; inner lip broadly excavated medially, callus wash thin but extending out of aperture and over whole shell. Columella bearing one highly oblique and rather low plication.

Measurements.—The holotype (USNM 131669) measures 39.5 mm in height and 14.8 mm in diameter.

Discussion.—The lack of sculpture and possession of a smooth evenly tapering spire that is devoid of pronounced callus ridges make *Liopeplum spiculatum* the most likely progenitor of the *Liopeplum* lineage that culminated in the appearance of *Liopeplum cretaceum*. This latter species is widespread in rocks of the uppermost Cretaceous (Owl Creek equivalents) from Maryland to Texas.

The lack of pronounced callus ridges differentiates *Liopeplum spiculatum* from the *L. liodermum-L. canalis* lineage (Sohl, 1963).

The *L. ruqosum* Stephenson lineage on the other hand is characterized by a development of strong callus ridges plus the possession of strong transverse ribs and strong shouldering of the whorls. *Volutomorpha tarensis* Stephenson from the Snow Hill Marl Member of the Black Creek Formation of North Carolina occurs at a slightly higher stratigraphic position. This species appears to belong in *Liopeplum*, but the type specimens (Stephenson, 1923, pl. 45, figs. 7–91) are not well preserved. As known, *V. tarensis* lacks pronounced callus ridges, transverse ribs on the body whorl, and may fill, in part, the gap between the ranges of *L. spiculatum* and *L. cretaceum*. *Liopeplum cretaceum* differs from the Coffee Sand

species by having poorly developed transverse ribs on the earlier whorls, a proportionally higher spire, two columellar plications, and by having a more complex growth line pattern.

Types: Holotype USNM 131669.
Occurrence: Mississippi: Owl Creek Formation.

Family CANCELLARIIDAE

Genus MATAXA Wade, 1916

Type by original designation, *Mataxa elegans* Wade.

Discussion.—The Coffee Sand species *Mataxa leioderma* records the lowest known occurrence of the genus. The type species is from the Ripley Formation on Coon Creek, Tenn. (Wade 1916, p. 456), but it is also known from the Nacatoch Sand of Texas (Stephenson, 1941, p. 365 [described as *M. valida*]) and from higher levels in the Ripley Formation of Mississippi (Sohl, 1963).

Mataxa leioderma Sohl, n. sp.

Plate 56, figures 2, 3

Diagnosis.—A small *Mataxa* virtually lacking spiral sculpture save for a subsutural welt.

Description.—Medium sized, globosely fusiform in outline, apex blunt, spire a little less than one-third total shell height. Pleural angle 70°. Suture abutting. Protoconch small, consisting of about 1½ smooth rounded whorls that are slightly inclined to and submerged below first teloconch volution; next two whorls raised, normally coiled, round sided, and smooth with no abrupt demarcation between teloconch and protoconch; fine spirals are added to whorl sides on third whorl, and a subsutural welt develops by fourth whorl. About five whorls constricted posteriorly to a narrow subsutural welt; below welt, body whorl well rounded over periphery and constricting to a broad pillar below.

Early whorls bear fine spiral lirae which, on body whorl, are present only over subsutural area. Aperture lenticular; posteriorly acute, anteriorly developing a broad somewhat inclined and twisted short siphonal canal. Outer lip incompletely known but appears to thin at edge and probably is denticulate within. Inner lip with a thin parietal callus; columella almost straight with two plications, one on upper columellar lip and one medial; a third plication or tooth appears shortly above truncate base but is weaker and appears to die out within aperture.

Measurements.—The slightly compressed holotype measures 9.7 mm in height and 7.3 mm in diameter.

Discussion.—Too few specimens of *Mataxa leioderma* are known to be assured of its limits of variation. The features displayed by this species, however, are distinctive.

This species lacks the strong spiral sculpture of all other species of *Mataxa* and is proportionally more obese. Compared to *Mataxa elegans* Wade the narrow subsutural collar is more of a welt and more sharply constricted. On *M. subteres* Stephenson only the faintest trace of such a feature can be seen. In addition the basal columellar truncation is more highly inclined on *M. leioderma.*

Types: Holotypes USNM 131670; paratype USNM 131671.
Occurrence: Mississippi: Coffee Sand.

Family PALADMETIDAE

Genus PALADMETE Gardner, 1916

Type by original designation, Trichotropis cancellaria Conrad, 1858

Paladmete cancellaria (Conrad)?

Plate 56, figure 4

1858. *Trichotropis cancellaria* Conrad, Acad. Nat. Sci. Philadelphia Jour. 2d ser., v. 3, p. 333, pl. 35, fig. 8
For complete synonymy see Sohl, 1964, page 271.)

Discussion—One specimen in the collections from the Coffee Sand exhibits the shape and cancellate sculpture typical of specimens commonly assigned to *Paladmete cancellaria.* On account of its incomplete condition and the lack of additional specimens for comparison, it is here only questionably assigned to that species.

This is the first recorded occurrence of a "*cancellaria*-type" *Paladmete* below the *Exogyra costata* zone although other members of the genus are present in the Eutaw Formation (Coniacian) of Alabama and Georgia.

Compared to topotypes of *Paladmete cancellaria*, the Coffee Sand specimen is somewhat smaller than the maximum size attained by that species. In addition it is proportionally slimmer, but in other features it falls well within the range of variability attributed to the type species.

Type: Figured specimen USNM 131672.
Occurrence: Mississippi: Coffee Sand.

Suborder TOXOGLOSSA
Superfamily MITRACEA
Family MITRIDAE

Subfamily MITRINAE

Plate 56, figures 5, 6

Discussion.—Only one small immature specimen in the collections from the Coffee Sand appears to be assignable to this family. Placement as to genus is impossible on the basis of the available material.

The only other smooth mitrid in the Upper Cretaceous of the Gulf Coastal Plain is *Paleofusimitra* Sohl from the Ripley Formation of Mississippi (Sohl 1963). The Coffee Sand specimen is similar to the early growth stages of both this genus and *Fusimitra* Con-

rad from the Eocene of the gulf coast in having three plications and a siphonal canal, but it is more obese and the columellar plications are not so highly inclined. In inclination of plications and in general shape it is closer to *Conomitra* Conrad, especially to *Conomitra fusoides lepa* de Gregorio (Palmer, 1937, pl. 66, figs. 23, 28) but has a more strongly developed anterior siphon.

Types: Figured specimen 131673.
Occurrence: Mississippi: Coffee Sand.

Superfamily CONACEA
Family TURRIDAE

Genus AMULETUM Stephenson, 1941

Type by original designation, *Turricula macnairyensis* Wade, 1926.

Discussion.—The little shells of the genus *Amuletum* are probably the most common turrids in the Upper Cretaceous rocks of the Gulf Coastal Plain.

The specimens from the Coffee Sand of Mississippi assigned to this genus below are very close and probably ancestral to those present in the rocks of the *Exogyra costata* zone of Texas and the Mississippi embayment region.

Amuletum aff. A. fasciolatum (Wade)
Plate 57, figure 2

1926. *Turricula fasciolata* Wade, U. S. Geol. Survey Prof. Paper 137, p. 112, pl. 36, figs. 3, 4.
1941. *Remnita fasciolata* (Wade), Stephenson, Texas Univ. Bull. 4101, p. 379.
1964. *Amuletum fasciolatum* Sohl, U.S. Geol. Survey Prof. Paper 331–B, p. 278, pl. 46, figs. 1–3.

Diagnosis.—An ornate *Amuletum* with well-developed spiral sculpture, but transverse ribs restricted to the earliest whorls.

Discussion.—The small specimen figured (pl. 57, fig. 2) appears to represent immature growth stages of a species closely similar to *Amuletum fasciolatum* Wade from Coon Creek, McNairy County, Tenn. The protoconch consists of three to four proportionally large smooth bulbous whorls typical of the genus. Transverse ribs are developed first and are strong and straight initially but become collabral following a normal turrid notch. After about two additional whorls the transverse ribs diminish, leaving only strong riblets over the subsutural constriction. The ontogeny of ornament displayed by these specimens is typical of that displayed by *A. fasciolatum* (Wade) (Sohl, 1964, pl. 46, figs. 1, 2). Wade's (1926, pl. 36, figs. 3, 4) figures of the holotype are highly retouched and misleading as they give no evidence of the early transverse sculpture and later strong subsutural growth riblets that are present on the specimen.

The fact that the specimens represent only the earlier growth stages prevents assured determination of the Coffee Sand species.

Types: Figured specimen USNM 131674.
Occurrence: Mississippi: Coffee Sand.

Amuletum sp.
Plate 57, figures 1, 5

Discussion.—One small specimen in the collections from the Coffee Sand possesses the nuclear characters, shape, and sculpture typical of an *Amuletum* but does not fit well in any previously described species. Unfortunately it represents only an immature individual and could not serve as the basis for a new species. It appears most similar to *Amuletum? costatum* Sohl, also from the Coffee Sand, but it is a less slender shell, has a stronger subsutural constriction, a deeper sinus, and a stronger shoulder but has weaker ribbing.

Types: Figured specimen USNM 131675.
Occurrence: Mississippi: Coffee Sand.

Amuletum? costatum Sohl, n. sp.
Plate 57, figures 3, 4

Diagnosis.—Moderately small shell with transverse ribs coarse for genus.

Description.—Moderately small slender fusiform turrids with spire a little more than half total shell length, pleural angle about 16°. Protoconch incompletely known, whorls smooth and round sided; junction with teloconch where first transverse ribs develop. Suture impressed. Whorls posteriorly constricted to a subsutural collar, shoulder best developed on earlier whorls, whorls tapering below to an elongate pillar. Sculpture initiated by straight transverse ribs on first teloconch whorl; ribs retract from subsutural collar on second whorl and develop a shoulder; on later whorls ribs subcollabral but curved and on body whorl low faint and broad over collar, raised at shoulder, dying out below periphery. Ribs number 12 on body whorl. Spiral sculpture develops after first ribs have appeared and consists of round-topped cords of about equal strength that override ribs and have interspaces almost as broad as cords. Growth lines especially strong on collar; deepest part of sinus about 1½ mm below suture; opisthocline growth line trend continues over shoulder and periphery, swinging back to prosocline over upper part of anterior body slope, and becoming orthocline low on pillar. Aperture sublenticular, posteriorly acute, anteriorly rather narrow with siphonal canal longer than aperture; outer lip incompletely known, thin at edge above; inner lip quite straight and only lightly washed by callus, columellar lip thinning anteriorly.

Measurements.—The holotype (USNM 131676) lacks the anterior 1 mm or so of the tip, but measures 10.4 mm in length and has a maximum diameter of 3.4 mm.

Discussion.—This is a very rare species in the Coffee Sand of Mississippi. On the other hand, its characters are so distinctive that it is unlikely to be confused with any other described Cretaceous turrids. Strong transverse sculpture is typical of other species of *Amuletum* from higher units, such as *Amuletum macnairyensis* (Wade), from the Ripley Formation of Tennessee, but *A. costatum* has much broader and coarser ribs and in addition the anterior or columellar lip also does not appear to develop a knifelike edge anteriorly.

The species is only questionably placed in *Amuletum* here because although the ontogeny of sculpture is similar, the protoconch character is not completely known, because the transverse sculpture is coarse, and because the columellar lip is thicker.

Types: Holotype USNM 131676.
Occurrence: Mississippi: Coffee Sand.

Genus BERETRA Stephenson, 1941
Type by original designation, Beretra firma Stephenson

Beretra preclara Sohl, n. sp.
Plate 57, figures 16–20

Diagnosis.—A *Beretra* bearing 10–11 wide spaced transverse ribs per whorl; spiral elements weak; fine spiral lirae present on nonnodose subsutural welt.

Description.—Medium-sized fusiform shells with a turriculate spire less than half total shell height. Protoconch unknown. Pleural angle 26°–29°. Suture impressed, bordered below by a weak subsutural welt. Below subsutural welt is a weakly excavated band bounded below by rib tops. Whorl sides broadly rounded, constricting anteriorly to a narrow and elongate pillar. Sculpture of 10 or 11 moderately strong transverse ribs that are somewhat narrower to about as wide as interrib spaces; ribs abruptly terminated at excavated band below subsutural welt or continuing to subsutural welt as a very faint indulation; ribs diminish in vigor anteriorly, dying out low on anterior slope of body. Spiral sculpture of faint spiral lirae on subsutural and excavated area; spiral ribbons of variable width cover whorl sides but do not cross top of ribs; ribbons strengthen, become more widely spaced on anterior slope, and bear several fine incised spiral grooves on their surface. Growth lines sinused on subsutural collar, are almost orthocline on whorl sides, and are sinused as they cross the spiral ribbons of the anterior slope. Aperture incompletely known, lenticular in outline, strongly narrowed posteriorly; outer lip sinused above; inner lip excavated above, strongly callused over posterior surface; columellar lip smooth, long, slightly twisted anteriorly.

Measurements.—The holotype missing the apical tip measures 40 mm in height and has a maximum diameter of 12.4 mm.

Discussion.—*Beretra preclara* is a common species at its type locality. Small, supposedly immature specimens show stronger spiral sculpture than do the larger individuals. In other respects the most notable amount of variation is in the strength of the subsutural welt which ranges from almost total absence (pl. 57, fig. 17) to moderately well developed.

This species is most similar to *Beretra ripleyana* Conrad, from the Owl Creek Formation of Mississippi. From that species it differs by its weaker subsutural welt and lack of nodings thereon. *B. gracilis* (Wade) from the Ripley Formation of Mississippi and Tennessee has more numerous closer-spaced and thinner transverse ribs, a noded subsutural collar, and much stronger spiral sculpture, as well as a more slender shell than *B. preclara.* From *B. speciosa* Sohl from the Ripley Formation of Tennessee this species differs by having fewer transverse ribs in its finer spiral sculpture and by its weaker and nonnoded subsutural welt.

This is the lowest recorded stratigraphic occurrence of the genus.

Types: Holotype USNM 131677; paratypes USNM 131678, 131697, 131698.
Occurrence: Mississippi: Coffee Sand.

Subclass EUTHYNEURA

Order CEPHALASPIDEA

Considering the abundance of euthyneurous gastropods in the Ripley faunas of Mississippi and Tennessee it is indeed strange that so few are found in the Coffee Sand among a fauna that in other ways is so similar. Apparently the two faunas lived in similar conditions of shallow water on an intermixed mud-sand bottom. An abundance of matrix was washed and picked in a specific attempt to recover small cephalaspids, but they are exceedingly rare both in numbers and in species. Of special note is the total lack of the Ringiculidae. Both in the Ripley Formation of Mississippi and Tennessee and in the whole of the Upper Cretaceous section of the Chattahoochee River valley of Georgia and Alabama these are among the more abundant of the smaller gastropods.

Superfamily ACTEONACEA
Family ACTEONIDAE
Subfamily ACTEONINAE

Genus EOACTEON Stephenson, 1955

Type by original designation, *Solidulus linteus* Conrad, 1858.

Discussion.—*Eoacteon* is similar to *Acteon* Montfort in form and sculpture, but the columellar plication is weak and not visible at the aperture. An argument could be made for its placement as a subgenus of *Acteon*.

Eoacteon is represented in the Cretaceous of the coastal plains by the following:

Solidulus linteus Conrad, Owl Creek Formation of Mississippi.
Acteon linteus Gardner not Conrad, Monmouth Formation of Maryland.
Acteon linteus Wade not Conrad, Ripley Formation of Tennessee.
Acteon ellipticus (Wade), Ripley Formation of Tennessee.
Acteon? throckmortoni Stephenson, Neylandville Marl of Texas.

Eoacteon ithyocheilus Sohl, n. sp.

Plate 57, figure 12

Diagnosis.—Shell small but broad for genus; secondary spiral sculpture absent on midwhorl and columellar lip straight.

Description.—Moderately small elongate subovate shells with spire one-third total shell length. Pleural angle about 52°. Protoconch unknown. Suture very narrowly channeled. Whorls five to six in number; body whorl broadly rounded over sides. Sculpture of incised grooves that are punctate where crossed by growth lines; grooves wider than interspaces over about lower one-fifth of whorl, narrow and equidistant over medial part of whorl and close spaced near suture. Growth lines broadly arched adaperturally; growth lines weak on surface but form raised sharp threads in spiral grooves. Aperture narrow and angulated posteriorly, well-rounded anteriorly, inner lip very thinly callused with a fold near the junction of the parietal and columellar lip which does not quite reach the aperture.

Measurements.—The holotype measures 10.1 mm in height and 5 mm in maximum diameter.

Discussion.—Compared with the type species, *Eoacteon linteus* (Conrad), from the Owl Creek Formation, this species is smaller in size and proportionally broader and has a straighter columellar lip. In sculpture the type species also differs by possessing secondary incised grooves over the midpart of the whorl. *Eoacteon ithyocheilus* in addition has a parietal and columellar callus which is thinner and less broadly applied over the inner lip, especially over the lower part of the columellar lip.

Acteon linteus (Conrad) of Wade (1926, p. 101) is similar in body proportions but has a curved columellar lip with thicker callus; the parietal lip lacks callus and, more important, the suture is strongly channeled lending the whorls a shouldered appearance that is not brought out by Wade's illustrations (pl. 33, fig. 5, Wade, 1926).

Acteon ellipticus Wade of the Ripley Formation of Tennessee likewise is larger but has a similar straight columellar lip. It differs noticeably by its lack of parietal callus, by its proportionally shorter spire, and by having incised grooves that are coarser, being about as wide as the interspaces over the whole body surface. In spite of these differences *Eoacteon ithyocheilus* appears most closely related to this species.

The presence of this species in the Coffee Sand extends the range of the genus well down into the *Exogyra ponderosa* zone.

Types: Holotype USNM 131679.
Occurrence: Mississippi: Coffee Sand.

Subfamily CYLINDROBULLINAE

Genus NONACTEONINA Stephenson, 1941

Type by original designation, *Nonacteonina graphoides* Stephenson, 1941.

Discussion.—The specimen from the Coffee Sand marks the lowest stratigraphic occurrence of the genus yet known unless, as Stephenson (1941, p. 383) suggested, the internal mold figured by Weller (1907, pl. 99, figs. 7, 8), from the Woodbury Clay of New Jersey, can be assigned here.

The genus as known is restricted to the Upper Cretaceous of the Gulf and Atlantic Coastal Plains.

Nonacteonina sp.

Plate 57, figure 11

Discussion.—One incomplete specimen consisting of the body whorl and aperture is present in the collections from the Coffee Sand. As is typical of *Nonacteonina* it has a nonplicate curved columellar lip and inner lip callus that extends out of the aperture only over the columellar surface.

The Coffee Sand specimen probably represents a new species, but the incomplete state of the available specimen negates formal specific designation.

Compared to the described species of *Nonacteonina*, this species has a suture lying in a V-shaped channel. In shape, especially the flat-sided whorls, it most closely approaches *Nonacteonina deflexa* Stephenson (1941, p. 385) from the Nacatoch Sand of Texas. It is, however, larger than that species and has a less curved columellar lip.

Type: Figured specimen USNM 131680.
Occurrence: Mississippi: Coffee Sand.

Superfamily PHILINACEA

Family SCAPHANDRIDAE

A few *Cylichna*-like shells have been recovered from the Coffee Sand. In view of the multiplicity of names and shifting generic concepts, shells of this type are difficult to deal with under the best of conditions. On conchological grounds Zilch (1959) accepts many genera which, according to Lemche (1948, p. 50), on anatomical grounds are poorly founded. Among the Retusidae, Lemche (1948, p. 57) found much variability in well-accepted characters such as surface sculpture, width of apical perforation, presence or absence of columellar folds, and width of umbilicus. Similarly in *Cylicha* Lovén, he illustrated great variability in shape and apical characters. In some cephalaspids, *Diaphana* (p. 37), he has shown that even characters such as an open elevated spire may develop in species thought to have an entirely hidden spire.

Such evidence makes the application of the name *Cylichna* to bulliform shells tenuous. The incomplete nature and scarcity of the shells from the Coffee Sand precludes confidence in their generic placement.

Genus CYLICHNA Lovén, 1846

Type by subsequent designation (Herrmannsen, 1852) *Bulla cylindracea* (Pennant), 1777.

Discussion.—*Cylichna* is generally characterized as being involute and cylindrical but with a concave imperforate apical truncation. The outer lip is longer than the body, the columella is uniplicate, and the umbilicus is closed or narrowly perforate. Some authors have noted that there is an apical perforation at least in the early stages of growth. Spiral sculpture is variable.

Lemche (1948, p. 46) illustrated and discussed several species of *Cylichna*, including the type species, and includes a wide spectrum of form within the genus. The Coffee Sand specimens conform more to the less cylindrical species than to the typical form.

Cretaceous cephalaspid species of subcylindrical form have long been assigned to *Cylichna*. In this sense the genus has served as a wastebasket for fossil species. A critical reexamination of most of these fossil species is needed.

Cylichna? sp.

Plate 57, figures 7, 9, 10

Discussion.—The small subcylindrical shells herein figured appear to all belong to the same species. All possess punctate incised spiral lirae that cover the surface completely. The lirae are coarsest and may even be wider than the raised flat interspaces on the basal slope and at the posterior. The apex is sunken and imperforate with coarse spirals carrying into the pit. The columellar lip is straight (pl. 57, fig. 10) and bears a low fold near its base. The umbilicus is narrow and slitlike. Unfortunately the outer lip is not completely preserved on any specimen, and one cannot be sure of the trend of the upper part, but the outer lip appears longer than the body (pl. 57, fig. 7).

Specimens similar to these occur at a higher position in the Ripley Formation in Mississippi.

Types: Figured specimens USNM 131681, 131699, 131700.
Occurrence: Mississippi: Coffee Sand.

Subgenus CYLICHNOPSIS Cossmann 1904
Type by original designation, Cylichna acrotoma Cossmann (1895, p. 50)

Cylichna (Cylichnopsis?) sp.

Plate 57, figure 6

Discussion.—One *Cylichna*-like specimen from the Coffee Sand possesses the apical features of *Cylichnopsis*. The apical pit is straight sided and inclined toward the center. The pit is bounded by a strong shoulder with the sloping inner sides marked by strong sinused growth lines that are similar in trend to those figured by Zilch (1959, fig. 69) for the type species. Spiral sculpture of the body whorl, on the other hand, is much stronger than that on the type species. The posterior part of the body bears strong broad incised spiral ribbons much wider than their interspaces (pl. 57, fig. 6). The medial two-thirds of the whorl is barren of spiral elements, but fine incised spiral lirae appear on the base. Under high magnification and oblique lighting, faint microscopic close-spaced transverse threads can be seen over most of the surface.

The lack of additional and better preserved specimens limits the confidence in the assignment of this species, but the apical pit features noted above are highly suggestive. The specimen here figured is only about 2.5 mm in height and probably represents an immature specimen. A formal description based on such material is unwise.

Type: Figured specimen USNM 131682.
Occurrence: Mississippi: Coffee Sand.

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PLATES 53–57

PLATE 53

FIGURES 1–3. *Urceolabrum mantachieensis* Sohl, n. sp. (p. 359).
1, 2. Back and front views of a paratype (× 6) from loc. 6. USGS 25483, USNM 131588.
3. Front view of the holotype (× 6) from loc. 6. USGS 26338, USNM 131589.

4–6. *Teinostoma* cf. *T. clara* Sohl (p. 359).
4, 5. Apical and basal views of a specimen (× 10) from loc. 6. USGS 25483, USNM131590.
6. Basal view of a specimen (× 10) from the same locality. USGS 26338, USNM131591.

7, 8. *Seila meeki* Wade (p. 364).
7. Apertural view of a hypotype (× 10) from loc. 6. USGS 25483, USNM 131608.
8. Back view of a hypotype (× 10) from loc. 6. USGS 25483, USNM 131674.

9, 17. *Cerithiella* n. sp. (p. 364).
9. Back view of a specimen (× 10) from loc. 6. USGS 26338, USNM 131609.
17. Back view of a specimen (× 6) from loc. 6. USGS 26338, USNM 131610.

10–16. *Potamides cowickeensis* Sohl n. sp. (p. 363).
10. Apertural view of a specimen (× 8) from loc. 6. USGS 25483, USNM 131691.
11. Apertural view of a specimen (× 10) from the same locality. USNM 131692.
12. Apertural view of a specimen (× 10) from loc. 6. USGS 26338, USNM 131693.
13, 14. Back and basal view of a paratype (× 6) from the Blufftown Formation of Russell County, Ala., USGS 26980, USNM 131607.
15. Apertural view of the holotype (× 6) from the same locality. USNM 131606.
16. Apertural view of an immature paratype (× 20) from the same locality. USNM 131701.

18. *Acmaea* sp. (p. 357).
Apical view of a specimen (× 3) from loc. 6. USGS 17254, USNM 131592.

19–22. *Architectonica* (*Granosolarium*) *coffea* Sohl, n. sp. (p. 360).
19, 20. Apical and basal views (× 10) of a paratype from loc. 6. USGS 25483, USNM 131687.
21. Back view of a paratype (× 8) from the same locality. USNM 131598.
22. Apical view of the holotype (× 4) from the same locality. USNM 131597.

23, 24. *Calliomphalus* (*Calliomphalus*) *paucispirilus* Sohl, n. sp. (p. 357).
Basal and back views of the holotype (× 6) from loc. 6. USGS 25483, USNM 131593.

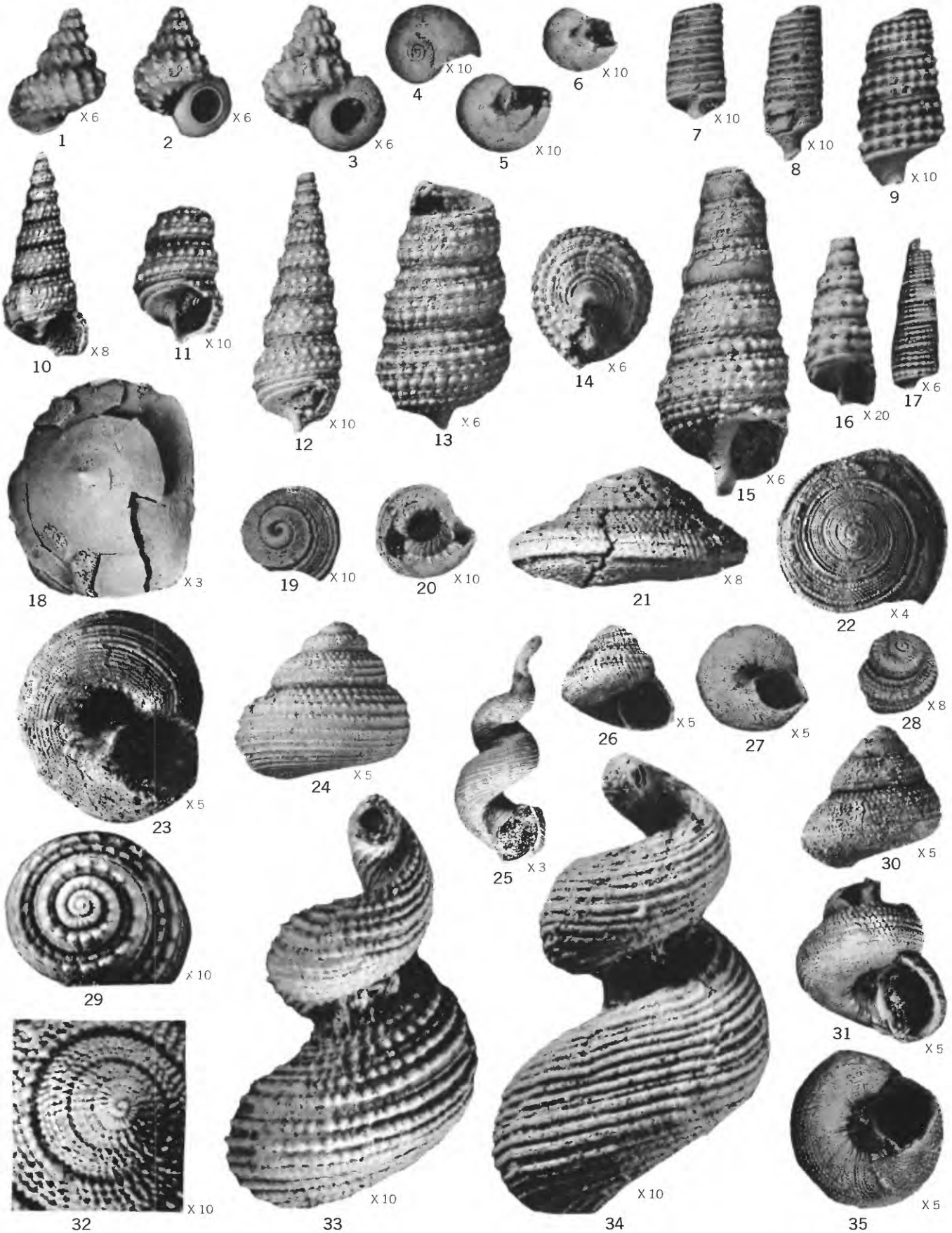
25, 34. *Laxispira lumbricalis* Gabb (p. 361).
25. Apertural view of a hypotype (× 3) from loc. 6. USGS 25483, USNM 131599.
34. View of a hypotype (× 10) from the same locality enlarged to show sculpture. USNM 131600.

26–28, 30, 31, 35. *Calliomphalus* (*Planolateralus*) *tuberculosus* Sohl, n. sp. (p. 358).
26, 27. Apertural and basal views of a paratype (× 5) from loc. 6. USGS 25483, USNM 131595.
28. Oblique apical view of a paratype (× 8) from the same locality. USNM 131684.
30. Back view of the holotype (× 5) from the same locality. USNM 131594.
31, 35. Apertural and basal views of a paratype (× 5) from the same locality. USNM 131596.

29. *Calliomphalus* (*Calliomphalus*) *americanus* Wade (p. 357).
Apical view of a hypotype (× 10) from the Ripley Formation on Coon Creek, McNairy County, Tenn. USGS 25406, USNM 131585.

32. *Calliomphalus* (*Planolateralus*) *argenteus* Wade (p. 357).
Apical view of a hypotype (× 10) from the Ripley Formation on Coon Creek, McNairy County, Tenn. USGS 25406, USNM 131586.

33. *Laxispira monilifera* Sohl, n. sp. (p. 361).
View of a paratype (× 10) from the Ripley Formation on Coon Creek, McNairy County, Tenn., inserted for comparison with *T. lumbricalis* Gabb. USGS 25406, USNM 131688.



URCEOLABRUM. TEINOSTOMA, SEILA, CERITHIELLA, POTAMIDES, ACMAEA, ARCHITECTONICA, CALLIOMPHALUS, AND *LAXISPIRA*

PLATE 54

FIGURES 1, 10. *Acirsa* (*Plesioacirsa*?) *culmosa* Sohl, n. sp. (p. 365).
1. Apertural view of a paratype (× 6) from the Coffee Sand at loc. 6. USGS 26338, USNM 131613.
10. Back view of the holotype (× 4) from the same locality. USNM 131612.

2, 3. *Anchura* aff. *A. substriata* Wade (p. 366).
2. Winglike extension of the outer lip (× 1) from the same locality. USGS 26338, USNM 131619.
3. Spire of an incomplete specimen (× 1) from the same locality. USGS 26338, USNM 131620.

4, 5. *Pterocerella* sp. (p. 367).
4. Spire of an incomplete specimen (× 10) from the Coffee Sand at loc. 6. USGS 26338, USNM131624.
5. Winglike extension of the outer lip (× 2) from the same locality. USMN 131625.

6–9. Epitoniid gastropods (p. 366).
6, 7. Back and apertural views of a specimen (× 20) from the Coffee Sand at loc. 6. USGS 25483, USNM 131614.
8. View of an incomplete immature specimen (× 8) from the same locality. USGS 26338. USNM 131615.
9. View of an incomplete specimen (× 5) from the same locality. USNM 131616.

11, 12. *Acirsa* (*Plesioacirsa*?) *gravida* Sohl, n. sp. (p. 365).
Apertural and back views of the holotype (× 4) from the Coffee Sand at loc. 6. USGS 26338. USNM 131611.

13, 14. *Haustator quadrilira* (Johnson) (p. 362).
Back and front view of a hypotype (× 3) from the Coffee Sand at loc. 6. USGS 26338, USNM 131602.

15. *Haustator trilira* (Conrad) (p. 361).
Front view of a hypotype (× 1) from the Coffee Sand at loc. 6. USGS 25483, USNM 131601.

16, 17, 18. *Thylacus cretaceus* Conrad (p. 366).
16, 17. Top and apertural views of a hypotype (× 3) from the Coffee Sand at loc. 6. USGS 26338. USNM 131617.
18. A hypotype (× 2) of *Thylacus cretaceus* in place on the columella and within the aperture of a specimen of *Morea corsicanensis, depressa*. USGS 25483, USNM 131618.

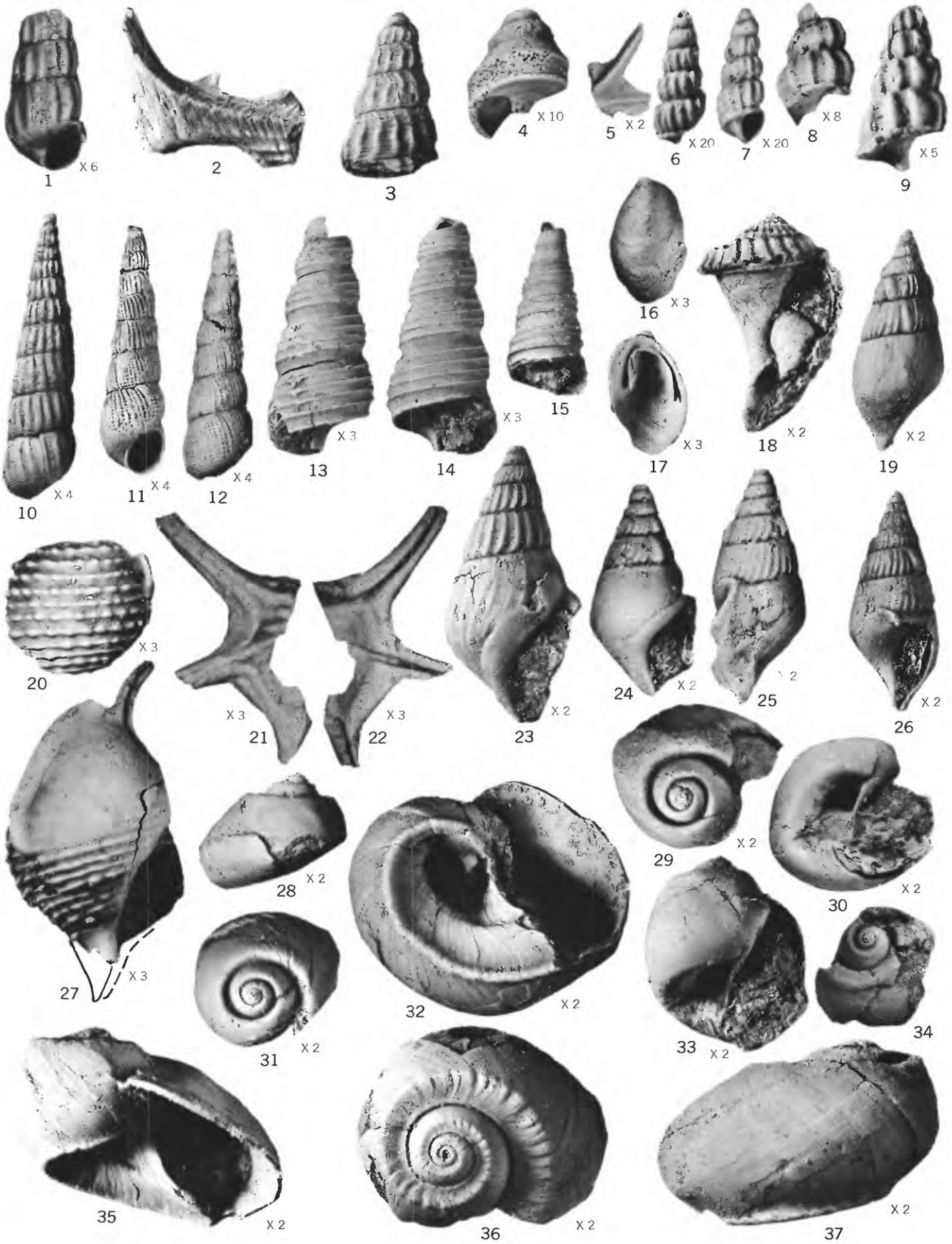
19, 24–26. *Arrhoges* (*Latiala*?) sp. (p. 367).
19. Back view of a specimen (× 2) from the Coffee Sand at loc. 6. USGS 26338, USNM 131621.
24, 25. Apertural and side view of a specimen (× 2) from the same locality. USGS 25423, USNM 131623.
26. Apertural view of a specimen (× 2) from the same locality. USGS 26338, USNM 144249.

23. *Graciliala johnsoni* Stephenson? (p. 367).
Apertural view of a specimen (× 2) from the Coffee Sand at loc. 6. USGS 25483, USNM 131622.

20, 21, 22, 27. *Tundora* cf. *T. tuberculata* Stephenson (p. 368).
20. View of a fragment of a body whorl (× 3) showing tuberculations of the spiral cords. Coffee Sand at loc. 6. USGS 26338, USNM 131626.
21, 22. Exterior and interior of a part of the expanded outer lip. Coffee Sand at loc. 6. USGS 26338, USNM 131702.
27. Apertural view of a mature specimen (× 3) that lacks the expanded outer lip, from the Coffee Sand at loc. 6. USGS 26338, USNM 131703.

28–31, 33, 34. *Gyrodes spillmani* Gabb (p. 369).
28, 31. Back and apical views of a hypotype (× 2) from the Coffee Sand at loc. 6. USGS 26338, USNM 131628.
29, 30, 33. Apical, basal, and apertural views (× 2) of a hypotype from the same locality. USGS 25483, USNM 131629.
34. Apical view of a hypotype (× 1) from the same locality. USNM 131630.

32, 35–37. *Gyrodes major* Wade (p. 369).
32, 35, 37. Basal, apertural, and back views of a hypotype (× 2) from the Coffee Sand at loc. 6. USGS 26338 USNM 131628.
36. Apical view of a hypotype (× 2) from the same locality. USGS 25483, USNM 131675.



ACIRSA, *ANCHURA*, *PTEROCERELLA*, EPITONID TYPES, *HAUSTATOR*, *THYLACUS*, *ARRHOGES*, *GRACILIALA*, *TUNDORA* AND *GYRODES*

PLATE 55

FIGURES 1, 2, 7, 8. *Euspira rectilabrum* (Conrad) (p. 370).
1, 2. Back and apertural views of a hypotype (× 3) from the Coffee Sand at loc. 6. USGS 26338, USNM 131631.
7, 8. Apertural and back views of a hypotype (× 3) from the same locality. USGS 25483, USNM 131632.

3–5. *Pseudamaura lepta* Sohl, n sp. (p. 370).
3, 4. Aperture and back views of the holotype (× 2) from the Coffee Sand at loc. 6. USGS 26338, USNM 131633.
5. Back view of a paratype (× 2) from the same locality USNM 131634.

6. *Stantonella* sp. (p. 372) View of an incomplete specimen (× 1) from the Coffee Sand at loc. 6. USGS 25483, USNM 131639.

9–11. *Gegania* sp. (p. 363).
9. Back view of a specimen (× 4) from the Coffee Sand at loc. 6. USGS 26338, USNM 131605.
10, 11. Apertural and back views of a specimen (× 5) from the same locality. USGS 25483, USNM 131689.

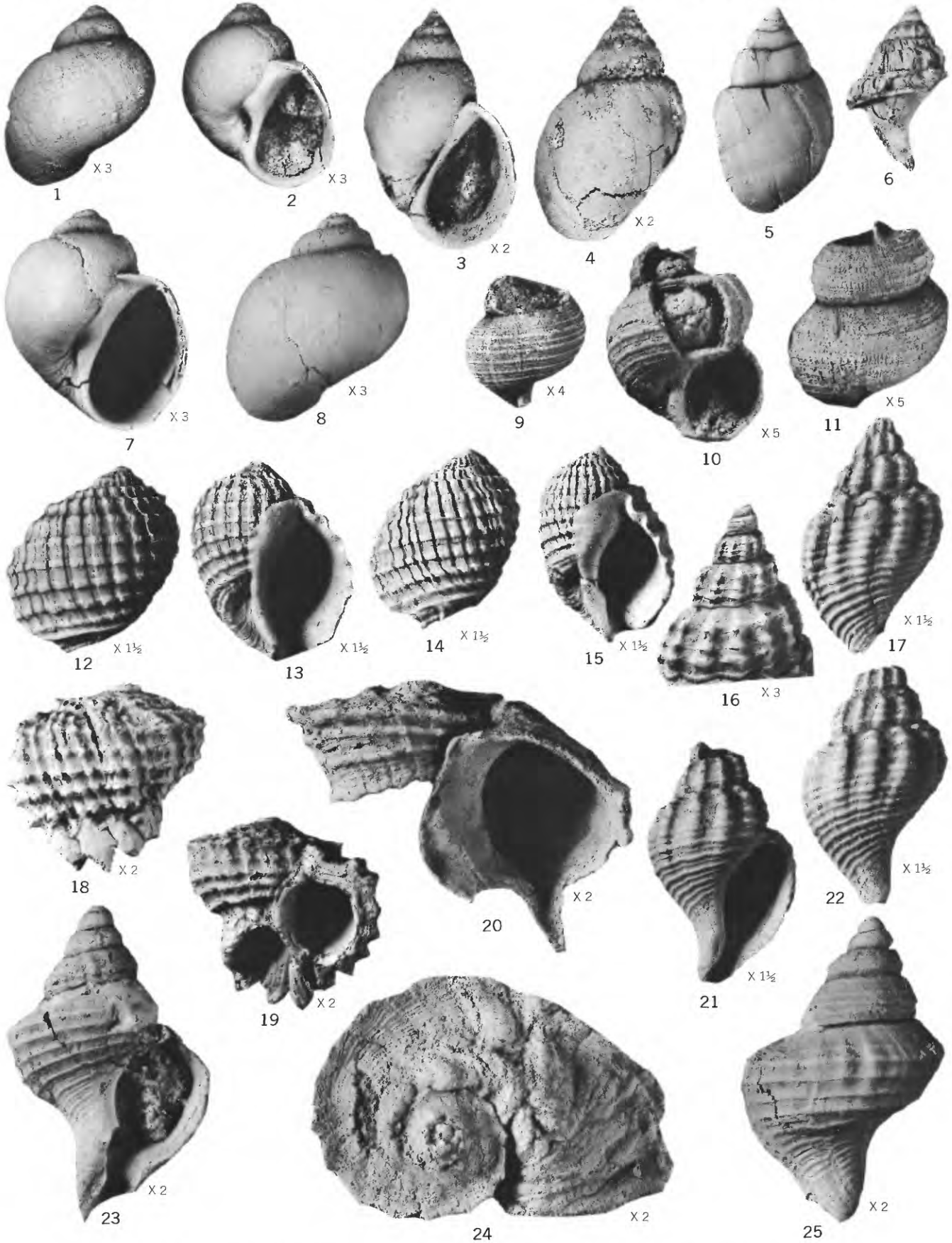
12–15. *Morea corsicanensis depressa* Sohl, n. subsp. (p. 371).
12, 13. Back and apertural views of a paratype (× 1½) from the Coffee Sand at loc. 6. USGS 25483, USNM 131637.
14, 15. Back and apertural views of the holotype (× 1½) from the same locality. USGS 26338, USNM 131638.

16, 17, 21, 22. *Cantharus* (*Cantharulus*) *lemniscatus* Sohl, n. sp. (p. 373).
16. View of the spire of a paratype (× 3) enlarged to show development of sculpture. Coffee Sand. USGS 26338, USNM 131644.
17. Back view of a paratype (× 1½) from the Coffee Sand at loc. 6. USGS 26338, USNM 131645.
21, 22. Apertural and back views of the holotype (× 1½) from the same locality. USGS 25483, USNM 131643.

18, 19. *Sargana stantoni* (Weller)? (p. 370).
Back and front views of a specimen (× 2) from the Coffee Sand at loc. 6. USGS 25483. USNM 131636.

20, 24. *Lowenstamia funiculus* Sohl (p. 372).
Apertural and apical views of the holotype (× 2) from the Coffee Sand at loc. 6. USGS 26338, USNM 130216.

23, 25. *Lomirosa carinata* Sohl, n. sp. (p. 374).
Apertural and back views of the holotype (× 2) from the Coffee Sand at loc. 6. USGS 26338, USNM 131647.



EUSPIRA, PSEUDAMAURA, STANTONELLA, GEGANIA, MOREA, CANTHARUS, SARGANA, LOWENSTAMIA, AND *LOMIROSA*

PLATE 56

FIGURES 1, 8. *Lupira disparila* Sohl, n. sp. (p. 377).
1. Apertural view of the holotype (× 2) from the Coffee Sand at loc. 6. USGS 26338, USNM 131657.
8. View of an incomplete paratype (× 2) that shows the columellar plication. Coffee Sand at loc. 6. USGS 25483, USNM 131658.

2, 3. *Mataxa leioderma* Sohl, n. sp. (p. 382).
2. Back view of the holotype (× 4) from the Coffee Sand at loc. 6. USGS 26338, USNM 131670.
3. Apertural view of a paratype (× 5) from the Coffee Sand at loc. 6. USGS 26338, USNM 131671.

4. *Paladmete cancellaria* (Conrad)? (p. 382).
Apertural view of a specimen (× 3) from the Coffee Sand at loc. 6. USGS 26338, USNM 131672.

5, 6. Mitrid gastropod (p. 382).
Back and front views of a specimen (× 5) from the Coffee Sand at loc. 6. USGS 26338, USNM 131673.

7. *Pyropsis* sp. A (p. 378).
View of a fragment of a body whorl (× 1) from the Coffee Sand at loc. 6. USGS 26338, USNM 131659.

9–11. *Fusinus*? cf. *F*? *macnairyensis* (Wade) (p. 377).
9. View of the spire of an incomplete specimen (× 4) from the Coffee Sand at loc. 6. USGS 25483, USNM 131655.
10, 11. Front and back view of a specimen (× 4) from the same locality. USGS 26338, USNM 131656.

12, 13. *Fulgerca compressilirata* Sohl, n. sp. (p. 379).
12. Apertural view of a paratype (× 8) from the Coffee Sand at loc. 6. USGS 25483, USNM 131664.
13. Back view of the holotype (× 8) from the same locality. USGS 25483, USNM 131663.

14. *Remera stephensoni* Harbison? (p. 376).
Apertural view of a hypotype (× 3) from the Coffee Sand at loc. 6. USGS 25483, USNM 131654.

15. *Drilluta* cf. *D. major* Wade (p. 376).
Back view of a specimen (× 1½) from the Coffee Sand at loc. 6. USGS 25483, USNM 131651.

16, 17. *Bellifusus* sp. (p. 375).
Back and front views of a specimen (× 2) from the Coffee Sand at loc. 6. USGS 25483, USNM 131649.

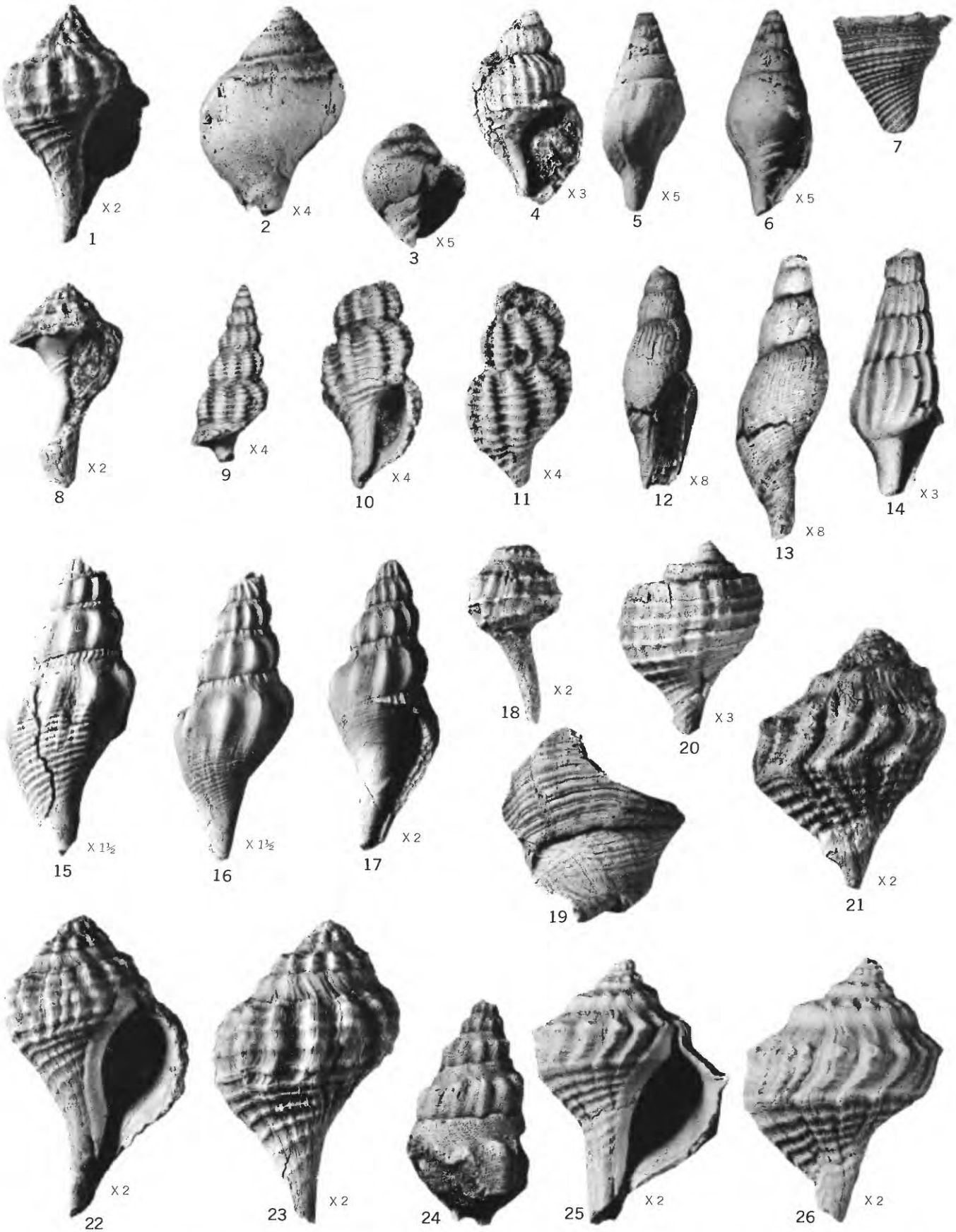
18, 20. *Napulus* cf. *N. fragilis* Sohl (p. 378).
18. Back view of a specimen (× 2) from the Coffee Sand at loc. 6. USGS 26338, USNM 131661.
20. Back view of a specimen (× 3) from the same locality. USNM 131662.

19. *Buccinopsis*? sp. (p. 372).
Back view of the anterior part of a body whorl (× 1) from the Coffee Sand at loc. 6. USGS 25483, USNM 131641.

21, 25, 26. *Hercorhyncus* (*Haplovoluta*) *bicarinatus* (Wade) (p. 376).
21. Back view of a hypotype (× 2) from the Coffee Sand at loc. 6. USGS 26338, USNM 131652.
25, 26. Apertural and back views of a specimen (× 2) from the same locality. USGS 25483, USNM 131653.

22, 23. *Pyrifusus sinuocostatus* Sohl, n. sp. (p. 374).
Front and back views of the holotype (× 2) from the Coffee Sand at loc. 6. USGS 25483, USNM 131648.

24. *Aliofusus*? sp. (p. 374).
View of the spire of an incomplete specimen (× 1) from the Coffee Sand at loc. 6. USGS 26338, USNM 131646.



LUPIRA, *MATAXA*, *PALADMETE*, MITRID TYPE *PYROPSIS*, *FUSINUS?*, *FULGERCA*, *REMERA*, *DRILLUTA*, *BELLIFUSUS*, *NAPULUS*, *BUCCINOPSIS?*, *HERCORHYNCUS* (*HAPLOVOLUTA*) *PYRIFUSUS*, AND *ALIOFUSUS?*

PLATE 57

FIGURES 1, 5. *Amuletum* sp. (p. 383).
Front and back views of a specimen (× 6) from the Coffee Sand at loc. 6. USGS 25483, USNM 131675.

2. *Amutelum* aff. *A. fasciolatum* (Wade) (p. 383).
Views of immature specimens (× 8) from the Coffee Sand at loc. 6. USGS 25483, USNM 131674.

3, 4. *Amuletum*? *costatum* Sohl, n. sp. (p. 383).
Back and front views of the holotype (× 4) from the Coffee Sand at loc. 6. USGS, USNM 131676.

6. *Cylichna* (*Cylichnopsis*?) sp. (p. 386).
Back view of specimen (× 15) from the Coffee Sand at loc. 6. USGS 25483, USNM 131682.

7, 9, 10. *Cylichna*? sp. (p. 386).
Back and front views of three incomplete specimens (× 15) from the Coffee Sand at loc. 6. USGS 25483, USNM 131681, 131699, 131700.

8. *Liopeplum spiculatum* Sohl, n. sp. (p. 381).
Back view of the holotype (× 1) from the Coffee Sand at loc. 6. USNM 131669.

11. *Nonacteonina* sp. (p. 385).
Apertural view of an incomplete specimen (× 4) from the Coffee Sand at loc. 6. USGS 25483, USNM 131680.

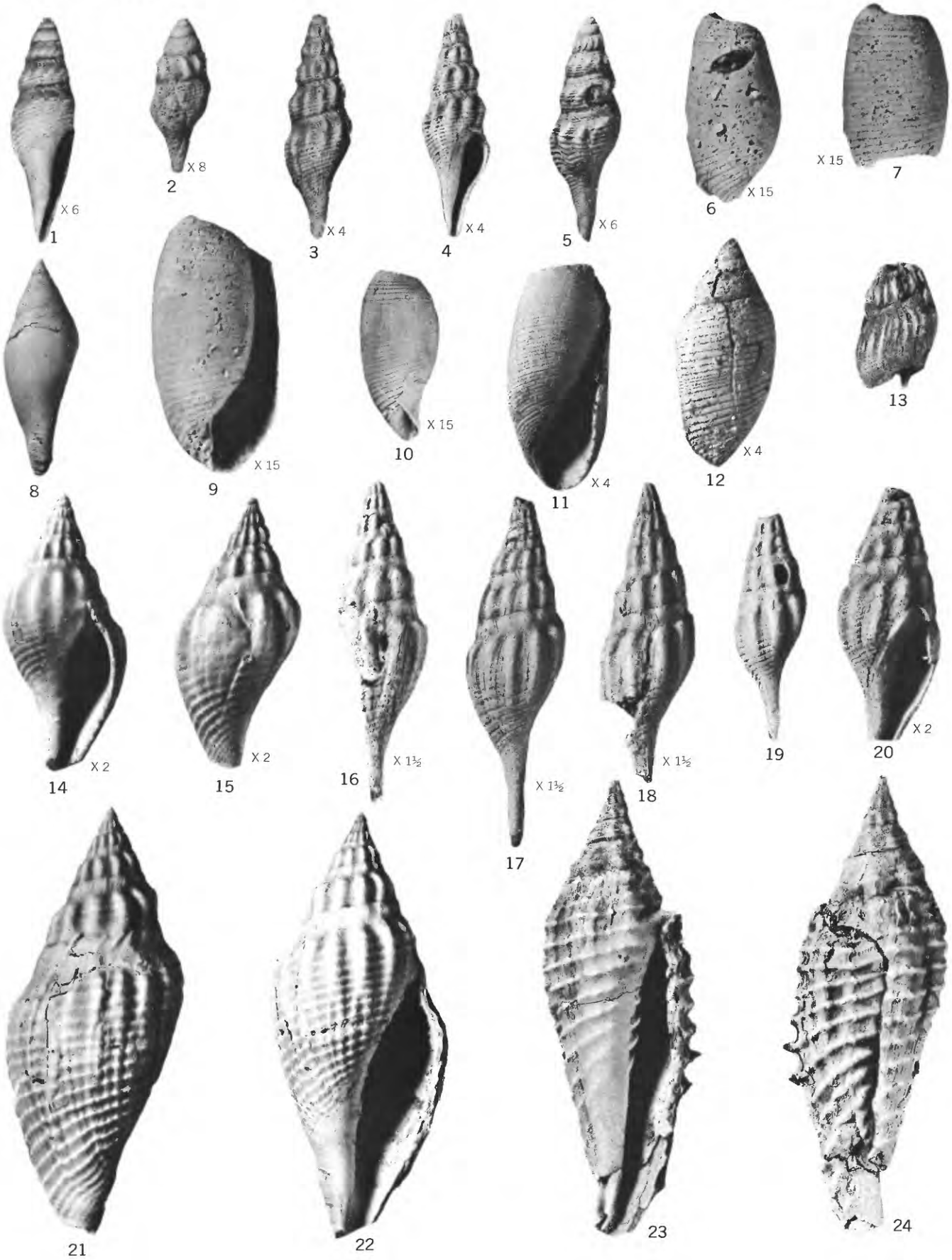
12. *Eoacteon ithyocheilus* Sohl n. sp. (p. 385).
Back view of the holotype (× 4) from the Coffee Sand at loc. 6. USGS 25483, USNM 131679.

13. *Bellifusus* sp. (p. 375).
Back view of an incomplete specimen (× 1) from the Coffee Sand at loc. 6. USGS 25483, USNM 131707.

14, 15, 21, 22. *Volutomorpha splendida* Sohl, n. sp. (p. 380).
14, 15. Apertural and back views of a paratype (× 2) from the Coffee Sand at loc. 6. USGS 25483, USNM 131668.
21, 22. Back and apertural views of the holotype (× 1) from the same locality. USNM 131667.

16–20. *Beretra preclara* Sohl, n. sp. (p. 384).
16, 17. Side and back views of the holotype (× 1½) from the Coffee Sand at loc. 6. USGS 25483, USNM 131677.
18. Back view of a paratype (× 1½) from the same locality. USNM 131678.
19. Back view of a paratype (× 1) from the same locality. USGS 26338, USNM 131697.
20. Apertural view of a paratype (× 2) from the same locality. USNM 131698.

23, 24. *Longoconcha imbricatus* Sohl, n. sp. (p. 379).
Front and back views of the holotype from the Coffee Sand at loc. 6. USGS 25483, USNM 131665.



AMULETUM, CYLICHNA, LIOPEPLUM, NONACTEONINA, EOACTEON, VOLUTOMORPHA, BERETRA, AND *LONGOCONCHA*

Late Cretaceous Gastropods in Tennessee and Mississippi

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STEWART L. UDALL, *Secretary*

GEOLOGICAL SURVEY

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