

Owl Creek
(Upper Cretaceous)
Fossils from Crowleys Ridge
Southeastern Missouri

GEOLOGICAL SURVEY PROFESSIONAL PAPER 274-E



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By LLOYD WILLIAM STEPHENSON

A SHORTER CONTRIBUTION TO GENERAL GEOLOGY

GEOLOGICAL SURVEY PROFESSIONAL PAPER 274-E

*Supplemented with descriptions and illustrations
of better preserved shells from the type section of
the Owl Creek formation 2.5 miles northeast of
Ripley, Tippah County, Miss.*



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A SHORTER CONTRIBUTION TO GENERAL GEOLOGY

OWL CREEK (UPPER CRETACEOUS) FOSSILS FROM CROWLEYS RIDGE, SOUTHEASTERN MISSOURI

By LLOYD WILLIAM STEPHENSON

ABSTRACT

The Owl Creek formation, which is typically developed in Tippah County, Miss., is now known to extend northward to the head of the Mississippi Embayment in southeastern Missouri. The formation is represented in Crowleys Ridge in Stoddard and Scott Counties, Mo., by 11 feet or less of weathered, mottled, yellowish-brown and greenish-gray, glauconitic, finely micaceous sand or sandy clay, indurated in part to ferruginous, argillaceous sandstone. In Missouri the formation is unconformably underlain by the McNairy sand (Upper Cretaceous), and is unconformably overlain by the Clayton formation (Paleocene). Fossils, mainly mollusks, are contained in the Owl Creek formation of Missouri in greater or less abundance; they are in the form of internal and external molds only; no shell material has escaped solution and removal by circulating ground waters, but many of the molds are identifiable.

Fifty-six species are identified and described in this paper. All of them occur also in the typical Owl Creek formation of Mississippi, where their shells have been more or less completely preserved, some in almost as perfect condition as the shells on a modern ocean beach. In describing the Missouri specimens it has seemed desirable in order to present their characteristic features more clearly, to include supplementary illustrations of the more perfect shells of the same species from Mississippi. Four new genera and nine new species are described. Although these new forms are present as molds in Missouri the holotypes and some of the paratypes are selected from among the more perfect Mississippi shells.

For the 4 new genera, including 1 pelecypod and 3 gastropods, the names *Tenuipteria*, *Trobus*, *Eoharpa* and *Eoacteon* are proposed; the new species are the pelecypods *Crenella microstriata*, *Cardium (Granocardium) lowei* and *Tellina buboana*, and the gastropods *Pseudomalaxis pateriformis*, *Trobus buboanus*, *Helicaulax formosa*, *Morea transenna*, *Liopeplum rugosum*, and *Eoharpa sinuosa*.

The Owl Creek formation is the youngest and stratigraphically the highest Upper Cretaceous formation present in outcrop in the eastern Gulf region. In terms of the European classification the formation falls within the Maestrichtian stage (upper part of Upper Cretaceous).

INTRODUCTION

The Owl Creek formation, the uppermost Cretaceous formation at the surface in northern Mississippi, which

is typically developed in Union and Tippah Counties, crops out in a narrow, irregular strip extending from the vicinity of New Albany, Union County, northward through Tippah County to and beyond the Tennessee State line (Stephenson and Monroe, 1940, p. 226-248, pl. 1A; Conant and McCutcheon, 1941, p. 25-27, pl. 1). North of the State line the belt of outcrop has been mapped about half way across Hardeman County, beyond which in Tennessee and Kentucky the formation is concealed by overlapping Paleocene and Eocene strata (Wade, 1926, p. 7, 8, fig. 1).

In Mississippi the formation typically consists of 20 to 40 feet of dark compact, fine-grained, micaceous, glauconitic sand and sandy clay, in part calcareous; it contains an abundance of marine fossil organisms, chiefly mollusks, many of which are in an unusually fine and complete state of preservation. About the middle of the 19th century Dr. W. Spillman of Columbus, Miss., collected fossils at the locality that was later designated the type locality of the formation; it is on Owl Creek 3 miles [2½ miles] northeast of Ripley, Tippah County (E½ sec. 7, T. 4 S., R. 4 E.). The section exposed on Owl Creek was described by Hilgard (1860, p. 88). The fossils were submitted to the pioneer American paleontologist, T. A. Conrad (1858), who described 56 new species of mollusks. A few additional species have been described by Conrad (1860), and by other authors in more recent years, but the Owl Creek fauna has never been as thoroughly studied as its importance justifies. The formation is separated from the underlying Ripley formation and from the overlying Clayton formation by erosional unconformities.

Authors who have contributed substantially to our knowledge of the unit now called Owl Creek formation in Mississippi and Tennessee include in chronologic order: Conrad (1858, 1860); Hilgard (1860); Crider (1906); Wade (1926); Stephenson and Monroe (1937, 1938, 1940); and Conant and McCutcheon (1941).

Strata presumed to be of Ripley (Late Cretaceous) age were known and mapped to the extreme head of the Gulf Embayment in southern Illinois as early as 1906, but no fossils were discovered in them and they were considered to be of nonmarine origin (Glenn, 1906, p. 27-29, pl. 1). More recent investigations have failed to disclose fossils in these beds in Illinois on which to base a correlation, but the geographic and stratigraphic relationship of the beds with reference to other known formations indicate that they are the northern extension of the McNairy sand member of the Ripley formation of Tennessee and Kentucky.

Lamar and Sutton (1930, p. 853-854, fig. 1) state that the Ripley of southern Illinois is unconformably overlain by the Porters Creek clay. He did not recognize the Clayton formation (Paleocene) between the Ripley and the Porters Creek. At the old Olmstead ferry landing the Porters Creek clay is 60 or 70 feet thick; the upper 30 feet is mined as fuller's earth. Lamar reports indistinct imprints of marine fossils that are too poorly preserved for identification in the fuller's earth in Illinois. I visited the Olmstead locality in 1936 and found paleontologic evidence in a small, poor exposure along an old abandoned road about 100 yards upstream from the old Olmstead ferry landing that the Clayton formation is present beneath the Porters Creek clay. The section here is as follows:

*Section along an old abandoned road 100 yards
from the old Olmstead ferry landing, Pulaski
County, Ill.*

Paleocene series:

Clayton formation:	Feet
Sand, greenish-gray argillaceous, richly glauconitic-----	2
Sand, weathered brown, ferruginous, argillaceous,, glauconitic, with many chert pebbles in lower 18 inches; contains poorly preserved prints of fossils in lower 2 feet; recognized <i>Venericardia</i> sp. (of the <i>V. planicosta</i> group), <i>Idonearca saffordi</i> (Gabb), <i>Turritella</i> sp-----	4½

Unconformity.

Upper Cretaceous series:

McNairy sand:	
Sand, fine white micaceous-----	2
Concealed to water level-----	40±
	48½±

The position of the preceding section is stratigraphically below the Porters Creek clay, and the recognized fauna in the glauconitic sand is sufficient to identify the Clayton formation. In a later visit to the Olmstead locality when the Ohio River was at flood stage several poor exposures of the richly glauconitic sand of the Clayton formation were seen in the immediate vicinity of the old ferry landing, but no additional fossils were found.

Prior to 1932 neither the Clayton formation nor the Porters Creek clay were known west of southern Illinois in southeastern Missouri; however, prophetic of their discovery Lamar and Sutton (1930, p. 853) said:

West from Pulaski County, Illinois, the formation dips below younger sediments and is not known to occur elsewhere at the surface, unless the gray clay reported at Idalia and Bloomfield, Missouri, is Porters Creek—a conclusion which a study of well records of the region seems to justify.

Lamar and Sutton also stated (p. 855-856):

Clays ascribed to the Lagrange, probably either the lower part or the dark gray upper phase described later, are also exposed near Idalia and Bloomfield, Missouri, in Crowleys Ridge. These clays have been called the Idalia shale by Marbut [1902, p. 21-23], who describes the clays as "uniformly dark in color and, where freshly exposed, it is black, very much resembling the dark shales of the Coal Measures". About 60 feet of this clay is exposed near Idalia, * * *. As previously stated, it is thought that the gray clay exposed at Idalia and Bloomfield may be the upper part of the Porters Creek formation instead of one of the Lagrange clays.

The clays at Idalia and Bloomfield were later mapped by Farrar (1935, pl. 6) as Midway group (Clayton formation and Porters Creek clay).

Before 1932 the Owl Creek formation, as such, was not known in outcrop in the Gulf Embayment area north of Hardiman County, Tenn. In 1932 the late F. E. Matthes, who was then engaged in physiographic studies in southeastern Missouri, discovered fossil imprints in a thin layer of greenish-gray oolitic, glauconitic, somewhat sandy clay, which crops out in a road bank in the southeast-facing slope of Crowleys Ridge, 0.35 mile northwest of Ardeola station, Stoddard County, Mo. (pl. 14, A, B). He collected a chunk of this material and submitted it to me for the determination of the fossils. I recognized several well-known Upper Cretaceous species. (Matthes, 1933, p. 1007-1009.)

A collection made from the oolitic clay in January 1933 by Willard Farrar of the Missouri Geological Survey and Water Resources showed that, in addition to the Cretaceous fossils, the clay contained several characteristic Clayton (Paleocene) fossils. Field investigations in 1933 by the Missouri Survey and by the present author proved that the bed of oolitic clay is in fact the basal bed of the Clayton formation which, together with an overlying section of Porters Creek clay, represents the Paleocene series (Midway group) in the Gulf Embayment area. It was found that the Cretaceous fossils in the oolitic clay were derived by mechanical reworking from a bed of ferruginous, micaceous, fossiliferous clayey sand and sandy clay (Cretaceous) in place immediately beneath the oolitic clay. This reworking must have taken place before the calcareous material composing the shells of the organisms was leached away, for the clay contains only

the imprints of the fossils. The fossils in the Cretaceous bed are also present as imprints only, but they represent an abundant fauna that includes many characteristic species of the Owl Creek formation of Mississippi. The sand is lithologically like that of the typical Owl Creek except that the calcareous content has been removed in solution by circulating ground waters, and the iron in the glauconite has been oxidized to reddish, brownish, and yellowish hematitic and limonitic compounds.

Before the discovery of Cretaceous fossils in Crowleys Ridge the beds now known to be of that age were believed to be of Tertiary age and were so classified and mapped by Marbut (1902). One of the reasons for this erroneous correlation was the mistaken assumption that masses of quartzitic sandstone in the McNairy sand at Bell City in northeastern Stoddard County, and elsewhere in adjacent parts of Crowleys Ridge, were of the same age as similar quartzitic masses in the Wilcox formation farther south in Crowleys Ridge in Clay, Greene, and Craighead Counties, Ark. The discovery of the Cretaceous and Paleocene fossils throws new light on the geologic history of the Gulf Embayment, for it shows that the seas in which the Owl Creek and Clayton formations were deposited extended northward to the extreme head of the embayment area.

Following the discovery of Cretaceous and Paleocene strata in Crowleys Ridge in southeastern Missouri, representatives of the Missouri Geological Survey and Water Resources were assigned to study the general geology, stratigraphy, and economic resources of the area, and reports, including areal geologic maps, were issued on these subjects. The report of most interest in connection with the present paper was prepared under the authorship of Willard Farrar (1935) and is entitled "The Cretaceous and Tertiary geology." The Cretaceous fossils listed in this report were identified by me, and the Paleocene fossils by Julia Gardner. This report was followed by one entitled "The geology of Stoddard County, Missouri," under the authorship of Farrar and McManamy (1937). In March 1933, it was my privilege to spend a short field season in the area with Farrar and with H. S. McQueen, of the Missouri Survey. Again in April 1938, I spent 2 days in the area with H. S. McQueen, D. R. Stewart and Lyle McManamy of the Missouri Survey, and with W. H. Monroe of the United States Geological Survey.

PHYSIOGRAPHIC SETTING

Crowleys Ridge is an attenuated remnant of a hilly part of the Coastal Plain that has withstood the ero-

sional attack of two large rivers, the Ohio and the Mississippi. The ridge is about 200 miles long, extending from Mississippi River below Cape Girardeau, Mo., to Helena, Ark.; the ridge is extremely irregular in outline and height, ranging in width from less than 1 mile to 18 miles, and rising to a maximum of about 580 feet above sea level and 260 feet above the surrounding lowlands. The continuity of the ridge is broken by four erosional gaps now traversed by streams. Little River traverses a gap about 9 miles wide in Scott and Stoddard Counties, and Castor River flows through a narrow gap in Stoddard County; St. Francis River passes through a narrow gap on the Missouri State line; and L'Anguille River traverses a gap 8 miles wide in Lee County, Ark. The part of the ridge between the Little and Mississippi Rivers, Missouri, is locally known as the Benton Hills and the part in Stoddard and Dunklin Counties as Bloomfield Ridge.

In his treatise on the geology of Crowleys Ridge, Call (1891, p. 128, 129) recognized that the lowland between the ridge and the Ozark province on the west was cut and partly refilled with sediments by the Mississippi River at a time when the course of the river was west of the ridge as far south as Helena, Ark., where it joined the Ohio River. Call says:

The Mississippi entered the great embayment just below Cape Girardeau and spreading into several considerable streams rapidly engaged in the work of denudation and removal. Two main channels were formed, one east, and the other west of Crowley's Ridge. That is to say, such was their relation to what is now that ridge. The great valley through which flows the White, lower Black, Cache, and other smaller streams was then dug out. On the west the great trough of the Mississippi was then deeper and wider than that of the Ohio to the east. At length the waters of the Mississippi cut through and passed to the east of the ridge and its work west of the ridge ended.

Although Call recognized some of the major facts in the geographic relationship of the Mississippi to the Ohio River his description of that relationship is somewhat confused and he did not offer a detailed explanation of how the Mississippi was diverted from its course west of Crowleys Ridge to join the Ohio in the vicinity of Cairo.

The physiography of Crowleys Ridge, as interpreted by Marbut (1902), and later with certain modifications by Matthes (1933), tells the astonishing story of the capture twice of one great river by another—the Ohio the "captor" and the Mississippi the "captured." The story is briefly summarized in the following paragraphs.

In early Quaternary time the Ohio River flowed to the southeast of a coastal-plain upland of which Crowleys Ridge is now an attenuated erosional remnant. At the same time the Mississippi River turned to the west and southwest at Cape Girardeau, Mo., and flowed to

the south on the west side of the upland. The two rivers came together in the vicinity of Helena, Ark., and continued as a single stream to the Gulf of Mexico. In the Cairo region near the head of the Gulf Embayment the gradient of the Ohio River was supposedly about 20 feet lower than that of the Mississippi.

The drainage on the upland in the region of Scott and Stoddard Counties was to the northwest to the Mississippi, the small tributary valleys of course becoming deeper in that direction. The Ohio meandering in its flood plain east of the upland scoured away the south-east side of the upland, which became continuously narrower. The valleys of the northwestward-flowing tributaries thus were beheaded forming notches in the profile of the upland along its south edge and, as cutting continued, the notches grew progressively deeper. Eventually one of the notches corresponding to the geographic position of the present Little River became so low that the flood waters of the Mississippi spilled through it and flowed southward to the lower flood plain of the Ohio. Repeated floods continued to cut the notch deeper and wider until eventually the great Mississippi abandoned its channel in the Advance Lowland and, following the course of the present Little River, joined the Ohio in that part of its flood plain which Marbut called the Morehouse Lowland. The Mississippi River must have followed this course for a relatively long time for the gap that it produced in Crowleys Ridge is nearly 9 miles wide.

While this great shift in the course of the Mississippi was taking place another notch in the upland, south of Cape Girardeau, was being lowered in the same manner as that in the Little River area. Eventually a second capture of the river was accomplished through this notch, which diverted its course to the channel it now occupies from Cape Girardeau via Commerce to Cairo. The channel now occupied by Little River was, in its turn, abandoned by the Mississippi River.

Marbut (1902, p. 3-7) named the great lowland west of Crowleys Ridge the Advance Lowland, from the village of Advance 24 miles southwest of Cape Girardeau. He applied the name to the lowland to and "beyond" the Arkansas State line. Stephenson and Crider (1916, p. 25) expanded the application of the name Advance to include the whole of the lowland in Arkansas between Crowleys Ridge on the east and the Ozark province on the west.

STRATIGRAPHY AND LITHOLOGIC CHARACTER OF THE FORMATIONS

The sedimentary rocks composing the northern part of Crowleys Ridge include beds of Paleozoic, Late Cre-

taceous, Paleocene, Eocene, Pliocene(?), Pleistocene, and Recent ages. The following generalized section based, with modifications, on the published results of the researches of Willard Farrar and his associates on the staff of the Missouri Geological Survey and Water Resources, pertains to Scott and Stoddard Counties (Farrar, 1935, p. 10-28; Farrar and McManamy, 1937, p. 14-44).

Generalized section of rocks in Crowleys Ridge, Missouri

[Maximum known thicknesses are given]

Quaternary system:		
Recent series:	<i>Feet</i>	
Silts, sands, and gravels of flood plains.....	20	
Pleistocene series:		
Terrace deposits.....	80	
Loess.....	70	
Unconformity.		
Tertiary system:		
Pliocene series:		
Gravel, sand, and clay, unnamed.....	60	
Unconformity.		
Eocene series:		
Wilcox formation.....	250	
Unconformity.		
Paleocene series:		
Porters Creek clay.....	100	
Clayton formation.....	10	
Unconformity.		
Cretaceous system:		
Upper Cretaceous series:		
Owl Creek formation.....	11	
Unconformity.		
McNairy sand.....	181	
Unconformity.		
Devonian system	} Undifferentiated sandstones, lime-	
Silurian system		stones, dolomites.....
Ordovician system		
<hr style="width: 100%; border: 0.5px solid black;"/>		
902+		

The Owl Creek formation as it is exposed in the section at the discovery locality near Ardeola is typical and its stratigraphic relationship to underlying and overlying formations is shown most completely and most clearly there. The description of the Ardeola section given by Farrar (1935, p. 16) is, with certain modifications, repeated here. One important modification is the transfer of the lower 11 feet of his Owl Creek unit to the McNairy sand, and the recognition of an unconformable relationship between the McNairy sand and the Owl Creek, as here interpreted. Other sections in Stoddard and Scott Counties, in which the Owl Creek formation is present, are less completely exposed than the one near Ardeola. (See pl. 14, following p. 140.)

Section along road in southeast-facing slope of Crowleys Ridge, 0.35 miles northwest of Ardeola in NW¼NW¼ sec. 10, T. 27 N., R. 11 E., Stoddard County, Mo.

[Altitude at top of section 493± feet]

Quaternary system :	Feet
Pleistocene series :	
Loess, yellowish-brown-----	5
Unconformity.	
Tertiary system :	
Pliocene series :	
Gravel, brown, well-rounded pebbles, and some red sand-----	6
Unconformity.	
Paleocene series :	
Midway group :	
Porters Creek clay :	
Clay, dark-green on fresh surface, weathering to light gray, locally including interstratified beds of ferruginous clay-----	47
Clayton formation :	
Clay, pale-green, sandy, very glauconitic, oolitic in lower part, containing white angular sand grains near base; abundantly fossiliferous, including indigenous species and reworked Owl Creek species-----	5
Unconformity.	
Cretaceous system :	
Upper Cretaceous series :	
Owl Creek formation :	
Sand, yellowish-brown, argillaceous, glauconitic, finely micaceous; contains many prints of fossils-----	5
Clay, greenish-gray mottled with yellow and brown, sandy, sparingly glauconitic, finely and strongly micaceous; contains a few prints of fossils-----	6
Unconformity, contact sharp.	
McNairy sand :	
Clay and sand, brown, laminated, cross-bedded, with parting planes of muscovite mica; contains abundant comminuted plant remains; borings in upper 8 or 10 inches are filled with sandy matrix from overlying Owl Creek formation-----	11
Sand, grains angular, white to bright orange, crossbedded, lignitic, locally cemented with limonite-----	11
Clay, brown, light- and dark-gray to black, with interbedded sand; limonite and muscovite mica along bedding planes-----	27
Lignite, very sandy-----	1
Sand, grains angular, white, with iron oxide stains, somewhat lignitic-----	11
Concealed to lowland level-----	38
	173

The sample is composed of clay oolites or pellets, ranging in size from 0.1 to 0.5 mm, and other mineral grains in a matrix of olive-green montmorillonite clay. The pellets comprise about 80% of the sample. In most instances detrital mineral grains or glauconite serve as nuclei for the oolites. The nuclei are surrounded by massive light-green montmorillonite (mean index of refraction=1.555), which in turn is encased by concentric shells of montmorillonite. The individual montmorillonite crystals apparently lie with their plates tangential to the sphere. This oriented aggregate shows maximum birefringence ($\alpha'=1.53$, $\tau'=1.56$) and pleochroism (X =pale brown, YZ =dark reddish brown). In many cases the oolite is merely a hollow shell of the oriented montmorillonite about a detrital grain, possibly as the result of shrinkage of the montmorillonite. The oolite itself has in almost all instances shrunk (?) away from the surrounding clay matrix leaving a smooth and lustrous surface.

The clay matrix is a light to olive-green montmorillonite with a mean index of refraction of 1.555 and appears to be similar to the massive montmorillonite in the pellets.

A few detrital grains and glauconite occur directly in the matrix in addition to those found in the oolites. The light fraction consists of subangular water-clear quartz with a few inclusions of biotite (?), apatite, and epidote; subangular to sub-round translucent quartz; angular fresh orthoclase; and microcline, some of which is being replaced by montmorillonite along cleavage cracks. The heavy fraction constitutes only a little of the sample. The minerals in approximate order of abundance in the heavy fraction are:

Opagues ($\frac{1}{3}$ to $\frac{1}{2}$ of the heavy fraction, mostly iron minerals), kyanite, zircon, staurolite, garnet, epidote, rutile, tourmaline, hornblende, muscovite, biotite, and chlorite. Almost all of the detrital grains are coated with montmorillonite, glauconite, or limonite.

Little or no phosphatic material is present and the amount of carbonate is negligible. The latter evidently has been leached from the rock for molds of shells, with delicate features well-preserved, are common. The shells are filled with both matrix clay and oolites although finer structures are preserved by the montmorillonite matrix alone.

Typical, nodular, dark-green glauconite with aggregate polarization is commonly found in the sample both as nuclei of the pellets and in the matrix. The chief occurrence of glauconite, however, is as slightly curved and twisted tubes which are polygonal in cross-section and closely resemble the faecal pellets figured by Moore (1939, p. 520, fig. 1-a, c, m). In longitudinal section the glauconite is seen to have a micaceous structure and to have expanded perpendicular to the basal cleavage in a manner similar to vermiculite. Optically the glauconite is biaxial negative, $\alpha'=1.593$, $\tau'=1.610$, mean index of refraction ≈ 1.61 , $2V$ is approximately 20° . These glauconitized faecal pellets are most commonly found as nuclei of the montmorillonite oolites.

A primary origin for the clay oolites, possibly coincident with the reworking of the underlying Cretaceous bed, seems likely. It is possible, however, that calcareous oolites have been partially or wholly replaced by clay and the remaining carbonate leached out.

In addition to the faecal pellets mentioned by Erd there are scattered through the oolitic clay a few clusters of larger pellets that resemble in form another kind of

A sample of the pale-green oolitic clay at the base of the Clayton formation was studied critically by R. C. Erd (written communication), whose report is quoted as follows:

faecal pellets illustrated by Moore (1939, p. 520, fig. 1f). In a subsequent study Erd reports on these as follows:

Large faecal pellets are abundantly present in these samples but were not found in the material submitted earlier. The pellets are grouped together usually with their long axes in sub-parallel arrangement. The pellets are normally round in cross-section but some have been squeezed together to produce a polygonal cross-section. Impressions of the oolites and detrital grains may be seen on the surface of the pellets, but they do not contain these objects. They are unique in this respect for even the matrix montmorillonite found in the molds of shells contains oolites and detrital grains. The large pellets do, however, contain about 10-20% of angular grains of quartz.

The pellets are composed of gray-green montmorillonite which is similar to that in the matrix and has the same mean index of refraction.

These pellets differ from the glauconitic (faecal?) pellets in composition, size (the small pellets are about 0.5 mm long by 0.15 wide), abundance (the small pellets are much more common and may make up 20% of the sample), and in grouping (they are scattered throughout the sample).

It is interesting to note that the oolitic clay in the Ardeola section is at the same stratigraphic position as the fossil mollusks replaced by clay of the montmorillonite group in a railroad cut half a mile south by west of Pontotoc, Pontotoc County, Miss. The latter occurrence was recorded by Stephenson (1939, p. 96-99, pl. 16) and later by Ross and Stephenson (1939, p. 393-397, fig. 1). At the Pontotoc locality the replaced fossil shells are in the basal bed of the Clayton formation of the Midway group (Paleocene), immediately and unconformably above glauconitic sand representing the southward extension of the Owl Creek formation. This identity of stratigraphic position is probably not accidental; it would seem to indicate a similarity in marine physical conditions in the Gulf Embayment area in early Midway time, extending from northern Mississippi to southeastern Missouri.

STRUCTURE

In structural attitude the Upper Cretaceous and Paleocene (Midway) beds, which form an important part of the body of Crowleys Ridge in southeastern Missouri, are monoclinical, dipping gently to the southeast into the synclinal basin formed by the downwarping of the Gulf Embayment region. Data furnished by Farrar and McManamy (1937 geol. map, pl. 9) indicate that the southeast dip of the Cretaceous-Paleocene contact in the Bloomfield area in Stoddard County is between 40 and 45 feet to the mile. The map cited shows a broad upwarp accompanied by minor faulting in the Bloomfield area, but the data presented seem to justify an estimated regional dip of the Cretaceous-Paleocene

contact to the southeast of 35 or 40 feet to the mile. As the beds below and above the contact are nearly parallel to each other the regional dip of the Cretaceous, Paleocene, and Eocene beds to the southeast may be assumed to be about the same as that of the contact.

Originally, and as late as late Tertiary (Pliocene) time, the Cretaceous and Paleocene strata of Crowleys Ridge in southeastern Missouri were physically continuous southward through the Gulf Embayment with the beds of the same age in Mississippi. Their physical continuity was broken in Pleistocene time by erosion, first by the Ohio River before the capture of the Mississippi, and later by the combined waters of the Ohio and the Mississippi, leaving the Cretaceous and Paleocene formations at elevated positions in the Crowleys Ridge upland.

FOSSIL LOCALITIES

With the exception of one collection (USGS 16221), all the Cretaceous fossils from Missouri described or mentioned in this paper were obtained from the Owl Creek formation at the localities in Stoddard and Scott Counties listed below; the Cretaceous fossils in this collection (USGS 16221) were found in the basal bed of the Clayton formation, into which they had been incorporated by mechanical reworking from the underlying Owl Creek formation. The collection bearing the number USGS 19088 consisted of one incomplete internal mold of the ammonite, *Sphenodiscus pleurisepta* (Conrad), which was collected by Edison Shrum of Advance, Mo., and donated to the United States Geological Survey, through Willard Farrar of the Missouri Survey. (See fig. 21.)

The one collection (USGS 16221) from the basal bed of the Clayton formation, previously mentioned, was made by F. E. Matthes in June 1932, at the locality near Ardeola station, the description of which is given below; the bed is reported to be at an altitude of 430 feet, and about 110 feet above the base of the slope. This is the collection that led to the discovery of the McNairy sand, and the Owl Creek formation of the Cretaceous, and the Clayton and Porters Creek formations of the Paleocene, in southeastern Missouri. All the fossils specifically identified in this collection are Owl Creek (Upper Cretaceous) species derived by mechanical reworking from the underlying Owl Creek formation. Some of the genera that are not identified as to species may be indigenous to the Clayton formation. Typical Clayton (Midway) fossils were later found in the oolitic clay, associated with the reworked Cretaceous fossils.

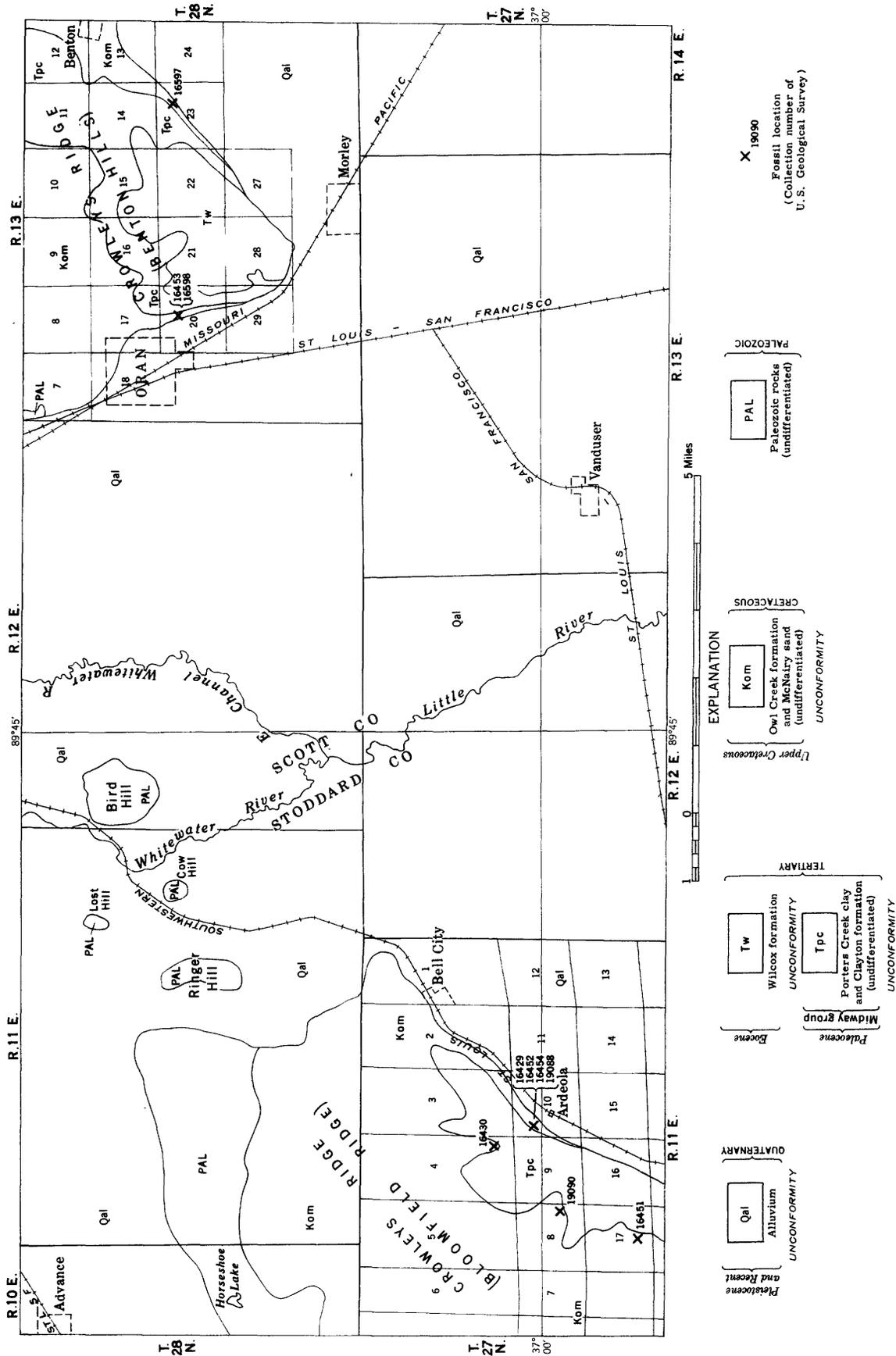


FIGURE 21.—Sketch map of parts of Stoddard and Scott Counties, southeastern Missouri, showing localities in Crowleys Ridge at which fossils have been collected from the Owl Creek formation (Upper Cretaceous-Maastrichtian age). The map includes parts of the Advance, Morley, Bloomfield, and Sikeston quadrangles of the United States Geological Survey. Geologic boundaries after Willard Farrar, Missouri Geological Survey and Water Resources (1985, pl. 6). A gravel formation (Pliocene?) and overlying loess (Pleistocene), which blanket all older formations in Crowleys Ridge, are disregarded in the mapping.

Cretaceous fossil localities in Stoddard and Scott Counties; numbers are the collection numbers of the U. S. Geological Survey

- USGS 16429, 16452, 16454, 19088. Road cut and ditch on the southeast-facing slope of Crowleys Ridge, 0.35 mile northwest of Ardeola station in SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 10, T. 27 N., R. 11 E., Stoddard County, Mo.; from the Owl Creek formation. Collectors Willard Farrar, H. S. McQueen, and L. W. Stephenson, March 1933; Farrar and Mr. Field, July 1933; Edison Shrum, 1940.
- USGS 16430. Road ditch about 150 feet south of road junction near the southeast corner of SE $\frac{1}{4}$ sec. 4, T. 27 N., R. 11 E., about 1 mile northwest of Ardeola station, Stoddard County, Mo. Collectors Willard Farrar, H. S. McQueen, L. W. Stephenson, March 19, 1933.
- USGS 19090. Ditch on east side of north-south road one-eighth mile south of road junction, 1.4 miles west by slightly south of Ardeola station, in center of east line of NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 8, T. 27 N., R. 11 E., Stoddard County, Mo.; ferruginous, finely micaceous sandstone. Collectors H. S. McQueen, D. R. Stewart, Lyle McManamy, L. W. Stephenson, W. H. Monroe, April 4, 1938.
- USGS 16451. Left bank of a dry branch 300 feet downstream from a road crossing, 2.1 miles southwest of Ardeola sta-

tion, in center S $\frac{1}{2}$ NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 17, T. 27 N., R. 11 E., Stoddard County, Mo.; from just below Owl Creek-Clayton contact.

Collectors Willard Farrar, Mr. Field, July 4, 1933.

- USGS 16597. U. S. Highway 61, one-fourth mile northeast of junction with secondary road near benchmark 374, 1.6 miles southwest of Benton, 16 feet below highway on east side, in NE $\frac{1}{4}$ SW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 23, T. 28 N., R. 13 E., Scott County, Mo.; Owl Creek formation just below contact with Clayton formation. Altitude, 360± feet.

Collector Willard Farrar, 1934.

- USGS 16598. Gully northeast of house on Fullenwider farm 1 mile southeast of Oran, in NW $\frac{1}{4}$ SW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 20, T. 28 N., R. 13 E., Scott County, Mo.; from uppermost bed of Owl Creek formation. Altitude 410± feet.

Collector Willard Farrar, 1934.

- USGS 16453. Loose on slope on Fullenwider farm 1 mile southeast of Oran, in NW $\frac{1}{4}$ SW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 20, T. 28 N., R. 13 E., Scott County, Mo.; this specimen must have been derived by weathering or erosion from the Owl Creek formation. Collector Willard Farrar, July 1933.

The distribution of the fossils collected and identified from the Owl Creek formation in Stoddard and Scott Counties is shown in the accompanying table.

Distribution of Owl Creek fossils in Stoddard and Scott Counties, Mo.

Numbers at heads of columns are collection numbers of the United States Geological Survey. Descriptions of localities are given above. Each column at right indicates the fossils from one locality. The asterisk indicates species restricted to the Owl Creek formation]

	Stoddard County			Scott County			
	16429, 16452, 16454, 19088,	16430	19090	16451	16453	16597	16598
Porifera (Spongiae):							
<i>Cliona microtuberum</i> Stephenson				X			
Annelida (Chaetopoda):							
<i>Serpula</i> sp.			X	X			
<i>Hamulus squamosus</i> Gabb			X				
Mollusca:							
Pelecypoda:							
<i>Nucula percrassa</i> Conrad			X				
sp.		X					
<i>Nuculana longifrons</i> (Conrad)	X		X				
sp. (smooth)	X	X					
sp. (with nonconcentric ribs)			X				
<i>Nemodon eufaulensis</i> (Gabb)	X	X	X				
<i>Glycymeris rotundata</i> (Gabb)	X		X	X			
<i>Breviarca?</i> sp.	X						
* <i>Idonearca capax</i> (Conrad)	X		X	X			
* <i>Pinna laqueata</i> Conrad	X						
* <i>Tenuipteria argentea</i> (Conrad), n. gen.	X		X	X			
<i>Ostrea tecticosta</i> Gabb			X				
<i>Exogyra costata</i> Say (juvenile)	X						
* <i>Trigonia angulicostata</i> Gabb	X	X	X	X			
<i>eufaulensis</i> Gabb	X	X	X				
* <i>Pecten</i> (<i>Campionectes</i>) <i>bubonis</i> Stephenson	X		X	X			
<i>hilgardi</i> Stephenson?		X					
(<i>Syncyclonema?</i>) <i>simplicius</i> Conrad	X	X	X				
<i>Lima acutilineata</i> (Conrad)	X		X	X			
<i>Crenella serica</i> Conrad	X						
* <i>microstriata</i> Stephenson, n. sp.	X			X		X	
<i>Cuneolus tippanus</i> (Conrad)			X				
* <i>Pholadomya tippana</i> Conrad	X				X		X
* <i>Anatimya anteradiata</i> (Conrad)			X				
? sp.				X			
<i>Liopistha protexta</i> (Conrad)	X	X	X	X		X	X

Distribution of Owl Creek fossils in Stoddard and Scott Counties, Mo.—Continued

	Stoddard County			Scott County			
	16429, 16452, 16454, 19088,	16430	19090	16451	16453	16597	16598
Mollusca—Continued							
Pelecypods—Continued							
<i>Veniella conradi</i> (Morton).....	X		X	X		X	
* <i>Crassatella vadosa ripleyana</i> (Conrad).....	X	X	X			?	X
* <i>Scambula perplana</i> Conrad.....	X		X				
* <i>Cardium (Granocardium) tippanum</i> Conrad.....	X	X	X	X			
* <i>lowei</i> Stephenson n. sp.....	X	X	X			X	X
(<i>Pachycardium</i>) <i>spillmani</i> Conrad.....	X						
* <i>Brevicardium fragile</i> Stephenson.....	X						
<i>Aphrodina tippana</i> (Conrad).....	X		X	X			
* <i>Cyprimeria alta</i> Conrad.....	X		X	X			
<i>Legumen ellipticum</i> Conrad.....	X	X	X	X			
<i>Tenea parilis</i> Conrad.....	X	X	X	X			
<i>Tellina buboana</i> Stephenson, n. sp.....			X				
<i>Linearia metastrata</i> Conrad.....		?	X	X			
<i>Leptosolen biplicatus</i> (Conrad).....	X	X	X				X
<i>Corbula</i> (several species).....	X	X	X	X			
* <i>Panope monmouthensis</i> Gardner.....				X			
* <i>Gastrochaena ripleyana</i> Stephenson.....	X						
<i>Goniochasma?</i> sp.....			X				
Gastropoda:							
* <i>Pseudomalaxis pateriformis</i> Stephenson, n. sp.....			X				
<i>Polinices rectilabrum</i> (Conrad).....				X			
<i>Gyrodes supraplicatus</i> (Conrad).....				X			
<i>spillmani</i> Gabb.....			X				
<i>Turritella tippana</i> Conrad.....		X	X	X		X	X
<i>vertebroides</i> Morton, s. l.....	X		X	X			X
* <i>Trobus buboanus</i> Stephenson, n. gen. and n. sp.....	?						
<i>Anchura?</i> (several unidentified species).....	X		X	X		X	
* <i>Helicaulax formosa</i> Stephenson, n. sp.....			X				
* <i>Napulus octoliratus</i> (Conrad).....			X	X			
sp.....				X			
* <i>Morea transenna</i> Stephenson, n. sp.....			X				
<i>Fusinus?</i> sp. A.....			X				
? sp. B.....			X				
* <i>Liopeplum rugosum</i> Stephenson, n. sp.....				X			
<i>Drillula</i> sp.....	X						
<i>Volutomorpha?</i> spp.....			X	X			
* <i>Eoharpa sinuosa</i> Stephenson, n. gen. and n. sp.....			X				
<i>Caveola</i> sp.....			X				
* <i>Hoacteon lineata</i> (Conrad), n. gen.....			X				
* <i>Bullopsis cretacea</i> (Conrad).....			X				
<i>Cylichna</i> sp.....			X				X
Cephalopoda:							
* <i>Baculites carinatus</i> Morton.....	X			X			
* <i>Discoscaphites iris</i> (Conrad).....		X	X				
* <i>Sphenodiscus pleurisepta</i> (Conrad).....	X						

CORRELATION

The table of distribution lists 56 identified species of marine organisms, mostly mollusks, from the Owl Creek formation of southeastern Missouri. With a few exceptions the species listed have been previously recorded from the Owl Creek formation of Mississippi or from beds of Owl Creek age in the Gulf region. As known at present 28 of the named species are restricted to the Owl Creek formation or to beds of that age in the Gulf region. The other 28 have longer ranges, occurring in deposits older than the Owl Creek forma-

tion; many of them are in the Ripley formation, which underlies the typical Owl Creek in Mississippi. The Owl Creek age of the marine fossiliferous beds forming the uppermost part of the Cretaceous sections above the McNairy sand in southeast Missouri is thus firmly established.

The McNairy sand, as it is developed in the head region of the Mississippi Embayment, is a shallow water, possibly in part nonmarine, facies of the marine Ripley formation in Mississippi. A few fossil leaves have been found in the McNairy sand in Tennessee, but the formation has yielded no marine organisms.

SYSTEMATIC DESCRIPTIONS

Phylum PORIFERA

Class SPONGIAE

Order MONACTINELLIDA

Family CLIONIDAE

Genus CLIONA Grant, 1826

Cliona microtuberum Stephenson

Plate 15, figures 1, 2

1941. *Cliona microtuberum* Stephenson, Tex. Univ. Pub. 4101, p. 54, pl. 3, figs 1-5; pl. 5, figs. 1, 2.

Two specimens from the collection 2.1 miles southwest of Ardeola, (USGS 16451), one an undetermined bivalve and the other a gastropod (*Turritella* sp.) preserve the ferruginous casts of a boring sponge, here referred to *Cliona microtuberum* Stephenson. In size, shape, pattern of distribution, and finely stippled surface, these casts appear to be essentially like those of the holotype from the Corsicana marl of Texas. The original material composing the casts, which presumably was phosphatic, has been replaced by hematitic oxide of iron. The casts are so densely crowded as to preserve the shape of the shells in which the borings were made. There is evidence of casts of slender, smooth, intercommunicating cavities, intermingled with the *Cliona* casts. These appear to be like the problematical casts (of a sponge?) associated with the holotype from the Corsicana marl and with one of the paratypes from the Kemp clay of Texas. Casts of *Serpula*-like tubes are attached to the gastropod specimen, apparently to the outside of the original shell.

Types.—Holotype, USNM 76266; paratype, USNM 76268, from the Corsicana marl, Texas. Paratype, USNM 76267, from the Kemp clay, Texas. Paratype, USNM 76270, from the Prairie Bluff chalk, Alabama. Two plesiotypes, USGS 16451, USNM 128081, from the Owl Creek formation, 2.1 miles southwest of Ardeola, Stoddard County, Mo.

Range.—Owl Creek formation and Prairie Bluff chalk of eastern Gulf region; Corsicana marl and Kemp clay of Texas. Phosphatic casts of boring sponges, some of them perhaps belonging to *Cliona microtuberum*, are common in the upper part of the Cretaceous series in the Atlantic and Gulf Coastal Plain.

Phylum ANNELIDA

Class CHAETOPODA

Family SERPULIDAE

Genus SERPULA Linné, 1758

Serpula sp.

Ferruginous casts of tubes that appear to pertain to the genus *Serpula* Linné are present in two of the collections, USGS 16451 and 19090. The tubes as preserved are short, taper a little more rapidly than is typical of tubes of this genus, and are irregular in

their longitudinal alinement. USNM 128122 (on *Turritella* sp.) and USNM 128082.

Genus HAMULUS Morton, 1934

Hamulus squamosus Gabb

Plate 15, figure 3

1860. *Hamulus squamosus* Gabb, Acad. Nat. Sci. Phila. Jour., 2d ser., v. 4, p. 398, pl. 68, fig. 45. (For synonymy through 1941, see Tex. Univ. Pub. 4101, 1941, p. 60.)

Add:

1940. *Hamulus squamosus* Gabb. Stephenson and Monroe, Miss. State Geol. Survey Bull. 40, p. 288, pl. 14, fig. 4. (Illustration only.)

This species is represented in the Owl Creek formation of southeastern Missouri by several incompletely preserved imprints and internal molds of tubes (USGS 19090). The tubes are short, evenly curved, rather rapidly expanding, and ornamented with 6 longitudinal ribs. Two of the ribs on opposite sides of the tube, and lying in the plane of curvature, are expanded to form prominent winglike extensions. The other 4 ribs are narrow, low, rather sharp, with small irregular nodes along the crest; they form 2 narrowly parallel pairs, 1 pair on one side, and the other on the opposite side of the tube, between the 2 expanded ribs.

Types.—Gabb's original material should be preserved in the Academy of Natural Sciences of Philadelphia, but it is not included in the Academy's list of Cretaceous types, and presumably is lost. Plesiotype from Missouri, USGS 19090, USNM 128083.

Range.—Geographic, Gulf Coastal Plain; geologic, Upper Cretaceous, through the zones of *Eoogyra ponderosa* and *E. costata*.

Phylum MOLLUSCA

Class PELECYPODA

Order PRIONODESMACEA

Superfamily NUCULACEA

Family NUCULIDAE

Genus NUCULA Lamarek, 1799

Nucula percrassa Conrad

Plate 15, figures 4-7

1858. *Nucula percrassa* Conrad, Acad. Nat. Sci. Phila. Jour., 2d ser., v. 3, p. 327, pl. 35, fig. 4.

1876. *Nucula percrassa* Conrad. Gabb, Acad. Nat. Sci. Phila. Proc. for 1876, v. 28, p. 318.

1926. *Nucula percrassa* Conrad. Wade, U. S. Geol. Survey Prof. Paper 137, p. 39, pl. 8, figs. 1-4.

1931. *Nucula percrassa* Conrad. Roberts, Ky. Geol. Survey, ser. 6, v. 36, p. 404, pl. 68, figs. 1, 2.

One incomplete internal mold from southeastern Missouri (USGS 19090) is here referred to *Nucula percrassa* Conrad. It represents the anterior part of a juvenile right valve. It appears to be identical with young shells of the species from Owl Creek, Miss., the type locality. Well-preserved shells of the species are

abundant at the Owl Creek locality, many of them having both valves intact. Shell thick, plump, elongate, inequilateral, equivalve, with greatest inflation below the beak a little above the midheight. Beaks prominent, opisthogyrate, closely approximate, situated slightly more than two-thirds the length from the anterior extremity. On most of the adult specimens from the Owl Creek formation in Mississippi the lower posterior slope of the shell back of the midlength bends in more or less steeply to the ventral margin. Although the species is common in the Ripley formation, which underlies the typical Owl Creek, at some localities the shells, even large ones, show little or none of the posterior inbending; however, in the Coon Creek tongue of the Ripley formation, a basal Ripley zone (Wade 1926, p. 39), the inbending is about as strongly developed in some shells as it is in the Owl Creek shells. Apparently this feature is a premature senile character caused by some local inhibiting environmental condition. Escutcheon broad, relatively short, distinctly outlined, slightly sunken. Lunule long, narrower than the escutcheon, faintly outlined, anterior margin sharply rounded, ventral margin broadly rounded, posterior margin subangular at the extremity. Surface marked with numerous, closely spaced, weak radial ribs, and irregular, concentric growth lines and ridges.

Dimensions of the figured shell from Owl Creek, Miss.: Length 31.6 mm, height 19 mm, thickness 18.7 mm.

Hinge taxodont, teeth numerous, sharp, in 2 unequal series; in adults about 11 teeth in the posterior series, and about 30 in the anterior series; 1 prominent cardinal tooth in the left valve below the beak is oblique forward just back of the resilifer; a corresponding socket in the right valve is back of the resilifer.

Resilifer deeply submerged, protruding inward, spoon-shaped, narrow, oblique forward. Adductor scars small, sunken, pallial line entire. Inner margin finely crenulated. Inner surface nacreous.

Weller (1907, p. 369) includes in the synonymy of *Nucula percrassa* Conrad the specimens described and figured by Whitfield (1885, p. 102, pl. 11, figs. 4-6) under that name, and also includes the two species *Leda slackiana* Gabb (p. 103) and *Donax fordii* Conrad (p. 171). All of these as originally described and illustrated, including those figured by Weller, appear to be different in form and seem obviously to belong to species other than *Nucula percrassa*.

Types.—Holotype, Academy of Natural Sciences, Philadelphia. Two topotypes from Owl Creek, Miss., USGS 707, USNM 128084.; plesiotype from southeastern Missouri, USGS 19090, USNM 128085.

Range.—Ripley and Owl Creek formations and beds of corresponding age (*Exogyra costata* zone) in the Gulf Coastal Plain.

Nucula sp.

Two small, poorly preserved internal molds of *Nucula*, one a left and the other a right valve, are present in the collection from a mile northwest of Ardeola station (USGS 16430, USNM 128086). They appear to represent a species other than *Nucula percrassa* Conrad.

Family NUCULANIDAE

Genus NUCULANA Link, 1807, *sensu lato*

Nuculana longifrons (Conrad)

Plate 15, figures 18, 19

1860. *Leda longifrons* Conrad, Acad. Nat. Sci. Phila. Jour., 2d ser., v. 4, p. 281, pl. 46, fig. 18.

(For synonymy through 1941, see Tex. Univ. Pub. 4101, 1941, p. 78.)

The species *Nuculana longifrons* (Conrad) is represented in the collections from southeastern Missouri by 3 specimens, 1 from the locality 0.35 mile northwest of Ardeola (USGS 16429) and 2 from the locality 1.4 miles west by slightly south of Ardeola (USGS 19090). Our collections contain well-preserved shells of the species from the Owl Creek formation in Mississippi, but apparently the individuals are not numerous.

The species is rather large for the genus. Shell thin, elongate, compressed, relatively high, smooth, inequilateral, equivalve; posterior slope somewhat flattened. Beak small, nonprominent, incurved, approximate, situated one-third the length of the shell from the anterior extremity. Anterior and posterior margins rounded narrower than a semicircle, the posterior one slightly truncated; dorsal and ventral margins nearly straight, subparallel. Hinge narrow with numerous fine teeth in two series, the posterior series longer than the anterior. Pallial sinus short, triangular. Inner margin smooth.

Dimensions of the figured internal mold of a right valve from Missouri (pl. 15, fig. 19): Length 16 mm, height 8.3 mm, convexity about 2 mm.

Types.—Holotype, Academy of Natural Sciences, Philadelphia. Plesiotype from the Owl Creek formation of southeastern Missouri, USGS 19090, USNM 128087; plesiotype from Owl Creek formation, Mississippi, USGS 707, USNM 128088.

Range.—The species has a long geologic range through the zones of *Exogyra ponderosa* and *E. costata*, and a geographic range throughout the length of the Atlantic and Gulf Coastal Plain of the United States.

Nuculana sp.

Poorly preserved internal molds of small shells of *Nuculana* Link were found at the locality 0.35 mile northwest of Ardeola (USGS 16429, USNM 128089),

and at the locality a mile northwest of Ardeola (USGS 16430, USNM 128090). At the locality 1.4 miles west by south of Ardeola (USGS 19090, USNM 128091), a small internal mold was found on which are the faint impressions of nonconcentric ribs that cross the concentric lines of growth obliquely; this probably pertains to an undescribed species.

Superfamily PARALLELODONTACEA

Family PARALLELODONTIDAE

Genus NEMODON Conrad, 1869

Nemodon eufaulensis (Gabb)

Plate 15, figures 8-12

1860. *Arca* (*Macrodon*) *eufaulensis* Gabb, Acad. Nat. Sci. Phila. Jour., 2d ser., v. 4, p. 398, pl. 68, fig. 39.
 1916. *Nemodon eufaulensis* (Gabb). Gardner, Md. Geol. Survey, Upper Cretaceous [Maryland], in W. B. Clark and others, p. 525, pl. 20, figs. 3, 4.
 1926. *Nemodon eufaulensis* (Gabb). Wade, U. S. Geol. Survey Prof. Paper 137, p. 42, pl. 8, figs. 17, 18.

This species is represented in the collections from southeastern Missouri by several internal molds and by one small external mold, from three localities (USGS 16430, 16452, 19090). The description is based mainly on complete shells from Owl Creek, Miss., and Eufaula, Ala. Shell small, elongate, moderately inflated, greatest inflation above midheight just below the beak, strongly inequilateral, equivalve. Umbonal ridge rounded; umbonal region broad; beaks nonprominent, incurved, approximate, prosogyrate, somewhat variable in position, ranging from 0.26 to 0.33 the length of the shell from the anterior extremity; a broad shallow depression extends radially from the beak to the ventral margin, centering slightly forward of midlength. Dorsal margin long, straight; anterior margin evenly rounded, meeting the hinge line at an approximate right angle; ventral margin long, nearly straight to broadly concave, subparallel to hinge line; posterior margin sharply rounded below, straight and inclined strongly forward above. Surface ornamented with numerous, closely spaced, flattened, nonprominent, radial ribs, those on the umbonal ridge and on the posterior and anterior slopes coarsest and showing a tendency to form pairs; concentric growth lines fine, sharply impressed.

Dimensions of a typical left valve from Eufaula, Ala.: Length 17 mm, height 7.8 mm, convexity about 2.5 mm. The shells may attain a length of 25 mm or more.

Hinge long, narrow, straight. Teeth long, narrow, nearly parallel to hinge line, all finely striated on both sides at right angles to hinge plate; three anterior teeth, the lowest one shortest; posterior teeth much longer, the middle one longest. Area amphidetic, long, narrow, smooth in front of beak and scored with 2 or 3 long,

narrow, oblique ligamental grooves back of beak. Adductor scars rather large, nearly flush with inner surface, pallial line entire; inner margin smooth; inner surface has weak radial lines.

Types.—Holotype, from Eufaula, Ala., Academy of Natural Sciences, Philadelphia. Two plesiotypes (=topotypes) from Eufaula, Ala., USNM 18830; 1 plesiotype from southeastern Missouri, USGS 19090, USNM 128092.

Range.—In the Gulf region the range of the species is through the Ripley and Owl Creek formations and beds of corresponding age (Maestrichtian). An apparently authentic specimen of the species is recorded by Gardner (1916, p. 525, pl. 20, figs. 3, 4) from the Monmouth formation of Maryland. Whitfield's (1885, p. 83, pl. 12, figs. 3-5), and Weller's (1907, p. 385, pl. 30, figs. 8-11) figured specimens from New Jersey, referred to this species, are internal molds that do not satisfactorily show specific characters; the one shown in Weller's figure 11 is from the Vincentown sand, which is now known to be of Eocene age; this specimen is probably not a *Nemodon*.

Superfamily GLYCYMERACEA

Family GLYCYMERIDAE

Genus GLYCYMERIS Da Costa, 1778

Glycymeris rotundata (Gabb)

Plate 15, figures 13-17

1860. *Axinaea rotundata* Gabb, Acad. Nat. Sci. Phila. Jour., 2d ser., v. 4, p. 396, pl. 68, fig. 33. (See Stephenson, 1941, p. 84.)

The species *Glycymeris rotundata* (Gabb) is represented in southeastern Missouri at three localities by internal molds (USGS 16429, 16451, 19090), only one of which is fairly well preserved (pl. 15, fig. 17). Two of the molds (USGS 19090) pertain to adult individuals. Beautifully preserved shells are present in the Ripley formation at the type locality at Eufaula, Ala., in the Owl Creek formation at Owl Creek, Miss., and at other localities in these formations in the Gulf region. The description is based on well-preserved shells from Eufaula, Ala., the type locality, and from Owl Creek, Miss. Several species of *Glycymeris* closely related to *G. rotundata* (Gabb) have been recorded from the Atlantic and Gulf Coastal Plain; some of them may prove to be identical with Gabb's species.

Shell of medium size, thick, moderately inflated, sub-circular in outline, nearly equilateral, equivalve. Some shells are faintly oblique in the posteroventral direction. Beaks nonprominent, direct, incurved, approximately central. Surface weakly ornamented with numerous flattish radiating ribs of different widths, narrowest on the anterior slope, widest on the posterior slope.

Dimensions of the adult right valve shown in plate 15, figures 13, 14: Length 44 mm, height 43.5 mm, convexity 18 mm. The small internal mold from Missouri (pl. 15, fig. 17) measures: Length 21.5 mm, height 20 mm, convexity, about 5 mm.

Cardinal area amphidetic, elongate triangular, with longest edge at top of hinge, bearing in adults 5 or 6 chevron-shaped, symmetrically divided ligamental grooves. Hinge plate strongly arched, transected above by the lower straight edge of the cardinal area. In adults 8 or 10 small, short, transverse teeth border the central part of the cardinal area; on either side of this central series are strong transverse, slightly angulated teeth, the anterior ones numbering 8 or 10 and the posterior ones 10 or 12. Adductor scars subtriangular, the anterior scar slightly the larger, both bordered on the inner side by a weak radiating carina. A small, elongate muscle scar, one under each end of the hinge plate, is a feature that appears to be common to all the species of *Glycymeris*. Pallial line simple. Inner margin strongly crenulated.

Types.—Holotype, from Eufaula, Ala., Academy of Natural Sciences, Philadelphia. Plesiotypes from Owl Creek, Miss. USGS 707, USNM 128093, and USGS 594, USNM 21681. Plesiotypes from Missouri, USGS 16429, USNM 128094; and USGS 19090, USNM 128095.

Range.—The species ranges at least through the Ripley and Owl Creek formations (Maestrichtian) and beds of corresponding age in the Gulf Coastal Plain.

Family NOETIDAE

Genus BREVIARCA Conrad, 1872

Breviarca? sp.

One small internal mold (USGS 16452) appears to have the form of *Breviarca* Conrad, but the hinge is not preserved and the identification is questioned. Shell strongly convex, beak prominent, dorsal slopes steep. Dimensions: Length 9 mm, height 6.8 mm, convexity about 3.5 mm. USNM 128096.

Family CUCULLAEIDAE

Genus IDONEARCA Conrad, 1862

Idonearca capax (Conrad)

Plate 15, figures 20–26

1858. *Cucullaea capax* Conrad, Acad. Nat. Sci. Phila. Jour., 2d ser., v. 3, p. 328, pl. 35, fig. 2.
1858. *Cucullaea tippiana* Conrad, Acad. Nat. Sci. Phila. Jour., 2d ser., v. 3, p. 328, pl. 35, fig. 1. [Younger stage of *C. capax* Conrad.]
1862. *Idonearca capax* (Conrad). Conrad, Acad. Nat. Sci. Phila. Proc., v. 14, p. 289.
1872. *Idonearca capax* (Conrad). Conrad, Acad. Nat. Sci. Phila. Proc., v. 24, p. 54, pl. 2, fig. 2.
- ?1876. *Idonearca alabamensis* Gabb, Acad. Nat. Sci. Phila. Proc., v. 28, p. 315.
1898. *Idonearca tippiana* Conrad. Dall, Wagner Free Inst. Sci. Phila. Trans., v. 3, pt. 3, p. 603. (Designated genotype of *Idonearca* Conrad.)
1916. *Cucullaea vulgaris* Morton. Gardner, Md. Geol. Survey, Upper Cretaceous [Maryland], in W. B. Clark and others, p. 529, pl. 20, figs. 8, 9; pl. 21, figs. 1, 2.

1930. *Cucullaea (Idonearca) tippiana* (Conrad). Stewart, Acad. Nat. Sci. Phila. Spec. Pub. no. 3, p. 74.
1940. *Idonearca capax* (Conrad). Stephenson and Monroe, Miss. State Geol. Survey Bull. 40, p. 280, pl. 10, figs. 6, 7. (Illustrations only.)
1941. *Idonearca capax* (Conrad). Stephenson, Tex. Univ. Pub. 4101, p. 92, pl. 11, figs. 1–4; pl. 12, fig. 3.
1950. *Cucullaea (Idonearca) capax* Conrad. Nicol, Jour. Paleontology, v. 24, no. 1, p. 93, pl. 21, fig. 9.
1954. *Idonearca* Conrad. Nicol, Jour. Paleontology, v. 28, no. 1, p. 97. Mentions *Cucullaea tippiana* Conrad (emended by Stephenson, *C. capax* Conrad) as genotype of *Idonearca*, designated by Dall, 1898.

The synonymy given by Stephenson (1941, p. 92) is not as complete as it should have been, for which reason a more complete synonymy is given here.

Emphasis is given to the fact that *Cucullaea tippiana* Conrad is a young stage of *C. capax* Conrad, and not an independent species. The two names were introduced by Conrad (1858, p. 328) on the same page. His description of *C. capax* pertains to an adult form of the species, and appears ahead of that of *C. tippiana* on the page. *Cucullaea capax* is therefore the name that should have been used by Dall (1898, p. 603) when he designated the genotype of *Idonearca*.

Internal and external molds show the unmistakable presence of *Idonearca capax* (Conrad) at three localities in the Owl Creek formation of southeastern Missouri (USGS 16451, 16452, 19090). The available material includes early, medial, and adult stages of growth.

The species has been described in considerable detail in a former treatise (Stephenson, 1941, p. 92, pl. 11, figs. 1–4; pl. 12, fig. 3) and need not be redescribed here. One feature not mentioned in that description is a narrow, low sharp ridge midway of the posterodorsal slope of the right valve, extending from the beak to the middle of the posterodorsal margin; this ridge is not matched by a corresponding ridge in the left valve (pl. 15, fig. 21).

Gardner (1916, p. 529, pl. 20, figs. 8, 9; pl. 21, figs. 1, 2) used specimens from Owl Creek, Miss. to illustrate her species *Cucullaea vulgaris* Morton. Shells from the Monmouth formation in the National Museum collections are very closely related to *Idonearca capax* Conrad, and may be identical but they are badly crushed and cannot be satisfactorily identified.

Types.—Holotype, Academy of Natural Sciences, Philadelphia. One plesiotype (= topotype) from Owl Creek, Miss. (Stephenson, 1941, pl. 11, figs. 3, 4, USGS 707, USNM 76356). Two plesiotypes (= topotypes) from the same source, USGS 707, USNM 128097; 1 is the rubber internal mold of an adult topotype. Two plesiotypes from southeastern Missouri, USGS 19090, USNM 128098.

Range.—*Idonearca capax* is common in the Owl Creek formation of southeastern Missouri and northern Mississippi, and in the Prairie Bluff chalk of Mississippi and Alabama. The occurrence of the species in formations older than the Owl Creek has not been satisfactorily confirmed.

Superfamily PTERIACEA

Family PINNIDAE

Genus PINNA Linné, 1758

Pinna laqueata Conrad

Plate 16, figures 10–12

1858. *Pinna laqueata* Conrad, Acad. Nat. Sci. Phila. Jour., 2d ser., v. 3, p. 328.

Conrad based this species on a fragment from Owl Creek, Tippah County, Miss. His description is very brief and without an illustration. The specimen is probably lost as it is not listed by Johnson (1905) as preserved in the collection of the Academy of Natural Sciences of Philadelphia. Although there can be no proof that the large shells from Owl Creek here figured (pl. 16, figs. 10, 11) are specifically identical with the fragment recorded by Conrad there would seem to be a reasonable assumption that they belong to the same species. Conrad described the species as follows: "A fragment—ventricose, with eleven prominent, slender ribs; interstices concave."

One fragment from the Owl Creek formation of Missouri is referred to *Pinna laqueata* Conrad (USGS 16452). It represents a part of the small end of the shell and includes an internal and an external mold. The latter bears nine nearly straight, narrow longitudinal ribs, separated by wider interspaces, on the upper part, with several ribs of irregular trend on the lower slope. The internal mold appears to expand rather rapidly. The ribbing on this specimen (pl. 16, fig. 12) may be compared with that on the specimen from Owl Creek, Miss., shown in plate 16, figure 11, which is believed to be a topotype.

The large shell from Owl Creek (USGS 707) is thin, elongate, pointed anteriorly, expanding posteriorly, moderately inflated, subcircular in cross section at the small end, becoming quadrate to diamond shaped in the medial part, and becoming compressed with long axis vertical, toward the posterior end. The upper surface from a little below the middle to the dorsal margin bears nine nearly straight, narrow, round-crested ribs with shallow, broad, concave interspaces; these ribs diverge slightly and increase gradually in strength front to rear; the lower slope of the shell bears a series of ribs of somewhat irregular trend and cross section, but all bend upward slightly as they pass from front to rear. The beak is terminal at the front. Faint curved lines on the upper slope back of the midlength mark

the position of the abductor muscle attachment. Other topotypes in the National Museum collection show that the number of straight ribs on the upper surface may range from 9 to 11. The ligamental groove is not observable but it must be paper thin and probably is about one-third the length of the shell.

Dimensions of the figured topotype: Length 225+ mm, height about 82 mm, maximum thickness 27 mm; the actual length is somewhat greater than indicated, as neither the anterior nor the posterior end is complete.

The shells from the Merchantville clay and from the Woodbury clay, New Jersey, referred by Whitfield (1885, p. 81) and by Weller (1907, p. 419) to *Pinna laqueata* Conrad, although closely related, lack irregular, coarse ribbing on the lower slope of the shell as shown on the illustrations, and should probably be regarded as specifically distinct. The same may be said of the fragment described by Gardner (1916, p. 545) from the Matawan formation, Delaware; some of the straight ribs on this specimen bear fine tubercles, in contrast to the corresponding smooth ribs on *P. laqueata*.

Types.—Holotype, whereabouts unknown. Topotype from Owl Creek, Miss., USGS 707, USNM 128100; topotype from Owl Creek (USGS 707, USNM 128099); plesiotype from the Owl Creek formation of Missouri, USGS 16452, USNM 128101.

Range.—So far as is known from satisfactorily identified specimens the species is restricted to the Owl Creek formation of the Gulf Embayment area.

Superfamily PTERIACEA

Family PTERIIDAE

Genus TENUIPTERIA Stephenson, n. gen.

Type species: *Inoceramus argenteus* Conrad.

Etymology.—Latin *tenuis*, thin; genus *Pteria*.

The species here made the type of the new genus *Tenuipteria* has been referred heretofore to the genus *Inoceramus* Sowerby. However, the series of pits on the ligamental area lacks the uniformity in size and spacing that characterizes Sowerby's genus. Instead the narrow ligamental area of *Tenuipteria* bears three or more pits of unequal size and spacing, some of them more or less elongated. The beaks are nearly terminal. The right valve possesses a small *Pteria*-like ear, and the left valve has a still smaller anterior earlike extension. The shell is nacreous, thin, of medium size, strongly inequilateral, strongly inequivalve, the left valve much more convex than the right. Both valves are ornamented with numerous radiating ribs, those on the left valve being weak and tending to fade out on the anterodorsal, posterodorsal and ventral slopes; the ribs on the right valve are moderately strong on the main part of the shell, but fade out and disappear on the posterodorsal slope and become very weak on the anterodorsal slope.

Tenuipteria argentea (Conrad)

Plate 16, figures 4-9

1858. *Inoceramus argenteus* Conrad, Acad. Nat. Sci. Phila. Jour., 2d ser., v. 3, p. 329, pl. 34, fig. 16.
 1858. *Inoceramus costellatus* Conrad, Acad. Nat. Sci. Phila. Jour., 2d ser., v. 3, p. 329, pl. 34, fig. 12.
 1940. *Inoceramus argenteus* Conrad. Stephenson and Monroe, Miss. State Geol. Survey Bull. 40, p. 280, pl. 10, figs. 8, 9. (Illustrations only.)

The species *Tenuipteria argentea* (Conrad) is represented by meager poorly preserved material from three localities in southeastern Missouri (USGS 16451, 16452, and 19090). However, the specimens, such as they are, possess sufficient characteristic features to permit positive identification. The description is based mainly on well-preserved topotypes from Owl Creek, Miss.

Shell of medium size, thin, nacreous, strongly inequilateral, strongly inequivalve, the left valve being much more convex and higher than the right. The beaks are nearly terminal and are slightly prosogyrate. The left valve is plumply convex anteriorly and rounds broadly to the ventral and posterior margins; the right is only moderately inflated in the umbonal region. The right valve has a small anterior *Pteria*-like ear and well-preserved shells show a small anterior ear on the left valve. The main flank of the right valve is ornamented with relatively coarse, subdued, round-crested, radiating ribs, coarsest centrally, becoming weaker in both directions, passing into a noncostate area on the posterodorsal slope and into a weakly costate anterodorsal slope; the right valve has fairly regular, subdued concentric ribbing that produces a cancellated appearance. The left valve bears very weak, much subdued radiating ribs on its main flank, and these ribs become weaker and fade out on the dorsal slopes; narrow subdued concentric lining marks this valve.

Approximate dimensions of the right valve shown in plate 16, figure 4: Length 40 mm, height 37 mm, convexity 4 mm. The convexity of a left valve of comparable length may be as much as 14 mm.

The ligamental area is long and narrow and bears from 3 to 6 shallow ligamental pits of irregular length and spacing and differing markedly in both length and spacing on different individuals.

Types.—The holotype should be in the collection of the Academy of Natural Sciences, Philadelphia, but it is not listed among the Cretaceous types now preserved in that institution; presumably it is lost. Two topotypes from Owl Creek, Miss., USGS 707, USNM 128104; 1 topotype from the same source, USGS 6464, USNM 128102. Three plesiotypes from southeastern Missouri, USGS 16451, USNM 128105; USGS 16452, USNM 128106; USGS 19090, USNM 128103.

Range.—So far as at present known this species is restricted in its stratigraphic range to the Owl Creek and Prairie Bluff formations of northern Mississippi and to the Owl Creek forma-

tion of southeastern Missouri. Geographically the species must have ranged at least from Mississippi to the head of the Gulf Embayment in Missouri.

Superfamily OSTRACEA**Family OSTREIDAE****Genus OSTREA Linné, 1758*****Ostrea tecticosta* Gabb**

Plate 16, figures 13, 14

1860. *Ostrea tecticosta* Gabb, Acad. Nat. Sci. Phila. Jour., 2d ser., v. 4, p. 403, pl. 68, figs. 47, 48. (For synonymy through 1941, see Tex. Univ. Pub. 4104, 1941, p. 107.)

The species *Ostrea tecticosta* Gabb is represented in the Owl Creek formation of southeastern Missouri (USGS 19090) by several rather poorly preserved internal molds on which the surface sculpture is weakly impressed. It is a small, simple oyster, the left valve of which is costate and the right valve noncostate. The species has been well described in several treatises (see synonymy) and its description will not be repeated in detail here.

Types.—Holotype, Academy of Natural Sciences of Philadelphia. Plesiotypes from southeastern Missouri, USGS 19090, USNM 128107.

Range.—The species ranges throughout the Atlantic and Gulf Coastal Plain, stratigraphically from the *Exogyra ponderosa* zone, where it is rather rare, upward through the *E. costata* zone, where it is common. This species is common in the Owl Creek and Prairie Bluff formations of Mississippi.

Genus EXOGYRA Say, 1820***Exogyra costata* Say**

Plate 16, figure 18

1820. *Exogyra costata* Say, Am. Jour. Sci., 1st ser., v. 2, p. 43. (For synonymy through 1941, see Tex. Univ. Pub. 4101, 1941, p. 122.)

Add:

1940. *Exogyra costata* Say. Stephenson and Monroe, Miss. State Geol. Survey Bull. 40, p. 274, pl. 7; p. 282, pl. 11, fig. 1. (Illustrations only.)

Exogyra costata Say in the Owl Creek formation of southeastern Missouri is indicated by the imprints of two juvenile individuals, one represented by an internal and an external mold and the other by an internal mold (USGS 16452). Both reveal the characteristic costae of the species. Well-preserved shells are common in the Owl Creek formation of Mississippi (Stephenson and Monroe, 1940, p. 282, pl. 11, fig. 1). The species has been adequately described in the papers listed in the synonymy cited above.

Types.—The whereabouts of Say's original type material is unknown. The first illustrations of the species were those of Morton (1829, p. 85, pl. 6, figs. 1-4). Morton's material is not listed as preserved in the Academy of Natural Sciences, Philadelphia, and is presumably lost. Shells that have been generally accepted as belonging to this species have been described

and illustrated in many papers. One plesiotype from southeastern Missouri, USGS 16452, USNM 128108.

Range.—*Exogyra costata* Say is a major zone marker in the Atlantic and Gulf Coastal Plain, ranging through beds considered to be approximately synchronous with the Maestrichtian of Europe, but possibly including the upper part of the Campanian.

Superfamily TRIGONIACEA

Family TRIGONIIDAE

Genus TRIGONIA Bruguière, 1789

Trigonia angulicostata Gabb

Plate 16, figures 1-3

1876. *Trigonia angulicostata* Gabb, Acad. Nat. Sci. Phila. Proc. for 1876, p. 312.
 1926. *Trigonia angulicostata* Gabb. Stephenson, Ala. Geol. Survey Spec. Rep. no. 14, p. 248, pl. 91, fig. 2. (Illustration only.)
 1940. *Trigonia angulicostata* Gabb. Stephenson and Monroe, Miss. State Geol. Survey Bull. 40, p. 280, pl. 10, fig. 10. (Illustration only.)

Imprints of *Trigonia angulicostata* Gabb, both external and internal molds, are common in the Owl Creek formation of southeastern Missouri. Most of them are incompletely preserved, but the characteristic angulation of the radiating ribs appear on some imprints (USGS 16429, 16430, 16451). Well-preserved shells showing the angulation of the ribs are present in the Owl Creek formation of Mississippi.

Shell small, moderately compressed, most inflated anteriorly, thinning wedgelike posteriorly, markedly inequilateral, equivalve; posterodorsal area flattish and separated into two narrow, parallel bands; the inner band is slightly excavated and borders the margin; the outer band forms a narrow, flattened, curved strip that slopes obliquely outward; a low obtusely angular ridge separates the two flattened bands, and a similar ridge separates the outer flattened band from the main lateral surface. Beaks nonprominent, incurved, opisthogyrate, situated about 0.2 the length from the anterior end. The main surface is ornamented with narrow, nodose ribs, separated by much wider, concave interspaces. These ribs, though roughly concentric with respect to the beak, are developed independently of the true concentric growth lines, which cross them obliquely. In the umbonal region the ribs extend from the outer angulation of the posterodorsal area in a broad curve down to the anterior margin; typically obliquely downward and rearward away from the beak a subobtuse angulation in the trend of the ribs appears and farther from the beak the successive ribs become more sharply angulated, attaining first a right angle, and eventually an acute angle toward the margin of the shell (pl. 16, fig. 1); beyond the last angulation the posterior ribs are shorter, weaker, and have only a slight curvature as they pass from the outer angulation above to the margin

below. The degree of angulation in the trend of the lateral ribs differs markedly on different individuals, and on an occasional shell the ribs pass in a regular curve to the lower margin without the angulation.

At the outer edge of the outer posterodorsal band each of the lateral ribs turns and extends as a weakly noded ridge obliquely forward across the band to the central ridge of the posterodorsal slope, thence turns and crosses the inner band transversely to the dorsal shell margin. The hinge and inner features of the shell are typical of the *Trigonia scabra* group of France (Upper Cretaceous), and need not be described here. (See Stephenson, 1941, p. 126.)

Dimensions of the shell shown in plate 16, figure 1: Length 25 mm, height 19 mm, convexity 6 mm.

Types.—Holotype (never figured), from Eufaula, Ala., Academy of Natural Sciences, Philadelphia. Two plesiotypes from Owl Creek formation, southeastern Missouri, USGS 16429, USNM 128109; plesiotype from Owl Creek, Miss., USGS 707, USNM 128110.

Range.—The species is known only from the Owl Creek formation and beds of Owl Creek age in the eastern Gulf region as far east as the Chattahoochee River, Georgia-Alabama.

Trigonia eufaulensis Gabb

Plate 16, figures 15-17

1860. *Trigonia eufaulensis* Gabb, Acad. Nat. Sci. Phila. Jour., 2d ser., v. 4, p. 396, pl. 68, fig. 32.
 1885. *Trigonia eufaulensis* Gabb. Whitfield, U. S. Geol. Survey Mon. 9, p. 113, pl. 14, figs. 1, 2, 4 (not fig. 3). (Also issued as N. J. Geol. Survey, Paleontology ser., v. 1.)
 1907. *Trigonia eufaulensis* Gabb. Weller, N. J. Geol. Survey, Paleontology ser., v. 4, p. 462, pl. 48, figs. 5-10.
 ?1916. *Trigonia eufaulensis* Gabb. Gardner, Md. Geol. Survey, Upper Cretaceous [Maryland], in W. B. Clark and others, p. 582, pl. 34, figs. 1, 2.
 1923. *Trigonia eufaulensis* Gabb. Stephenson, N. C. Geol. and Econ. Survey, v. 5, p. 189, pl. 54, figs. 1-4, (?5, 6).
 ?1926. *Trigonia eufaulensis* Gabb. Wade, U. S. Geol. Survey Prof. Paper 137, p. 61, pl. 20, figs. 3, 4.

Among the imprints of *Trigonia* from the Owl Creek localities in southeastern Missouri (USGS 16430?, 16452, 19090) are several incomplete internal and external molds that differ in detail of sculpture from *Trigonia angulicostata* Gabb, and appear to be referable to *T. eufaulensis* Gabb. The ribs are fewer and more widely spaced than in *T. angulicostata*, and they lack the characteristic angulation in the trend of the larger ribs of that species. *T. eufaulensis* appears to be less common in the Owl Creek formation than *T. angulicostata*.

Types.—Holotype, Academy of Natural Sciences, Philadelphia, from Eufaula, Ala. One topotype from Eufaula, Ala., USGS 854, USNM 128112; 2 plesiotypes from the Owl Creek formation of southeastern Missouri, USGS 19090, USNM 128111.

Range.—As identified and recorded this species ranges through the zones of *Exogyra ponderosa* and *E. costata* (Campanian through Maestrichtian) in the Atlantic and Gulf Coastal Plain.

Superfamily PECTINACEA

Family PECTINIDAE

Genus PECTEN Mueller, 1776

Subgenus CAMPTONECTES (Agassiz MS) Meek, 1864

Pecten (Camptonectes) *bubonis* Stephenson

Plate 17, figures 1-4

1916. *Pecten argillensis* Conrad. Gardner, Md. Geol. Survey, Upper Cretaceous [Maryland], in W. B. Clark and others, p. 588, pl. 34, figs. 3-5.

1941. *Pecten* (Camptonectes) *bubonis* Stephenson, Tex. Univ. Pub. 4101, p. 131, pl. 21, figs. 3-6.

Fragmentary imprints from the Owl Creek formation at three localities in southeastern Missouri (USGS 16429, 16451, 19090) are referred to *Pecten* (Camptonectes) *bubonis* Stephenson. The characteristic flat, curved, radiating costae of the species are clearly portrayed on the external molds and are less clearly impressed on the internal molds. A detailed description of the species is given in Texas University Publication 4101 cited above.

Types.—Holotype, from Owl Creek, Tippah County, Miss., USGS 707, USNM 76432; one paratype from the same locality, USNM 76433. Two plesiotypes from southeastern Missouri, USGS 19090, USNM 128114. Two Plesiotypes from the Owl Creek formation, Mississippi, USGS 707, USNM 128113.

Range.—In the eastern Gulf region the species is recorded from the Owl Creek formation of southeastern Missouri and northern Mississippi, and from the marine facies of the Providence sand (Owl Creek age) of Alabama and Georgia. In Texas the species is recorded from the upper part of the Navarro group in the Corsicana marl, the Kemp clay, and questionably in the Escondido formation. The species described by Gardner (1916, p. 588) as *Pecten argillensis* Conrad is questionably referable to this species.

As at present known the species is restricted to beds of late Maestrichtian age. However, closely related species occur in earlier Upper Cretaceous formations in the Coastal Plain.

Pecten (Camptonectes) *hilgardi* Stephenson?

Plate 17, figure 5

1923. *Pecten hilgardi* Stephenson, N. C. Geol. and Econ. Survey, v. 5, p. 206, pl. 57, figs. 6, 7.

This species is questionably present in the collection from one locality in the Owl Creek formation of southeastern Missouri (USGS 16430). The material includes the external and internal molds of one individual and fragments of two external molds, all representing young stages of growth.

In form and radial ornamentation the species resembles that of *Pecten* (Camptonectes) *bubonis* Stephenson. The concentric sculpture is, however, much coarser; it consists of relatively prominent lamellae

spaced in this young stage 1 millimeter or less apart; these lamellae curl downward touching the surface below, thus forming hollow round-crested ridges. In the holotype from Mississippi, a much larger shell, the spacing of the concentric lamellae reaches a maximum of 3 millimeters near the outer margin. A detailed description of the species is given by Stephenson (1923, p. 206).

Types.—Holotype, from the lower part of the Ripley formation, Pontotoc County, Miss., USGS 6471, USNM 31669. Figured specimen from the Owl Creek formation, southeastern Missouri, USGS 16430, USNM 128115.

Range.—The species range appears to be through the *Exogyra costata* zone in the Atlantic and Gulf Coastal Plain. It has been recorded from the Ripley formation of Mississippi and the Peedee formation of North Carolina, and is here recorded from the Owl Creek formation of southeastern Missouri.

Subgenus SYNCYCLONEMA Meek, 1864

Pecten (Syncyclonema?) *simplicius* Conrad

Plate 17, figure 6

1860. *Pecten simplicius* Conrad, Acad. Nat. Sci. Phila. Jour., 2d ser., v. 4, p. 283, pl. 46, fig. 44. (For synonymy through 1941 see Tex. Univ. Pub. 4101, 1941, p. 133.)

Pecten simplicius Conrad, a small, simple smooth species, has been adequately described in several papers. Its presence in the Owl Creek formation in Missouri (USGS 16430, 18452, 19090) is indicated by several internal molds and one external mold. Beautifully preserved shells of the species are numerous in the Owl Creek formation at Owl Creek, Tippah County, Miss.

Types.—The type material is not listed as preserved in the collection of the Academy of Natural Sciences of Philadelphia and is probably lost. Eufaula, Ala., and Tippah County, Miss., are given as the known localities at the time of the original description. Plesiotype from southeastern Missouri, USGS 16452, USNM 128116.

Range.—As recorded the species ranges through the zones of *Exogyra ponderosa* and *E. costata* in the Atlantic and Gulf Coastal Plain (Campanian through the Maestrichtian), and is abundant in some beds.

Family LIMIDAE

Genus LIMA Bruguière, 1797

Lima acutilineata (Conrad)

Plate 17, figures 19-21

1858. *Ctenoides acutilineata* Conrad, Acad. Nat. Sci. Phila. Jour., 2d ser., v. 3, p. 329, pl. 34, fig. 2.

1923. *Lima acutilineata* (Conrad). Stephenson, N. C. Geol. and Econ. Survey, v. 5, p. 215, pl. 58, figs. 4-9.

1928. *Lima acutilineata* (Conrad). Adkins, Tex. Univ. Bull. 2838, p. 133.

Imprints of the shells of *Lima acutilineata* (Conrad) are fairly common in the Owl Creek formation in southeastern Missouri (USGS 16429+16452, 19090). Well-preserved shells are present in the Owl Creek formation at the type locality in Tippah County. A description

and good illustrations of shells from Owl Creek are given by Stephenson (1923, p. 215, pl. 58, figs. 4-7). The shell is elongated obliquely rearward and downward and is only moderately inflated. The ventral and posterodorsal margins are approximately parallel. Sharp, narrow finely tuberculated costae are present over all the surface except the posterodorsal slope. The wider flattish interspaces bear numerous fine radiating lines. For further details see the reference cited above.

Dimensions of right valve shown in plate 17, figure 19: Length 21 mm, height 18 mm, convexity about 5 mm.

A varietal form of the species, *Lima acutilineata texana* Stephenson (1941, p. 145, pl. 23, figs. 1, 2) is recorded from the Corsicana marl (Maestrichtian) of Texas.

Types.—The holotype, which came from the Owl Creek formation on Owl Creek, Tippah, County, Miss., is apparently lost. Four plesiotypes (=topotypes) from Owl Creek were figured by Stephenson (1923, pl. 58, figs. 4-7) and one of them (fig. 5) is refigured here on plate 17, figure 19, USGS 707, USNM 128117. Three plesiotypes from southeastern Missouri, USGS 16451, USNM 128118; USGS 16452, USNM 128119.

Range.—Upper part of *Exogyra costata* zone (Maestrichtian) in the Atlantic and Gulf Coastal Plain.

Superfamily **MYTILACEA**

Family **MYTILIDAE**

Genus **CRENELLA** Brown, 1827

Crenella serica Conrad

Plate 17, figures 11, 12

1860. *Crenella* (*Stalagmium*) *serica* Conrad, Acad. Nat. Sci. Phila. Jour., 2d ser., v. 4, p. 281, pl. 46, fig. 23. (For synonymy through 1941 see Tex. Univ. Pub. 4101, 1941, p. 153.)

This small bivalve mollusk is represented in the Owl Creek formation of southeastern Missouri at one locality (USGS 16429) by one internal and one external mold, both incomplete and too poorly preserved for illustration. Descriptions and illustrations are given by Stephenson (1923, p. 241, pl. 62, figs. 1, 2; 1941, p. 153, pl. 25, figs. 13-15). The adult shell is less than 5 mm long and under 6 mm high. It is equivalve, plumply inflated and is delicately reticulated with fine radiating ribs crossed by evenly spaced fine concentric ridges. The hinge is edentulous. Although the type is not available the species is distinctive in form and ornamentation and no one has questioned the correctness of its identification as heretofore recorded.

Types.—The present whereabouts of the holotype, which was recorded by Conrad as in the "Tuomey collection," is not known and is assumed to be lost. It came from the Cretaceous at Eufaula, Ala. A topotype from Eufaula is figured, USGS 854, USNM 128120. Two examples from southeastern Missouri, USGS 16429, USNM 128121.

Range.—With one possible exception the species as recorded is restricted in stratigraphic range to the *Exogyra costata* zone in the Atlantic and Gulf Coastal Plain. Weller (1907, p. 510, pl. 56, figs. 7, 8) records it in the Marshalltown formation (upper part of *E. ponderosa* zone) in New Jersey, but his illustrations do not show the surface ornamentation in sufficient detail to permit critical comparison with authentic examples of the species.

Crenella microstriata Stephenson, n. sp.

Plate 17, figures 7-10

?1916. *Crenella elegantula* Meek and Hayden. Gardner, Md. Geol. Survey, Upper Cretaceous [Maryland], in W. B. Clark and others, p. 625, pl. 36, fig. 19.

Internal molds of *Crenella microstriata*, n. sp., with radiating sculpture obscurely impressed upon them are present in the Owl Creek formation at two localities in Stoddard County (USGS 16451, 16452) and at one locality in Scott County (USGS 16597). Well-preserved shells occur in the Owl Creek formation at Owl Creek, Tippah County, Miss., one of which is selected as holotype of the species.

Shell large for the genus, thin, inflated, subovate in outline, higher than long, slightly inequilateral, equi-valve, with steep dorsal slopes. Lunule and escutcheon wanting. Beaks prominent, incurved, prosogyrate, approximate, nearly central. Dorsal margin arched, anterior margin broadly rounded, ventral margin sharply rounded, posterior margin broadly rounded, becoming subtruncated in adults. Surface ornamented evenly all over with very fine radiating ribs numbering 6 to 8 to the millimeter near the ventral margin of adults; these are crossed by very fine concentric lines, thus producing a delicately reticulated surface. Hinge very thin, edentulous. A narrow slit extends from the tip of the beak rearward and obliquely inward to the inner dorsal margin. Inner margin finely crenulated, the crenulations corresponding to the ends of the ribs and interspaces.

Dimensions of the holotype: Length 10 mm, height 12.7 mm, convexity about 4 mm. A large paratype from Owl Creek, Miss., measures: Length 13 mm, height 16.3 mm, convexity 7 mm.

In size and form *Crenella microstriata* is very similar to *C. elegantula* Meek and Hayden from the Fox Hills sandstone, Wyoming, but the ribbing of the latter is consistently coarser, having only 5 or 6 ribs to the millimeter near the ventral margin. The specimen from the Monmouth formation (Upper Cretaceous) of Maryland, referred by Gardner (1916, p. 625, pl. 36, fig. 19) to *C. elegantula*, possesses finely radiating striae similar to, but apparently a little coarser than, those on the shell of *C. microstriata*. Specimens from the Tinton sand member of the Red Bank sand (Upper Cretaceous) of New Jersey, referred by Weller (1907, p. 511, pl. 56,

fig. 6) to *C. elegantula*, are similar in size and form to *C. microstriata*, but the illustration accompanying his description fails to show the pattern of the striae.

Type.—Holotype, from the Owl Creek formation, Owl Creek, Tippah County, Miss., USGS 707, USNM 128123; 2 unfigured paratypes from the same source, USGS 75, USNM 20617; 1 figured paratype from southeastern Missouri, USGS 16451, USNM 128126; 6 unfigured paratypes from Missouri, USGS 16452, USNM 128124; 1 unfigured paratype from Missouri, USGS 16597, USNM 128125.

Range.—Owl Creek formation (Maestrichtian) in Mississippi and Missouri.

Cuneolus tippanus (Conrad)

Plate 17, figures 13, 14

1858. *Dreissena tippana* Conrad, Acad. Nat. Sci. Phila. Jour., 2d ser., v. 3, p. 328, pl. 34, fig. 14.
(For synonymy and description see Tex. Univ. Pub. 4101, 1941, p. 157, pl. 25, figs. 20–26.)

The incomplete internal and external molds of one individual are present in one collection from the Owl Creek formation of southeastern Missouri (USGS 19090). The description cited is based on well-preserved shells from the type locality on Owl Creek, Tippah County, Miss. The original type material is not listed as present in the collection of the Academy of Natural Sciences, Philadelphia, and is believed to be lost. The shell is of moderate size, inflated, falcate, mytiliform, smooth. It is a simple, easily recognized shell and the material available for comparison does not seem to afford a basis for the recognition of more than one species of the genus.

Types.—Whereabouts of holotype unknown, probably lost. Neotype (designated by Stephenson, 1941, p. 158) from Owl Creek, Tippah County, Miss., USGS 6464, USNM 76499. Mentioned example from Owl Creek formation of southeastern Missouri, USGS 19090, USNM 128127.

Range.—The recorded range of the species is through the zone of *Exogyra costata* (Maestrichtian) in the Atlantic and Gulf Coastal Plain.

Order ANOMALODESMACEA

Superfamily PANDORACEA

The superfamily name Pandoracea was proposed by Stewart (1930, p. 26, footnote), who finds that the name *Anatina* Schumacher as a generic name for the group, typified by *Solen anatinus* Linné, is invalid. He considers *Pandora* Bruguière an appropriate genus to typify the superfamily.

Family PHOLADOMYACIDAE

Genus PHOLADOMYA Sowerby, 1823

***Pholadomya tippana* Conrad**

Plate 18, figures 8–13

1858. *Pholadomya tippana* Conrad, Acad. Nat. Sci. Phila. Jour., 2d ser., v. 3, p. 324, pl. 34, fig. 9.
1860. *Pholadomya occidentalis* Morton. Conrad, Acad. Nat. Sci. Phila. Jour., 2d ser., v. 4, p. 276.

1860. *Pholadomya occidentalis* Morton. Owen, Geol. Recon. Ark. 2d Rept., pl. 8, fig. 9. (No text.)

1916. *Pholadomya conradi* Gardner, Md. Geol. Survey, Upper Cretaceous [Maryland], in W. B. Clark and others, p. 632, pl. 38, fig. 1.

1940. *Pholadomya tippana* Conrad. Stephenson and Monroe, Miss. State Geol. Survey Bull. 40, p. 282, pl. 11, figs. 2, 3. (Illustrations only.)

The specimen of *Pholadomya tippana* from the Owl Creek formation at Owl Creek, Tippah County, Miss., originally figured by Conrad (1858, p. 324, pl. 34, fig. 9) was small and incomplete. It is not listed in the collection of the Academy of Natural Sciences and is presumed to be lost. A dozen or more specimens, most of them larger and more completely preserved, are in a collection from the Owl Creek locality, made by T. W. Stanton in 1889. Conrad's original figure, though poor, is adequate for the satisfactory identification of the specimens subsequently obtained from the type locality. Gardner in her description of *Pholadomya conradi* cited Tippah County, Miss., as the type locality, but her one illustrated specimen was obtained from a locality in the marine facies of the Providence sand (upper Maestrichtian), 1.5 miles north of Fort Deposit, Lowndes County, Ala.; this figured specimen appears to be identical with Conrad's species.

One fragmentary young shell referred by Wade (1926, p. 73, pl. 24, fig. 1) to *Pholadomya conradi* Gardner appears to have nonprominent beaks, and is probably not that species.

The available topotypes consist of internal molds with the radial sculpture sharply impressed upon them, and irregular patches of the thin shell adhere over parts of their surfaces. Shell large, very thin, elongate, inflated anteriorly, thinning wedgelike posteriorly, gaping widely at the rear, markedly inequilateral, equivalve. Beaks very prominent, incurved, nearly direct, approximate, situated about 0.18 the length of the shell from the anterior extremity. Anterior margin rounding regularly from the beaks to the very broadly rounded ventral margin, posterior margin rounded narrower than a semicircle, dorsal margin back of the beaks straight. Lunule and escutcheon wanting. Surface ornamental with numerous (25 to 28) narrow more or less irregularly spaced radiating costae, the widest spacing being on the posterodorsal and anterior slopes; regular weak nodding is present on the ribs in the umbonal region; toward the margins the nodes become irregular in strength, producing a roughened crest on each rib. Hinge and internal features not uncovered.

Dimensions of the medium-sized topotype shown in plate 18, figure 8: Length 79 mm, height 64 mm, thickness about 43 mm. Dimensions of the internal mold

from southeastern Missouri shown in plate 18, figure 13: Length about 91 mm, height about 72 mm, thickness 51 mm.

Types.—Whereabouts of holotype unknown. Two topotypes figured, USGS 707, USNM 128128; 11 unfigured topotypes, USGS 707, USNM 20716. One plesiotype from Stoddard County, Mo., USGS 16454, USNM 128129; 1 plesiotype from Scott County, Mo., USGS 16453, USNM 128130.

Range.—Available data indicate that the range of this species is restricted to the Owl Creek formation, the Providence sand, and to corresponding beds deposited late in Cretaceous time. However, closely related species occur in the Ripley formation beneath the Owl Creek formation, and in corresponding beds of Ripley age.

Family **LATERNULIDAE**

Genus **ANATIMYA** Conrad, 1860

Anatimya anteradiata (Conrad)

Plate 17, figures 15–17

1860. *Pholadomya* (*Anatimya*) *anteradiata* Conrad, Acad. Nat. Sci. Phila. Jour., 2d ser., v. 4, p. 276, pl. 46, fig. 3.

The presence of *Anatimya anteradiata* (Conrad) in the Owl Creek formation of southeastern Missouri is indicated by one fragmentary imprint from Stoddard County (USGS 19090). The description is based mainly on six topotypes from Owl Creek, Miss.

Shell thin, of medium size, compressed, subelliptical in outline, subequilateral, equivalve. Umbonal ridge low, weak, posterodorsal slope broadly excavated. Beaks small, nonprominent, fissured, nearly direct, approximate, situated about at the midlength. Anterodorsal margin nearly straight, nearly horizontal, anterior margin evenly rounded, ventral margin nearly straight to very broadly rounded, posterior margin subtruncated, posterodorsal margin nearly straight and nearly horizontal.

The surface presents fine growth lines and coarser growth undulations. A group of 8 to 10 sharp, irregularly spaced radiating ribs diverge fanlike obliquely downward and rearward, spreading a few millimeters on either side of the umbonal ridge. The posterodorsal slope is nearly smooth, but some individuals exhibit 1 or 2 faint radiating ribs. Hinge edentulous, external ligamental groove opisthodontic, short, shallow. One of the topotypes shows a pair of opposing short, stout, spoon-shaped chondrophores, protruding inward and directly downward from under the beaks. The adductor scars, pallial line, and pallial sinus cannot be seen on the available material, but as seen on a related species, *Anatimya longula* Stephenson, in the Woodbine formation of Texas (Stephenson, 1953, p. 90, pl. 21, fig. 2), the pallial sinus is wide, deep, and rounded on the front, but falls short of reaching the midlength of the shell.

The fragment of the imprint from the Owl Creek formation of Missouri (pl. 17, fig. 17) pertains to the posterior part of a right valve and includes impressions of five of the group of sharp radiating ribs.

Types.—Holotype, collection of the Academy of Natural Sciences of Philadelphia; this type came from "Tippah County, Miss.," and because it was collected by Dr. W. Spillman it is assumed that it was collected at the Owl Creek locality. Two topotypes, figured, USGS 707, USNM 128132; 1 plesiotype from the Owl Creek formation of southeastern Missouri, USGS 19090, USNM 128131.

Range.—As at present known the species is restricted to the Owl Creek formation of Mississippi and southeastern Missouri. A closely related variety, *Anatimya anteradiata tewana* Stephenson, is recorded from the Nacatoch sand (Navarro group) of Texas (Stephenson, 1941, p. 161, pl. 25, fig. 11).

Anatimya? sp.

Plate 17, figure 18

The external molds of the dorsal parts of both valves of one individual, questionably referred to *Anatimya* Conrad, is present in the collection from one locality in the Owl Creek formation of southeastern Missouri (USGS 16451). These molds appear to pertain to a medium-size elongate shell, moderately inflated in the umbonal region, with the beaks nonprominent and nearly direct; from the beak forward the surface is ornamented with relatively coarse concentric ridges and toward the rear the surface appears to become smooth. In form the shell resembles the genus *Anatimya* but no evidence of a slit in the beak could be detected. USNM 128133.

Superfamily **POROMYACEA**

Family **POROMYACIDAE**

Genus **LIPISTHA** Meek, 1864

Liopistha proteata (Conrad)

Plate 19, figures 17–21

1853. *Cardium proteatum* Conrad, Acad. Nat. Sci. Phila. Jour., 2d ser., v. 2, p. 275, pl. 24, fig. 12.

(For synonymy through 1941 see Tex. Univ. Pub. 4101, 1941, p. 162.)

Imprints of the shells of *Liopistha proteata* (Conrad) are present in the collections from every locality at which Owl Creek fossils were obtained in southeastern Missouri. Specimens with more or less of the shell preserved are abundant at the Owl Creek locality in Tippah County, Miss.

The species has been fully delineated in several treatises (see synonymy) and need not be described in detail here. It may be noted, however, that there is some individual variation in the number and coarseness of the radial ribs. Although the species has been recorded in beds older than the Owl Creek formation at a few scattered localities in the Atlantic and Gulf Coastal Plain it is nowhere as abundant as it is in the Owl

Creek formation. The imprints from Missouri include both internal and external molds, none of which show impressions of complete individuals. The shells of this species are very thin, which accounts for the fact that the radiating ribs are impressed on all the internal molds. Impressions of the characteristic fine nodes on the ribs may be seen on some of the external molds. The right valve from Owl Creek, Miss., shown in plate 19, figure 18, measures: Length 30 mm, height 19 mm, convexity about 8 mm.

Types.—Holotype, from Burlington County, N. J., Academy of Natural Sciences, Philadelphia. Two plesiotypes from Owl Creek, Tippah County, Miss., USGS 707, USNM 128136; 1 plesiotype from the Owl Creek formation, Stoddard Co., Mo., USGS 16451, USNM 128134; USGS 16452, USNM 128135.

Range.—*Exogyra costata* zone in the Atlantic and Gulf Coastal Plain; abundant in the Owl Creek formation in Mississippi and southeastern Missouri and elsewhere in beds of Owl Creek age (upper part of zone); less abundant in the Ripley formation and beds of Ripley age (lower part of zone). Reported in the Wenonah sand (upper part of *E. ponderosa* zone), New Jersey.

Order TELEODESMACEA
Superfamily CYPRICARDIACEA
Family PLEUROPHORIDAE
Genus VENIELLA Stoliczka, 1870
Veniella conradi (Morton)
Plate 18, figures 1, 2

1833. *Veniella conradi* Morton, Am. Jour. Sci., 1st ser., v. 23, p. 294, pl. 8, figs. 1-2.
(For synonymy through 1941 see Tex. Univ. Pub. 4101, 1941, p. 168.)

Veniella conradi (Morton) is represented by poorly preserved internal and external molds at four localities in southeastern Missouri (USGS 16451, 16452, 16597, and 19090). Detailed descriptions of the species and full accounts of its distribution in the Atlantic and Gulf Coastal Plain are given in several treatises (see synonymy).

Types.—Holotype, collection of the Academy of Natural Sciences, Philadelphia, from "New Jersey," probably from the Navesink marl. The specimen in the Academy marked "type" is badly broken. One plesiotype from Owl Creek, Tippah County, Miss., USGS 707, USNM 128138. One plesiotype from the Owl Creek formation, southeastern Missouri, USGS 19090, USNM 128137.

Range.—The species ranges through the zones of *Exogyra ponderosa* and *E. costata* in the Atlantic and Gulf Coastal Plain.

Superfamily ASTARTACEA
Family CRASSATELLIDAE
Genus CRASSATELLA Lamarck, 1799
Crassatella vadosa ripleyana (Conrad)
Plate 19, figures 11-16

1858. *Crassatella ripleyana* Conrad, Acad. Nat. Sci. Phila. Jour., 2d ser., v. 3, p. 327, pl. 35, fig. 3.

1905. *Crassatellites ripleyanus* (Conrad). Johnson, Acad. Nat. Sci. Phila. Proc., v. 57, p. 14.

1941. *Crassatella vadosa ripleyana* (Conrad). Stephenson, Tex. Univ. Pub. 4101, p. 177.

1945. *Crassatella vadosa* Morton. Harbison, Acad. Nat. Sci. Phila. Proc., v. 97, p. 80, pl. 1, fig. 2 (from the Owl Creek formation, Owl Creek, Tippah County; not from the Ripley formation at Pleasant Ridge Lake).

Crassatella vadosa ripleyana (Conrad) belongs to a group of closely related *Crassatellas*, typified by *C. vadosa* Morton (1834, p. 66, pl. 13, fig. 12). This group includes *Crassatellites vadosus* (Morton) Wade, equals *Crassatella vadosa wadei* (Stephenson, 1941, p. 176, 177), from the Coon Creek tongue of the Ripley formation, McNairy County, Tenn. (Wade, 1926, p. 79, pl. 25, figs. 6-8); *Crassatella gardnerae* Harbison (1945, p. 79, pl. 1, figs. 3, 4) from the Ripley formation of Mississippi; *Crassatellites vadosus* (Morton) Gardner, from the Monmouth formation of Maryland (Gardner, 1916, p. 649, pl. 39, figs. 1-4); three varietal forms from the Navarro group of Texas, *Crassatella vadosa chatfieldensis* Stephenson from the Nacatoch sand, *C. vadosa manorensis* Stephenson, and *C. vadosa bewarensis* Stephenson (1941, pp. 177-178, pl. 29, figs. 1-11) from the Kemp clay.

Imprints of *Crassatella vadosa ripleyana* (Conrad), both internal and external molds of juvenile shells, mostly fragmentary, are common in the Owl Creek formation of southeastern Missouri (USGS 16429+16452, 16430, 16598, 19090). The following description is based on perfectly preserved topotypes from Owl Creek, Miss.

Shell of medium size, subtrigonal in outline, rather strongly inflated in the umbonal region, inequilateral, subequivalve; anterodorsal slope steep; posterodorsal slope elongated, rather broad, sinuous, somewhat flattened, separated from the main flank by a broad sub-obtusely angular umbonal ridge; this slope is divided into 3 bands by 2 weak radial ridges. Lunule relatively short, deeply excavated, the left half a little wider than the right half; escutcheon long, deeply and sharply excavated in the right half, and narrower and weakly excavated in the left half. A broad, weak radial depression in front of the umbonal ridge extends from the umbonal region to the ventral margin.

Anterior margin evenly rounded; ventral margin broadly rounded, nearly straight, or slightly and broadly excavated; posterior margin short, subtruncated; posterodorsal margin nearly straight, descending. Beaks prominent, incurved, prosogyrate, approximate, situated 0.34 the length from the anterior extremity. Surface of shell has rather coarse, irregular growth ridges and intervening fine growth lines. Corrosion reveals internal radiating shell structure.

Dimensions of the topotype shown in plate 19, figures 11, 12: Length 47 mm, height 37.5, thickness 28 mm.

Hinge plate thick, relatively short. Ligament (resilium) short internal, seated in a spoon-shaped depression (resilifer) in the hinge plate below and a little back of the beak. Left valve has a deep trigonal socket separating two cardinal teeth, the anterior one strong, the posterior one prominent, sharp, standing between the resilifer and the inner margin of the hinge. A ridge on the inner edge of the lunule fits into a corresponding channel on the margin of the right valve, and a channel paralleling the inner margin of the escutcheon receives a marginal ridge of the right valve. A prominent trigonal cardinal tooth on the right valve fits into the deep socket of the left hinge; in front of the cardinal tooth is a socket to accommodate the anterior cardinal of the left valve, and a posterior socket, separating the resilifer from the inner margin of the hinge plate, receives the posterior cardinal of the left valve. The sides of the large trigonal cardinal tooth of the right valve and of the corresponding socket of the left valve are striated in the direction of hinge movement. The posterior adductor scar is subcircular and the anterior adductor is elliptical; both are sunken well below the inner surface. Pallial line simple. Inner margin crenulated.

Compared with the typical *Crassatella vadosa* Morton this variety is shorter, more ventricose, more prominent in the umbonal region, and narrows to a more pointed posterior extremity.

Types.—Holotype, collection of the Academy of Natural Sciences of Philadelphia. Three topotypes from Owl Creek, USGS 707, USNM 128139; 1 plesiotype from southeastern Missouri, USGS 16429, USNM 128141; 1 plesiotype from southeastern Missouri, USGS 19090, USNM 128140.

Range.—Owl Creek formation of Mississippi and southeastern Missouri.

Genus SCAMBULA Conrad, 1869

***Scambula perplana* Conrad**

Plate 18, figures 3-5

1869. *Scambula perplana* Conrad, Am. Jour. Conchology, v. 5, p. 48, pl. 9, figs. 7, 8.

(For synonymy and description see Tex. Univ. Pub. 4101, 1941, p. 182, 183, pl. 26, figs. 11, 12.)

The small compressed species, *Scambula perplana* Conrad, is represented in the Owl Creek formation of southeastern Missouri by several fairly well preserved internal molds and by one incomplete external mold (USGS 16452, 19090). One specimen, an internal mold of a left valve, is recorded from the Owl Creek formation of Mississippi at a locality about 3 miles south of New Albany, Union County (USGS 6872). Fairly well preserved shells that appear to be correctly referred to

the species are recorded from the Coon Creek tongue of the Ripley formation (early Maestrichtian?) at the classic Coon Creek locality in McNairy County, Tenn. (Wade, 1926, p. 82, pl. 25, figs. 11, 12, 15, 16).

Types.—Holotype, collection of the Academy of Natural Sciences Philadelphia, from the Woodbury clay (*Exogyra ponderosa* zone) at Haddonfield, N. J. Three plesiotypes from the Owl Creek formation, southeastern Missouri, USGS 19090, USNM 128142.

Range.—Zones of *Exogyra ponderosa* and *E. costata* (Campanian through Maestrichtian) in the Atlantic and Gulf Coastal Plain.

Superfamily CARDIACEA

Family CARDIIDAE

Genus CARDIUM Linné, 1758

Subgenus GRANOCARDIUM Gabb, 1869

***Cardium (Granocardium) tippanum* Conrad**

Plate 19, figures 9, 10

1858. *Cardium tippanum* Conrad, Acad. Nat. Sci. Phila. Jour., 2d ser., v. 3, p. 326, pl. 34, fig. 8b.

1864. *Cardium (Acanthocardia) tippanum* Conrad. Meek, Check list of the invertebrate fossils of North America, Cretaceous and Jurassic, Smithsonian Misc. Coll. 177, p. 12.

1876. *Cardium (Granocardium) tippanum* Conrad. Gabb, Acad. Nat. Sci. Phila. Proc., v. 28, p. 310.

1940. *Cardium (Granocardium) tippanum* Conrad. Stephenson and Monroe, Miss. State Geol. Survey Bull. 40, p. 284, pl. 12, figs. 1, 2. (Illustrations only.)

1941. *Cardium (Granocardium) tippanum* Conrad. Stephenson, Tex. Univ. Pub. 4101, p. 199, pl. 37, figs. 9-12.

Meek (1864, p. 12) referred *Cardium tippanum* Conrad to the subgenus *Acanthocardia* Gray, a Recent group inhabiting the marine waters of the northeast Atlantic. *Acanthocardia* differs from *Granocardium* in having the spines on the crests of the ribs instead of in the interspaces.

Fragmentary imprints of both internal and external molds of *Cardium (Granocardium) tippanum* Conrad are present in the collections from four localities in the Owl Creek formation in Stoddard County, Mo. (USGS 16429+16452, 16430, 16451, 19090). A detailed description of the species is given by Stephenson (1941, p. 199, pl. 37, figs. 9-12); the well-preserved topotype from the Owl Creek formation of Mississippi, there figured, was designated neotype; it is refigured in this paper (pl. 19, fig. 9).

Types.—The whereabouts of the holotype is unknown. Neotype (designated by Stephenson, 1941, p. 200), from Owl Creek, Miss., USGS 707, USNM 76611; 1 plesiotype from southeastern Missouri, USGS 16451, USNM 128143.

Range.—As at present known the species is restricted to the Owl Creek formation and to beds of Owl Creek age in the eastern Gulf region, and to the Corsicana marl of Texas. It appears to be confined in range to the upper part of the *Exogyra costata* zone (upper Maestrichtian).

Cardium (*Granocardium*) *lowei* Stephenson, n. sp.

Plate 19, figures 1-8

Imprints of a species of *Cardium* (*Granocardium*) Gabb that appear to be essentially like a heretofore undescribed species from Owl Creek, Tippah County, Miss., are present in collections from five localities in the Owl Creek formation of southeastern Missouri (USGS 16429+16452, 16430, 19090, Stoddard County; 16597, 16598, in Scott County). The description is based mainly on nine Mississippi specimens, the original shells of which are more or less completely preserved.

Shell thin, strongly inflated, subquadrate in outline, subequilateral, equivalve. Beaks prominent, strongly incurved, slightly prosogyrate, approximate, situated centrally. Dorsal slopes steep, the posterior one flattened. Radiating ribs numerous, flattened on crests, closely spaced, some of them bearing a weak radiating groove midway of their flattened crests. As a rule every fourth interspace on the main flank is occupied by relatively large spines that may be regularly spaced, or may be widely and irregularly spaced; however, the large spines occupy every third interspace on parts of some shells. Most of the larger spines are broken away on the available material, but their presence is indicated by scars; on the dorsal slopes the number of interspaces between those bearing the rows of larger spines may range from 2 to 7. There is considerable individual variation in the number and spacing of the larger spines. The larger spines are solid and some of them, accidentally broken away during removal of the matrix, rose as much as 1 millimeter above the shell surface. Some of the interspaces that do not bear large spines reveal a very weak development of closely spaced tiny spines or tubercles, or the interspaces and parts of interspaces may appear smooth; however, on some small areas where an outer layer of shell has been removed the inner shell structure shows incipient, tiny, closely spaced tubercles that do not come to the outer surface. The termini of the radiating ribs and interspaces produce a fine crenulation on the inner margin of the shell.

The ligamental groove is opisthodontic, short and very narrow; in each valve it is bordered on the outside by a paralleling groove that is V-shaped in cross section, and on the inside by a narrow, moderately prominent nymph. The hinge is narrow, the inner dental elements overhanging the interior slightly. In the left valve a short bluntly pointed posterior cardinal tooth rises below and slightly back of the tip of the beak; in front of this tooth and extending around below it is a

deep, irregular cavity, the front part of which is a tooth socket; below the cavity and slightly toward the front is a short, prominent, upcurved anterior cardinal tooth. Above the socket the thin margin of the shell folds up against the front side of the incurved beak. The anterior lateral tooth is distant, short, and relatively thick and is separated from the thin margin by a short, deep socket; the posterior lateral tooth is also distant, short, and thick and is near the margin.

In the right valve a small pointed anterior cardinal tooth fits into the socket of the left valve and back of this tooth is a socket that receives the small posterior cardinal of the left valve; below this socket is a prominent, short, upturned posterior cardinal that fits against the posterior side of the anterior cardinal of the left valve. The tip of the prominent cardinal in each valve fits into a deeply submerged shallow dent (socket) low on the inner side of the opposite valve. The anterior lateral dentition of the right valve is a pair of claspers the inner element of which is thick and strong and the outer element small and weak; the posterior lateral dentition includes a strong inner element separated from the margin of the shell by a deep socket that accommodates the single lateral tooth of the left valve.

Inner surface smooth, adductor scars not indented; posterior adductor scar relatively large and somewhat elongated; anterior adductor smaller, subcircular.

Dimensions of the holotype, a specimen of medium size: Length 11.5 mm, height 12.6 mm, convexity 5 mm. The adult paratype from Owl Creek shown in plate 19, figure 1, measures: Length 17 mm, height 20 mm, convexity about 7 mm.

Cardium (*Granocardium*) *lowei* is closely related to *C. (G.) alabamense* Gabb from Eufaula, Ala. (Gabb, 1876, p. 310), a species in which the larger spines on the lateral surface occupy every third interspace, are more closely and more regularly spaced, and whose smaller spines in the intervening spaces are much more conspicuously developed. Gabb apparently failed to recognize the spine scars on the type specimen. (See Stephenson, 1923, p. 295, pl. 72, figs. 9, 10, 10a.)

Types.—Holotype, a medium-size shell from Owl Creek, Tippah County, Miss., USGS 707, USNM 128148; 2 figured paratypes from the same source, USNM 128147; 5 unfigured paratypes from the same source, USNM 20854; 1 unfigured paratype from the same source, USGS 594, USNM 21675. Two figured paratypes from the Owl Creek formation southeastern Missouri, USGS 19090, USNM 128144; 4 unfigured paratypes from the same source, USNM 128145; 1 figured paratype, USGS 16597, USNM 128146. Named in honor of the late Dr. E. N. Lowe, past Director of the Mississippi State Geological Survey.

Range.—Owl Creek formation of Mississippi and southeastern Missouri.

Subgenus **PACHYCARDIUM** Conrad, 1869
Cardium (Pachycardium) spillmani Conrad
 Plate 20, figure 1

1858. *Cardium (Laevicardium) spillmani* Conrad, Acad. Nat. Sci. Phila. Jour., 2d ser., v. 3, p. 326, pl. 34, fig. 3. (See synonymy in N. C. Geol. and Econ. Survey, v. 5, pt. 1, 1923, p. 298.)

Add:

1876. *Cardium (Pachycardium) spillmani* Conrad. Gabb, Acad. Nat. Sci. Phil. Proc., v. 28, p. 309.

Two small internal molds of about the same size, representing a juvenile stage of *Cardium (Pachycardium) spillmani* Conrad, were found at one locality in the Owl Creek formation of southeastern Missouri (USGS 16452). The type locality of the species is Owl Creek, Tippah County, Miss. Twenty-eight topotypes in the collection of the United States National Museum (USNM 20615, 20857, and 21665) afford examples of growth stages of the species ranging in greatest dimension (in height) from 16 to 142 mm. A description of the species, including its distribution, is given by Stephenson (1923, p. 298).

The following species are closely related to *Cardium (Pachycardium) spillmani*: *C. (P.) stantoni* Wade (1926, p. 86) and *C. (P.) wadei* Stephenson (1941, p. 194).

Types.—Holotype, from Owl Creek, Tippah County, Miss., collection of the Academy of Natural Sciences of Philadelphia. Plesiotype (juvenile) from the Owl Creek formation of southeastern Missouri, USGS 16452, USNM 128149; 1 unfigured example from the same source, USNM 128150.

Range.—The stratigraphic range of this species has been given as through the zones of *Exogyra ponderosa* and *E. costata*; but it is probable that internal molds of this subgenus belonging to closely related species, such as *Cardium (Pachycardium) stantoni* Wade (1926, p. 86), have been mistakenly referred to *C. (P.) spillmani*, and the true range may not be as great as previously recorded.

Genus **BREVICARDIUM** Stephenson, 1941
Brevicardium fragile Stephenson
 Plate 18, figures 6, 7

1941. *Brevicardium fragile* Stephenson, Tex. Univ. Pub. 4101, p. 204, pl. 36, figs. 5–8.

The small species, *Brevicardium fragile* Stephenson, is represented in southeastern Missouri by one internal mold of a right valve on which the surface sculpture is obscurely impressed (USGS 16452). The mold agrees well with the holotype of the species, which came from Owl Creek, Tippah County, Miss.; the types are described in my treatise on the Navarro group of Texas (Stephenson, 1941, p. 204), where the species has been questionably identified in the Corsicana marl. A topotype, a right valve from Owl Creek, shown in plate 18,

figure 6, measures: Length 5.7 mm, height 5.7 mm, convexity about 2 mm. The internal mold from Missouri measures: Length 4.8 mm, height 4.7 mm, convexity about 1.5 mm.

Types.—Holotype, from Owl Creek, Tippah County, Miss., USGS 707, USNM 76644; 1 plesiotype (=topotype) from the same source, USGS 6464, USNM 128151. One plesiotype from southeastern Missouri, USGS 16452, USNM 128152.

Range.—Owl Creek formation of Mississippi and southeastern Missouri. Questionably in the Corsicana marl (Navarro group), Texas.

Superfamily **VENERACEA**
 Family **VENERIDAE**
 Genus **APHRODINA** Conrad, 1869
Aphrodina tippana (Conrad)
 Plate 20, figures 2–4

1858. *Meretrix tippana* Conrad, Acad. Nat. Sci. Phila. Jour., 2d ser., v. 3, p. 326, pl. 34, fig. 18. (For synonymy see Tex. Univ. Pub. 4101, 1941, p. 208.)

Add:

1940. *Aphrodina tippana* (Conrad). Stephenson and Monroe, Miss. State Geol. Survey Bull. 40, p. 284, pl. 12, figs. 5, 6. (Illustrations only.)

A few small, poorly preserved, incomplete internal molds of *Aphrodina tippana* (Conrad) are present in the collections from three localities in Stoddard County, Mo. (USGS 16429+16452, 16451, 19090). The type locality of the species in Owl Creek, Tippah County, Miss., where well-preserved shell are of common occurrence. The species has been described in detail in the papers cited in the synonymy.

Types.—Holotype, Academy of Natural Sciences Philadelphia, from Owl Creek, Tippah County, Miss. On topotype USGS 707, USNM 128154; 2 plesiotypes from the Owl Creek formation of southeastern Missouri, USGS 19090, USNM 128153.

Range.—*Exogyra costata* zone (Maestrichtian) in the Atlantic and Gulf Coastal Plain.

Genus **CYPRIMERIA** Conrad, 1864
Cyprimeria alta (Conrad)
 Plate 20, figures 26–28

1858. *Dosinia densata* Conrad, Acad. Nat. Sci. Phila. Jour. 2d ser., v. 3, p. 325, pl. 34, fig. 13.

1875. *Cyprimeria alta* Conrad, N. C. Geol. Survey, Rept., v. 1 (by W. C. Kerr), app. A, p. 27.

1876. *Cyprimeria torta* Gabb, Acad. Nat. Sci. Phila. Proc., v. 28, p. 308.

1916. *Cyprimeria major* Gardner, Md. Geol. Survey, Upper Cretaceous [Maryland], in W. B. Clark and others, p. 689, pl. 40, figs. 11, 12; pl. 41, figs. 1–4; pl. 42, fig. 1; pl. 43, fig. 1.

1940. *Cyprimeria alta* (Conrad). Stephenson and Monroe, Miss. State Geol. Survey Bull. 40, p. 284, pl. 12, figs. 3, 4. (Illustrations only.)

1941. *Cyprimeria alta* (Conrad). Stephenson, Tex. Univ. Pub. 4101, p. 212, pl. 40, figs. 1, 2; pl. 41, figs. 1–4.

Incomplete, internal molds, small to medium size, from three localities in the Owl Creek formation of southeastern Missouri are referred to *Cyprimeria alta* (Conrad), (USGS 16429, 16451, 19090). The species is described in Texas University Publication 4101 (Stephenson, 1941, p. 212).

Types.—The whereabouts of the original type material is not known and it is probably lost. One topotype, USGS 707, USNM 128155; neotype (designated by Stephenson, 1941, p. 214), USNM 76664; 1 plesiotype from southeastern Missouri, USGS 16429, USNM 128156.

Range.—Upper part of *Exogyra costata* zone (Maestrichtian) in the Atlantic and Gulf Coastal Plain.

Genus LEGUMEN Conrad, 1858

Legumen ellipticum Conrad

Plate 20, figures 5–7

1858. *Legumen ellipticum* Conrad, Acad. Nat. Sci. Phila. Jour., 2d ser., v. 3, p. 325, pl. 34, fig. 19.
(For synonymy through 1941 see Tex. Univ. Pub. 4101, 1941, p. 215.)

Imprints of the shells of this species, though small, are nevertheless complete enough for satisfactory identification. They have been collected at three localities in Stoddard County, Mo. (USGS 16429+16452, 16430, 16451). A description of the species is given in the Texas University publication cited above.

Types.—Holotype, from Owl Creek, Tippah County, Miss., collection of the Academy of Natural Sciences, Philadelphia. Topotype from Owl Creek, Miss., USGS 707, USNM 128158; 2 plesiotypes from the Owl Creek formation of southeastern Missouri, USGS 16452, USNM 128157.

Range.—This species ranges through the *Exogyra costata* zone in the Atlantic and Gulf Coastal Plain. Closely related, possibly identical, shells are present in the upper part of the *E. ponderosa* zone (Campanian) beneath the *E. costata* zone.

Genus TENEA Conrad, 1870

Tenea parilis (Conrad)

Plate 20, figures 8–11

1860. *Mysia parilis* Conrad, Acad. Nat. Sci. Phila. Jour., 2d ser., v. 4, p. 278, pl. 46, fig. 16.
(For synonymy through 1941 see Tex. Univ. Pub. 4101, 1941, p. 217.)

Imprints of *Tenea parilis* (Conrad) are common in the Owl Creek formation of southeastern Missouri; the collections include specimens from four localities in Stoddard County (USGS 16429+16452, 16430, 16451, 19090). The impressions are especially abundant at the road ditch exposure 1.4 miles west by slightly south of Ardeola station (USGS 19090). This small, smooth, subcircular bivalve is described in detail in Texas University Publication 4101 (Stephenson, 1941, p. 217) cited above.

Types.—The type of *Mysia parilis* Conrad (= *Tenea parilis* (Conrad)) is in the collection of the Academy of Natural Sci-

ences, Philadelphia. It was collected by Dr. W. Spillman from Tippah County, presumably at the Owl Creek locality. One plesiotype (= topotype?), USGS 707, USNM 128160; 2 plesiotypes from the Owl Creek formation of southeastern Missouri, USGS 19090, USNM 128159.

Range.—Through the zones of *Exogyra ponderosa* and *E. costata* (Campanian through Maestrichtian) in the Atlantic and Gulf Coastal Plain.

Superfamily TELLINACEA

Family TELLINIDAE

Genus TELLINA Linné, 1758

Tellina buboana Stephenson, n. sp.

Plate 20, figures 12–14

The following description is based on the shells of two individuals from the Owl Creek formation on Owl Creek, Tippah County, Miss. (USGS 707). The larger of the two shells (holotype) includes both valves; the right valve is well preserved, but the left is broken and distorted in the umbonal region. The other shell (paratype) is a well-preserved valve with the hinge uncovered.

Shell small, thin, subelliptical in outline, compressed, inequilateral, subequivalve. Lunule and escutcheon wanting. Posterodorsal slope narrow, flattened, descending rather steeply; shell flexed slightly to the right in the posterior region. Beaks small, nonprominent, slightly opisthogyrate, situated about 0.57 the length of the shell from the anterior extremity. Anterodorsal margin long, broadly arched, descending; anterior margin sharply rounded; ventral margin long, broadly arched; posterior margin subangulated below, with a short subtruncation inclined forward above; posterodorsal margin broadly arched, descending. Surface smooth and polished in the umbonal region, becoming sharply and nearly regularly lined concentrically toward the outer margins.

Dimensions measured on the right valve of the holotype: Length 15.5 mm, height about 10 mm, convexity about 2 mm.

Ligamental groove external, opisthodetic, narrow, about 2 mm long in the types. Hinge as seen in a paratype, a right valve, very narrow. Below the beak is a short, trigonal, deeply bifid cardinal tooth, slightly oblique to the rear; a short delicate anterior cardinal tooth is strongly oblique to the front and is separated from the posterior cardinal by a deep trigonal socket. About 2.5 mm back of the beak (partly broken away) is a short, thin lateral tooth separated from the margin by a shallow channel; about 1.2 mm forward from the beak is a short, thin lateral tooth, observed when first uncovered, but broken away in preparation; between this lateral and the margin is a shallow channel that continues on to the front. Other internal features not

uncovered. The hinge of the left valve was not seen completely uncovered, but in a broken left valve of the holotype, a short, relatively prominent, deeply bifid trigonal cardinal tooth, slightly oblique forward, stands opposite the deep trigonal socket of the right valve.

The holotype and paratype of *Tellina buboana* from Owl Creek, Miss. (USGS 707, USNM 20706) have been previously labelled *Tellinimera eborea* Conrad, but Conrad's original illustrations indicate a shell differing in form and outline from this new species. Besides, Conrad's (1860, p. 278, pl. 46, figs. 10, 14; 1870, p. 73) original descriptions of the two species he referred to *Tellinimera* are inadequate; he indicated the locality of the two species as "Ala.;" but according to Johnson (1905, p. 16) the original label accompanying the type of *Tellinimera eborea* indicates "Miss." There is therefore uncertainty as to both the geographic and stratigraphic position of the types of both *T. eborea* and *T. limatula*.

Tellinimera eborea Conrad was designated as type of *Tellinimera* by Gardner (1916, p. 695).

Types.—Holotype, from Owl Creek, Tippah County, Miss., USGS 707, USNM 20706; 1 paratype from the same source, USNM 128161. One figured paratype from the Owl Creek formation of southeastern Missouri, USGS 19090, USNM 128162; 1 unfigured paratype from the same source, USNM 128163.

Range.—Owl Creek formation of northern Mississippi and southeastern Missouri.

Genus LINEARIA Conrad, 1860

The features of the genus *Linearia* Conrad are described and discussed at some length by Stephenson (1941, p. 221). The type species is *Linearia metastrata* Conrad, from Eufaula, Ala. One of the distinguishing features of the genus is the pair of conspicuously elongated cardinal teeth in the right valve, extending obliquely forward and downward, in contrast to the short, trigonal, bifid cardinal in the right valve of *Tellina* Linné, which extends downward and is slightly oblique to the rear. One long oblique cardinal in the left valve of *Linearia* is received in the socket separating the pair of cardinals in the right valve. Species having sculpture ranging from nearly smooth to radial ribbing covering the whole surface have been referred to this genus. All of them have in common the pair of long cardinal teeth oblique forward in the right valve.

Linearia metastrata Conrad

Plate 20, figures 17–25

1860. *Linearia metastrata* Conrad, Acad. Nat. Sci. Phila. Jour. 2d ser., v. 4, p. 279, pl. 46, fig. 7.

1870. *Linearia* Conrad, Am. Jour. Conchology, v. 6, p. 73, pl. 3, fig. 11.

1885. *Linearia metastrata* Conrad. Whitfield, U. S. Geol. Survey Mon. 9, p. 165, pl. 23, figs. 6, 7?, 8. (Also issued as N. J. Geol. Survey, Paleontology ser., v. 1.)

1899. *Linearia metastrata* Conrad. Harris, La. State Exp. Sta. Spec. Rept. 6, Geol. and Agr., pt. 5, p. 296, pl. 50, fig. 7.

1905. *Linearia metastrata* Conrad. Johnson, Acad. Nat. Sci. Phila. Proc., v. 57, p. 16.

1907. *Linearia metastrata* Conrad. Weller, N. J. Geol. Survey. Paleontology ser., v. 4, p. 618, pl. 70, figs. 8, 9.

1916. *Linearia metastrata* Conrad. Gardner, Md. Geol. Survey, Upper Cretaceous [Maryland], in W. B. Clark and others, p. 699.

1923. *Linearia metastrata* Conrad. Stephenson, N. C. Geol. and Econ. Survey, v. 5, pt. 1, p. 329, pl. 84, figs. 1–5.

1926. *Linearia metastrata* Conrad. Wade, U. S. Geol. Survey Prof. Paper 137, p. 93, pl. 31, figs. 1, 2.

1926. *Linearia ornatissima* Weller. Wade, U. S. Geol. Survey Prof. Paper 137, p. 94, pl. 30, figs. 6, 7.

1941. *Linearia metastrata* Conrad. Stephenson, Tex. Univ. Pub. 4101, p. 221.

The species *Linearia metastrata* Conrad is represented in the Owl Creek formation of southeastern Missouri by internal and external molds at three localities in Stoddard County (USGS 16430, 16451, 19090). The species is present in the Owl Creek formation at Owl Creek Tippah County, Miss., where specimens with the shell more or less completely preserved have been collected (USGS 707, USNM 20713). Rather full descriptions of the species are given in several of the papers cited in the synonymy.

The species is characterized by beautiful surface cancellation produced by regularly spaced, narrow, sharp concentric ridges, crossed transversely by radiating costae that differ markedly in strength on different parts of the surface. The strongest and most widely spaced radials are on the dorsal slopes, and the weakest and most closely spaced ones are in broad areas on the flanks. The intersections of the concentric and radiating ribs are marked by round-crested, beadlike nodes that enhance the attractiveness of the cancellation. The internal mold shown in plate 20, figure 22, a nearly full-grown individual, measures: Length 14 mm, height 10 mm, convexity about 2.5 mm.

Perfectly preserved shells referred to this species are recorded from the Coon Creek tongue of the Ripley formation at the classic Coon Creek locality in McNairy County, Tenn. (Wade, 1926, p. 93, pl. 31, figs. 1, 2). These shells show considerable individual variation in the coarseness of their surface ornamentation.

Types.—Holotype, from Eufaula, Ala., collection of the Academy of Natural Sciences, Philadelphia. Three plesiotypes from Owl Creek, Miss., USGS 707, USNM 20713; 3 plesiotypes from the Owl Creek formation of southeastern Missouri, USGS 19090, USNM 128164; 2 plesiotypes from the Coon Creek tongue of the Ripley formation at Coon Creek, McNairy County, Tenn. USGS 10198, USNM 128165.

Range.—Through the zones of *Exogyra ponderosa* and *E. costata* (Campanian and Maestrichtian).

Superfamily SOLENACEA

Family SOLENIDAE

Genus LEPTOSOLEN Conrad, 1865

Leptosolen biplicatus (Conrad)

Plate 20, figures 15, 16

1858. *Siliquaria biplicata* Conrad, Acad. Nat. Sci. Phila. Jour., 2d ser., v. 3, p. 324, pl. 34, fig. 17.
1865. *Solena* (*Leptosolen*) *biplicata* (Conrad), Acad. Nat. Sci. Phila. Proc., v. 17, p. 184.
1867. *Leptosolen biplicata* (Conrad), Am. Jour. Conchology, v. 3, p. 15, 188.
1885. *Leptosolen biplicata* Conrad. Whitfield, U. S. Geol. Survey Mon., 9, p. 183, pl. 25, figs. 1, 2. Also issued as N. J. Geol. Survey, Paleontology ser., v. 1)
1907. *Leptosolen biplicata* Conrad. Weller, N. J. Geol. Survey, Paleontology ser., v. 4, p. 624, pl. 70, figs. 30, 31.
1916. *Leptosolen biplicata* Conrad. Gardner, Md. Geol. Survey, Upper Cretaceous [Maryland], in W. B. Clark and others, p. 703, pl. 42, figs. 7, 8.
1923. *Leptosolen biplicatus* Conrad. Stephenson, N. C. Geol. and Econ. Survey, v. 5, pt. 1, p. 332, pl. 85, figs. 10–13.
1926. *Leptosolen biplicata* Conrad. Wade, U. S. Geol. Survey Prof. Paper 137, p. 94, pl. 31, figs. 4, 7.
1928. *Leptosolen biplicatus* Conrad. Adkins, Tex. Univ. Bull. 2838, p. 167.
- ?1929. *Leptosolen* aff. *L. biplicatus* Conrad. Dane, Ark. Geol. Survey Bull. 1, p. 40, pl. 8, fig. 7. (Illustration only.)
1940. *Leptosolen biplicatus* Conrad. Stephenson and Monroe, Miss. State Geol. Survey Bull. 40, p. 290, pl. 15, fig. 5. (Illustration only.)
1941. *Leptosolen biplicatus* Conrad. Stephenson, Tex. Univ. Pub. 4101, p. 226, pl. 43, figs. 4, 5.
1944. *Leptosolen biplicatus* (Conrad). Bergquist, Jour. Paleontology, v. 18, no. 1, p. 23.

The species *Leptosolen biplicatus* (Conrad) has been adequately described in several of the papers listed in the synonymy. The few imprints that represent the species in the Owl Creek formation of southeastern Missouri are small and incomplete (USGS 16430, 16452, and 19090, in Stoddard County; USGS 16598 in Scott County). Well-preserved shells are common in the Owl Creek formation of Mississippi at Owl Creek, Tippah County, the type locality of the species. The adult shell (topotype) shown in plate 6, figure 15, measures: Length 53 mm, height 16mm, convexity 5 mm.

Types.—Holotype, collection of the Academy of Natural Sciences, Philadelphia. One plesiotype from the Owl Creek formation of southeastern Missouri, USGS 19090, USNM 128166; 1 plesiotype (=topotype) from the Owl Creek formation, Tippah County, Miss., USGS 707, USNM 128167.

Range.—Through the zones of *Exogyra ponderosa* and *E. costata* (Campanian and Maestrichtian) in the Atlantic and Gulf Coastal Plain.

Superfamily MYACEA

Family CORBULIDAE

Genus CORBULA Lamarck, 1799, sensu lato

Corbula spp.

The family Corbulidae is represented in the Owl Creek formation of southeastern Missouri by a few poor imprints including both internal and external molds (USGS 16429 + 16452, 16430, 16451, 19090). The Corbulidae from the Upper Cretaceous formations of Mississippi have not been critically studied, identified, and compared and it does not seem feasible for present purposes to attempt to assign specific names to the Missouri material.

Family SAXICAVIDAE

Genus PANOPE Menard, 1807

Panope monmouthensis Gardner

Plate 21, figures 24–26

1916. *Panope monmouthensis* Gardner, Md. Geol. Survey, Upper Cretaceous [Maryland], in W. B. Clark and others, p. 722, pl. 45, figs. 4, 5.

One internal mold of a left valve of a juvenile example of *Panope monmouthensis* Gardner has been identified from the Owl Creek formation of southeastern Missouri (USGS 16451). The surface sculpture is impressed upon the mold and, compared with the early stage of a well-preserved shell from the Owl Creek formation of Mississippi, shows no essential difference. The shell is elongate, subelliptical in outline, plump, inequilateral, equivalve, widely gaping at the rear, slightly gaping at the front. Beaks nonprominent, nearly direct, incurved, approximate, situated about 0.4 the length of the shell from the anterior extremity. The anterodorsal slope descends steeply and is slightly excavated. Dorsal margin straight; anterior margin subtruncated, inclined a little rearward; ventral margin broadly convex; posterior margin subtruncated, inclined rearward, rounding sharply into the dorsal margin above. The surface is roughly ornamented with concentric lamellae, ridges, and undulations, and fine intervening growth lines; over much of the surface there is developed a fine, almost microscopic covering of stipples and tiny nodes of irregular size. Lunule and escutcheon wanting. External ligament opisthodontic and relatively short. One shell from Owl Creek reveals a stout projection (chondrophore?), only partly uncovered, extending into the interior from beneath the beak.

Dimensions of the large shell from Owl Creek, Miss., shown in plate 21, figures 24, 25: Length 110 mm, height 62 mm, thickness about 42 mm.

Types.—Holotype, collection of the Maryland Geological Survey on deposit in the U. S. National Museum. One plesiotype

from Owl Creek, Tippah County, Miss., USGS 707, USNM 128168; 1 plesiotype from the Owl Creek formation of southeastern Missouri, USGS 16451, USNM 128169.

Range.—Monmouth formation, Maryland; Owl Creek formation of Mississippi and southeastern Missouri.

Family GASTROCHAENIDAE

Genus GASTROCHAENA Spengler, 1783

Gastrochaena ripleyana Stephenson

Plate 21, figures 22, 23

1926. *Gastrochaena americana* Gabb. Wade, U. S. Geol. Survey Prof. Paper 137, p. 99, pl. 32, figs. 5-7.

1941. *Gastrochaena ripleyana* Stephenson, Tex. Univ. Pub. 4101, p. 244, pl. 46, figs. 5-14.

One incomplete internal mold of a partly crushed tube of *Gastrochaena ripleyana* Stephenson was collected at one locality in the Owl Creek formation of southeastern Missouri (USGS 16452). A description of the species, preceded by a critical review of the introduction, subsequent usage, and validity of the generic name *Gastrochaena* Spengler, is given in my Texas University Publication 4101, p. 242-246 as cited above. The one available mold from Missouri is the large end of a tube having a maximum diameter of 12.3 mm; the part of the tube represented is 23.5 mm long, and the smaller half is crushed to a minimum diameter of 7.5 mm. No evidence of the shell that inhabited the tube is observable.

Types.—Holotype, from Owl Creek, Tippah County, Miss., USGS 707, USNM 76752. One plesiotype (=topotype), USGS 75, USNM 128170; 1 plesiotype from the Owl Creek formation of southeastern Missouri, USGS 16452, USNM 128171.

Range.—Coon Creek tongue of Ripley formation of Tennessee. Owl Creek formation of Mississippi and southeastern Missouri. Nacatoch sand and Corsicana marl of the Navarro group, Texas. Age Maestrichtian, possibly in part Campanian.

Superfamily ADESMACEA

Family PHOLADIDAE

Genus GONIOCHASMA Meek, 1864

In my previous comments on this genus (Stephenson, 1941, p. 249) I mistakenly referred to the anterior rib of a pair of internal ribs that extend from the beak downward to the ventral margin as the internal umbonal ridge, whereas the posterior rib is the true internal umbonal ridge. The anterior rib of the pair is of variable strength on different individuals but appears to be recognizable on all adult specimens of *Goniochasma scaphoides* Stephenson from Texas; it appears to be absent on the types of *Xylophaga stimpsoni* Meek and Hayden, the genotype of *Goniochasma* Meek, which fact, together with the presence of a mesoplax on the Texas species, may be sufficient reason for considering the latter generically distinct from *Goniochasma*.

The mold from the Owl Creek formation of Missouri shows only one internal groove, not a pair of grooves,

and affords no evidence of a mesoplax above the beaks; it may therefore be a true *Goniochasma*.

GONIOCHASMA? sp.

Plate 21, figure 1

The one internal mold from the Owl Creek formation of southeastern Missouri (USGS 19090) shows the impressions of a wide, angular hiatus in front, one internal umbonal rib, a strong internal posterodorsal rib, and fine concentric ribbing typical of that of *Goniochasma* Meek. The anterior part of the shell is inflated, the posterior part cuneate. The beaks are strongly incurved, prosogyrate and far forward. The mold measures: Length 12 mm, height about 6.5, convexity 4 mm. USNM 128172.

Class GASTROPODA

Subclass STREPTONEURA

Order CTENOBRANCHIATA

Suborder PLATYPODA

Superfamily PTENOGLOSSA

Family ARCHITECTONICIDAE

Genus PSEUDOMALAXIS Fischer, 1885

Pseudomalaxis pateriformis Stephenson, n. sp.

Plate 21, figures 19-21

The external and internal molds of the bottom side of a nearly planispiral gastropod was collected at one locality in the Owl Creek formation of southeastern Missouri (USGS 19090), and is referred to the new species *Pseudomalaxis pateriformis* Stephenson, here described, which is based on one incomplete shell from Owl Creek, Tippah County, Miss. (USNM 20448).

Shell small, closely coiled; upper surface nearly flat, under surface very broadly and widely umbilicate (bowl-shaped). Protoconch smooth, coiled, slightly tilted. Whorls quadrangular in cross section. Outer angles of whorls densely beaded, the beads slightly elongated transversely. All outer surfaces covered with fine, rather obscure spiral lining; however, two or three of the lines on the inner side of the bead-rows on the upper of the two outer angles are a little larger than the others. The fine growth lines cross the bottom, outer edge, and top surfaces with a moderate obliquity toward the rear. Aperture not preserved but obviously quadrate. The greatest diameter of the incomplete holotype, as preserved, is about 13 mm.

The molds from Missouri apparently pertain to a specimen about as large as the holotype from Mississippi; the sculpture has become somewhat obscured in the process of preservation but it appears to match that of the holotype except that it appears to be a little coarser.

This species is closely related to *Pseudomalaxis pilsbryi* Harbison (1945, p. 81, pl. 1, figs. 5-7), but is much

larger, has a broader and shallower umbilical depression, and has much finer spiral sculpture.

A specimen from the Coon Creek tongue of the Ripley formation at the Coon Creek locality in McNairy County, Tenn., figured by Wade as belonging to his new species, *Pseudomalaxis ripleyana*, appears to be a juvenile example of *P. pilsbryi* Harbison; it does not belong to *P. ripleyana*.

Types.—Holotype, from Owl Creek, Tippah County, Miss., USNM 20448. One paratype from the Owl Creek formation, USGS 19090, USNM 128173.

Range.—Owl Creek formation of Mississippi and southeastern Missouri.

Superfamily TAENIOGLOSSA

Family NATICIDAE

Genus POLINICES Montfort, 1810

Polinices rectilabrum (Conrad)

Plate 21, figures 10–12

1858. *Natica* (*Lunatia*) *rectilabrum* Conrad, Acad. Nat. Sci. Phila. Jour., 2d ser., v. 3, p. 334, pl. 35, fig. 28.

1926. *Polinices* (*Euspira*) *halli* (Gabb). Wade, U. S. Geol. Survey Prof. Paper 137, p. 163, pl. 56, figs. 11, 12.

1941. *Polinices rectilabrum* (Conrad). Stephenson, Tex. Univ. Pub. 4101, p. 276, pl. 50, figs. 1–6.

One incomplete internal mold from the Owl Creek formation of southeastern Missouri (USGS 16451) is referred to *Polinices rectilabrum* (Gabb). In form it appears to be identical with topotypes of the species from Owl Creek, Tippah County, Miss. An account of the species and its distribution is given in Texas University Publication 4101 (Stephenson, 1941, p. 276, pl. 50, figs. 1–6).

The species belongs to a group whose separation must depend on very slight consistent differences. There appears to be no essential difference between *Polinices rectilabrum* (Conrad) and the specimens referred by Wade (1926, p. 163) to *Polinices* (*Euspira*) *halli* (Gabb) from Coon Creek, McNairy County, Tenn. *P. umbilica* Wade is also almost too close for separation, though the slight differences mentioned by Wade (1926, p. 163) may justify giving it a separate specific identity.

Types.—Conrad's original specimen is not listed as present in the collection of the Academy of Natural Sciences at Philadelphia and is presumed to be lost. In Texas University Publication 4101 as cited above, I figured a topotype from Owl Creek, Tippah County, Miss. and designated it neotype (USGS 707, USNM 76839); 1 figured topotype from Owl Creek, USGS 707, USNM 128210; 20 unfigured topotypes, USGS 707, USNM 20439. Plesiotype from the Owl Creek formation of southeastern Missouri, USGS 16451, USNM 128174.

Range.—The range of specimens that appear to be inseparable from *Polinices rectilabrum* (Conrad) is through the zones of *Eoogyra ponderosa* and *E. costata* (Campanian through Maestrichtian).

Genus GYRODES Conrad, 1860

Gyrodes supraplicatus (Conrad)

Plate 21, figures 15, 16

1858. *Rapa supraplicata* Conrad, Acad. Nat. Sci. Phila. Jour., 2d ser., v. 3, p. 332, pl. 35, fig. 20.

(For synonymy through 1941 and description see Tex. Univ. Pub. 4101, 1941, p. 280.)

An incomplete internal mold of *Gyrodes supraplicatus* (Conrad) is present in one collection from the Owl Creek formation of southeastern Missouri (USGS 16451). The specimen is identified by the form of its upper side and by the characteristic crenations that are rather weakly impressed upon the shoulder of the mold. In a well-preserved shell of the species the umbilicus is deep, flares outward at a wide angle, and is bordered by a crenulated carina; on the inner wall of the umbilicus a few millimeters away from the outer carina is a narrow less prominent, weakly crenulated spiral ridge.

Types.—The type specimen from Owl Creek, Tippah County, Miss., is presumed to be lost; topotype, USGS 707, USNM 128176. One plesiotype from the Owl Creek formation of southeastern Missouri, USGS 16451, USNM 128175.

Range.—Questionably from the upper part of the *Eoogyra ponderosa* zone through the *E. costata* zone in the Atlantic and Gulf Coastal Plain. Specimens from the former zone that have been referred to the present species on the basis of poorly preserved material may actually belong to nearly related species such as *Gyrodes major* Wade.

Gyrodes spillmanii Gabb

Plate 21, figures 13, 14

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

1861. *Gyrodes spillmanii* Gabb, Acad. Nat. Sci. Phila. Proc. (1861), v. 13, p. 320.

1892. *Gyrodes petrosus* (Morton). Whitfield, U. S. Geol. Survey Mon. 18, p. 127, pl. 16, figs. 1–4. (Also issued as N. J. Geol. Survey, Paleontology ser., v. 2.)

1905. *Gyrodes spillmanii* Gabb. Johnson, Acad. Nat. Sci. Phila. Proc., v. 57, p. 21.

1907. *Gyrodes petrosus* (Morton). Weller, N. J. Geol. Survey, Paleontology ser., v. 4, p. 689. (In part; not the figured specimens.)

1926. *Gyrodes alveata* Conrad. Wade, U. S. Geol. Survey Prof. Paper 137, p. 164, pl. 57, figs. 6, 9.

1941. *Gyrodes spillmani* Gabb. Stephenson, Tex. Univ. Pub. 4101, p. 284, pl. 52, figs. 20, 21.

Incomplete internal and external molds of one individual from the Owl Creek formation of southeastern Missouri (USGS 19090) clearly show a well-developed shoulder carina paralleling the suture; this is the principal feature characterizing the species *Gyrodes spillmanii* Gabb. A full description of the species is given in Texas University Publication 4101, cited above.

Types.—Collection of the Academy of Natural Sciences of Philadelphia. One plesiotype from the Owl Creek formation of southeastern Missouri, USGS 19090, USNM 128177.

Range.—As at present known the range of this species is through the *Exogyra costata* zone in the Gulf coastal plain.

Gyrodos sp.

Plate 21, figures 17, 18

One internal mold from the Owl Creek formation of southeastern Missouri (USGS 19090) is referred to *Gyrodos* sp. The mold indicates a shell of about two and a half turns, a low spire and a rounded shoulder lacking a carina. The umbilicus is open though not as wide as in most species of *Gyrodos*. There probably was a weak carina on the rim of the umbilicus, but no carina on the inner wall. The mold measures: Height 11+ mm, diameter about 12.5 mm. USNM 128178.

Family TURRITELLIDAE

Genus TURRITELLA Lamarek, 1799, sensu lato

Turritella tippiana Conrad

Plate 22, figures 20–22

1858. *Turritella tippiana* Conrad, Acad. Nat. Sci. Phila., Jour., 2d ser., v. 3, p. 333, pl. 35, fig. 19.
 ?1860. *Turritella tippiana* Conrad, Acad. Nat. Sci. Phila. Jour., 2d ser., v. 4, p. 285.
 1907. *Turritella tippiana* Conrad. Weller, N. J. Geol. Survey, Paleontology ser., v. 4, p. 700, pl. 79, figs. 6, 7.
 ?1916. *Turritella tippiana* Conrad. Gardner, Md. Geol. Survey, Upper Cretaceous [Maryland], in W. B. Clark and others, p. 491.
 1926. *Turritella tippiana* Conrad. Wade, U. S. Geol. Survey Prof. Paper 137, p. 162, pl. 56, fig. 9.

Imprints of *Turritella tippiana* Conrad are abundant in the Owl Creek formation of southeastern Missouri (USGS 16430, 16451, 16597, 16598, 19090). Well-preserved shells of this species are abundant in the Owl Creek formation of Mississippi at the type locality on Owl Creek, Tippah County. The description is based mainly on the Mississippi shells.

Shell high turreted, imperforate; apical angle about 20°. Protoconch not observed. Suture closely appressed, moderately impressed, situated at the bottom of a rather wide revolving sulcus. The whorls number 13 or 14 on large adults and are ornamented with revolving sculpture that exhibits some individual variation in the strength of the ribs and in the presence or absence of small secondary ribs in the spaces between the larger ribs; there is, however, a general similarity in the form and sculpture of 11 shells from the type locality, such as to leave no doubt that they all belong to the same species. The shell shown in plate 22, figure 20, is one that was illustrated by Weller (1907, p. 700, pl. 79, fig. 6), and the description of the sculpture here given is based mainly on that specimen.

The flank of each of the larger whorls bears four primary spiral costae; two of these form a pair on the lower half of the flank, separated from each other by a

flat relatively wide interval; above the pair at a narrower interval is a third smaller primary costa; and on the upper half of the flank above a wider slightly excavated interval is the fourth, which may or may not be a little more prominent than either of the other three. Closely paralleling the upper side of the lower suture is a low, narrow, weak secondary spiral, and between the uppermost primary and the suture above is a similar secondary spiral. Weak to obscure spiral lining, variable on different individuals, may be present in any of the intercostal areas. The growth lines are rather strongly convex forward on the base and periphery and concave forward above the periphery. The periphery bends sharply over to a steep, slightly convex base, which bears fine, more or less obscure, spirals that are coarsest near the periphery. The aperture is subcircular except that it is angulated at the rear. A thin callus is present on the parietal wall.

The sculpture as seen in the imprints from the Owl Creek formation of southeastern Missouri agrees essentially with that of the topotypes from Mississippi.

Conrad's original description of this species is brief and inadequate, and his illustration is inaccurate. The topotype from Owl Creek, which Weller figured, and which is refigured here, may be considered a neotype.

The specimen figured by Wade from the Coon Creek tongue of the Ripley formation, McNairy County, Tenn., exhibits sculpture quite similar to that of typical specimens except that the spiral costae are more sharply and more strongly developed; also the growth lines stand out more conspicuously giving to the surface a finely roughened appearance.

Types.—The whereabouts of Conrad's figured specimen is not known and it is presumed to be lost. Topotype, USGS 707 USNM 20419; 10 unfigured topotypes, USGS 707, USNM 128180. Two plesiotypes from southeastern Missouri, USGS 16451, USNM 128179.

Range.—The species ranges questionably from the upper part of the *Exogyra ponderosa* zone through the *E. costata* zone in the Atlantic and Gulf Coastal Plain. It is common in the Owl Creek formation of Mississippi and southeastern Missouri.

Turritella vertebroides Morton, sensu lato

Plate 22, figures 16–19

1834. *Turritella vertebroides* Morton, Synop. Organ. Remains Cretaceous group, United States, Philadelphia, p. 47, pl. 3, fig. 13.
 1892. *Turritella vertebroides* Morton. Whitfield, U. S. Geol. Survey Mon. 18, p. 146, pl. 18, figs. 13–15, questionably figs. 16–18. (Also issued as N. J. Geol. Survey, Paleontology ser., v. 2.)
 1907. *Turritella vertebroides* Morton. Weller, N. J. Geol. Survey, Paleontology ser., v. 4, p. 693, pl. 78, fig. 15 (not fig. 14; questionably figs. 16, 17).
 1923. *Turritella vertebroides* Morton. Stephenson, N. C. Geol. and Econ. Survey, v. 5, p. 366, pl. 91, figs. 11–14.

1926. *Turritella vertebroides* Morton. Wade, U. S. Geol. Survey Prof. Paper 137, p. 161, pl. 56, fig. 1.

Fossil imprints, both external and internal molds, identified as belonging to *Turritella vertebroides* Morton, were found in the Owl Creek formation of southeastern Missouri at four localities (USGS 16429 + 16452, 16451, 16598, 19090). Morton's type specimen is a crushed shell including parts of two of the larger whorls, from "New Jersey." The sculpture is fairly well preserved on what appears to be the penultimate whorl, but the shell is too incomplete for satisfactory comparison with shells from the Gulf region. However, there is no question but that the sculpture as shown by the Missouri imprints is of the vertebroid sort and appears to be essentially like that of Morton's type specimen. Well-preserved shells of the species are common in the Owl Creek formation of Mississippi.

The species is characterized by a high turreted, uniformly tapering spire of 12 or 13 whorls and an apical angle of about 20°. The sides of the whorls are gently and uniformly convex and the suture is closely appressed in the bottom of a broad shallow depression. Some adult shells show a gerontic stage in which the body whorl becomes separated from the penultimate whorl and crowded coarse growth lamellae form an upraised apertural outer lip. The flanks of the body whorl bear four narrow primary spiral ridges, much narrower than the interspaces; these primaries may be uniformly spaced, or, as in most of the Missouri and Mississippi specimens, the space between the two upper primaries may be a little wider than the others; a secondary spiral lies a little below the upper suture, and a secondary forms a sharp peripheral ridge on the body whorl and is exposed immediately above the lower suture on the penultimate and earlier whorls.

The base is flat, very steep and nearly smooth, though microscopic spiral lirae may be detected on some specimens. The growth lines cross the base in a broad, curve concave toward the front and strongly oblique in that direction; at the periphery they swing sharply back and cross the flank above in a pronounced curve concave toward the aperture. The aperture is subcircular to broadly ovate and flares a little in the gerontic stage.

The dimensions of the specimen from Owl Creek, Miss., shown in plate 22, figures 16, 17, are: Height 68 mm, maximum diameter 21 mm. The largest shell in the Owl Creek collection is 76.5 mm high.

Types.—Holotype, collection of the Academy of Natural Sciences of Philadelphia; the holotype is figured by Stephenson (1923, pl. 91, fig. 11). One plesiotype from Owl Creek, Tippah County, Miss., USGS 707, USNM 128181; 1 plesiotype from the Owl Creek formation of southeastern Missouri, USGS 16451, USNM 128182.

Range.—The known range of the species is through the *Eoogyra costata* zone in the Atlantic and Gulf Coastal Plain.

Genus TROBUS Stephenson, n. gen.

Type species: *Trobus buboanus* Stephenson

Etymology.—By anagram from *robust*. Gender, masculine.

Shell large, thick, robust, high turreted, with spiral angle of about 13°. Whorls 18 or 20 (estimated), flat to slightly concave on the sides. Suture in a deep furrow that is squarish in cross section. The earlier whorls are smooth on the flank, the upper edge, however, projecting upward and overhanging the sutural furrow; at a diameter of about 20 mm the upper edge of the flank begins to swell outward and as growth proceeds this swelling gradually increases to a distinct narrow spiral ridge that borders and overhangs the sutural furrow; at a diameter of about 25 mm the lower border of the flank begins to swell outward and it too develops into a narrow prominent spiral; the upper spiral is irregularly undulating on the crest, and the lower is nearly smooth. The space between these two spirals is wide, flat, or slightly and broadly concave.

The base is steep, gently convex, and bears four moderately strong, evenly spaced spiral ridges that decrease slightly in strength downward; the upper one of these spirals is exposed on the penultimate whorl just above the lower suture. The trend of the growth lines on the base is slightly sinuous and nearly directly upward; they cross the flank above in a broad curve concave toward the aperture. The aperture is subcircular to broadly subovate, the outer lip is uniformly arched, and the inner lip forms a thick callus on the parietal wall.

Trobus buboanus Stephenson, n. sp.

Plate 22, figures 23-25

The species, *Trobus buboanus* Stephenson appears to be represented in the Owl Creek formation of southeastern Missouri by a fragment of one distorted internal mold from Stoddard County (USGS 16452). The fragment pertains to the adult portion of a large turreted gastropod and is too imperfect for certain identification. However, no other turreted gastropod as large as *T. buboanus* is known in the Owl Creek formation and the reference of the fragment to this species is probably correct. The description of the species is based on the holotype from Owl Creek, Tippah County, the features of which are described in detail in connection with the description of the genus. The holotype is well preserved and includes the body whorl (outer lip broken) and four successively earlier whorls; the apex and younger part of the spire to a diameter of 16 mm are missing.

The dimensions of the incomplete holotype are: Height 111+ mm, greatest diameter, measured on the most prominent spiral, 40 mm.

A large internal mold from the Ripley formation at Lander's Mill, Tippah County, Miss. (USGS 714) is referable to the genus *Trobus*, but is too incomplete for certain specific identification. However, a fragment of the external mold of the body whorl reveals surface features indicating very close relationship, if not specific identity with *T. buboanus*.

Types.—Holotype, from the Owl Creek formation, Owl Creek, Tippah County, Miss., USGS 707, USNM 20423; a fragment of an internal mold, from the Owl Creek formation of southeastern Missouri, is provisionally identified as belonging to *Trobus buboanus*, USGS 16452, USNM 128184.

Range.—Known from the Owl Creek formation of Mississippi and Missouri, and questionably from the upper part of the Ripley formation in Tippah County, Miss.

Family APORRHAIIDAE

Genus **ANCHURA** Conrad, 1860, *sensu lato*

Anchura? spp.

Plate 22, figures 10–12

Imprints of incomplete shells that probably belong to the Aporrhaidae and possibly to the genus *Anchura* (*sensu lato*) are in collections from three localities in the Owl Creek formation of southeastern Missouri (USGS 16429, 16451, 19090). The preservation is poor but enough of the sculpture is shown to suggest that three or more species are represented. Two of the imprints are illustrated in plate 22, figures 10–12. USNM 128185 and 128186.

Genus **HELICAILAX** GABB, 1868

Helicailax formosa Stephenson, n. sp.

Plate 21, figures 7–9

Imprints of several fragments of this species are in the collection from one locality in the Owl Creek formation of southeastern Missouri (USGS 19090). About a dozen fairly well preserved, though incomplete, shells from the Owl Creek formation on Owl Creek, Tippah County, Miss., afford the main basis for the description of the species.

The shell is of medium size, medium high turreted, with apical angle of about 25°. Whorls 10 to 12 in adults, moderately and uniformly convex on the side. Protoconch not well preserved. Suture closely appressed, moderately impressed. Body whorl elongate, broadly rounded on the periphery and base. Axial ribs numerous, narrow, separated by wider interspaces; on the larger whorls of the spire there are about 24 axials that trend with a slight obliquity rearward across the flank but bend forward above as they approach the suture. Each of the larger whorls of the spire bears four weak primary spiral ribs that produce beadlike nodes where they cross the axials; these primaries become weaker rearward and are wanting on the early

apical whorls; the side of each whorl is covered with fine, closely spaced spiral lirae that override the axials. The body whorl bears 7 or 8 primary spiral ribs that produce more prominent nodes where they cross the axials than are present on the whorls of the spire above; the second primary rib below the suture increases in prominence as it approaches the aperture.

The aperture is elongate-lanceolate, acutely angular at the rear, and extends far forward as a narrow siphonal channel in a nearly straight spinelike beak. In mature shells the outer lip expands forward to form a broad winglike extension of somewhat variable outline on different individuals; the upper part of this wing is produced forward and upward spurlike and bears a narrow sharp ridge; this ridge is the forward continuation of the prominent primary rib on the body whorl, previously mentioned. The inner lip forms a rather thick band of callus that, in mature shells, extends spinelike up the side of the spire, toward the top of which it is deflected away from close contact with the whorls; the anal channel traverses this band of callus.

Dimensions of the holotype: Height, tip of apex to tip of beak, about 41 mm; diameter, exclusive of expanded wing about 10 mm; including expanded wing, 24 mm.

The Missouri material, though incomplete, reveals enough features for satisfactory identification. The form of the shell, the ornamentation, and the expanded winglike outer lip appear to be identical with the types from Owl Creek, Miss.

Types.—Holotype, from Owl Creek, Tippah County, Miss., USGS 707, USNM 128189; 7 paratypes from Owl Creek, USNM 20434; 2 figured paratypes from the Owl Creek formation of southeastern Missouri, USGS 19090, USNM 128187; 1 unfigured paratype from the same source, USNM 128188.

Range.—Known only from the Owl Creek formation of Mississippi and southeastern Missouri.

Superfamily RACHIGLOSSA

Family PYROPSIDAE

Genus **NAPULUS** Stephenson, 1941

Napulus octoliratus (Conrad)

Plate 21, figures 2–5

1858. *Ficus octoliratus* Conrad, Acad. Nat. Sci. Phila. Jour., 2d ser., v. 3, p. 332, pl. 35, fig. 6.

1941. *Napulus octoliratus* (Conrad). Stephenson, Tex. Univ. Pub. 4101, p. 320, pl. 60, figs. 7, 8.

Internal molds of three examples of *Napulus octoliratus* (Conrad), all incomplete, are present at one locality in the Owl Creek formation of southeastern Missouri (USGS 19090). The external spiral ribbing of the whorls is rather weakly impressed upon the molds. The shell described by Conrad came from the

Owl Creek formation at Owl Creek, Tippah County, Miss., and two topotypes from that locality are here figured (pl. 21, figs. 2, 3).

Shell small, thin, pyriform, with a low spire having an angle of about 95°. Protoconch smooth, low turbinate, coiled about one and a half turns. The body whorl is plumply rounded and bears six nearly evenly spaced primary spiral ribs having flattish to broadly rounded crests; the interspaces are about three times as wide as the ribs are thick and are smooth or bear obscure spiral lining; low on the base and on the upper part of the siphonal extension (beak) are 3 or 4 revolving ribs of secondary strength. Axial ribbing is wanting. Aperture broadly lanceolate with an acute angle at the rear and a narrow siphonal channel traversing a long nearly straight beak at the front. Outer lip evenly arched; inner lip forming a thin layer of callus extending well forward on the parietal wall.

The internal molds of the three specimens from the Owl Creek formation of Missouri appear to be identical in form with the topotypes from Mississippi, and have closely similar sculpture impressed upon them.

Types.—The whereabouts of Conrad's type specimen is unknown and is presumed to be lost. Two topotypes from Owl Creek, Tippah County, Miss., USGS 707, USNM 128190; 2 pleiotypes from the Owl Creek formation of southeastern Missouri, USGS 19090, USNM 128191.

Range.—The species has been identified from the Owl Creek formation and the Prairie Bluff chalk (Maestrichtian) of northern Mississippi and from the Owl Creek formation of southeastern Missouri; it has been questionably identified from the Kemp clay of the Navarro group (Maestrichtian) of Texas.

Napulus? sp.

Plate 21, figure 6

One shell referred to *Napulus?* sp., from the Owl Creek formation of southeastern Missouri, is represented by incomplete internal and external molds (USGS 16451). It is probably an undescribed species, but is too poorly preserved to serve as a type. It is about the same size as *Napulus octoliratus* and possesses about the same number of revolving ribs, but these ribs are weakly noded. The incomplete penultimate whorl indicates that the spire is higher than the spire of *Napulus*, and the specimen may belong to a different genus. USNM 128192.

Family MOREIDAE

Genus MOREA Conrad, 1860

Morea transenna Stephenson, n. sp.

Plate 22, figures 6-9

Shell of medium size and has about four rapidly expanding whorls. Spire low with an apical angle of

about 90°. Protoconch rather high turbinate, coiled one and a half or two times. Suture deeply impressed, closely appressed in earlier stages, opening out a little in adults. Body whorl large, with a pronounced narrow shoulder above, the surface rounding down broadly from shoulder to base. The surface of an adult body whorl bears from top to bottom 11 pronounced square-topped spiral ribs, separated by interspaces of equal or greater width than the ribs. The axial ribs are numerous, closely spaced and form squarish nodes where they intersect the spirals. The spiral rib at the shoulder angle is thicker than any of the others and is separated from the uppermost spiral by a relatively wide excavated interspace. Three spirals are exposed between sutures on the earlier whorls and a fourth spiral may appear above the lower suture of the penultimate whorl as the coiling of the body whorl becomes looser. Aperture elongate-lanceolate with a short anal notch at the rear and a rather wide siphonal notch at the front. Outer lip broadly arched, notched at the ends of the ribs; inner lip forming a callus that spreads forward somewhat on the parietal wall above, but opens out to form a rather wide umbilical fissure below. A narrow, sharp, twisted columellar fold lies just above the siphonal canal.

The holotype, which is shortened a little by a break at the forward end, measures: Height 22 + mm, diameter 14 mm. A small, nearly complete paratype (pl. 22, fig. 8) measures: Height 12.5 mm, diameter 8 mm.

The species is more similar to *Morea marylandica* Gardner (1916, p. 466) than it is to any available species of *Morea*. Compared with the Maryland species *M. transenna* has more numerous and closely spaced axials, thus producing a finer sculpture pattern at the same growth stages, and its shoulder droops at a much steeper angle.

One incomplete external mold from the Owl Creek formation of southeastern Missouri (pl. 22, fig. 9) pertains to an immature individual of *Morea transenna* that is about as large as the figured paratype from Owl Creek, Miss. (USGS 19090).

Types.—Holotype, from the Owl Creek formation on Owl Creek, Tippah County, Miss., USGS 707, USNM 128194; paratype from the same source, USNM 20443; 1 paratype from the Owl Creek formation of southeastern Missouri, USGS 19090, USNM 128193.

Range.—So far as known this species is restricted in range to the Owl Creek formation (Maestrichtian) of Mississippi and Missouri. However, closely related species occur in the Ripley formation and beds of Ripley age in the Gulf region and as far north in the Atlantic Coastal Plain as the Monmouth formation of Maryland.

Family FASCIOLARIIDAE
Genus FUSINUS Rafinesque, 1815

Fusinus? sp. A
Plate 22, figure 13

The internal mold of one small gastropod having the external sculpture impressed upon it, from one locality in the Owl Creek formation of southeastern Missouri (USGS 19090) has form and ornamentation that suggests the genus *Fusinus* Rafinesque. Its distinguishing features are a medium low spire, with spiral angle about 40°, short plump whorls, seven short, narrow, prominent, widely spaced axial ribs, numerous weak spiral ribs that override the axials, and a long straight beak. The suture is deeply impressed and there is no collar band. The dimensions are: Height 13+ mm, diameter 6 mm. No shell matching this one is present in our collections from the Owl Creek formation of Mississippi, and the mold appears to represent an undescribed species. USNM 128195.

Fusinus? sp. B
Plate 22, figure 14

The incomplete external mold of a small gastropod from the Owl Creek formation of southeastern Missouri (USGS 19090) is referred questionably to *Fusinus* Rafinesque. The spire is short with an angle of about 50°. The whorls are plump and bear prominent axial ribs and small, weak to obscure spiral ribs. A narrow shoulder is produced by a constriction below the suture. On the body whorl the axial ribs number 7 or 8, are separated by wider interspaces, extend down over the rounded periphery, and fade out about halfway down the base. A narrow collar band below the suture bears small nodes of irregular strength and even spacing. Four or five spiral ribs of medium strength and even spacing are on the base below the ends of the axial ribs. The mold as preserved measures: Height 8+ mm, diameter 5 mm. The mold probably pertains to an undescribed species. USNM 128196.

Family VOLUTIDAE
Genus LIOPEPLUM Dall, 1890
Liopeplum rugosum Stephenson, n. sp.
Plate 22, figures 1-5

1890. *Liopeplum subjugosum* Dall (not Gabb), Wagner Free Inst. Sci. Trans., v. 3, pt. 1, p. 83, pl. 6, fig. 12a.

Three incomplete internal molds from the Owl Creek formation of southeastern Missouri (USGS 16451) are here referred to the new species, *Liopeplum rugosum* Stephenson. The description of the species is based on shells more or less completely preserved from

the Owl Creek formation of Tippah County, Miss. The species is characterized by the medium height of its spire of 4 or 5 whorls, its elongated body whorl, the coarse, thick, short axial ribs on the upper part of the body whorl and on the exposed parts of the earlier whorls, the thick ridge of bluntly nodose callus on the lower part of the penultimate and earlier whorls, the anal canal that follows the line of the suture just below the ridge of callus, the three or four columellar plaits mounted on a thickened part of the callus on the lower part of the inner lip, and the bright glaze that covers the entire shell. Where not covered with callus a few spiral threads may be seen on the outer surface near the forward end of the shell.

The three incomplete internal molds from Missouri agree in form with *Liopeplum rugosum*, and the axial ribs, which also seem to agree in number and spacing, are weakly impressed upon the molds. The largest of the molds measures: Height 32+ mm, diameter 17.5 mm.

The shell from Coon Creek, referred by Wade (1926, p. 118) to *Liopeplum subjugosum* (Gabb) differs from *L. rugosum* in several of its features. The axials are shorter, and, though present in medium strength on the penultimate whorl, they are much more numerous and become successively weaker forward on the body whorl, and on adults they fade out to a smooth surface before reaching the aperture; the ridge of callus above the suture is smoother and more uniformly developed, and the columellar plaits are fewer, weaker, and are not mounted on a thickened part of the inner lip. These differences seem to justify treating the Coon Creek shells as specifically different from those from Owl Creek. There is also the added consideration that the Coon Creek shells are from the Coon Creek, or basal, tongue of the Ripley formation, whereas the Owl Creek shells are from the Owl Creek formation which overlies the Ripley formation.

Nomenclatorial considerations require that an explanation be given as to why the name *Liopeplum subjugosum* Dall cannot be validly used for the species here described. In 1855 a species, *Voluta jugosa*, was described by Tuomey (1855, p. 169). Gabb (1861, p. 149) found that the name *V. jugosa* was preoccupied by Sowerby and he renamed Tuomey's species *V. subjugosa*. There is no indication in Gabb's paper that he saw Tuomey's material; he merely substituted in a list the new name for the preoccupied specific name *jugosa*.

Tuomey's type material came from "Noxubie" County, Miss. His description of both the fossils and

the localities at which they were collected are inadequate, he published no illustrations, and his types are lost. The zonal source of his species, *Voluta jugosa*, is unknown because outcrops in Noxubee County include Upper Cretaceous beds ranging in age from Santonian to Maestrichtian. Dall (1890, p. 83) described and figured a shell from Tippah County, Miss., to which he applied the name *Liopeplum subjugosum* Dall. In attaching his own name as author of the species he seems to recognize the uncertainty of the identity of the shells from Tippah and Noxubee Counties. In reality he treats the Tippah County specimens as previously undescribed and assumes responsibility for the name which he applies to them. Actually there is no basis, other than Tuomey's brief description, for concluding that the shells from Tippah and Noxubee Counties are specifically identical. In view of these facts it seems necessary to conclude that the name *L. subjugosum*, as of Dall, is preoccupied by *L. subjugosum* (Gabb). This is the interpretation here accepted and the new name, *L. rugosum* Stephenson is proposed for the Tippah County shells.

Dall recorded the source of his *Liopeplum subjugosum* as "the Ripley sands of Tippah Co., Miss., Mr. Stanton." The "Ripley sands" as used at that time (1890) included the Ripley and Owl Creek formations of the current classification. There is nothing in our records to show whether Dall's figured specimen came from the Ripley or from the Owl Creek. However, his type specimen agrees closely in its features with the primary types of my new species, *Liopeplum rugosum*, which are from the Owl Creek formation at Owl Creek, Tippah County, and the assumption seems justified that Dall's type came from the Owl Creek formation, probably from the Owl Creek locality; the name *L. subjugosum* Dall seems therefore properly to belong in the synonymy of *L. rugosum* Stephenson.

Types.—Holotype, from Owl Creek formation, Owl Creek, Tippah County, Miss., USGS 707, USNM 128200; 1 paratype from same source, figured, USNM 128199. Two figured paratypes from the Owl Creek formation of southeastern Missouri, USGS 16451, USNM 128198; 1 unfigured paratype from the same source USNM 128197.

Range.—As here restricted the species is known only from the Owl Creek formation of Mississippi and Missouri.

Genus **DRILLUTA** Wade, 1916

Drilluta sp.

Plate 22, figure 15

The internal mold of about half a turn of the body whorl of a gastropod from the Owl Creek formation of southeastern Missouri (USGS 16429), appears to pertain to the genus *Drilluta* Wade. The sculpture as

it is impressed upon the mold includes eight axial ribs that extend well down over the base, and each rib bears a weak node at its upper end; 8 or 9 weak to obscure spirals are present and override the axials. The sculpture resembles that of *Drilluta ripleyana* (Conrad) except that the axial ribs appear to be more numerous and closely spaced. USNM 128201.

A similar specimen from another locality in Missouri (USGS 19090) has about the right number of axial ribs to match *D. ripleyana*, but the specimen is too poorly preserved for certain identification. USNM 128202.

Genus **VOLUTOMORPHA** Gabb, 1877

Volutomorpha? spp.

Plate 23, figures 1, 2

Fossil molds of gastropods from two localities in the Owl Creek formation of Stoddard County, Mo., are referred questionably to *Volutomorpha* Gabb. The specimens from the two localities may belong to the same species, but their specific identity is not established. The specimen from one of the localities (USGS 14651) is the internal mold of a medium-sized shell with a rather high spire and a spiral angle of about 35° (pl. 23, fig. 2). The suture is deeply impressed. Three whorls are preserved and have impressed upon them thick strong axial ribs separated by interspaces that are about as wide as the ribs are thick; the axials number 9 or 10 on each of the whorls; on the body whorl the axials die out downward about at the periphery. Ten spirals are rather distinctly impressed on the lower part of the body whorl, the lower 5 are coarser and more widely spaced than the upper 5. This incomplete mold measures: Height 43+ mm, diameter about 24 mm. USNM 128204.

The other locality (USGS 19090) yielded the internal and external molds of part of the body whorl of one individual (pl. 23, fig. 1). Three short thick axial ribs are present on the upper part of this fragment, and the whole surface is ornamented with 15 revolving ribs the lower 5 of which are stronger and more widely spaced than the other ribs higher on the shell. The upper 5 or 6 spirals override the axials, and in the interspaces these spirals are weakly nodose. USNM 128203.

Family **HARPIDAE**

Genus **EOHARPA** Stephenson, n. gen.

Type species: *Eoharpa sinuosa* Stephenson.

Etymology.—Greek *eo*, early; *Harpa*, a gastropod genus.

The new genus *Eoharpa* is a medium-sized gastropod with a low spire of 3 or 4 whorls, a moderately plump body whorl constricted anteriorly and extending well

forward as a markedly sinuous beak and siphonal canal. The surface ornamentation consists of long, narrow, sharp, widely spaced axial ribs that extend to the base of the whorl, and numerous weak, evenly spaced sharp-crested spirals that are narrower than the interspaces. The aperture is long and narrow and the inner lip forms a rather thick band of callus extending well forward on the parietal wall and beak; small tubercles of irregular size, shape and distribution stipple a band several millimeters wide on the callus near its forward margin.

Eoharpa sinuosa Stephenson, n. sp.

Plate 23, figures 3-6

Shell of medium size, pyriform, with a low spire of 3 or 4 whorls; spiral angle about 70°. Protoconch not preserved. Suture moderately impressed. Body whorl plump above, rounding broadly down over the periphery to the base; shoulder narrow, poorly defined, with a slight narrow crinkled overlap on the side of the whorl above. Axial ribs long, narrow, sharp, widely spaced, above extending across the shoulder with diminishing strength to the suture; 12 axial ribs are on the body whorl and 11 on the penultimate whorl. The spiral ribs are very subdued, regularly spaced and narrower than the interspaces.

Aperture elongate-lanceolate, acutely angular at the rear and extending forward as a narrow, siphonal canal in a long sinuous beak. The outer lip, which is not complete, is thin and broadly arched; the inner lip forms a wide band of callus on the parietal wall and beak; it is broadly concave in its upper half and sinuous below. Tubercles of irregular size, shape, and distribution ornament the callus covering in a band just back of its forward margin. The columella is strongly twisted and apparently without plaits.

Dimensions of the holotype: Height 24+ mm, diameter about 11 mm; length of aperture, including siphonal canal, 19 mm.

An external mold that includes part of the body whorl and part of the penultimate whorl of a shell of *Eoharpa sinuosa* (pl. 23, fig. 6) is present in the collection from one locality in the Owl Creek formation of southeastern Missouri (USGS 19090); accompanying the outer mold is the internal mold of part of the body whorl. These molds pertain to an individual that has a diameter of at least 17 mm, and is therefore considerably larger than the holotype from Mississippi.

Types.—Holotype, from the Owl Creek formation, Owl Creek, Tippah County, Miss., USGS 707, USNM 20400; one paratype from the Owl Creek formation of southeastern Missouri, USGS 19090, USNM 128205.

Range.—Known only from the Owl Creek formation of Mississippi and Missouri.

Superfamily TOXOGLOSSA
Family CANCELLARIIDAE
Genus CAVEOLA Stephenson, 1941

Caveola sp.

Plate 23, figure 7

The external and internal molds of a small gastropod from the Owl Creek formation of southeastern Missouri (USGS 19090) appears to be referable to *Caveola* Stephenson. The spire is of medium height with a spiral angle of about 30°. The sutures are deeply impressed. The whorls are moderately convex on the side. The body whorl is broadly convex from the ill-defined shoulder above to the base, with no indication of an angle at the periphery; a slight steepening of the surface above as it rounds down to the suture is suggestive of a narrow shoulder.

The surface of the shell above the periphery is ornamented with a network of revolving riblets crossed by similar axial riblets; the axial riblets die out on the base below the periphery but the spirals continue well developed to the base. The aperture is elongate-lanceolate, ending anteriorly in a short open siphonal canal. The columella bears at least two prominent plaits somewhat below the base of the parietal wall. The dimensions of the shell are: Height apex to end of beak 25 mm; diameter 5 mm. USNM 128206.

This shell resembles rather closely the species, *Caveola producta* Stephenson, from the Nacatoch sand of the Navarro group (Maestrichtian), Texas (Stephenson, 1941, p. 364, pl. 7, figs. 11, 12). The details of sculpture and form are, however, not well enough shown in the one available specimen to justify referring it to the Texas species.

Order OPISTHOBRANCHIA

Suborder TECTIBRANCHIATA

Family ACTEONIDAE

Genus EOACTEON Stephenson, n. gen.

Type species: *Solidulus luteus* Conrad

Etymology.—Greek *eo*, early; *Acteon*, a gastropod genus

The new genus *Eoacteon* is similar to and closely related to the Recent *Acteon* Montfort, but differs mainly in the features of the columella. In *Acteon* there is a conspicuous columellar fold that reaches the aperture in strength; in *Eoacteon* there is a corresponding but much weaker fold and in addition there is a second and still weaker fold low on the columella just above and parallel to the siphonal canal. The Recent genus *Solidula* Fischer appears to be closely related to *Eoacteon*, but it too possesses a conspicuous columellar fold that reaches the aperture. *Fictoacteon* Stephenson, a genus represented by several species in the Wood-

bine formation (Cenomanian) of Texas, appears to possess a smooth columella.

Eoacteon linteus (Conrad)

Plate 23, figures 8-10

1858. *Solidulus linteus* Conrad, Acad. Nat. Sci. Phila. Jour., 2d ser., v. 3, p. 334, pl. 35, fig. 10.

The species *Eoacteon linteus* (Conrad) is represented in the Owl Creek formation of southeastern Missouri by one internal mold on which the surface sculpture is weakly impressed (USGS 19090). One of several shells from Owl Creek, Tippah County, Miss., the type locality of the species is nearly complete and is available for comparison and description. Shell rather small, lanceolate in outline, moderately inflated, with about six rapidly expanding whorls. Spire short with spiral angle of 45°. Body whorl nearly twice as long as the spire is high, broadly rounded from suture above to base. Suture closely appressed in a shallow depression.

Surface ornamented all over with numerous flat-topped spiral ribs of differing width, separated by narrow, shallow, finely punctate grooves. Aperture elongate, narrow above, ending at the rear in a narrowly acute angle, widening below and ending in front in a sharply rounded margin. Outer lip thin, broadly arched; inner lip lacking callus at the upper part of the aperture, with callus appearing low on the parietal wall and extending as a slightly upraised rim to the anterior margin. Columella with one relatively weak fold just below the base of the parietal wall, and a second still weaker fold low on the columella just above and parallel to the siphonal canal.

Dimensions of the figured topotype: Height 17.3 mm, diameter 7.6 mm; length of aperture 11.5 mm.

The internal mold from Missouri is not quite as large as the figured topotype but agrees with it in form and sculpture. It is 13.7 mm high and 6.2 mm in diameter.

The shell from the Monmouth formation of Maryland, referred to this species by Gardner under the name *Acteon linteus* (Conrad), (1916, p. 397), although closely related, appears to be more slender in profile, with a slightly higher spire, and should probably be treated as specifically distinct. The shell from the Coon Creek tongue of the Ripley formation referred by Wade (1926, p. 101) to the species, has a slightly higher spire and is less inflated on the upper part of the body whorl; these differences are slight but if persistent would seem to justify specific separation.

Types.—Conrad's type material is apparently lost, but the specimen shown in plate 23, figures 8, 9 (USGS 707, USNM 128208), is from the type locality on Owl Creek, Tippah County, Miss.; it is believed to be a topotype. One plesiotype from the

Owl Creek formation of southeastern Missouri, USGS 19090, USNM 128207.

Range.—So far as at present known the species, as here restricted, is confined to the Owl Creek formation of Mississippi and Missouri. However, very closely related forms occur in the stratigraphically lower Ripley formation and in the Monmouth formation of Maryland.

Family BULLARIIDAE

Genus BULLOPSIS Conrad, 1858

Bullopsis cretacea Conrad

Plate 23, figures 11-19

1858. *Bullopsis cretacea* Conrad, Acad. Nat. Sci. Phila. Proc., 2d ser., v. 3, p. 334.

1860. *Bullopsis cretacea* Conrad, Acad. Nat. Sci. Phila. Proc., 2d ser., v. 4, p. 298, pl. 46, fig. 27. (No text description.)

One internal mold of a medium-sized shell, 4 internal molds and 1 external mold probably representing youthful stages of the same species, from 1 locality in the Owl Creek formation of southeastern Missouri (USGS 19090), are referred to *Bullopsis cretacea* Conrad. The description which follows is based mainly on a collection of many well-preserved shells from the type locality on Owl Creek, Tippah County, Miss.

Shell small, involute, broadly subovate in vertical profile, with spire sunken in a shallow depression. Protoconch small, smooth, tilted. The shell expands rapidly and the body whorl is large. Superficially the surface appears smooth but fine spiral grooves may be seen under a magnifying lens; these grooves range in strength, on different individuals, from fairly plain on some to obscure on others; the grooves also range in number and spacing on different shells, from many closely spaced, to fewer more widely spaced. Typically they are relatively widely spaced, numbering 25 or 30 on the body whorl. The aperture is as long as the shell is high; it is narrow but rounded at the posterior end, widens considerably toward the front and is rounded on the front margin. Outer lip thin and broadly arched; inner lip forming a thin wash of callus above on the parietal wall, thickening below where it bears two prominent columellar folds.

Dimensions of the adult shell shown in plate 23, figures 11, 12: Height 18 mm, diameter 13.4 mm.

The one medium-sized internal mold from Missouri (pl. 23, figs. 17, 18) has the typical form of *Bullopsis cretacea* but does not bear the impressions of external grooves. Obscure traces of the grooves can be seen on one of the juvenile internal molds, and the grooves are clearly shown on the external mold of one small shell (pl. 23, fig. 19).

Types.—Holotype, from Owl Creek, Tippah County, Miss., collection of the Academy of Natural Sciences Philadelphia. Three figured topotypes, USGS 594, USNM 128221; 2 figured topotypes,

USGS 707, USNM 128211. Two plesiotypes from the Owl Creek formation of southeastern Missouri, USGS 19090, USNM 128209. Many topotypes are present in the National Museum collection, USNM 21685 (USGS 594), and USNM 20438 (USGS 707).

Range.—Owl Creek formation of Mississippi and Missouri.

Family SCAPHANDRIDAE

Genus CYLICHNA Lovén, 1846

Cylichna sp.

Two internal molds of a small gastropod from the Owl Creek formation in southeastern Missouri (Scott County, USGS 16598; Stoddard County, 19090) appear to belong to *Cylichna* Lovén. They are similar in form to shells from the Upper Cretaceous that have been referred to *Cylichna recta* (Gabb) by Weller (1907, p. 814), Gardner (1916, p. 411), and Wade (1926, p. 106). However, Gabb's species came from the so-called "Green Marl" of New Jersey, a geologic unit later named Hornerstown marl, and now known to be of Eocene age. The specific identification by the authors cited is therefore questioned. The molds pertain to small, slender, completely involute shells that do not show the impressions of surface sculpture. The largest of the two molds measures: Height 6.5 mm, diameter 3.4 mm. USNM 128212 and 128213.

Class CEPHALOPODA

Subclass TETRABRANCHIATA

Order AMMONOIDEA

Family BACULITIDAE

Genus BACULITES Lamarck, 1799

Baculites carinatus Morton

Plate 24, figures 5-9

1834. *Baculites carinatus* Morton, Synopsis of the organic remains of the Cretaceous group of the United States, p. 44, pl. 13, fig. 1.
 1858. *Baculites tippaensis* Conrad, Acad. Nat. Sci. Phila. Jour., 2d ser., v. 3, p. 334, pl. 35, fig. 27.
 1858. *Baculites spillmani* Conrad, Acad. Nat. Sci. Phila., Jour., 2d ser., v. 3, p. 335, pl. 35, fig. 24.

The presence of *Baculites* Lamarck in the Owl Creek formation of southeastern Missouri is shown by fragmentary external and internal molds pertaining to early stages of growth, at two localities (USGS 16451 and 16452). One of the external molds reveals three features that permit its identification with *Baculites carinatus* Morton the type of which came from the Prairie Bluff chalk at Prairie Bluff, Wilcox County, Ala. Morton's figured type is an incomplete internal phosphatic mold about 50 mm long, measuring in its dorsoventral diameter about 15 mm at the small end and 18 mm at the large end.

The species is represented by numerous incomplete examples from Owl Creek, Tippah County, Mo. (USGS 707, USNM 20862), most of which retain all or

parts of the shell. They are all more or less distinctly carinated on the ventral side. The features preserved on the one external mold (USGS 16452) mentioned in the preceding paragraph include first, two weak ribs on the flank, which herald the larger, stronger ribs on later stages of growth, second, long sweeping growth lines that extend obliquely forward from the ribs to the edge of the venter, and third a series of small oblique folds that ornament the venter. Only the edge of the venter can be seen but presumably it is weakly carinated. The significance of the features exhibited by this mold is determined by comparing them with the features of the shells from Owl Creek, Miss. It appears from this comparison that the mold belongs to Morton's species, *Baculites carinatus*.

The Owl Creek shells show that in later stages the ribs become strongly developed on the flanks. An early stage in which the ribs are weak and a later stage in which they become strong are shown in the illustrations. There is much individual variation in the stage of growth at which the ribs make their first appearance on the flanks, some shells remaining smooth until a much later stage than do others. In cross section the shell is broadly subovate, the dorsum being slightly flattened and the venter weakly carinated. The trend of the growth lines and ribs on the flanks is strongly concave toward the aperture, those nearest the venter being strongly oblique and extending far forward.

The maximum dorsoventral diameter of the shell shown in plate 24, figure 5, is 24 mm, and the corresponding transverse diameter 19 mm. This incomplete shell is about 109 mm long and includes about 60 mm of the length of the living chamber.

Types.—The type of *Baculites carinatus* Morton is listed as present in the collection of the Academy of Natural Sciences of Philadelphia. One plesiotype from the Owl Creek formation at Owl Creek, Tippah County, Miss., USGS 707, USNM 128215; plesiotype from the same formation on Braddock's farm, Walnut Creek, 7 miles northeast of Ripley, Tippah County, Miss., USGS 713, USNM 128216. Plesiotype from the Owl Creek formation in southeastern Missouri, USGS 16452, USNM 128214.

Range.—Owl Creek formation of Mississippi and Missouri.

Family SCAPHITIDAE

Genus DISCOSCAPHITES Meek, 1870

Discoscaphites iris (Conrad)

Plate 23, figures 23-30

1858. *Scaphites iris* Conrad, Acad. Nat. Sci. Phila. Jour., 2d ser., v. 3, p. 335, pl. 35, fig. 23.
 1892. *Scaphites iris* Conrad. Whitfield, U. S. Geol. Survey Mon. 18, p. 265, pl. 44, figs. 4-7. (Also issued as N. J. Geol. Survey, Paleontology ser., v. 1.)
 1926. *Scaphites conradi* Morton (var.). Stephenson, Ala. Geol. Survey Spec. Rept. 14, p. 248, pl. 91, fig. 11. (Illustration only.)

The Owl Creek formation of southeastern Missouri has yielded 30 or more internal and external molds that are identified as belonging to *Discoscaphites iris* (Conrad), (USGS 19090); none of the specimens are entirely complete, the collection including poorly preserved parts of individuals representing young, medium and adult stages of growth. The larger internal molds show the characteristic form and ornamentation of Conrad's species. Internal molds of two juvenile shells are present in another collection (USGS 16430). Collections in the United States National Museum include 40 or more topotypes from Owl Creek, Tippah County, Miss. (USGS 594 and 707), many of which are in a fair to good state of preservation.

Shell of medium size, closely coiled in early stages of growth, more loosely coiled in later stages; there is considerable individual variation in form and in the development and spacing of the nodes. Umbilicus small with steep sides. The living chamber expands rapidly, straightens out a little and becomes somewhat elongated, and in the gerontic stage bends inward and becomes noticeably constricted. In its earlier stages the shell is ornamented with numerous weak radiating ribs, some of which do not extend inward as far as the umbilical shoulder; in adults these ribs die out somewhat back of the inner end of the living chamber. In early stages the ribs are short, relatively stout, and cross the flank directly; in later stages their trend is obliquely toward the front.

The shells are typically ornamented with four rows of nodes on each flank. The outer row on the ventral angle has the most numerous and closely spaced nodes; the following rows inward have successively fewer and more widely spaced nodes; on one medium-sized shell there are 32 nodes in the outer row, 26 in the second row inward, 17 in the third, and 8 in the inner row. The nodes on the early stages of the shell are quite small; they become gradually larger in the forward direction, and are relatively coarse on the first half of the living chamber; toward the aperture they become smaller again.

The septate part of nearly every available specimen was not filled with matrix before burial and subsequently was mechanically crushed, making it difficult to determine in detail the complete pattern of the sutures; the sutures on the flank of a crushed topotype are shown on plate 23, figure 27. The septa on the interior of one topotype are shown in plate 23, figure 28. Apparently the sutures as far as they can be seen conform closely to the sutures of *Discoscaphites conradi* (Morton), the type of the genus. The aperture is subquadrate in outline, with the lateral margins converging slightly outward.

Dimensions of the medium-sized topotype shown in plate 23, figures 23-25: Maximum diameter 41 mm, minimum diameter of the ultimate coil 28 mm, maximum radius center to venter 24 mm, dorsoventral diameter of the slightly constricted aperture 13 mm, maximum transverse diameter of the aperture 12 mm. The most inflated part of the shell at right angles to the plain of coiling is near the midlength of the living chamber; here the transverse diameter of the measured topotype is 16 mm.

Types.—The specimen (holotype) figured by Conrad is listed by Johnson (1905, p. 27) as present in the collection of the Academy of Natural Sciences, Philadelphia; three figured topotypes from Owl Creek, Tippah County, Miss., USGS 707, USNM 128218. One plesiotype from the Owl Creek formation of southeastern Missouri, USGS 19090, USNM 128217.

Range.—Owl Creek formation of Mississippi and Missouri; Prairie Bluff chalk of Alabama. (Maestrichtian.)

***Discoscaphites* sp.**

Plate 23, figures 20-22

An internal mold representing part of the living chamber of an undescribed species of *Discoscaphites* Meek is present in one of the collections from the Owl Creek formation of southeastern Missouri (USGS 16429). The mold indicates a plumply rounded, closely coiled shell ornamented with numerous closely spaced, slightly sigmoid, radiating ribs and 4 rows of nodes. On this mold 10 ribs cross the venter where, however, they are much weaker than on the flanks. Eight of the ribs extend inward to the umbilical shoulder, the 2 additional ribs on the venter having been added by the dichotomy of 2 ribs on the flank. One row of small, weak nodes is present on each ventral angle, where each rib has a node on its crest; on each flank 3 to 4 millimeters inward from the ventral angle is a second row of weak nodes, 1 node on each rib. The maximum diameter of the mold as preserved is about 25 mm, the maximum radius center to venter about 16 mm; the estimated maximum dorsoventral diameter is 18 mm and the maximum transverse diameter 20 mm. USNM 128219.

The ribbing on this mold from Missouri matches rather closely that on a fragment of an undescribed species of *Discoscaphites* from Owl Creek, Tippah County, Miss. (USGS 707, USNM 20861), and the two appear to belong to the same species.

Family ENGONOCERATIDAE

Genus SPHENODISCUS Meek, 1871

***Sphenodiscus pleurisepta* (Conrad)**

Plate 24, figures 1-4

1857. *Ammonites pleurisepta* Conrad, United States and Mexican Boundary Survey Rept., v. 1, pt. 2, p. 159, pl. 15, figs. 1a-c.

(For synonymy through 1941 see Tex. Univ. Pub. 4101, 1941, p. 436.)

Add:

1940. *Sphenodiscus* aff. *P. pleurisepta* Conrad. Stephenson and Monroe, Miss. State Geol. Survey Bull. 40, p. 286, pl. 13, fig. 6. (Illustration only.)

The only available specimen of this species from the Owl Creek formation of southeastern Missouri is a fragment of the internal mold of the septate part of a large individual (USGS 19088). Nineteen incomplete internal molds with shell substance adhering to parts of their surfaces, are present in one collection from the Owl Creek formation on Owl Creek, Tippah County, Miss. (USGS 707). All of these have suffered mechanical compression and appear thinner than their true original form. The shell substance where preserved is brightly iridescent and in reflected light exhibits a play of greenish, pinkish, and bronzy tints. The well-preserved growth lines on some of the shells are broadly sigmoid in trend and indicate the presence on each flank at the margin of the aperture of a broad lateral crest centering a little outside the inner row of nodes, and a broad lateral sinus centering on the outer row of nodes; the growth lines also indicate the presence of a short ventral crest.

The one large fragment of an internal mold from Missouri is not mechanically compressed, as are the shells from Owl Creek, Miss.; its maximum transverse thickness about midway of the flanks is 42 mm; its venter is sharply rounded and it shows the sutures well preserved. The ventral lobe is broad and shallow and the ventral saddle is low, broad, and finely notched on its front edge. The first 5 saddles inward from the venter are divided; they increase in size to the 3d saddle and decrease from the 4th inward; as preserved the last 3 saddles inward from the venter are simple; the inner saddles are simple and number 7 or more.

The evidence for the reference of the Missouri specimen to *Sphenodiscus pleurisepta* (Conrad) is the presence on the flanks of low undulations at positions corresponding to the positions of the nodes on earlier stages of growth of the species.

Types.—The holotype of this species is recorded as having come from "Jacun, 3 miles below Laredo"; since no Cretaceous rocks are exposed in that area the stated locality is obviously an error, unless the specimen was transported there by human or other mechanical agency. There is reasonable certainty that the holotype (USNM 9888) came from the Escondido formation (Maestrichtian) somewhere in the Rio Grande region of Texas, probably Maverick County. Plesiotype from the Owl Creek formation, Owl Creek, Tippah County, Miss. (USGS 707, USNM 128183); plesiotype from the Owl Creek formation of southeastern Missouri, collected and donated to the U. S. Geological Survey by Edison Shrum of Advance, Mo., through

Willard Farrar of the Missouri Survey. (USGS 19088, USNM 128220.)

Range.—Owl Creek formation of Mississippi and Missouri; Corsicana marl, Kemp clay, and Escondido formation, of the Navarro group of Texas; Escondido formation of Mexico; all of Maestrichtian age.

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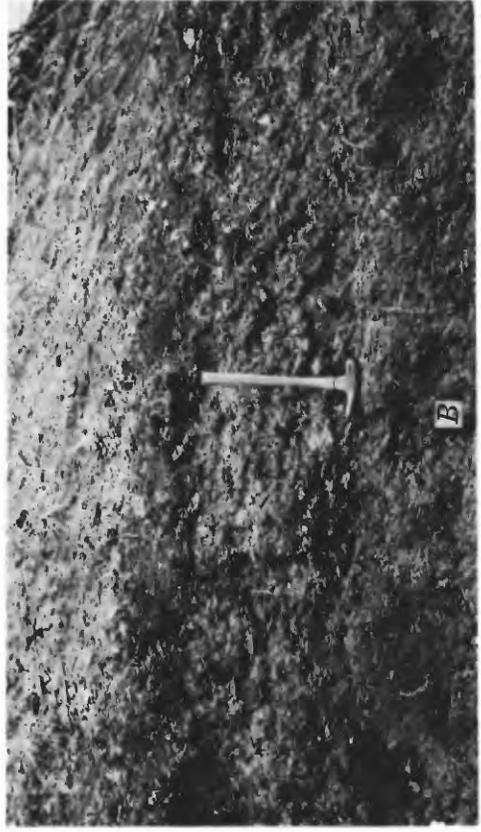
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PLATES 14-24



A. UNCONFORMABLE CONTACT BETWEEN PLANT-BEARING CLAY OF McNAIRY AND OVERLYING OWL CREEK FORMATIONS. In road cut on southeast-facing slope of Crowley's Ridge, 0.35 mile northwest of Ardeola station, Stoddard County, Mo.



B. UNCONFORMABLE CONTACT BETWEEN OWL CREEK AND OVERLYING CLAYTON FORMATIONS. Same locality as A. Head of hammer marks contact.

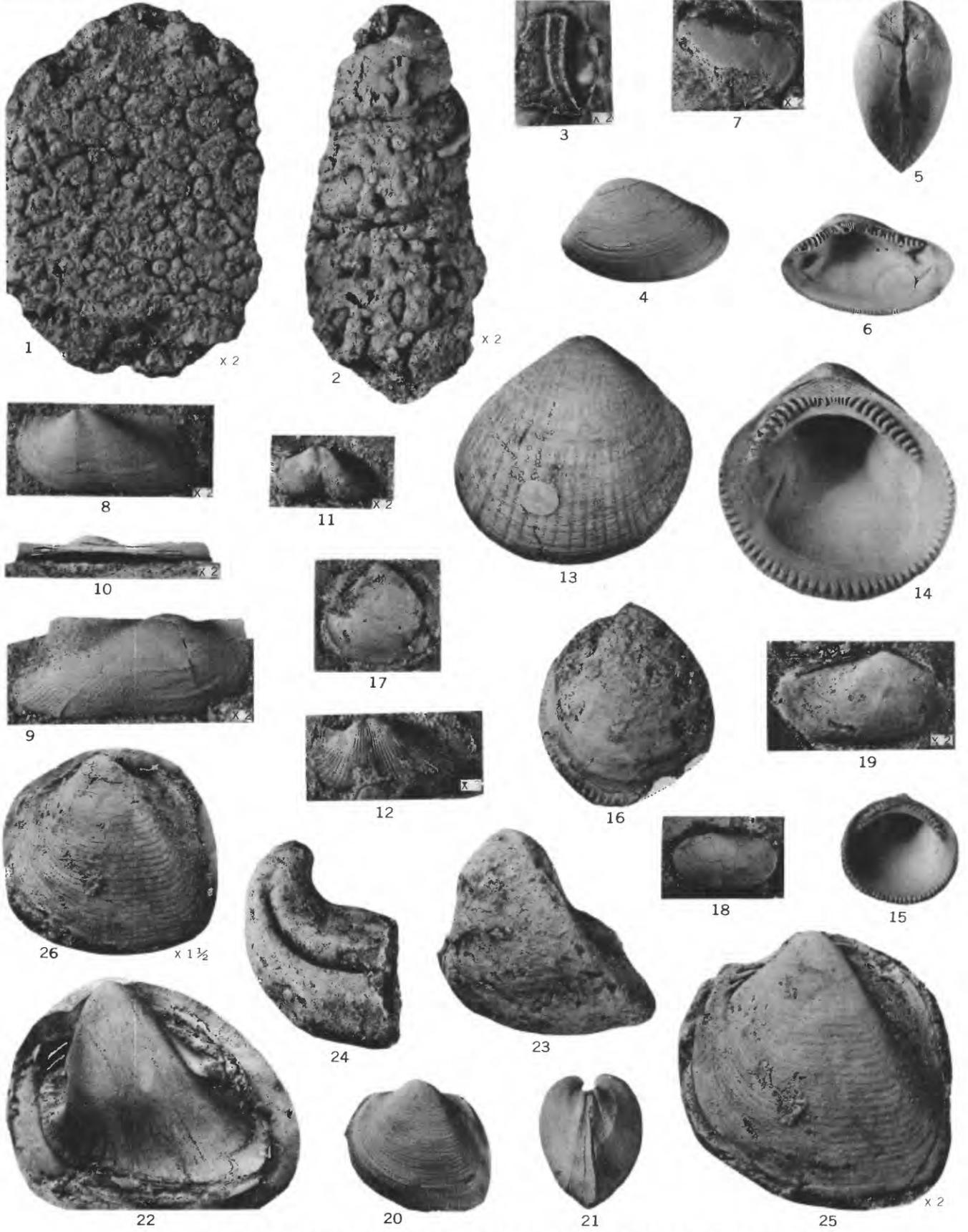


C. PLANT-BEARING CLAY AT TOP OF McNAIRY SAND, OVERLAIN IN SUCCESSION BY OWL CREEK AND CLAYTON FORMATIONS. Exposure in SE 1/4 sec. 26, T. 29 N., R. 14 E., Scott County, Mo. McManamy site on Clayton formation with feet on Clayton-Owl Creek contact; Stewart stands at Owl Creek-McNairy contact.



D. NEAR VIEW OF OWL CREEK-PLANT-BEARING CLAY CONTACT. See preceding photograph (view C). Head of hammer marks contact.

VIEWS OF CLAYTON (PALEOCENE), OWL CREEK AND McNAIRY (UPPER CRETACEOUS), FORMATIONS IN STODDARD AND SCOTT COUNTIES, MO.
 Photographs by H. S. McQueen.



CLIONA, HAMULUS, NUCULA, NEMODON, GLYCYMERIS, NUCULANA, AND IDONEARCA

PLATE 15

[Figures natural size except as indicated]

FIGURES 1, 2. *Cliona microtuberum* Stephenson (p. 106).

Casts of borings, $\times 2$, in a fragment of bivalve shell (1) and in a gastropod shell (2), from a dry branch 300 feet downstream from a road crossing, 2.1 miles southwest of Ardeola station, Stoddard County, Mo. USGS 16451, USNM 128081.

3. *Hamulus squamosus* Gabb (p. 106).

Rubber cast from external mold, $\times 2$, from ditch on north-south road 1.4 miles west by south of Ardeola station, Stoddard County, Mo. USGS 19090, USNM 128083.

4-7. *Nucula percrassa* Conrad (p. 106).

4, 5. Views of a nearly perfect topotype, from Owl Creek, Tippah County, Miss. USGS 707, USNM 128084.

6. Interior of the left valve of a topotype, from the same source. USNM 128084.

7. Internal mold, $\times 2$, of part of a right valve, from ditch on north-south road 1.4 miles west by south of Ardeola station, Stoddard County, Mo. USGS 19090, USNM 128085.

8-12. *Nemodon eufaulensis* (Gabb), (p. 108).

8. Left valve, $\times 2$, of a topotype, from Eufaula, Barbour County, Ala. USNM 18830.

9, 10. Right valve, $\times 2$, of another topotype, and hinge, $\times 2$, of the same, from Eufaula. USNM 18830.

11, 12. Internal mold, $\times 2$, and rubber cast of external mold, $\times 3$, of a left valve, from ditch on north-south road 1.4 miles west by south of Ardeola station, Stoddard County, Mo. USGS 19090, USNM 128092.

13-17. *Glycymeris rotundata* (Gabb), (p. 108).

13, 14. Views of a right valve, from Owl Creek, Tippah County, Miss. USGS 594, USNM 21681.

15. Interior of a juvenile left valve, from Owl Creek, Tippah County, Miss. USGS 707, USNM 128093.

16. Internal mold of a right valve, from ditch on north-south road 1.4 miles west by south of Ardeola station, Stoddard County, Mo. USGS 19090, USNM 128095.

17. Internal mold of a juvenile left valve, from road on southeast-facing slope of Crowleys Ridge 0.35 mile northwest of Ardeola station, Stoddard County, Mo. USGS 16429, USNM 128094.

18, 19. *Nuculana longifrons* (Conrad), (p. 107).

18. A left valve, from Owl Creek, Tippah County, Miss. USGS 707, USNM 128088.

19. Internal mold, $\times 2$, of a right valve, from ditch on north-south road 1.4 miles west by south of Ardeola station, Stoddard County, Mo. USGS 19090, USNM 128087.

20-26. *Idonearca capax* (Conrad), (p. 109).

20, 21. Views of a medium-sized topotype, from Owl Creek, Tippah County, Miss. USGS 707, USNM 128097.

22. Rubber cast from the interior of an adult topotype, for comparison with figures 23, 24. USGS 707, USNM 128097.

23, 24. Views of the internal mold of a left valve, from ditch on north-south road 1.4 miles west by south of Ardeola station, Stoddard County, Mo. USGS 19090, USNM 128098.

25. Internal mold, $\times 2$, of a medium-sized left valve, with surface sculpture impressed upon it, from the preceding locality, USNM 128098.

26. Rubber cast, $\times 1\frac{1}{2}$, from the external mold of the preceding specimen.

PLATE 16

[Figures natural size except as indicated]

FIGURES 1-3. *Trigonia angulicostata* Gabb (p. 112).

1. Right valve, from Owl Creek, Tippah County, Miss. USGS 707, USNM 128110.

2, 3. Internal mold of right valve (2) with sculpture impressed upon it, and rubber cast from external mold of a left valve (3), from road on southeast facing slope of Crowleys Ridge 0.35 mile northwest of Ardeola station, Stoddard County, Mo. USGS 16429, USNM 128109.

4-9. *Tenuipteria argentea* (Conrad), (p. 111).

4, 5. Two topotypes, a right valve (4) and hinge, $\times 2$, of a left valve (5), from Owl Creek, Tippah County, Miss. USGS 707, USNM 128104.

6. Left valve from the Owl Creek locality. USGS 6464, USNM 128102.

7. Internal mold of left valve with weakly impressed sculpture, from ditch on north-south road 1.4 mile west by south of Ardeola station, Stoddard County, Mo. USGS 19090, USNM 128103.

8. Incomplete internal mold, $\times 1\frac{1}{2}$, of right valve, from a dry branch 300 feet downstream from a road crossing, 2.1 miles southwest of Ardeola station, Stoddard County, Mo. USGS 16451, USNM 128105.

9. Incomplete external mold of left valve, from road on southeast-facing slope of Crowleys Ridge 0.35 mile northwest of Ardeola station, Stoddard County, Mo. USGS 16452, USNM 128106.

10-12. *Pinna laqueata* Conrad (p. 110).

10. Left side of topotype, from Owl Creek, Tippah County, Miss. USGS 707, USNM 128100.

11. Left side of an incomplete topotype, from the same source. USNM 128099.

12. Rubber cast from incomplete external mold of right valve, from southeast-facing slope of Crowleys Ridge 0.35 mile northwest of Ardeola station, Stoddard County, Mo. USGS 16452, USNM 128101.

13, 14. *Ostrea tecticosta* Gabb (p. 111).

Internal molds of two left valves, from ditch on north-south road 1.4 miles west by south of Ardeola station, Stoddard County, Mo. USGS 19090, USNM 128107.

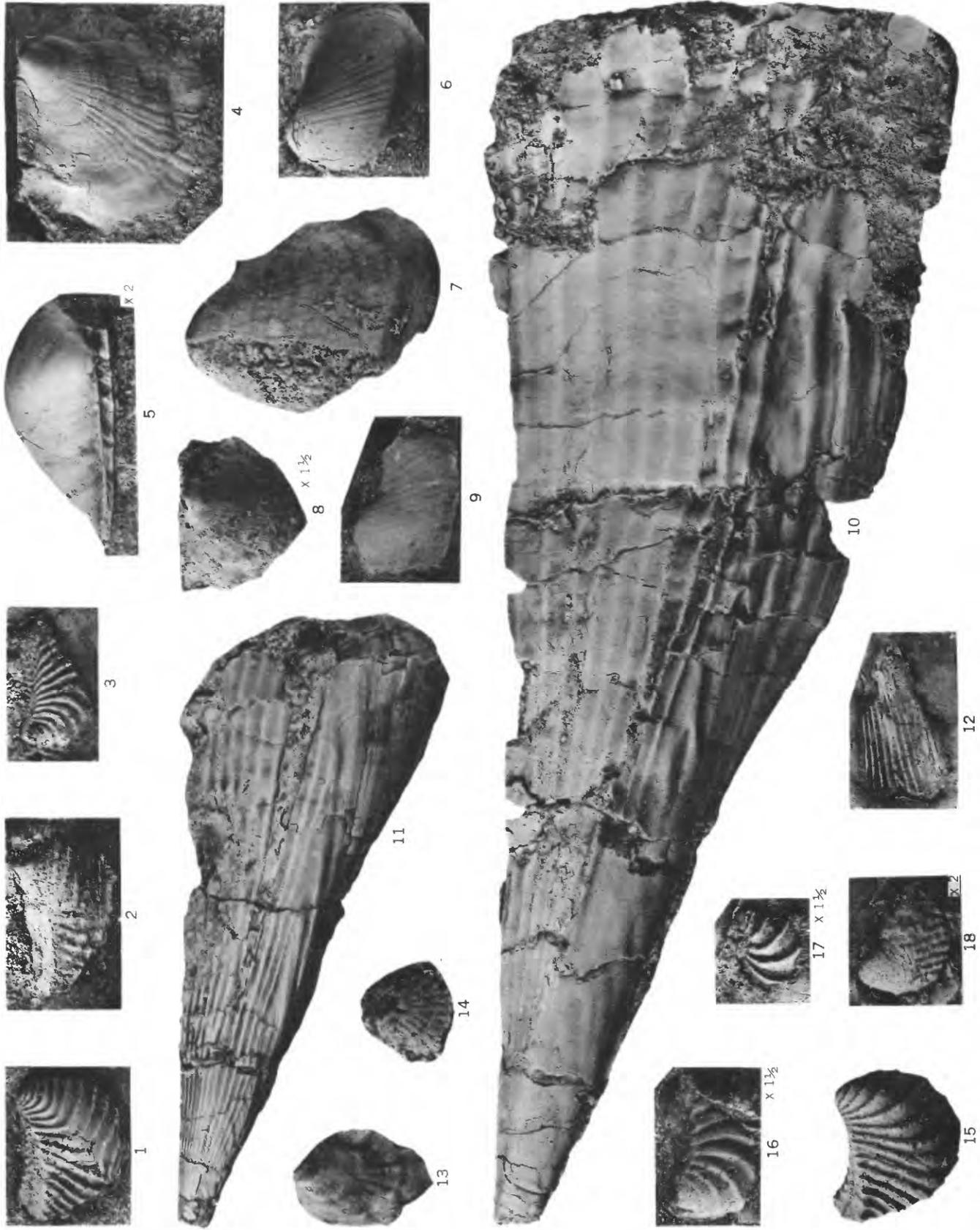
15-17. *Trigonia eufaulensis* Gabb (p. 112).

15. A topotype, right valve, from bluff on Chattahoochee River at Eufaula, Barbour County, Ala. USGS 854, USNM 128112.

16, 17. Internal mold, $\times 1\frac{1}{2}$, of left valve and rubber cast, $\times 1\frac{1}{2}$, from incomplete external mold of right valve, from ditch on north-south road 1.4 miles west by south of Ardeola station, Stoddard County, Mo. USGS 19090, USNM 128111.

18. *Exogyra costata* Say (p. 111).

Rubber cast from external mold, $\times 2$, of a left valve from road on southeast-facing slope of Crowleys Ridge 0.35 mile northwest of Ardeola station Stoddard County, Mo. USGS 16452, USNM 128108.



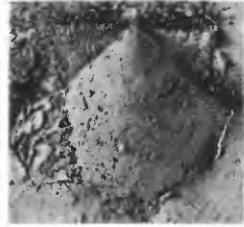
TRIGONIA, TENUIPTERIA, PINNA, OSTREA, AND EXOGYRA



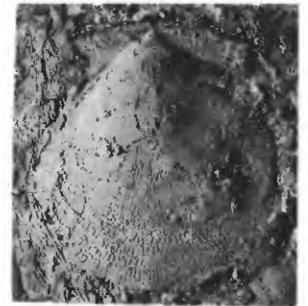
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2 x 2



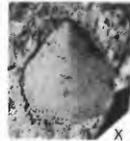
3 x 2



4 x 2



5 x 2



6 x 2



11 x 3



12 x 6



9 x 3



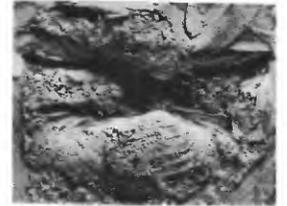
10 x 3



x 1 1/2



x 1 1/2



18 x 1 1/2



7 x 3



17 x 1 1/2



x 1 1/2



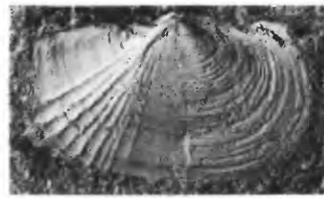
21 x 3



8 x 6



16 x 3



15 x 3



19 x 3

PECTEN, CRENELLA, CUNEOLUS, ANATIMYA, AND LIMA

PLATE 17

[Figures natural size except as indicated]

FIGURES 1-4. *Pecten (Camptonectes) bubonis* Stephenson (p. 113).

1, 2. Two topotypes, left and right valves, $\times 2$, from Owl Creek, Tippah County, Miss. USGS 707, USNM 128113.

3, 4. Rubber casts from two external molds of a left and a right valve, $\times 2$, from ditch on north-south road 1.4 miles west by south of Ardeola station, Stoddard County, Mo. USGS 19090, USNM 128114.

5. *Pecten (Camptonectes) hilgardi* Stephenson? (p. 113).

Rubber cast from external mold, $\times 2$, from a road ditch 150 feet south of a road junction about a mile northwest of Ardeola station, Stoddard County, Mo. USGS 16430, USNM 128115.

6. *Pecten (Syncyclonema?) simplicius* (Conrad), (p. 113).

Internal mold, $\times 2$, from road in southeast-facing slope of Crowleys Ridge 0.35 mile northwest of Ardeola station, Stoddard County, Mo. USGS 16452, USNM 128116.

7-10. *Crenella microstriata* Stephenson, n. sp. (p. 114).

7, 8. The holotype, a right valve, $\times 3$, and the same, $\times 6$, from Owl Creek, Tippah County, Miss. USGS 707, USNM 128123.

9, 10. Views of an internal mold, $\times 3$, from a dry branch 300 feet downstream from a road crossing 2.1 miles southwest of Ardeola station, Stoddard County, Mo. USGS 16451, USNM 128126.

11, 12. *Crenella serica* Conrad (p. 114).

A topotype, a left valve, $\times 3$, and the same $\times 6$, from bluff on Chattahoochee River at Eufaula, Barbour County, Ala., USGS 854, USNM 128120.

13, 14. *Cuneolus tippanus* (Conrad), (p. 115).

Right and left valves, $\times 1\frac{1}{2}$, of neotype, from Owl Creek, Tippah County, Miss. USGS 6464, USNM 76499.

15-17. *Anatimya anteradiata* (Conrad), (p. 116).

15, 16. Two topotypes, the internal mold of a right valve with sculpture impressed upon it, and the interior of left valve, from Owl Creek, Tippah County, Miss. USGS 707, USNM 128132.

17. Internal mold, $\times 1\frac{1}{2}$, of posterior part of a right valve, from ditch on north-south road 1.4 miles west by south of Ardeola station, Stoddard County, Mo. USGS 19090, USNM 128131.

18. *Anatimya?* sp. (p. 116).

Incomplete external molds, $\times 1\frac{1}{2}$, of right and left valves of a shell from a dry branch 300 feet downstream from a road crossing 2.1 miles southwest of Ardeola station, Stoddard County, Mo. USGS 16461, USNM 128133.

19-21. *Lima acutilineata* (Conrad), (p. 113).

19. A topotype, a right valve, $\times 3$, from Owl Creek, Tippah County, Miss. USGS 707, USNM 128117. (Also illustrated in N. C. Geol. and Econ. Survey v. 5, pl. 58, fig. 5, 1923, under old cat. no. 20665.)

20. Internal mold, $\times 1\frac{1}{2}$, of a left valve, from a dry branch 300 feet downstream from a road crossing 2.1 miles southwest of Ardeola station, Stoddard County, Mo. USGS 16451, USNM 128118.

21. Rubber cast from internal mold, $\times 3$, of a right valve, from southeast-facing slope of Crowleys Ridge 0.35 mile northwest of Ardeola station, Stoddard County, Mo. USGS 16452, USNM 128119.

PLATE 18

[Figures natural size except as indicated]

FIGURES 1, 2. *Veniella conradi* (Morton), p. 117).

1. Right valve, from Owl Creek, Tippah County, Miss. USGS 707, USNM 128138.

2. Incomplete internal mold of right valve, $\times 1\frac{1}{2}$, with concentric ridges impressed upon it, from ditch on north-south road 1.4 miles west by south of Ardeola station, Stoddard County, Mo. USGS 19090, USNM 128137.

3-5. *Scambula perplana* Conrad (p. 118).

Internal molds, $\times 2$, of two right valves and one left valve, from the preceding locality. USGS 19090, USNM 128142.

6, 7. *Brevicardium fragile* Stephenson (p. 120).

6. A topotype, $\times 5$, a right valve, from Owl Creek, Tippah County, Miss. USGS 6464, USNM 128151.

7. Internal mold, $\times 5$, of a right valve, from southeast-facing slope of Crowleys Ridge 0.35 mile northwest of Ardeola station, Stoddard County, Mo. USGS 16452, USNM 128152.

8-13. *Pholadomya tippiana* Conrad (p. 115).

8, 9. Views of a topotype, from Owl Creek, Tippah County, Miss. USGS 707, USNM 128128.

10, 11. Views of another topotype in the same collection. USNM 128128.

12. An incomplete internal mold with sculpture impressed upon it, from Fullenwider farm 1 mile southeast of Oran, Scott County, Mo. USGS 16453, USNM 128130.

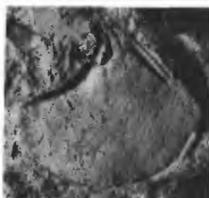
13. An incomplete internal mold with impressed sculpture, from road ditch in southeast-facing slope of Crowleys Ridge 0.35 mile northwest of Ardeola station, Stoddard County, Mo. USGS 16454, USNM 128129.



1



2 x 1½



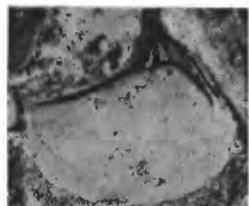
4 x 2



5 x 2



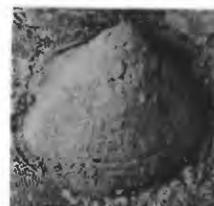
6 x 5



3 x 2



8



7 x 5



10



12



9



11



13

VENIELLA, SCAMBULA, BREVICARDIUM, AND PHOLADOMYA



1 x 2



3 x 3



5 x 2



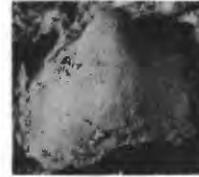
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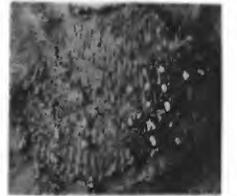
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4 x 3



6 x 1 1/2



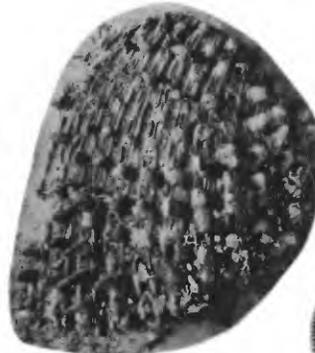
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11



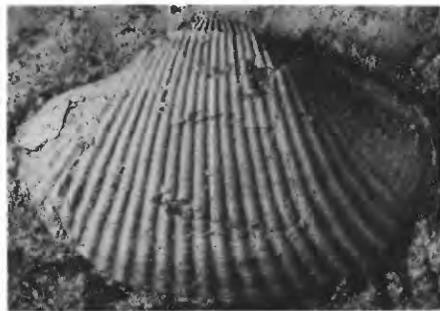
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10



14



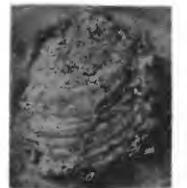
17 x 2



12



13



15



20 x 3



19 x 3



16



21 x 2



18 x 2

CARDIUM, CRASSATELLA, AND LIPISTHA

PLATE 19

[Figures natural size except as indicated]

FIGURES 1-8. *Cardium (Granocardium) lowei* Stephenson, n. sp. (p. 119).

1-4. Views, $\times 2$, of a paratype, a left valve, (1, 2) and hinge, $\times 3$, of same (3), and hinge, $\times 3$, of a paratype (4), from Owl Creek, Tippah County, Miss. USGS 707, USNM 128147.

5. Holotype, $\times 2$, a right valve, from the Owl Creek locality. USNM 128148.

6, 7. Two paratypes, one (6) an internal mold, $\times 1\frac{1}{2}$, of a right valve, and the other (7) a rubber cast, $\times 3$, from the incomplete external mold of a left valve, from ditch on north-south road 1.4 miles west by south of Ardeola station, Stratford County, Mo. USGS 19090, USNM 128144.

8. Rubber cast from a paratype, $\times 3$, an incomplete external mold of a right valve, from U. S. Highway 61, 1.6 miles southwest of Benton, Scott County, Mo. USGS 16597, USNM 128146.

9, 10. *Cardium (Granocardium) tippanum* Conrad, (p. 118).

9. Neotype, a right valve, from Owl Creek, Tippah County, Miss. USGS 707, USNM 76611. (Also illustrated in Miss. State Geol. Survey Bull. 40, pl. 12, figs. 1, 2, 1940, using old cat. No. 20853.)

10. Rubber cast from incomplete external mold of a large right valve, from a dry branch 300 feet downstream from a road crossing 2.1 miles southwest of Ardeola station, Stoddard County, Mo. USGS 16451, USNM 128143.

11-16. *Crassatella vadosa ripleyana* (Conrad), (p. 117).

11-14. Views of three topotypes, from Owl Creek, Tippah County, Miss. USGS 707, USNM 128139.

15. Rubber cast from external mold of anterior part of a right valve, from road cut in southeast-facing slope of Crowleys Ridge 0.35 mile northwest of Ardeola station, Stoddard County, Mo. USGS 16429, USNM 128141.

16. Internal mold of left valve of a young shell, from ditch on north-south road 1.4 miles west by south of Ardeola station, Stoddard County, Mo. USGS 19090, USNM 128140.

17-21. *Liopistha protexta* (Conrad), (p. 116).

17-19. Two plesiotypes, left (17) and right (18) valves, each, $\times 2$, and hinge, $\times 3$, of the right valve, from Owl Creek, Tippah County, Miss. USGS 707, USNM 128136.

20. Rubber cast, $\times 3$, from incomplete external mold of left valve, from southeast-facing slope of Crowleys Ridge 0.35 mile northwest of Ardeola station, Stoddard County, Mo. USGS 16452, USNM 128135.

21. Internal mold, $\times 2$, with ribs impressed upon it, from a dry branch 300 feet downstream from a road crossing 2.1 miles southwest of Ardeola station, Stoddard County, Mo. USGS 16451, USNM 128134.

PLATE 20

[Figures natural size except as indicated]

- FIGURE 1.** *Cardium (Pachycardium) spillmani* (Conrad), (p. 120).
 Internal mold, $\times 2$, of the right valve of a juvenile shell, from road on southeast-facing slope of Crowleys Ridge 0.35 mile northwest of Ardeola, Stoddard County, Mo. USGS 16452, USNM 128149.
- 2-4.** *Aphrodina tippiana* (Conrad). (p. 120).
 2. Left valve of a topotype, from Owl Creek, Tippah County, Miss. USGS 707, USNM 128154.
 3, 4. Incomplete internal molds, one (3) a left valve, $\times 1\frac{1}{2}$, and the other (4) a right valve, from ditch on north-south road 1.4 miles west by south of Ardeola station, Stoddard County, Mo. USGS 19090, USNM 128153.
- 5-7.** *Legumen ellipticum* Conrad (p. 121).
 5. Left valve, $\times 1\frac{1}{2}$, of a topotype, from Owl Creek, Tippah County, Miss. USGS 707, USNM 128158.
 6, 7. Internal molds, $\times 1\frac{1}{2}$, of two young shells, from road on southeast-facing slope of Crowleys Ridge 0.35 mile northwest of Ardeola station, Stoddard County, Mo. USGS 16452, USNM 128157.
- 8-11.** *Tenea parilis* (Conrad). (p. 121).
 8, 9. Plesiotype (= topotype?), a right valve, $\times 1\frac{1}{2}$, and hinge of same, ($\times 3$), from Owl Creek, Tippah County, Miss. USGS 707, USNM 128160.
 10, 11. Internal molds, $\times 1\frac{1}{2}$, of left and right valves, from ditch on north-south road 1.4 miles west by south of Ardeola station, Stoddard County, Mo. USGS 19090, USNM 128159.
- 12-14.** *Tellina buboana* Stephenson, n. sp. (p. 121).
 12. Right valve, $\times 2$, of holotype, from Owl Creek, Tippah County, Miss. USGS 707, USNM 20706.
 13. Hinge, $\times 5$, of right valve of a paratype from the same locality. USGS 707, USNM 128161.
 14. Internal mold, $\times 2$, of a right valve, from ditch on north-south road 1.4 miles west by south of Ardeola station, Stoddard County, Mo. USGS 19090, USNM 128162.
- 15, 16.** *Leptosolen buplicatus* (Conrad), (p. 123).
 15. Left valve of a topotype, from Owl Creek, Tippah County, Miss. USGS 707, USNM 128167.
 16. Internal mold, $\times 2$, of a small left valve, from ditch on north-south road, 1.4 miles west by south of Ardeola station, Stoddard County, Mo. USGS 19090, USNM 128166.
- 17-25.** *Linearia metastrata* Conrad (p. 122).
 17, 18. Right valve, $\times 3$, and interior of same, $\times 3$, from Owl Creek, Tippah County, Mo. USGS 707, USNM 20713.
 19. Interior of left valve, $\times 3$, from the same source, USNM 20713.
 20. Hinge of a right valve, $\times 3$, from the same source. USNM 20713.
 21-23. Rubber cast, $\times 2$, of external mold of left valve (21), and internal molds, $\times 1\frac{1}{2}$, of a right valve (22) and a left valve (23), from ditch on north-south road 1.4 miles west by south of Ardeola station, Stoddard County, Mo. USGS 19090, USNM 128164.
 24, 25. Exterior of left valve, $\times 2$, and interior of right valve, $\times 3$, from Coon Creek tongue of Ripley formation at Coon Creek, McNairy County, Tenn. USGS 10198, USNM 128165.
- 26-28.** *Cyprimeria alta* (Conrad), (p. 120).
 26, 27. Exterior and interior views of a topotype, from Owl Creek, Tippah County, Miss. USGS 707, USNM 128155.
 28. Internal mold of a right valve, from road on southeast-facing slope of Crowleys Ridge 0.35 mile northwest of Ardeola station, Stoddard County, Mo. USGS 16429, USNM 128156.



1 x 2



2



3 x 1½



5 x 1½



8 x 1½



9 x 3



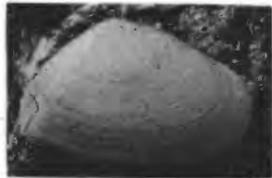
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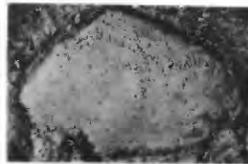
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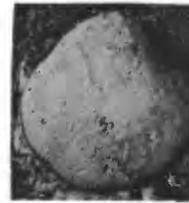
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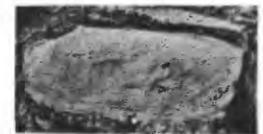
12 x 2



14 x 2



11 x 1½



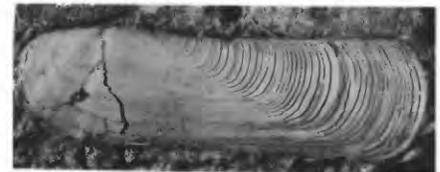
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17 x 3



13 x 5



15



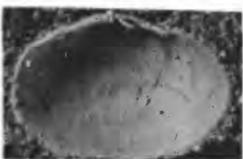
18 x 3



20 x 3



16 x 2



19 x 3



21 x 2



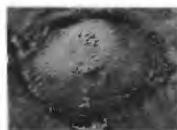
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25 x 3



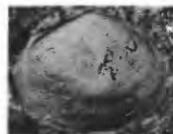
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22 x 1½



28

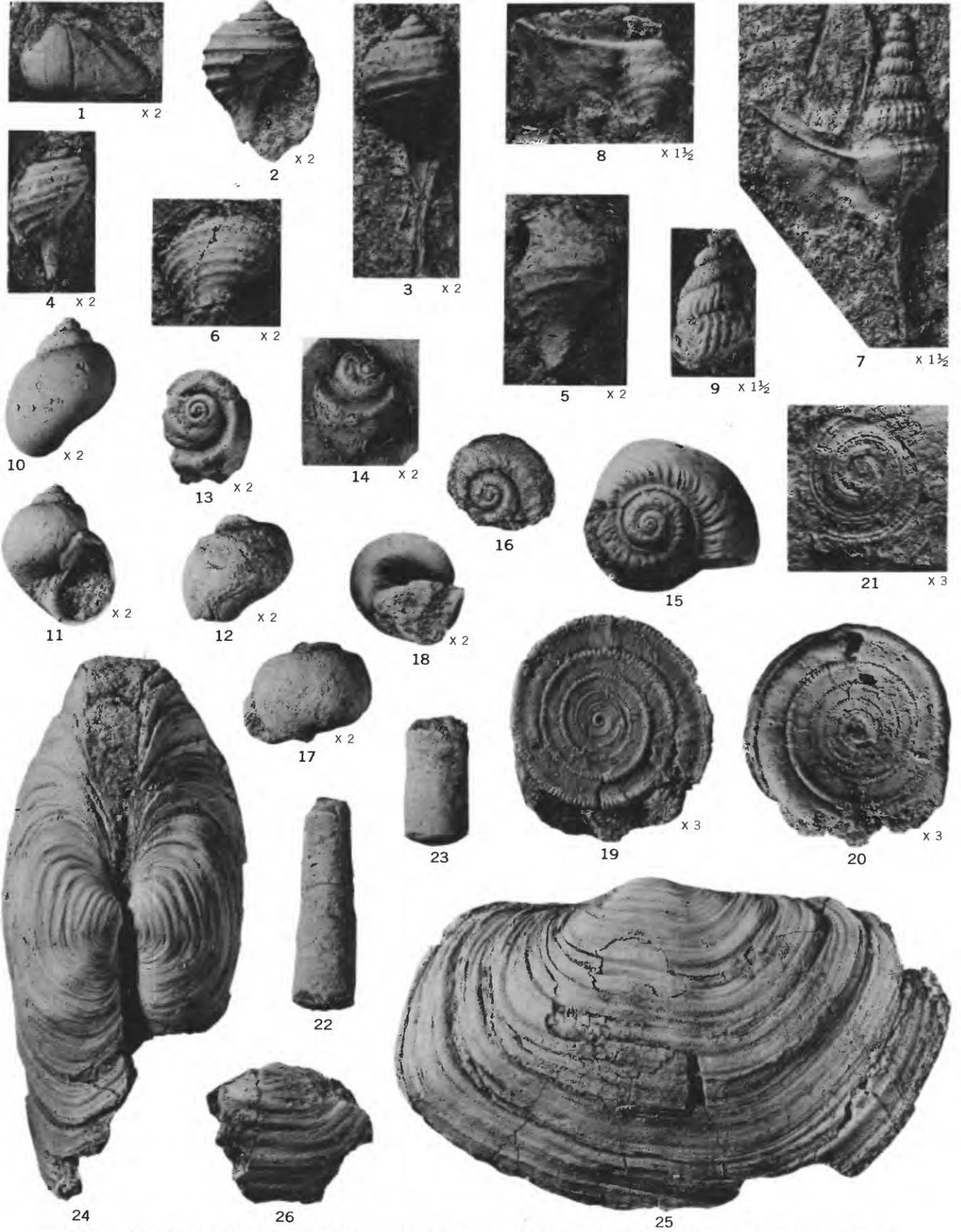


23 x 1½



27

CARDIUM, APHRODINA, LEGUMEN, TENEA, TELLINA, LEPTOSOLEN, LINEARIA, AND CYPRIMERIA



GONIOCHASMA, NAPULUS, HELICAULAX, POLINICES, GYRODES, PSEUDOMALAXIS, GASTROCHAENA, AND PANOPE

PLATE 21

[Figures natural size except as indicated]

FIGURE 1. *Goniochasma?* sp. (p. 124).

Internal mold, $\times 2$, of left valve, from ditch on north-south road 1.4 miles west by south of Ardeola station, Stoddard County, Mo. USGS 19090, USNM 128172.

2-5. *Napulus octoliratus* (Conrad), (p. 128).

2, 3. Two topotypes, $\times 2$, from Owl Creek, Tippah County, Miss. USGS 707, USNM 128190.

4, 5. Internal molds, $\times 2$, from ditch on north-south road 1.4 miles west by south of Ardeola station, Stoddard County, Mo. USGS 19090, USNM 128191.

6. *Napulus?* sp. (p. 129).

Rubber cast, $\times 2$, from incomplete external mold, from a dry branch 300 feet downstream from a road crossing 2.1 miles southwest of Ardeola station, Stoddard County, Mo. USGS 16451, USNM 128192.

7-9. *Helicaulax formosa* Stephenson, n. sp. (p. 128).

7. Holotype, $\times 1\frac{1}{2}$, from Owl Creek, Tippah County, Miss. USGS 707, USNM 128189.

8, 9. Two incomplete internal molds, $\times 1\frac{1}{2}$, from ditch on north-south road 1.4 miles west by south of Ardeola station, Stoddard County, Mo. USGS 19090, USNM 128187.

10-12. *Polinices rectilabrum* (Conrad), (p. 125).

10, 11. Views of topotype, $\times 2$, from Owl Creek, Tippah County, Miss. USGS 707, USNM 128210.

12. Internal mold, $\times 2$, from a dry branch 300 feet downstream from a road crossing, 2.1 miles southwest of Ardeola station, Stoddard County, Mo. USGS 16451, USNM 128174.

13, 14. *Gyrodes spillmanii* Gabb (p. 125).

Internal mold, $\times 2$, and rubber cast, $\times 2$, from external mold of same, from ditch on north-south road 1.4 miles west by south of Ardeola station, Stoddard County, Mo. USGS 19090, USNM 128177.

15, 16. *Gyrodes supraplicatus* (Conrad), (p. 125).

15. Apical view of a topotype, from Owl Creek, Tippah County, Miss. USGS 707, USNM 128176.

16. Apical view of an incomplete internal mold showing faint impressions of the characteristic crenations, from a dry branch 300 feet downstream from a road crossing 2.1 miles southwest of Ardeola station, Stoddard County, Mo. USGS 16451, USNM 128175.

17, 18. *Gyrodes* sp. (p. 126).

Views of an internal mold, $\times 2$, from ditch on north-south road 1.4 miles west by south of Ardeola station, Stoddard County, Mo. USGS 19090, USNM 128178.

19-21. *Pseudomalaxis pateriformis* Stephenson, n. sp. (p. 124).

19, 20. Top and bottom views, $\times 3$, of the holotype, from Owl Creek, Tippah County, Miss. USGS 707, USNM 20448.

21. Rubber cast, $\times 3$, from bottom side of external mold, from ditch on north-south road 1.4 miles west by south of Ardeola, Stoddard County, Mo. USGS 19090, USNM 128173.

22, 23. *Gastrochaena ripleyana* Stephenson (p. 124).

22. Incomplete tube of a topotype, from Owl Creek, Tippah County, Miss. USGS 75, USNM 128170.

23. Internal mold of incomplete tube, from road on southeast-facing slope of Crowleys Ridge 0.35 mile northwest of Ardeola station, Stoddard County, Mo. USGS 16452, USNM 128171.

24-26. *Panope monmouthensis* Gardner (p. 123).

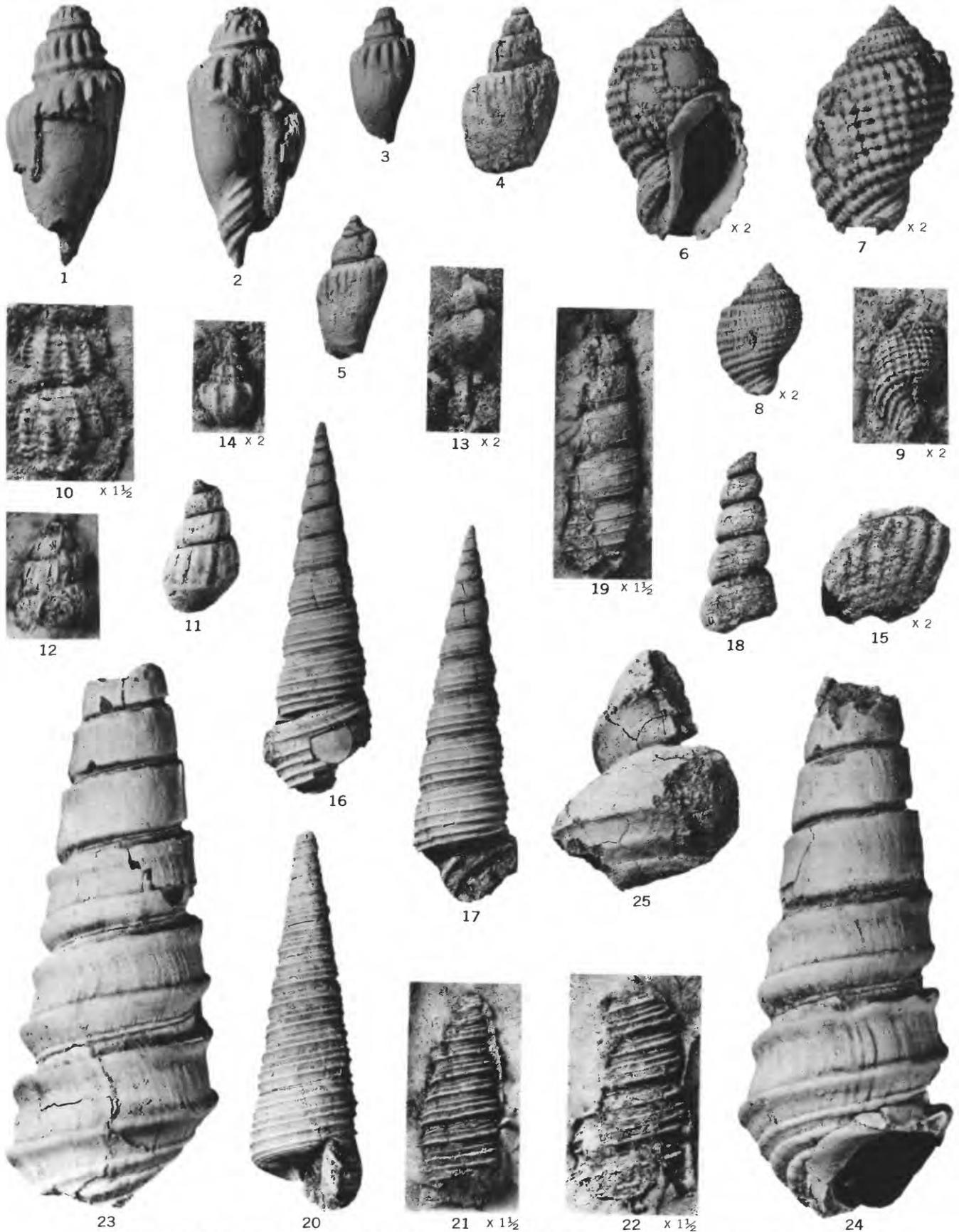
24, 25. Views of an incomplete shell, from Owl Creek, Tippah County, Miss. USGS 707, USNM 128168.

26. An incomplete internal mold of right valve of a young shell from a dry branch 300 feet downstream from a road crossing 2.1 miles southwest of Ardeola station, Stoddard County, Miss. USGS 16451, USNM 128169.

PLATE 22

[Figures natural size except as indicated]

- FIGURES 1-5. *Liopeplum rugosum* Stephenson, n. sp. (p. 130).
1, 2. Views of the holotype, from Owl Creek, Tippah County, Miss. USGS 707, USNM 128200.
3. A medium-sized paratype, from the same source. USNM 128199.
4, 5. Two internal molds, from a dry branch 300 feet downstream from a road crossing 2.1 miles southwest of Ardeola station, Stoddard County, Mo. USGS 16451, USNM 128198.
- 6-9. *Morea transenna* Stephenson, n. sp. (p. 129).
6, 7. Views of the holotype, $\times 2$, from Owl Creek, Tippah County, Miss. USGS 707, USNM 128194.
8. Back view, $\times 2$, of a small paratype, from the same source. USNM 20443.
9. Rubber cast, $\times 2$, from external mold, from ditch on north-south road 1.4 miles west by south of Ardeola station, Stoddard County, Mo. USGS 19090, USNM 128193.
- 10-12. *Anchura?* spp. (p. 128).
10. Rubber cast, $\times 1\frac{1}{2}$, from incomplete external mold, from a dry branch 300 feet downstream from a road crossing 2.1 miles southwest of Ardeola station, Stoddard County, Mo. USGS 16451, USNM 128185.
11, 12. Internal mold and rubber cast from external mold, of a shell from the same source. USNM 128186.
13. *Fusinus?* sp. A (p. 130).
Internal mold, $\times 2$, of a shell from ditch on north-south road 1.4 miles west by south of Ardeola station, Stoddard County, Mo. USGS 19090, USNM 128195.
14. *Fusinus?* sp. B (p. 130).
Rubber cast, $\times 2$, from external mold of a shell from the preceding locality, USNM 128196.
15. *Drilluta* sp. (p. 131).
Incomplete internal mold, $\times 2$, from road on southeast-facing slope of Crowleys Ridge 0.35 mile northwest of Ardeola station, Stoddard County, Mo. USGS 16429, USNM 128201.
- 16-19. *Turritella vertebroides* Morton, sensu lato (p. 126).
16, 17. Views of a shell from Owl Creek, Tippah County, Miss. USGS 707, USNM 128181.
18, 19. Internal mold and rubber cast, $\times 1\frac{1}{2}$, from external mold, of a shell from a dry branch 300 feet downstream from a road crossing 2.1 miles southwest of Ardeola station, Stoddard County, Mo. USGS 16451, USNM 128182.
- 20-22. *Turritella tippiana* Conrad (p. 126).
20. Front view of neotype, from Owl Creek, Tippah County, Miss. USGS 707, USNM 20419. This specimen was figured by Stuart Weller (1907, p. 700, pl. 79, fig. 6).
21, 22. Rubber casts, $\times 1\frac{1}{2}$, from incomplete external molds of two shells, from a dry branch 300 feet downstream from a road crossing 2.1 miles southwest of Ardeola station, Stoddard County, Mo. USGS 16451, USNM 128179.
- 23-25. *Trobus buboanus* Stephenson, n. sp. (p. 127).
23, 24. Views of the holotype, from Owl Creek, Tippah County, Miss. USGS 707, USNM 20423.
25. Fragment of distorted internal mold, from southeast-facing slope of Crowleys Ridge 0.35 mile northwest of Ardeola station, Stoddard County, Mo. USGS 16452, USNM 128184.



LIOPEPLUM, MOREA, ANCHURA, FUSINUS, DRILLUTA, TURRITELLA, AND TROBUS



1 x 1½



x 1½



x 1½



x 1½



6 x 1½



x 3



2



x 2



x 2



x



x 2



x 3



x 2



x 2



x 2



x 2



x 2



x 2



x 3



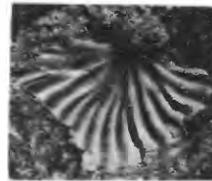
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24



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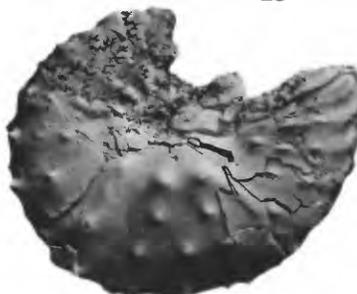
x 2



26



29



27



30

VOLUTOMORPHA, EOHARPA, CAVEOLA, EOACTEON, BULLOPSIS, AND DISCOSCAPHITES

PLATE 23

[Figures natural size except as indicated]

Figures 1, 2. *Volutomorpha?* spp. (p. 131).

1. Rubber cast, $\times 1\frac{1}{2}$, from incomplete external mold, from ditch on north-south road 1.4 miles west by south of Ardeola station, Stoddard County, Mo. USGS 19090, USNM 128203.

2. Internal mold with sculpture impressed upon it, from a dry branch 300 feet downstream from a road crossing 2.1 miles southwest of Ardeola station, Stoddard County, Mo. USGS 16451, USNM 128204.

3-6. *Eoharpa sinuosa* Stephenson, n. sp. (p. 132).

3-5. Views, $\times 1\frac{1}{2}$, of the holotype, from Owl Creek, Tippah County, Miss. Figure 5 shows the band of tubercles on the callus forming the forward part of the inner lip. USGS 707, USNM 20400.

6. Rubber cast, $\times 1\frac{1}{2}$, from incomplete external mold, from ditch on north-south road 1.4 miles west by south of Ardeola station, Stoddard County, Mo. USGS 19090, USNM 128205.

7. *Caveola* sp. (p. 132).

Rubber cast, $\times 3$, from an external mold, from the preceding locality, USNM 128206.

8-10. *Eoacteon linteus* (Conrad), (p. 133).

8, 9. Views, $\times 2$, of a topotype, from Owl Creek, Tippah County, Miss. USGS 707, USNM 128208.

10. Internal mold, $\times 2$, with sculpture weakly impressed upon it, from ditch on north-south road 1.4 miles west by south of Ardeola station, Stoddard County, Mo. USGS 19090, USNM 128207.

11-19. *Bullopsis cretacea* Conrad (p. 133).

11-14. Views of three topotypes from Owl Creek, Tippah County, Miss.; 11, back view, $\times 2$, 12, apical view, $\times 3$, 13, 14, front and apical views, $\times 2$. USGS 594, USNM 128221.

15, 16. Front views, $\times 2$, of two topotypes. USGS 707, USNM 128211.

17-19. Views, $\times 2$, of an internal mold (17, 18) and rubber cast, $\times 3$, from an external mold (19), from ditch on north-south road 1.4 miles west by south of Ardeola station, Stoddard County, Mo. USGS 19090, USNM 128209.

20-22. *Discoscaphites* sp. (p. 135).

20. Side view of an incomplete shell, from Owl Creek, Tippah County, Miss. USGS 707, USNM 20861.

21, 22. Side and back views of an incomplete internal mold, from road on southeast-facing slope of Crowleys Ridge 0.35 mile northwest of Ardeola station, Stoddard County, Mo. USGS 16429, USNM 128219.

[23-30. *Discoscaphites iris* (Conrad), (p. 134).

23-28. Views of three topotypes from Owl Creek, Tippah County, Miss.; 23-25 back, front, and side views, 26, 27 back and side views, 28 interior view, $\times 2$, showing septa of an inner volution. USGS 707, USNM 128218.

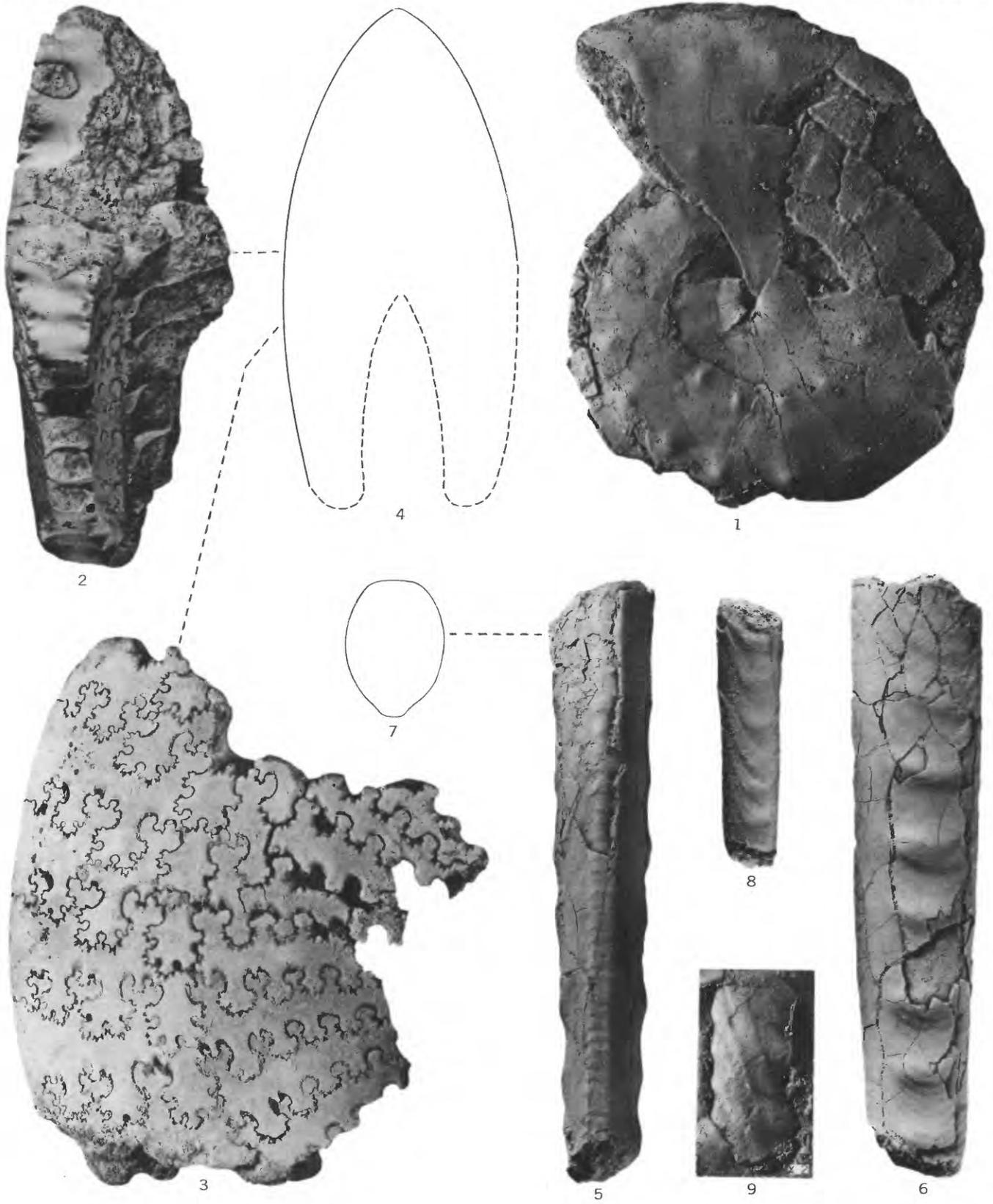
29, 30. Back and side views of an incomplete internal mold, from ditch on north-south road 1.4 miles west by south of Ardeola station, Stoddard County, Mo. USGS 19090, USNM 128217.

PLATE 24

[Figures natural size except as indicated]

FIGURES 1-4. *Sphenodiscus pleurisepta* (Conrad), (p. 135).

1. Lateral view of a medium-sized shell, from Owl Creek, Tippah County, Miss. USGS 707, USNM 128183. (Also illustrated in Miss. State Geol. Survey Bull. 40, pl. 13, fig. 6, 1940, under old cat. no. 20283.)
- 2-4. Views of an incomplete internal mold of a large shell, from the southeast-facing slope of Crowleys Ridge 0.35 mile northwest of Ardeola station, Stoddard County, Mo. USGS 19088, USNM 128220; figure 4 is a cross section of the large end of this specimen. The specimen was collected and donated to the United States Geological Survey by Edison Shrum of Advance, Mo.
- 5-9. *Baculites carinatus* Morton (p. 134).
 - 5-7. Views of an incomplete plesiotype, from Owl Creek, Tippah County, Miss.; figure 7 is a cross section of the large end of this shell. USGS 707, USNM 128215.
 8. An incomplete younger shell, from Braddock's farm on Walnut Creek 7 miles northeast of Ripley, Tippah County, Miss. USGS 713, USNM 128216.
 9. Rubber cast, $\times 2$, from incomplete external mold of a young shell, from southeast-facing slope of Crowleys Ridge 0.35 mile northwest of Ardeola, Stoddard County, Mo. USGS 16452, USNM 128214.



SPHENODISCUS AND BACULITES