Neogastropoda, Opisthobranchia and Basommatophora from the Ripley, Owl Creek, and Prairie Bluff Formations

GEOLOGICAL SURVEY PROFESSIONAL PAPER 331-B
Neogastropoda, Opisthobranchia and Basommatophora from the Ripley, Owl Creek, and Prairie Bluff Formations

By NORMAN F. SOHL

LATE CRETACEOUS GASTROPODS IN TENNESSEE AND MISSISSIPPI

GEOLOGICAL SURVEY PROFESSIONAL PAPER 331-B

A discussion of Late Cretaceous gastropod faunas, including a diagnosis of 95 genera and subgenera and 210 named species from the Mississippi embayment

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LATE CRETACEOUS GASTROPODS IN TENNESSEE AND MISSISSIPPI

NEOGASTROPoda, OPISTHOBRANCbIA, AND BASOMMATOPHORA FROM THE RIPLEY, OWL CREEK, AND PRAIRIE BLUFF FORMATIONS

ABSTRACT

Description of the gastropods found in the Upper Cretaceous (Late Campanian-Maastrichtian) deposits of southwestern Tennessee and northeastern Mississippi is concluded in this chapter. A discussion of the major monographed gastropod faunas of the geologic column indicates that there is a decided progression with decreasing age as to the percentage representation of the Archaeogastropoda, Mesogastropoda, and Neogastropoda of any given fauna. Paleozoic gastropod faunas were dominated by the Archaeogastropoda. The Mesogastropoda grew in proportional abundance at the expense of a decrease in Archaeogastropoda until they became the dominant group during most of the Mesozoic. About 50 percent of the represented species and genera of any Upper Cretaceous gastropod fauna were mesogastropods. The Neogastropoda became the dominant group, in terms of the number of species and genera in the Tertiary. The graphs presented indicate that the gastropod fauna of the Ripley, Owl Creek, and Prairie Bluff Formations was unique among Upper Cretaceous faunas in that the Neogastropoda were dominant and the percentage representation of the various groups mirrors that of the Tertiary and Recent fauna.

The gastropod fauna of the Ripley Formation was perhaps the largest in terms of species and genera of any known Upper Cretaceous formation. The literature offers little information pertinent to determining its development. New evidence derived from preliminary studies of the gastropod faunas of the Chattahoochee River region of Georgia and Alabama indicates that the major Ripley faunal components are well developed in the Butaw Formation (Santonian). Knowledge of the Turonian Gastropoda of the Gulf Coast is lacking. The Woodbine (Cenomanian) faunas of Texas show numerous similarities with the Comanche faunas (Lower Cretaceous) and few similarities with the Ripley or later Upper Cretaceous faunas. Therefore, the Ripley faunas did not appear suddenly but developed gradually from Campanian and possibly Turonian time through the late Upper Cretaceous.

Analysis of the Upper Cretaceous faunas of the world indicates broad outlines of possible zoogeographic provinces. Although specific and generic similarities between the Gulf Coast Ripley faunas and those of other areas are small, save for cosmopolitan genera, gross aspect and composition of many are similar. The faunas of other zoogeographic realms such as those of Pondoland, Union of South Africa, northern Germany (Aschen and Limburger Kreide), and those of southern India all show a gross similarity, especially when compared to those of the Caribbean, Gosta, north Africa, the Middle East, or Baluchistan. These differences appear to be due to the proximity to, or being a component part of, the Tethyan Belt. The former are ecologically similar. For the most part these were sand-facies faunas and generally occupied coastal embayments outside of the major Tethyan sphere of influence.

The main body of this report consists of the systematic description of the Ripley, Owl Creek, and Prairie Bluff species of the Neogastropoda, Opisthobranchia, and Bassommatophora. There are 210 species and subspecies described and formally named. Fifty-two species represented by inadequate material are only tentatively assigned or are merely mentioned. Of the 210 named species, 77 are described as new. These species are assigned to 95 genera and subgenera. Of the genera and subgenera Leuwetsestia and Ornoptis (Porvian) are proposed as new.

INTRODUCTION

This is the second part of an investigation of the gastropod faunas of the Ripley, Owl Creek, and Prairie Bluff Formations that crop out in southwestern Tennessee and northeastern Mississippi.

In this part, some 95 genera and subgenera and 210 species definitely assigned and 52 less certainly assigned species of the Neogastropoda, Opisthobranchia, and Bassommatophora are described. The first part (Sohl, 1960) dealt in detail with the stratigraphy and correlation of these formations and included the description of 57 genera and 99 species definitely assigned to the Archaeogastropoda and Mesogastropoda (table 1).

ACKNOWLEDGMENTS

The present paper is an outgrowth of research for a thesis submitted in partial fulfillment of requirements for the Ph. D. degree at the University of Illinois in 1954. Dr. Bernhard Kummel, formerly of the University of Illinois and now of Harvard University, is due thanks for suggesting the problem and for supervision of the early stages of the work. Thanks are due also to the members of the Department of
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RÉSUMÉ OF THE STRATIGRAPHY

The major stratigraphic zonation of the Upper Cretaceous deposits of the Gulf Coastal Plain is based principally upon the occurrence of certain pelecypods and in particular upon the oysters, although other fossils are locally useful. The uppermost major zone is that of *Eogyra costata*, and it is within that zone that all the gastropod faunas herein described occur. According to Stephenson and others (1942), this zone includes all the Maastrichtian Stage of the standard section of Europe. The author (Sohl, 1960, p. 8) has presented evidence to indicate that part of the upper part of the Campanian probably is also involved (fig. 12).

Throughout the time represented by the rocks of the *Eogyra costata* zone, deposition of clastic material was dominant in the northern part of the Mississippi embayment. The rocks become increasingly finer grained and more argillaceous as the arcuate outcrop...
belt is followed to the south from southwestern Tennessee into northeastern Mississippi. This change is shown not only by the pinching out of the McNairy Sand Member of the Ripley Formation southward in Mississippi, but also by the interfingering of the sandy marls of the Owl Creek of the north with the Prairie Bluff Chalk in Pontotoc County, Miss. In addition to the decrease in grain size, the carbonate content appears to increase correspondingly southward. For example, the chalk of Pontotoc County is commonly less pure than that of Kemper County, Miss. Similar relations exist in the downdip subsurface areas of the Mississippi embayment as shown by Stearns and Armstrong (1955) and by Stearns (1957, figs. 8, 19).

The location of the basal boundary and the distinction of the members within the Ripley Formation must be arbitrarily established owing to the gradational character of the units. The underlying formation, the Demopolis Chalk, becomes increasingly argillaceous and clayey toward its top and grades, through a unit informally called the transitional clay, into the sands of the basal Coon Creek Tongue of the Ripley Formation. The boundary between these formations in northern Mississippi is arbitrarily placed at the top of the Eoxyla cancellata subzone. In southern Tennessee (loc. 1), however, typical sediments of the Coon Creek Tongue occur lower in the section and the formation boundary within the transitional clay falls well within the subzone of E. cancellata (fig. 12). The argillaceous sandstone of the Coon Creek Tongue becomes less massive upward and grades into the shallower blanket and deltaic sands and sandstone of the McNairy Sand Member. This sandstone in turn not only pinches out southward along the outcrop but grades upward into argillaceous sands of the upper part of the Ripley Formation, indicating a return to conditions similar to those that obtained during the deposition of the Coon Creek Tongue. Locally an intraplatform unconformity can be demonstrated at the top of the sands of the upper part of the Ripley Formation below the Chiwapa Member, but at other places (loc. 29) there are indications that the change was rather one of transition to deposition of sandy limestone. Thus the Demopolis-Ripley interval can be viewed as a part of a single sedimentary cycle that was interrupted in the north by the deposition of the McNairy Sand Member, but that south of Union County, Miss., is represented by an almost undisturbed upward gradation from chalk through clays to silty sands.

The magnitude of the unconformity separating the Ripley and Owl Creek Formations is not precisely known, although it represents a time interval long enough in some areas, as in parts of Pontotoc County, Miss., to permit removal of the Chiwapa Member. Formerly this time interval was thought to have been rather extensive, but faunally the two formations are very similar; most of the genera and many species present in the Owl Creek Formation are present in the Ripley. The Chiwapa fauna shows affinities to both the Ripley and Owl Creek faunas and appears to bridge the faunal gap between the two.

The Prairie Bluff Chalk is a facies equivalent of the Owl Creek Formation, with which it intergrades through a lateral transition zone that extends from southernmost Tippah County, Miss., southward through Pontotoc County.

The unconformity at the top of the Owl Creek Formation that separates the Cretaceous from the Tertiary no longer is believed to encompass the whole of Danian and part of Maastrichtian time as was maintained by Stephenson (1941). Recent micropaleontological work by Loeblich and Tappan (1957) and others has brought to light considerable evidence to support a Tertiary (Paleocene) age for the Danian. The Clayton Formation is thus assigned to the Danian, and Stephenson's Danian gap does not exist. At most localities, however, the basal Paleocene beds contain reworked Cretaceous fossils and have furnished foraminiferal and megainvertebrate evidence indicating that a moderate part of the Maastrichtian is missing.

The disparity between the Paleocene and Cretaceous faunas, although perhaps not as great as had been thought in the past (Stephenson, 1915, 1941), does indicate a change of source area for some of the elements of the fauna, if not a considerable hiatus. The tendency of paleontologists to overemphasize the dissimilarities between the faunas of the Cretaceous and Paleocene has probably exaggerated both past and current concepts of the extent of this faunal break. The same attitude has, as Chavarr notes (1946), also influenced many European studies. In part this emphasis on dissimilarity may have been a reflection of the disappearance of the ammonites that formed the basis for so many Cretaceous stratigraphic and faunal studies. Conversely, if one considers Cretaceous mollusks other than cephalopods, it is seen that numerous genera of gastropods range up into the Tertiary and some into the Recent. An even greater percentage of the total number of pelecypod genera is found in the Tertiary or Recent faunas. In addition some Cretaceous gastropod genera such as Eoharpa, Liopeplum, and Paleofusimitra were probably direct antecedents of such Tertiary genera as Harpa, Athleta, and Fusimitra.
Considerations of similarity and continuity have been overlooked and proponents for a great unconformity have emphasized differences in order to strengthen their argument. Thus Stephenson (1941, p. 33) postulated a great retreat of the seas to the steep outer slope of the continental margins. In this restricted environment, many forms were extinguished in the struggle. "Evolution" of the survivors was rapid but took a part of Maestrichtian, all of "Danian," and part of Paleocene time. If the Danian be considered Paleocene, however, the time available for the development of a new fauna is much reduced.

Such a long period of time and extreme conditions, as postulated by Stephenson, does not appear necessary when one considers the large number of genera that transgress the boundary and the large number of potential ancestors to Tertiary genera and species that are present in the Cretaceous. Even on a physical basis, according to Monroe (1953), there is little evidence for a great lapse of time.

**EVOLOVATION OF THE GASTROPOD FAUNAL BALANCE**

The gastropod faunas of Late Cretaceous age are of special interest on several counts. One feature they possess is that of the culmination of a number of stocks that were present during most of the Mesozoic. A second noticeable feature is that of a gross similarity to the early Tertiary groups. Many genera and a number of families that became important elements in the Tertiary faunas appeared at this time. Overall, the gastropods blossomed with the introduction of many new groups. This is especially true of the Neogastropoda, which, in the late Upper Cretaceous, became quite diversified. However, as during most of the rest of the Mesozoic, the Mesogastropoda remained an important if not a dominant element. The only group that suffered a decline in diversification was the Archaeogastropoda.

The graphs produced in figure 13 provide an informative sidelight upon the development of the Upper Cretaceous gastropod faunas. For the purpose of constructing the graphs the percentage of the total fauna of the divisions Archaeogastropoda, Mesogastropoda, Neogastropoda, and Opisthobranchia were plotted. The pulmonates were not included as their occurrence was limited to only a few genera or species, which never reached a total of more than 3 percent of the total fauna and more often were totally absent. In the older monographs the taxonomy was not brought up to date. To do this in a thorough fashion would have taken a prohibitive amount of time and would have been outside the scope of the present paper. Actually for the purpose of the comparisons made it was found that such revisions added little to the information to be gleaned from the original source. Spot checks were run by revising the taxonomy in papers such as Huddleston's monograph (fig. 13, No. 26). It was found that although the number of recognizable genera and species usually increased significantly, the percentage of the total remained proportionally the same. Revision of all the faunas considered was done to the extent that they conform on a superfamily level to the classification used in the present paper, mainly that of Knight and others (1954).

Upon viewing the graphs, one is immediately struck by the gradual decline of the Archaeogastropoda. The graph (fig. 13, No. 30) of the Ordovician shows the Archaeogastropoda to be the dominant element, composing more than 90 percent of the total fauna. Through the Triassic (fig. 13, Nos. 27-29) the Archaeogastropoda were still dominant, but as much as 25 percent of the genera present belonged in the Mesogastropoda. By Jurassic time (fig. 13, Nos. 25, 26), an essential balance or equality in diversification was reached between the two dominant elements, the Archaeogastropoda and the Mesogastropoda.

The Lower Cretaceous graphs give a poor idea of the abundance of archaeogastropods. The graph (fig. 13, No. 23) of the Comanche fauna, based on Stanton's monograph, is a rather poor representation of the total fauna. This is reflected by the rather wide discrepancy between the percentage of genera and species. The rather high representation of Archaeogastropoda in the fauna of Baja California (fig. 13, No. 21) is an artifact of the ecology with a fairly high representation of neritaceans that, along with *Pyrazus* and the numerous cerithiids, point to a strong very shallow water or littoral element. The percentage of archaeogastropod genera for any graphed Upper Cretaceous through Tertiary fauna rarely exceeds 25 percent, and the percentage of species is generally 20 or less, except for the Maestrichtian of Belgium (fig. 13, No. 15) in which there is a strong development of patelliform species and which may reflect ecolonic conditions. In general the percentage of archaeogastropod genera is 15 or less and reaches a consistent low of about 5-10 percent in the faunas of the Upper Cretaceous *Exogyra costata* zone of Texas and the Mississippi embayment.

The Mesogastropoda rose from total absence in the Ordovician to about 25 percent of the total genera in the St. Cassian Triassic (fig. 13, No. 28). During the Jurassic they vied with the Archaeogastropoda for dominance. They are firmly established as the dominant prosobranch element in all the Cretaceous
faunas graphed (fig. 13, Nos. 12-24) except for those of the Campanian and Maestrichtian of the Gulf coast and Persia and at times make up as much as 70 percent of the total prosobranch genera (fig. 13, No. 12). The Cretaceous ascendency of the Mesogastropoda is accomplished primarily at the expense of the declining Archaeogastropoda.

One may note especially in the later Upper Cretaceous faunas that, although the mesogastropods remained dominant, in general there is an increasing representation of the Neogastropoda, with a tendency toward balance between the two groups in many faunas (fig. 13, Nos. 13-19). The most notable exception to the transitional nature of either balance or of mesogastropod dominance is found in the gastropod fauna of the *Eozygia costata* zone of the Gulf coast (fig. 13, Nos. 7-10). These are the best preserved and most diversified of the late Upper Cretaceous gastropod faunas. In their high percentage (as much as 50%) and dominance of the neogastropod element, they show great similarity to the Tertiary gastropod faunal balance (fig. 13, Nos. 1-6).

The picture presented by the graphs is one of rather uniform change with time, and this lends support to the subdivision of the Prosobranchia into these three coordinate orders.

Opisthobranch representation appears most constant for the Tertiary faunas present, being generally about
10 percent or more of the total. The rest of the faunas show a greater spread from almost total absence especially in the Triassic and Jurassic faunas (fig. 13, Nos. 25–30) to 20 percent or more in the gulf coast (fig. 13, Nos. 7–10), Anchen (fig. 13, No. 16), and Indian (fig. 13, No. 14) faunas of the Upper Cretaceous. Many of the figures would be even lower if the Pyramidellacea and Epitoniiacea were not included in the Opisthobranchia. Some of the Cretaceous high, such as that for the fauna of India (15 percent) as described by Stoliczka (fig. 13, No. 14), can be ascribed to the presence in the fauna of a large number of acteonellids. For the low percentages in other faunas, two factors must be considered—that of actual sparsity and second that of technique of collecting. The opisthobranchs generally have small fragile shells that may frequently be poorly preserved, as in the bubble shells like Bulla or in other genera like Scaphander. The smaller forms may be easily overlooked even though present. The constantly good representation in the Tertiary is a reflection of recovery from unconsolidated sediments, which is much simpler than recovering such forms from more thoroughly lithified rocks in which the shell material has been replaced. The high representation in the Ripley fauna (fig. 13, Nos. 8–9) is a result of washing of bulk samples of the unconsolidated sands and picking the small shells from the sieved residue. In this respect it is interesting to note that although the opisthobranchs appear to be truly more poorly represented in the Triassic faunas, the best Triassic representation is in the Peruvian fauna described by Haas. This fauna has an abundance of small forms that are silicified and simple to recover. This fauna may indicate that opisthobranchs were more common during the early Mesozoic than is indicated by the literature.

The graphs lend credence to the statements that the Upper Cretaceous was a time of blossoming and diversification for the Gastropoda. Of all the faunas such diversification appears to be best shown by the fauna of the *Exogyra costata* zone of the gulf coast. With their predominant neogastropod element they form something of a dress rehearsal for the development of the large Tertiary gulf coast faunas and yet they retain a Cretaceous aspect. In the fauna of this zone in the Mississippi embayment alone there are about 150 gastropod genera represented by 300 species. This is the largest and, at the same time, the most diverse Cretaceous gastropod fauna known. In spite of the many forms that foreshadow early Tertiary genera, such as *Ephora, Pleistionat, Dolicholatirus* and the abundance of turrids (*Amuletum* and others) and other typically Tertiary groups, we find distinct gaps. The cones, tons, and cypraeids, so common to Tertiary faunas elsewhere, are not represented. This, of course, may be partly related to the fact that those groups are more typical of the tropic realms, as well as to a lack of a coral-reef environment. In spite of the many strong Tertiary leanings, the fauna retains its Cretaceous aspect in its diversity of aporroids and in its typically Cretaceous strombids, such as *Pugnelia*. The volutes, although more common here than is typical of most Late Cretaceous faunas, bear a distinctive Mesozoic stamp.

**DEVELOPMENT OF THE GULF COAST LATE UPPER CRETACEOUS GASTROPOD FAUNAS**

Table 2 indicates that the gastropod fauna of the *Exogyra costata* zone of the Mississippi embayment has a high percentage of endemic elements. Of the 150 genera and subgenera represented, 42 genera or 28 percent are, as now known, restricted to the Gulf Coastal Plain, and 46 genera or 37 percent are restricted to the Gulf and Atlantic Coastal Plains. As expected, the number of geographically restricted species is considerably higher. Table 2 also shows that some 23 percent of the genera are known only in the span of time represented by the *Exogyra costata* zone. With such a high degree of endemism, one must ask if such a large number of genera are truly so restricted, and where and how did this diversified fauna arise. Such questions cannot at present be answered thoroughly, but evidence bearing on their solution is assembled below.

At least in part the seemingly sudden development of such a diversified and largely endemic gastropod fauna can be viewed as a monographic burst in the sense of Cooper and Williams (1952). This is amply shown by the works of Stephenson (1941), Wade (1926), and earlier papers by Gabb and Conrad that dealt exclusively with the faunas of this zone on the gulf coast. Related but stratigraphically more inclusive works are the reports on the Upper Cretaceous faunas of North Carolina (Stephenson, 1923), Maryland (Gardner, 1916), New Jersey (Whitfield, 1892; Weller, 1907; Richards and others, 1958). Unfortunately the gastropod elements in faunas in the parts of the section that are older than the *Exogyra costata* zone are either sparse or are, as in the New Jersey faunas, represented generally as indeterminable internal molds. Thus our knowledge of the older Upper Cretaceous gastropod faunas of the coastal plains is sparse.

That this apparent burst of diversification is not quite as sudden as the literature indicates is shown by several gulf coast faunas that as yet have not been
described. For example, the author has recently (1955 to present) been engaged in geological investigations in the Chattahoochee River region of Georgia and Alabama where an excellent Upper Cretaceous section is exposed in bluffs along the river. In general, the sediments consist of unconsolidated argillaceous sand much like that of the Ripley Formation of the Mississippi embayment. The Upper Cretaceous part of the river section (fig. 12), from the top in the Providence Sand down through the Ripley, Casseta, Blufftown, and Eutaw Formations, contains well-preserved fossils that range in age from Santonian to Maestrichtian. Preliminary studies of these faunas by the author have shown that the ranges of many of these *Exogyra costata* zone genera can be extended well down the column. Below the Santonian we find a distinct gap in the Turonian, which evidently is not represented, by fossiliferous rocks, at least on the east Gulf coast.

In Texas the Eagle Ford Formation is in good part of Turonian age, but the Gastropoda are poorly known and evidently poorly represented. The slightly older late Cenomanian faunas of the Woodbine Formation have recently been monographed by Stephenson (1955), who described some 117 gastropod species that are assigned to 47 genera. More than 55 percent of the species belong in the Mesogastropoda (fig. 13, No. 20). Such a balance compares more closely with the Comanche faunas of Texas described by Stanton (1947) (fig. 13, No. 23) than with that of the *Exogyra costata* zone. Only 14 of the 47 gastropod genera range upward to the Ripley fauna, and of these, 5 assignments are questionable and 7 of the genera (*Gyrodus, Turritella, Euprya, Acmaea, Ringiidea, Anichura, Nervita*) are long ranging and their mere presence has little meaning.

In viewing the Woodbine fauna of Texas (Cenomanian), one is forced to the conclusion that it is necessary to look elsewhere to find the true beginnings of the fauna that is so richly developed in the late Upper Cretaceous of the Gulf coast. To this end, until well-preserved gastropod faunas from the Turonian of the Gulf coast are found, we are forced to turn to the Eutaw Formation of the Chattahoochee River Valley of Alabama and Georgia. In 1955, the author in the company of L. W. Stephenson visited a locality in a new roadcut in northwestern Russell County, Ala. The collections made then and subsequently (USGS 25657, 27065) have yielded a well-preserved fauna from the uppermost units of the Eutaw Formation (Santonian). Preliminary study of this fauna has yielded more than 25 genera of gastropods. Of these about 50 percent are Neogastropoda, a proportion like that of the typical Ripley fauna. Related species of such genera common to the Ripley as *Gegania, Calliomphalus, Liopeplum, Acisra (Hemicirrus), Longoconcha, Stantonella, Bucinopsis, Fulgerca, Palademet, and Fusimilis* are present.

Whereas the Woodbine species of *Turritella*, such as *Turritella schuleri* Stephenson, possessed nodose spiral sculpture in the fashion of *T. seriatingrunulata* Roeper and others from the Albion of Texas, the Eutaw turritellids are of the lirate nonnodose type prevalent through the *Exogyra ponderosa* and *E. costata* zones.

The combination of a dominantly neogastropod fauna as well as the appearance of representatives of such lineages as that of the lirate turritellids (*T. quadricula* Johnson, *T. trilora* Conrad, *T. bilora* Stephenson) indicates that the Ripley fauna was developing at least as early as the late Santonian and was not due to a sudden blossoming in Ripley time nor necessarily to a flood of new forms that came from some other unknown area.

**STRATIGRAPHIC VALUE OF THE GASTROPODS**

For the most part little attempt has ever been made to use the gastropods as an aid in correlation in the Upper Cretaceous section of the Gulf Coastal Plain. The one notable exception is that of the *turritella bilora* zone proposed in 1955 by Stephenson as yet unpublished in a paper presented at the International Geological Congress in Mexico City.

There were a number of reasons for ignoring gastropods in the past. First of all, most obvious are the facts that the oysters, both *Ostrea* and *Exogyra*, are common, large, and thus easily seen, and that they occur widely in different lithologic facies. Secondly, the ammonites, the traditional zonal markers of the Mesozoic, are fairly common in the western Gulf area and, along with the oysters, have been used successfully in solving correlation problems. Third, the gastropods at many places are so poorly preserved that they cannot be identified precisely. Unlike the oysters, their shells are composed primarily of aragonite, which is much less stable than the calcitic shells of the oysters and more easily dissolved. Commonly, as in the Selma and Prairie Bluff Chalks, the shells are found only as internal molds, whereas the associated oysters retain their shells. Fourth, gastropods are commonly not represented in some areas whereas they may be exceedingly abundant in others.

Judging by the stratigraphic use that has been made of the Gastropoda among the Tertiary faunas, one might state positively that the potential usefulness of Cretaceous snails is great. This potential must, however, remain untapped until much more is known of
the Upper Cretaceous gastropod faunas. In general, workers in the past have assumed that most gastropods had poor dispersal abilities. The works of Thorson (1946), Lenchke (1948), and others on larval forms have illustrated that at least some species may have quite an extended free-floating larval life and that under favorable circumstances dispersal can be great.

That some species evidently did possess a considerable range is brought out by the distribution pattern of such forms as the Maestrichtian species *Turritella forgemalli* Coquand (= *Nerinea quettensis* Noetling, *Turritella morgani* Douville). As pointed out in the discussion of the comparisons of the gulf coast Upper Cretaceous Gastropoda with those of the rest of the world, this species appears throughout the Tethyan realm from Baluchistan to Algeria and also in Madagascar and French West Africa. There also appears to be an undescribed but very closely related, if not conspecific, form in the Escambia Formation of Texas and the Providence Sand of Alabama. Such a distribution in rocks considered to be of the same relative age is rather astounding. It must be admitted that such dispersal patterns, at least in the late Upper Cretaceous faunas, are rare and that intercontinental correlations must rest primarily on the ammonites and perhaps the planktonic Foraminifera.

The gastropods may, however, prove to be of considerable usefulness in local correlations. In the Mississippi embayment region many forms have proved to be sufficiently abundant and stratigraphically limited to be used in zonation. Several of these have been included on the correlation chart (fig. 12). Some of these range geographically from Texas to Georgia, as does *Turritella biliva* Stephenson. This species in addition is restricted to the higher beds. The Cretaceous gastropod faunal record on the east gulf coast is good. Here a number of lineages, such as those of the genera *Urecolabrum*, *Calliomphalus*, and *Lovenstamia*, and the *Turritella quadririlia* Johnson line, have demonstrated that the gastropods can be used in zonation the section. Subtle changes, such as the general size increase upward in time with a greater development of apical callus, have been noted in the species *Pugnellus densatus* Conrad, through its range in the *Exogyra costata* zone in Mississippi and Tennessee. Coordinate changes have been noted in the same species from the same zone as far away as the Chattahoochee River section in Georgia. With a detailed knowledge of the gastropod fauna of the Ripley Formation of the Mississippi embayment, it is possible to distinguish five levels in the 300 feet of the Ripley Formation section, provided, of course, that the sample of the assemblage is sufficient. (See Sohl, 1960.)

Finally one must add that the small opisthobranchs, perhaps the least known group, may offer the greatest value as an aid in correlation for two reasons. First, they are small enough to be commonly preserved where other forms may be crushed and distorted; secondly, because of size they can be recovered from well cores and thus aid in downdip correlation; thirdly, their free-floating larval stage increases their chance of dispersal. On the East Gulf Coastal Plain the species of genera such as *Zikhuraria*, *Cytherox*, *Melanella*, *Rinieula*, and *Crenella* are to be found at the same level from Georgia to Tennessee, and future work will probably indicate a greater geographic range.

**COMPARISON WITH MARINE UPPER CRETAUCEOUS GASTROPOD FAUNAS OF OTHER AREAS**

Stephenson (1941, p. 34-46) discussed the distribution of the outcropping Maestrichtian and late Campanian marine rocks throughout the world. He emphasized correlation and paleontologically dealt primarily only with forms common to given areas and did not discuss relationships of the faunas as a whole. The gastropod faunas and their paleogeographic relationships are emphasized here and the discussion is not necessarily restricted to the Maestrichtian alone.

An inspection of the graphs of the Upper Cretaceous faunas shown in figure 13 shows that marked changes occur in the balance or the proportions of the groups represented in the gastropod faunas in areas away from the East Gulf Coastal Plain. The distribution of genera (table 2) gives an indication of how few of the gastropod genera present in the Mississippi embayment fauna of the *Exogyra costata* zone have a wide dispersal. Although even at a generic level, faunas from widely separated places may be different, many show quite a similar aspect. This similarity is probably a reflection of similar environmental conditions.

The faunas of the *Exogyra costata* zone from this eastern part of the Mississippi embayment lived primarily on a sand bottom having a moderate amount of intermixed mud. The water was relatively shallow and, although fluctuating to a minor degree, the temperature probably was subtropical to temperate throughout the time interval. Both the infauna and the epifauna were large, with a faunal balance much like that of the early Tertiary faunas of the gulf coast.

As a whole the Cretaceous gulf coast may be thought of as a temperate to subtropical clastic province although locally at certain times impure chalks were
dominant, as in central Alabama. In contrast, immediately to the south in the Caribbean region, southern Florida, and Mexico a probable tropical belt was characterized by dominantly carbonate sediments. This carbonate belt contains a different fauna dominated by rudistid pelecypods and their associates, the acteonellid and nerineid gastropods. It has long been known that this belt of rudistid development is co-extensive with the old Tethyan seaway. With the discovery by Hamilton (1953, p. 204) of Upper Cretaceous rudistids on Pacific seamounts, we find that a plot of the distribution of rudistids delimits a circum-equatorial belt paralleling, over most of its extent, the present-day distribution of the reef building corals (Termier and Termier, 1952, maps 27 and 28). This probable tropical belt, bordered on the north and on the south by subtropical and temperate belts, dominates the paleogeographic picture of the Upper Cretaceous and to a great extent governs the type of fauna to be found. Although this zonation parallels the temperate zonation of the present the temperate belt probably extended farther north than at present.

Several Cretaceous faunal provinces are more or less discernible in the world over. Certainly there is an Indo-Pacific province in which the same genera and some species occur in Peru, Chile, New Zealand, India, Japan, and California. These provinces in turn may be divided, as is shown by the close similarity between many elements of the California, Alaska, and Japanese faunas, or between the Chilean and New Zealand faunas. Another province, called the Mediterranean or Tethyan, is in itself a complex unit owing to numerous facies developments, but it does exhibit a certain amount of cohesiveness because it probably served as a pathway for migration. Again West Africa and Brazil might be set aside as a province. Arguments both for and against such divisions exist. In total the Upper Cretaceous climatic zonation does not appear to have been exceedingly different than that which we have today and the faunal affinities for many of the areas considered are similar to those of the present.

**Gulf Coastal Plain**

When the Ripley and Owl Creek fauna of the Mississippi embayment is compared with that of the remainder of the East Gulf Coastal Plain, one is forced to admit that a great similarity exists. Throughout western and central Alabama the chalk facies dominates and, with the exception of the oysters, preservation is poor, thus close comparison of the faunas is impractical. In the clastic or sand facies in eastern Alabama and in the Ripley Formation of the Chattahoochee River region, however, the gastropod fauna is an essential duplicate of that in Mississippi. Like the Owl Creek Formation of Mississippi, the correlative Providence Sand of Alabama and Georgia contains a fauna in which pelecypods outnumber the gastropods both in diversity and in individual abundance and even on a specific level there is uniformity.

Westward toward Texas closely similar gastropod faunas are to be found in the Owl Creek Formation of Missouri (Stephenson, 1955) and in the Ripley (Nacatocah Sand) equivalents in Arkansas. In general the similarities are great in both the gastropod and pelecypod segments of the Navarro Group fauna of Texas as discussed by Stephenson (1941). The apparent differences in species between the Texas and the Tennessee and Mississippi areas are artifacts of too stringent a taxonomy and an evident belief on the part of some workers that gastropods had very narrow dispersal limits. In essence many of the reported differences can be laid to too narrow definitions of species. Perhaps the most noticeable real difference in the faunas of the two areas occurs in the Cephalopoda. Although all the Mississippian, Ripley, and Owl Creek ammonite species occur in Texas, with perhaps the exception of the narrowly limited cartine baculites (Baculites carinatus Conrad), the Texas faunas have in addition a variety of heteromorphs not to be found in the Mississippi embayment area.

Much more significant changes are noticeable when the Exogyra costata zone is traced to the south in Texas. The Escondido Formation is considered by Stephenson (1941) and Stephenson and others (1942) as a southern equivalent of the Kemp Clay (= Owl Creek Formation in part). Although most of the species present are the same as those of the Kemp Clay the proportion of the groups represented are different. Pelecypods are probably the most numerous elements of the Escondido fauna. Cephalopods of the Sphendodiscus type are abundant, and Coahuillites, a sphenodiscid that is more typically a Mexican element, appears. Among the gastropods, genera such as Stantonella, Buccinopsis, and Liopephum, as well as certain species of the ubiquitous Turrilites and Gyrodes, show a distinct affinity to the east gulf coast fauna. On the other hand, new species of these genera as well as genera not represented elsewhere on the gulf coast are present. As noted below in the discussion of the Mexican faunas, the character of the faunas appears to change consistently southward. These changes in the Escondido may reflect a closer approach to the warmer seas in which carbonate deposition was prevalent.
ATLANTIC COASTAL PLAIN

Equivalents of the Ripley and Owl Creek Formations are found widely scattered along the Atlantic Coastal Plain from South Carolina to New Jersey. Nowhere are they as richly fossiliferous as the formations of the Mississippi embayment. The most diversified fauna is probably that of New Jersey, but comparisons with this fauna are difficult, because the mollusks generally are preserved as internal molds. Sufficient evidence exists to indicate that Gulf and the Atlantic Coastal Plains provinces had free access to one another during this time and that peninsular Florida did not serve as a barrier, although it was in a dominantly calcareous province rather than in a clastic province (Appin and Appin, 1944).

The fauna from the Black Creek and PeeDee Formations of North Carolina, described by Stephenson (1923, 1927), is dominated by the pelecypods. Of the 181 species and subspecies of mollusks Stephenson described (1923, p. 37) only 29 were gastropods, and most of these were restricted to the Snow Hill Marl Member of the Black Creek Formation (Exogyra ponderosa zone). The gastropods as well as the pelecypods show a strong affinity for the Gulf coast faunas and are especially close to those of the Chattahoochee River region (Stephenson, 1923, p. 46).

The Monmouth Formation of Maryland has yielded a well-preserved molluscan fauna. Like the molluscan fauna of North Carolina it is dominated by pelecypods (170 species of a total of 262 molluscan species, Gardner, 1916). The classic locality at Brightseat, Md., in the Monmouth Formation has yielded an especially well-preserved fauna that appears to be equivalent to that of the Owl Creek Formation. At this locality a moderate number of gastropod species occur, but almost all are represented by only a few specimens. On the other hand, the pelecypods far outnumber the gastropods in diversification and numbers of individuals. The gastropods that are present at Brightseat show strong affinities for Gulf coast forms even on a specific level.

Close comparison of species between the Cretaceous gastropods of New Jersey and the Gulf coast is almost impossible because most New Jersey species are based on internal molds. Most recognizable genera that occur in the New Jersey Cretaceous are also common to the Gulf coast. The diversification and abundance of gastropods is greatest in the Mount Laurel and Navesink (Exogyra costata zone) part of the section. In addition, Weller (1907, p. 132) pointed out that the gastropod-pelecypod ratio of species in these formations is almost equal. In the other formations of the New Jersey Upper Cretaceous section, pelecypod species are at least twice as abundant as are the gastropod species.

Weller (1907, p. 133) pointed out that the common occurrence of belemnites and terebratuloid brachiopods in New Jersey is distinctive. These elements he considered as being introduced from northern Europe. There appears to have been no southern source, as such elements are exceedingly rare in the Gulf coast faunas. This may be a reflection of temperature differences. In spite of these exotic elements, when the presence in the New Jersey fauna of such geographically restricted gastropod genera as Remora, Pterocerella, Longocochea, Drillata, and others is considered, we must of necessity include New Jersey within the same faunal province as that of the Gulf coast. The similarity to the Gulf coast fauna would no doubt increase if better preserved material were to be found in New Jersey.

With such similarities in the gastropod faunas from Texas to New Jersey one must conclude that they belong to a single faunal province that grades south through Texas, as exhibited by the transitional Escalante Formation, into a warmer water or tropical fauna. Northward along the Atlantic Coastal Plain, the molluscan fauna is generally dominated by the pelecypod elements. This may indicate a change to slightly cooler waters, which in turn may account for the presence of the numerous belemnites and brachiopods.

It is also interesting to note that the greatest diversification of gastropod faunas in this province occurs in the lower parts of the Exogyra costata zone as exhibited by the Ripley, Nacatoch, and Mount Laurel and Navesink Formations. At that time the number of gastropod species was virtually in balance with or may have exceeded the number of pelecypod species. Higher in the zone, as represented by the faunas of the Kemp Clay of Texas, the Owl Creek Formation of Mississippi, the Providence Sand of Georgia, the upper part of the Monmouth Formation of Maryland, and the Trenton Sand Member of the Red Bank Sand and Red Bank Sand of New Jersey, the pelecypods gain dominance over the gastropod elements. It is interesting to speculate on correlation between the trend in increasing dominance of the pelecypods with the general trend of decreasing temperature through the latest Cretaceous that has been postulated by Lowenstam (1954, p. 268).

WESTERN INTERIOR

Stephenson and Reeside (1938) dealt with correlation and faunal comparisons between the Gulf coast and western interior. In the main, with the exception
of local occurrences, the gastropod fauna of the western interior is rather poorly developed. Genera common to both areas are listed on table 2.

Reeside, 1957, summarized the paleogeography of the Cretaceous of the western interior. On page 539, he stated:

As noted above, a succession of faunas, chiefly molluscan and none yet thoroughly studied, marked these late Campanian and Maestrichtian seas. These faunas are perhaps best characterized by the succession of species of the straight ammonite Baculites and of the scaphitid ammonites. Some have close relatives in the Gulf region, in Canada, and in western Europe, which suggests relatively free communication of marine waters and widespread similarity of conditions. However, the interior faunas have a provincial aspect that suggests the presence of a considerable endemic, or perhaps boreal, element, so much so that the presence in a few zones in the southern part of the interior of a few species identical with those of the Gulf region is a marked feature. Among the gastropods the number of species common to the two regions is small in comparison to the total fauna.

Many of the most characteristic elements of the *Exogyra costata* zone fauna are absent. As pointed out by Reeside, the fauna has not been thoroughly studied. When a concentrated effort is made there is considerable likelihood that there will be a significant change in the appraisal of the gastropod elements. The published record cites only such forms as *Euspira rectilabrum* (Conrad) and *Capulus spargleri* Henderson as occurring in common.

The collections of the Geological Survey from the western interior Cretaceous, however, do contain many undescribed forms that are closely related to or conspecific with Gulf Coast species. Such genera as *Calliomphalus* (*Calliomphalus*), *Calliomphalus* (*Planolateralis*), *Graphidula* *Actiga* (*Hemicycla*), *Morea*, *Ptychochusa* *Astandis*, *Belliifusus* *Renuera*, *Liopephus*, *Anuleatum*, *Bereatra*, *Ringicula*, and *Bullopsermis* are represented though previously unreported. An intensive collecting campaign would most likely bring many more to light. None the less, gastropods still remain a lesser element of the fauna in total and the ratio of abundance of gastropods to pelecypods to cephalopods is, with few exceptions, decidedly different than on the Gulf Coast. Cephalopods commonly dominate the interior fauna, whereas pelecypods and gastropods dominate the Campian-Maestrichtian east gulf coast faunas.

**MEXICO AND CENTRAL AMERICA**

The Escondido Formation is present in northern Mexico and bears the same fauna as it does in Texas. In general the gastropods bear great similarity to those of the Kemp Clay of Texas and to other equivalent beds of the gulf coast in general. Somewhat lower in the section (*Exogyra ponderosa* zone) the Difunta Formation (Imlay, 1937) bears a fauna with definite affinities with the gulf coast. Aside from specifically indeterminable specimens of *Morea*, *Pugnollus*, and others we find such forms as *Idoneacoides* *indecii* Imlay and *Cymella bella* Conrad. The source of the fauna is certainly not wholly the gulf coast, however, as forms like *Lissapiopsis* find their affinities with more tropical genera.

In east-central Mexico a fauna of Campanian and Maestrichtian age was found in the vicinity of Cerdenas in the State of San Luis Potosi (Boe, 1906). In this fauna the gastropods are generally dominated by the acteonellid and nerineid elements associated with a rudistid fauna much more characteristic of the Caribbean area than of the gulf coast. Interbedded with these, however (see Imlay 1944, p. 1138), are collections that have yielded faunas surprisingly similar to those of the Nacatoch-Ripley type. Such typical Ripley gastropod genera as *Hercynchyes*, *Liophenum*, *Pugnellus*, *Morea*, *Bereatra*, *Longocoeha*, *Saragna*, *Bellifusus*, *Drillita*, and others are represented in collections (USGS Mesozoic colln. 27178, 28172, 28178) from beds that were evidently not considered by Boe (1906). About 300 miles farther south in Guerrero the gastropods *Nerinea* and *Acanthella* were present during the Coniacian and Santonian (Boe, 1923, p. 91–92, pl. 13–17). In both areas the faunas are commonly dominated by tropical gastropods, although they contain both pelecypod and cephalopod elements of more northerly affinities.

In southeastern Mexico thoroughly tropical rudistid facies are present. The presence of elements of the *Titanosaurusites* fauna of the Caribbean in southern Mexico was noted by Müller (1934, 1936), Stephenson (1922), MacGillavry (1934), and Chubb (1959), but they have scarcely mentioned the associated mollusks. Imlay (1944, p. 1016) summarized the Cretaceous occurrences in Honduras and Guatemala, but no information on gastropod faunas has been published.

**CARIBBEAN AND WEST INDIES**

Thick sequences of Upper Cretaceous rocks have been known for many years in the Greater Antilles and Trinidad. The presence of varied Campanian and Maestrichtian rudistid faunules has been well shown by Whitfield (1897a, 1897b), Trechmann (1924, 1925), MacGillavry (1937), Palmer (1933), and others. Aside from occasional reports of a few ammonites (Spath, 1925; Reeside, 1947) the rest of the Mollusca have been neglected. The Palmer collections from Cuba in the U.S. National Museum show that the
Upper Cretaceous fauna is large, although its preservation is variable in quality. Among the gastropods, nerineids and acteonellids are generally present. Anachura and other genera occur occasionally but most of the fauna has an endemic aspect. The same holds true for collections made by the author in Puerto Rico. (See table 2.) In general these collections bear little resemblance to those of the United States gulf coast, but one collection from the south coast of Puerto Rico near Central Aguirre contains several species in common with the gulf coast, namely Turritella triloba Conrad, Turritella bilira Stephenson, Cerithium cf. C. nodariatum Wade, and Hamulus onyx Gabb. At most localities in Puerto Rico where gastropods occur in any great numbers the nerineids and acteonellids are almost always more abundant than the other gastropods. The naticids are next most common. In both the Puerto Rican and Cuban collections the gastropod shells tend to be massive and thick, as one might expect in the agitated warm water near reefs.

The fauna of the Caribbean region indicates environmental isolation from the gulf coast. No prominent geographic barriers are known and the opportunity for interchange between the two regions should have been great, yet few exchanges of species are known.

WEST COAST

Only about 21 California Upper Cretaceous gastropod genera, far less than half the total number present, occur in common with the equivalent gulf coast faunas (Gabb, 1864; Stewart, 1927; and others). With the exception of the four genera—Paladmea, Diricella, Margaritella, and Anisomya—all are long ranging and so widely dispersed that their presence in the California fauna is not indicative of any close relationship with other regions. Many of the described genera are restricted to the Upper Cretaceous of the west coast, Tessarolae, Biplicia, Locium, Lysis, Sycodes, Haydenia, and others all show the strong endemic nature of the gastropod fauna. Recent studies by Poppenoe (written communication, 1958) of the large gastropod fauna of the Redding area of California corroborate the endemic aspects of the gastropod fauna. Of special note in this Redding fauna is Trophon condoni White (1889, p. 21) that generically closely approximates the characters of Sargana Welli. Sargana is known only from the Gulf and Atlantic Coastal Plains; from Coahuila, Mexico; and from the Senonian of Pondoiland, South Africa. White's species is from a lower stratigraphic position than the known range of Sargana and may be ancestral to Sargana. The presence of a few related species of Pugnellus (Gynmarus), of volutes of the Volutoderma stock, and the evident common ancestry of Turritella chicoensis Gabb and Turritella vertebroides Morton (Merriam, 1941, p. 38) show a common source for certain elements in the Upper Cretaceous fauna of the gulf coast, the western interior, and the Pacific coast. Allison (1955, p. 404, 405) pointed out that middle Albian connections existed between the gulf coast region and Baja California. The above similarity of some forms, then, does not necessarily indicate a free intermixing of faunas, but a potential common ancestry of a few hardy stocks, perhaps Albian or Cenomanian in age, that may have evolved separate lineages owing to isolation from a common source.

Anderson (1958, p. 74) has listed a number of species, primarily ammonites, that he considered closely related to gulf coast and western interior species. The stated similarities need further verification before acceptance. In spite of noted similarities to either the gulf coast or western interior, the west coast Upper Cretaceous Molluscan faunas bear closest affinities to the faunas of Alaska and Japan. In spite of its many endemic elements the fauna appears to be definitely Indo-Pacific in makeup. This relationship is well displayed by the occurrence of Eubaculites, a form found throughout this region in Chile, Peru, Southern India, western Australia, Madagascar, Japan, and Vancouver Island, as well as California (Matsuzato, 1959).

SOUTH AMERICA

Described late Late Cretaceous faunas are widely scattered throughout South America. In general, the representation of the Gastropoda is small. Both Stephenson (1941) and Olsson (1944) have given generalized accounts of the various faunas in relation to their specific problems.

Steinmann (in Steinmann and others, 1895) pointed out the similarities of the fauna of the Chilean Quinquira-schichten with those of the Indo-Pacific region. This holds true not only for the ammonites but for the other mollusks as well (Wilckens, 1904; Wetzel, 1930). Among the gastropods there is a distinct lack of nerineid and acteonellid elements, indicating that the fauna was probably a warm temperate or temperate fauna. To the north in Peru, a warmer water origin is indicated for faunas of the Paita region described by Olsson (1944). Olsson (1944, p. 23) stated “With northern Peru, the affinities of the Chilean Cretaceous is not nearly so close as we would have expected from * * * the widely distributed character of the Indo-Pacific ammonite fauna.” The Peruvian fauna has an entirely different faunal balance, ammonites are few, and the number of gastropod genera (39) is almost equal to that of the pelecypods (42). Many of
the gastropods are restricted or endemic forms and for this reason are of small value for comparison with outside areas. Their distinctive character may well be heightened by the fact that a large number of them appear to be large sized highly ornamented brackish-water forms. These are especially abundant in the Tortuga fossil beds of Olsson (1944, p. 15) of probable Maestrichtian age.

The plecypod fauna of the Paita region points to Caribbean affinities as shown by the presence of *Durania* (= *Sauvagesia* of Olsson) in the radiolite sandstone and of *Pseudocyclaea* in the Baculites beds. The latter genus is known from India (?), Equatorial West Africa, Brazil, Venezuela, and Peru (Darteville and Freneix, 1957, p. 42). In addition, *Pseudocyclaea* has also been noted by the author in Puerto Rico (in Mattson, 1957, p. 67) and in the Palmer collections from Cuba in the U.S. National Museum.

These similarities to the Caribbean faunas support Olsson’s opinion that the Peruvian fauna is tropical. Thus the relationships between the Chilean and Peruvian gastropod faunas mirror those between the United States Upper Cretaceous gulf coast and the Caribbean region.

Of the 39 gastropod genera represented in the Peruvian fauna, only 10 appear in the gulf coast Campanian and Maestrichtian faunas and the identification of several of these is tenuous. *Turrilitella bilirata* Stephenson finds an analog in *Mesalia panja* Olsson. *T. trillata* and *T. saposa* Olsson are very close, but few other species appear closely related.

Campanian and Maestrichtian sedimentary rocks are present in Colombia and Venezuela, but as yet their faunas are almost unknown except for a few ammonites and rudistids. Therefore, there is little basis for a comparison with the other faunas except to say that as far as known the Colombian and Venezuelan faunas are similar to the Caribbean faunas and show little if any relationship to the gulf coast Upper Cretaceous faunas.

The Cretaceous fauna of Brazil has yielded few gastropods (White, 1888; Maury, 1939), and those present show little if any similarity to the gulf coast gastropod faunas. There are few genera (see table 2) and no gastropod species common to the two areas. On the other hand, Darteville and Freneix (1957) have pointed out many similarities in the plecypod faunas between Brazil and Equatorial West Africa.

**EUROPE**

The widespread Late Cretaceous seas of Europe can be divided into two primary areas. One area is that of the chalk sea or northern platform. Over this area from Ireland to the Caucasus were deposited chalks of variable but commonly great purity. Generally the chalk was deposited at moderate depths and becomes less pure away from the center of the basins. Clastic or detrital facies developed at the basin margins. The second area—including the Pyrenees, northern Italy, the Alps, and their eastward continuation through the Balkans to the Caucasus—formed an elongate generally east-west trending trough, the Tethyan geosyncline. This structurally active and complex trough contrasts greatly with the stable shelf area to the north, and its fauna likewise is decidedly different. The various facies of this trough have been succinctly characterized by Willis (1952, p. 51) as follows:

Several facies are characteristic: deeper water pelagic ammonite shales (*Scaglia*); rudist limestones of shallow waters and reefs; more open sea white limestones; and breccias, detrital sandstones and shales and even lagoonal deposits (*Gosau* or Cretaceous flysch facies) derived from rising cordilleras.

The sharp faunal distinctions between these two areas as well as differences between the facies of each has led to much difficulty in correlation. The northern chalk faunas are zoned on the basis of a number of forms, including echinoids, crinoids, inoeramids, belemnites, and locally the ammonites. In contrast to the United States gulf coast, the oysters (Woods, 1899) are generally too long ranging to be of great value. When one tries to carry these zones from the chalk area into the Tethyan area, exact correlation becomes difficult, because many of the forms, as exemplified by the belemnites, are almost entirely restricted to the northern province (Haug, 1908; Gignoux, 1950). The same difficulty holds true for attempts to carry the Tethyan zones to the north. For example, both the rudistids and the reef-building corals (Vaughan and Wells, 1943, p. 72) of the Tethys become increasingly infrequent northward, although Neverson (1955, p. 545) noted the presence of the rudistid genus *Durania* in England.

Gastropods are only locally common in the chalks. Neverson (1955, p. 510) recorded an abundance of gastropods in the lower part of the Senonian in the English chalk, but it is in the marginal sand facies that gastropods are most abundant and most diverse. Such occurrences are described throughout the literature dealing with the Cretaceous of Europe, but the most notable are those of the Aachen sands (Holzapfel, 1888) of Germany and the Maestrichter Kreide (Binckhorst, 1873; Kaunhoven, 1898).

The Aachen sands have yielded a varied fauna of gastropods and plecypods (126 genera according to Chavan, 1946, p. 196). Although of considerably
older age (lower Senonian, Scaphites hippocrepis and Actinocamara zones) than the Ripley fauna, the Aachen fauna is that of a near-shore clastic facies. The general aspect of the Aachen gastropod fauna is much like that of the Ripley fauna of the Mississippi embayment area but the number of gastropod genera common to the two areas is relatively small. These similarities can be ascribed to the similarity of the environment. Even to the description of the lithologies represented, the similarity is striking (Holzapfel, 1888; Bohm, 1885). Interstratified irregularly bedded sands and plant-bearing clay lenses and fossiliferous greensands compose the Aachen sections, as they do that of the Ripley Formation of northern Mississippi. Another striking parallel is that of the abundance and diversification of the opisthobranchs present. This may be a reflection of the ease of recovery from the loose sands, much as it is one explanation for their abundance in the Ripley fauna. In addition, volutes with Volutederma-like species are present, as well as similar fasciolarids, cancelariids, aporrhais, cernihid, and trochids. Perhaps the greatest disparity is in the presence of a few acteonellids that were evidently migrants from the Tethyan belt and in the Turritella that possess sculpture like of a type more typical of the earlier turritellids than those of the Campanian and the Maestrictian.

The following list indicates the genera common to both areas. With better illustrations, descriptions or type material for comparison, perhaps the list would be increased.

Urecolobium (Liatia of Holzapfel)
Damesia
Astandes (Tritonium cretaceum Müller)
Turrítella
Lazispira
Capulus
Cerithium
 Xenophora
Trichotrias
Pseudomalanea? (Discocellia simplex Holzapfel)
Arcohogyas (Latrilia) (Liatiaesh schlotheimii Roemer)
Holcosulax
Euspira (Lanthinia and Amuropis of Holzapfel)
Gyrodes
Pythis (Strombus fenestratus Müller)
Drillata? (Voluitlithes subinsipitata Holzapfel not d’Orbigny)
Hercoryneus (Rapa monheimi Müller)
Boltenella? (Hemispira cornuta Roemer)
Pygopsis (Tudicle quadricarinata)
Palaeospheana (Voluitlithes nana Müller)
Cancellaria?
Cycliche
Tornatella (Acteon müllior Bosquet)
Nonacteconina (Acteonella rinculata Reuss)
Ringicula
Eulina

Some of the species assigned by Holzapfel to Eutochus may well belong in Calliophalus, but like a number of other forms insufficient information is available for a definite assignment. As represented, the list of genera in common is imposing and is not just a matter of long-ranging and widely distributed genera.

The Turoanian Gosau fauna (Zekeli, 1852, Stolitzer, 1865) although closer geographically to the Aachen Cretaceous fauna is more dissimilar than the Aachen fauna is to the Ripley fauna of the gulf coast. This dissimilarity can be accounted for primarily on the basis of environmental differences. The Aachen fauna represents an environment parallel to that of the Ripley fauna at the gulf coast, a temperate to subtropical shallow-water clastic facies, whereas the Gosau beds represent the shallow-water tropical carbonate Tethyan facies.

The works of Binckhorst (1873) and Kaunhoven (1888) on the Limberg-Maestricten Kreide affords another view of the northern fauna with an age closer to that of the Ripley and Owl Creek Formations. The units involved here have yielded Sphenodiscus and Parapachydiscus, as well as Boltenella muenronata (Schlotheim) (Bohm, 1898) and thus are considered Maestrictenian age. In general Kaunhoven’s Limberg fauna is neither as well preserved nor as diversified as the Aachen fauna described by Holzapfel, and relationships could be more easily decided if the descriptions and illustrations were of better quality. The fauna may well represent somewhat shallower water conditions than that in the Mississippi embayment area; it contains a proportionally large fissurelloid element, indicating somewhat different bottom conditions that afforded these rock crawlers a habitat. Compared with the gulf coast faunas we find the Limberg fauna to be more heavily dominated by the mesogastropod elements. A large proportion of all the genera, however, occur in common. Among the more narrowly restricted genera we find Lazispira, a possible Astandes, an Ornoppsis, and some cerithids similar to Ripley types. Several closely related species also occur, among which the following show striking similarities:

Trochus rossinae granulata Kaunhoven...Calliophalus (Calliophalus) americana Wade
Turritella plana Binckhorst (1873, pl. 3, figs. 12-14)...Turritella chalybeataensis, Sohl
Aporrhais (Culitiga) propinquu Kaunhoven...Pterocerella poinsettiformis Stephenson
Aporrhais (Arthroge) pelcephora Kaunhoven...Arthroge (Latitalo) lobata (Wade)

Elsewhere in the sand facies of the chalk seas, similar forms have been noted as occurring in northern
NEOGASTROPODA, OPISTHOBRANCHIA, AND BASOMMATOPHORA

Germany and Bohemia and have been well illustrated by Weinzitze (1910) and others. These shallow-water faunas all show a similar balance and appearance but occasionally include a few nerineids or acteonellids as a reminder of the proximity to the Tethyan sea.

One of the best representative gastropod faunas of the European Tethyan facies is that of the Gosau beds of upper Austria (Zekeli, 1852; Stolizczka, 1863). Few genera occur therein that are common even to beds of similar age in the chalk seas of northern Europe. Comparison with the gulf coast gastropod fauna is not only extremely difficult because of the disparity in age (Turonian as compared to Campanian-Maastrichtian) but because of environmental differences. The Gosau beds according to Vaughan and Wells (1948, p. 72) were one of the greatest reef developments in the Upper Cretaceous. The pelecypods (Zittle, 1865) appear to be more tolerant of variation in environmental factors than are the gastropods and, with the exception of the rudistid elements, they are much closer in aspect to those of the gulf coast. Only about nine genera of gastropods occur in common between these two areas, but a modern revision of the fauna might indicate a few more. As one would expect in a reef environment, one of the more striking features of the fauna is the abundance of acteonellid and nerineid elements. In addition there is an unusually great diversification of large ornate cerithiids. The large size attained by most of the species suggests warm waters with abundant calcium carbonate and the thickness of the shells suggest well-agitated waters as might be expected in the vicinity of reefs.

AFRICA

The faunal relationships between north and south Africa parallel those between the northern and southern parts of South America. The north African faunas are related to those of the Tethyan realm, whereas those of south Africa and Madagascar appear to be closer to those of southern India but also possess some elements that are strikingly similar to those of the gulf coast.

NORTH AFRICA

Gastropod faunas have been well documented from Tunisia and Libya, but in general, little similarity to gulf coast faunas exists. Even on a generic level few gastropods appear to be similar. (See table 2.) It is worthy of note, however, that these faunas, although Tethyan in aspect, do not appear to be dominated by abundant nerineids, acteonellids, or rudistids, although such elements are present.

A large number of species in the Tunisian faunas (Thomas and Peron, 1889; Pervinquiére, 1912) are based on indeterminable internal molds. Even on the basis of such molds one is forced to admit that, although a few species are similar, the faunas are quite distinct from those of the gulf coast. A most striking similarity, however, is the presence of Turritella forgemoli Coquand, a species typical of the north African and Tethyan faunas, which ranges from Algeria to Baluchistan in Maastrichtian equivalents. This species finds an analog or closely comparable species in an undescribed turritellid in the Escondido Formation of Texas and the Providence Sand of Alabama. Scelaria desortorum Wanner and Scelaria calaminata Wanner described from the Libyan faunas, but also present in Tunisia, appear to belong to Striatocostatum; the latter species is closely related to S. congestum Sohl from the Prairie Bluff Formation.

The Libyan faunas as described by Wanner (1902) and Quass (1902) are somewhat better preserved in general than are those of Tunisia and show a few additional similar species in the beds bearing Eoogyrina overweigi and Libycoceros. The former is a probable synonym of E. costata and the latter appears to be analogous to or closely related to Sphenodiscus. Besides the species mentioned above, which occur in both Tunisia and Libya, Turritella quadricincta Goldfuss of Quass is similar to T. vertebroides Morton and T. (Zaria) figur Quass is very close to T. triloba Conrad. In addition Lawispira appears to be represented by Verruca libyca Quass. There are a number of other common genera represented from these areas (see table 2), but, generally, they are widespread forms and the representative species are not closely similar to those of the gulf coast.

WEST COAST OF AFRICA

The recent works of Riedel (1929), Rennie (1929), Cox (1952), Darteville and Bréton (1956), and Darteville and Freneix (1957) have afforded a fine picture of the Upper Cretaceous faunas of the West Coast of Africa from the Gold Coast to Angola. Although many of the species are known only from material too poorly preserved to be certain even of generic placement, a number of others do appear to belong to genera common to the gulf coast. (See table 2.) Of the 26 gastropod genera in common, several appear to occur nowhere else except on the gulf coast and on the West Coast of Africa. Fusimilis auritellaris Cox appears to be a true Fusimilis, but the application of such generic names as Nudivega, Ornopis, and Paleopsepho to species of west Africa appears to be highly questionable. The presence of some genera, of which the pelecypod Pseudococculina Solger is a good example, shows that there was direct
access to northern South America and the Caribbean. Dartville and Frenex (1937, p. 223–229) summarized the relationships of the pelecypod faunas and conclude that the closest relationships are with the faunas of north Africa, but there are also startling similarities to those of South America. The gastropods on the other hand are more localized in development.

SOUTH AFRICA

The faunas of South Africa, especially those of Pondoland (Woods, 1906; Rennie, 1930), bear the same relationship to the faunas of north Africa as those of Chile do to those of Peru and the Caribbean. That is, the distinctive Tethyan flavor retained in the West Coast African faunas has disappeared to a considerable extent in those of South Africa. On this basis alone, although more distant, one might expect the Senonian faunas of Pondoland to appear closer to those of the gulf coast than do those of the geographically closer north or west African faunas. They are similar and more so than one would suspect. Stephen-son (1941, p. 45) listed a series of molluscan species he considered analogous or closely related. The following gastropods are all closely similar: *Paleospheca scalaris* Rennie is close to *P. mutabilis* Wade; *Cryptorhytis rigida* Baily may well be an *Aliofusus: Arcottia vanhooepi* Rennie is similar to *Gegania parabella* (Wade); *Diceroloma (Perisopertha) hayliyi* (R. Etheridge, Jr.) is close to *Arrhopus (Latiola) lobata* Wade; *Gyrodus tenellus* Stoliczka of Rennie is similar to *Gyrodus spillmanii* Gabb; *Solarium hayliyi* Gabb may be a *Margaritella*, and *Turritella (Zaria) bonei* Baily is like *T. triliria* Conrad. In addition, several other genera appear to be common to both areas, but the species are farther removed and in general they appear closer to species from India than to gulf coast forms. Of special interest is the species *Pyrosia geversi* Rennie a form remarkably close to *Surgana stantoni* Weller. This genus is known from only the Gulf and Atlantic Coastal Plains, northern Mexico, and South Africa. Likewise, *Woodseila* Wade is known only from these two regions in the form of *Woodseila typica* Wade from Coon Creek, Tenn., and *Cryptorhytis rigida* Baily from Pondoland. Although Rennie (1930, p. 166) accentuated what he interprets as the endemic nature of the southeast African faunas, one cannot help but be struck by the close similarities with the gulf coast species. No other gastropod fauna outside of North America contains such a high proportion of related forms, although many come from areas that are much closer geographically. The Pondoland fauna appears to have been a melting pot with free access to both the gulf coast and to India. It is impossible to say at present whether these common forms were immigrants or emigrants.

In contrast to the Pondoland molluscan fauna, the Upper Cretaceous faunas of Madagascar are dominantly species with affinities to species from India. The gastropods of the various faunas generally compose only a small number of species. These suffice to show that a rather wide variety of environments is represented, ranging from brackish-water, probably estuarine, facies to normal shallow-water marine facies. Unfortunately, like faunas from so many other areas these gastropods to a large extent are represented by either incomplete specimens or internal molds, which makes comparison difficult. A number of species have been assigned to genera in common with North America (see table 2) by Delpey (1949), Collignon (1931, 1933, 1949a, b), and others, but for the most part these assignments should be viewed with extreme caution. There appear to be few species of gastropods in common between Madagascar and Pondoland. Surprisingly there is not only a closer similarity with the gastropod fauna from southern India, but some of the Tethyan species from Europe and the Middle East also appear to be present. A good example of the latter is *Turritella forgemoli* Coquand (= *T. morgani* Douville of Collignon, 1949), which ranges from Algeria to Baluchistan in beds of Maestrichtian age. *Turritella (Zaria) besairie* Collignon (1949a) and *T. breanti"a d'Orbigny of Boule and Thennin (1906) represent the ubiquitous trilirate turritellid common to the Campanian and Maestrichtian. The other common elements such as *Gyrodus, Pugnellus, Pyrosia*, and *eupira* appear to be related to the faunas of India described by Stoliczka (1867–68), rather than to those of Europe and the southeastern United States.

NEAR EAST

The Upper Cretaceous molluscan faunas of the general area of Turkey, Syria, and Palestine are of the Tethyan type and overall do not contain abundant and diversified gastropods. The works of Blankenhorn (1890, 1927), Delpey (1939), and Picard (1930) show few gastropod genera comparable to those present in the gulf coast fauna. The presence of such forms as *Scalara desororum* Wanner indicates a relationship of the late Upper Cretaceous gastropod fauna of this area to that of the Libyan desert.

PERSIA

The Upper Cretaceous molluscan faunas of Iran, as described by Douvillé (1904), appear to have their greatest affinities with those of Baluchistan. In aspect they, like the preceding, belong definitely to the
Tethyan province. Gastropod representation is poor in Persia until the Maestrichtian and the fauna is either dominated by cephalopods and pelecypods in general, or by rudistids in particular. The large Maestrichtian gastropod fauna is quite diversified, but few genera occur in common with the gulf coast fauna. (See table 2.) Lyria cf. L. turnigudula Deshayes of Douville has a considerable similarity to Tectaplica simplicia Wade and Procerithium morgani Douville is reminiscent of Cerithium weelsi Wade. Some of the species assigned to Scala may belong in Striaticosta, but the available descriptions and illustrations are too indefinite to be sure. Turritella morgani Douville is an analog of T. forgemoli Coquand of north Africa and Madagascar.

Overall the gastropod fauna of Iran is dominated by the litorinid, cerithid, and melanoepis elements (Pyrazus, Potamides, Procerithium, Campanile, Cerithium, Pirenza, Pauwus, Melanoepis, and other) that indicate local shallow water, probably brackish environments with a highly endemic aspect.

TRANSCAUCASIAN RUSSIA

Two recent well-illustrated monographs by Pchelintsef (1953, 1954) on the Transcaucasus and central Asia give us a good overall picture of the Upper Cretaceous gastropod faunas (predominantly Cenomanian and Turonian). Although moderately diversified, the fauna is thoroughly dominated by the nerineid and acteonellid elements. More than 90 percent of the species are described as new and the fauna is difficult to evaluate. The use of such names as Drilicta, Pyropis, and Tectaplica is open to considerable question. Haustator submorgani Pchelintsef (1953, pl. 7, fig. 3) is probably related to Turritella forgemoli Coquand, a typical Tethyan form. The fauna is thoroughly dissimilar to that of the Gulf Coastal Plain.

INDIA

As pointed out by Noetling (1897) the Upper Cretaceous faunas of India can be divided into two parts. The first, that described by Noelting from the Mari Hills, is typical of the Baluchistan-Himalaya region. This fauna aside from a few scattered long-ranging species is distinctly different from that of southern India. Little basis for comparison with the gulf coast gastropod fauna exists in regard to the 23 gastropod species present. Only Pugnella crossicostatus Noetling is at all similar to a gulf coast species. Noetling (1897, p. 7) on rather scant evidence believed the rest of the fauna to be most closely similar to that of southwestern France, and the Tethyan flavor of the molluscan fauna cannot be denied. Even comparing the gastropods with nearby areas, one finds that most of the species appear to be endemic. Of special note on the other hand is the occurrence of Nerinea quetens Noetling. The author stated that he viewed no internal plications and was doubtful of its true generic assignment. The form and growth lines are reminiscent of Turritella forgemoli Coquand which, as has been noted before, occurs widely in the Tethyan belt from Algeria to Syria and has analogs in Persia in the form of the probably conspecific Turritella morgani Douville, a similar form in the Transcaucasus and Central Asia. Haustator premorgani (Pchelintsef), and a related species in the Escondido Formation of Texas.

The faunas from southern India (Stoliczka, 1867–68) of the Trichinopoly and Arialoor groups, in contrast to those from northern India, are more typical of the Indo-Pacific realm and appear to be more closely related to those of Madagascar, New Zealand, and South America. A fair number of genera occur in common with those of the gulf coast, but most of these (see table 2) are wide ranging both geographically and stratigraphically and have little significance as far as provincial relationships are concerned.

The gastropod fauna of southern India is the most diversified to be found in the Indo-Pacific region. Whereas it does not compare very closely on either a generic or specific level with the gastropods of the Gulf Coastal Plain, the proportional representation by families of the fauna is similar. The diversity of the aporrids and volutes and the presence of a number of pyropids all give the fauna a familiar aspect. This similar aspect is to be expected as much of the fauna comes from rocks that were laid down in small coastal embayments and that seem to represent environmental conditions similar to those found in the Mississippi embayment. On the other hand, temperature conditions may have been warmer here than were those in the Mississippi embayment as is noted by the presence of cypraeids and by the presence of a few warm-water nerineids and acteonellids. The diversity of cerithiids, litorinids, and neritids represent a greater proportion of very shallow to brackish-water elements than are to be found in the gulf coast faunas.

JAPAN

The Upper Cretaceous mollusks of Japan have been the subject of numerous works by Nagao (1939), Matsumoto (1953), Yabe (1927), and others, but in general, gastropods are not abundant. The ammonite-inoceramid domination of the fauna is reminiscent of the western interior of the United States.
There are few genera in common with those of the Gulf Coastal Plain (see table 2), and the occurrence of such genera as Volutodera, Tessarolax, and Biplica show a very strong affinity to the gastropod fauna of California.

NEW ZEALAND

Wilkens (1922) described a rather small late Upper Cretaceous gastropod fauna from Amauri Bluff and other localities on South Island. These forms bear little resemblance to the gastropods of the Ripley fauna, but compare well with the Indo-Pacific faunas. Procanicollaria parkiana Wilkens may belong in the genus Morea. The genus Conchothyris, a strombid related to Pugnellius, is close to some South American species from Chile. Wilkens (1922, p. 30) pointed out other similarities to Chile, southern India, and Antarctic faunas.

PROPOSED NEW GENERA AND SUBGENERA

Lovenastamia
Ornopis (Pornosis)

PROPOSED NEW SPECIES AND SUBSPECIES

Morea corynicernis coenensis rotonda
marylandica halli
Lovenastamia junicula cuclata
Alloofodus stamineus
Buccinopsis solidus sulcata
dorothiella
Odontobasis sulcata
Protopsycyon binodosum
Pyriusus crassus
ejundicus
Rhombopas molinensis
Dessensiella belladoncosta
Bellifusus spinosus
curvicostatus crenulatus
angulocostatus
Drillita lemnicola
buboanus
Paleopsephaena tenuilirata
Doliolithus torquatus
Ornopis (Pornosis) modica (Pornosis) modica laevia
Latirus leonivittensis
Hercohy strenuus (Hercohy strenuus) pagodiformis
(Haplovoluta) triliatus
quadridrillus
Remera Rxerogastta
Anomalofoton subnodosus
lemnisicatus
Lupra turbinata
Pyriusus cornutus
protasa
Napalus reesidei
fragilis
Hydrotrilus elegans
Longoconcha quadrilirata

TENNESSEE AND MISSISSIPPI

Volutomorpha valida
producta
Liopeplum coronatum
nodosum
Paraisurus saufordii
Trigonostoma ripelagaa
Cancellaria macnaryensis
Caveola acuta speciosa
Paladmete gardinerae pygmaea
laevis
Amautum macnaryensis torquatum
dumascens
wodei
(Lutema) limbatum
Remnita hastata
Gemnula crotea
Beretra speciosa
Fusimelia kummeli
Acteon pistilliformis
cestricolus
Eoacteon percibula
Rincaula yochelmi
Oligoptycha corrigata
Cylicophtycha diversilirata
intermissia
intermissa curta
pessumata
Gonioechan eocyonota
Bulbusis demersus
Eulimo gracilostyla
Creconella subangulata
turreiforma
Acra (Hemiacrisa) flexicostata
(Hemiacrisa) clahtra
(Pleacoacrisa) implica
Striaticostatum aspera
congesta
sparsa
Opalia (Opalva?) fistulos
(Pliciscola) wadei

CHANGES IN GENERIC OR SPECIFIC ASSIGNMENTS

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

<table>
<thead>
<tr>
<th>Old assignment</th>
<th>New assignment</th>
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<tr>
<td>Pyropsis geversi Rennie</td>
<td>Sargana</td>
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<tr>
<td>Pinellia Stephenson</td>
<td>Morea</td>
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<tr>
<td>Pseudomorea Cossman</td>
<td>Morea</td>
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<td>Pinella reticulata Stephenson</td>
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<td>Morea cancellaria corynicernis</td>
<td>Morea corynicernis</td>
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<td>Strepsidura interrupta Conrad</td>
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<td>Old assignment</td>
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<td>Seminola Wade</td>
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<td>Seminola solida Wade</td>
<td>Seminola solida Wade</td>
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<td>Nassa globosa Gabb (in part)</td>
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<td>Fascioculata (Cryptothystis) crassicausta Gabb</td>
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<td>Fuszus culebertoni Meek and Hayden</td>
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<td>Turbonilla (Chennizia) melananopia Conrad</td>
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<td>Rimella curvattillata Conrad</td>
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<td>Hercyromonas radosum Stephenson</td>
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<td>Hercyromonas gracilis Harbison</td>
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<td>Anchoa petersiando Johnson of Wade</td>
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<td>Xoneus variabilis Wade</td>
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<td>Lupira polycynma Harbison</td>
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<td>Medonius Stephenson</td>
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<td>Tropifusus spinosus Wade</td>
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<td>Tropifusus intercalatus Wade</td>
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<tr>
<td>Eonella Stephenson</td>
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<td>Fascioculata riplebana Wade</td>
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<td>Volutoverma (Lonconocha)</td>
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<tr>
<td>Volutoverma appressa Wade</td>
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<td>Voluta elongata Sowerby of d'Orbigny</td>
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<td>Volutoderma protracta Dall</td>
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<td>Rotellites texturatus Whiffeld</td>
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<td>Volutoderma tennesseeensis Wade</td>
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<td>Volutomorpha tarensis Stephenson</td>
<td>Volutomorpha tarensis Stephenson</td>
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<tr>
<td>Volutomorpha hosta Dall</td>
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<td>Lioepylum mommonthensis Gardner</td>
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<td>Mataxena valida (Stephenson)</td>
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<td>Cancellaria eufaulensis Gabb</td>
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</tbody>
</table>

**DEFINITIONS OF MORPHOLOGIC TERMS**

Below are listed morphologic terms applied to gastropod shells in this report. The more common and well-defined terms are not listed, but those which have a confused history of usage or are infrequently applied have been defined in the sense herein used. In general
the terminologies of Cox (1955) and Knight (1941) have been used.

Ab—Used as a prefix indicating away from, as in abapertural.
Ad—Used as a prefix indicating toward, as in adapertural.
Anomalous—Without an umbilicus.
Body whorl—Last complete volution of the conch.
Cancellate—Ornament of intersecting spiral and transverse elements of similar strength.
Carina—A strong spiral ridge which in many species forms a whorl angulation.
Channeled suture—Suture in a trough.
Collabral—Ornament trending with path of growth lines.
Columnellar lip—See inner lip.
Cord—Round-topped, prominent element of spiral sculpture.
Costa—Round-topped, prominent element of transverse sculpture.
Deviated—Axis of protoconch and axis of teleoconch forming an angle of less than 180°.
Funicle—Strong spiral cord extending from edge of inner lip into umbilicus.
Hemihemaphalous—Umbilicus partly plugged by secondary growth of callus.
Immersed—Initial whorls sunken below plane of later volutions.
Inner lip—that part of the aperture extending from suture to base of columella and which includes the parietal and columnellar lips.
Opisthoclinal—Growth lines which slope forward (adaperturally) from upper suture to lower suture.
Orthoclinal—Growth lines that are mainly parallel to axis of coiling between the sutures.
Parietal lip—Part of inner lip extending across penultimate whorl.
Penultimate whorl—Volution immediately preceding the body or last whorl.
Phaneromaphalous—With open umbilicus.
Pleural angle—Angle formed by two lines tangent to last two whorls.
Proscline—Growth lines that slope backward (adaperturally) from upper suture to lower suture.
Protoconch—Earliest formed whorls, generally clearly demarcated from the teleoconch whorls by lack of ornament or a change in outline.
Punctate—Pitted surface.
Ramp—Inclined flattened area on upper whorl surface limited by a peripheral or subperipheral carina.
Reflected—Inner lip or part thereof that is turned backward at margin.
Ribs—Elements of transverse sculpture similar to but weaker than costae.
Ribbon—Flat-topped prominent element of spiral sculpture.
Septum—A plate, commonly hemispherical, that seals off early whorls from later whorls.
Shoulder—Flattened area on upper whorl surface lacking the inclination of a ramp but similar and limited by the shoulder carina.
Sinus—Parasagittal curve of the outer lip or growth line.
Siphonal canal—(Anterior canal)—Channel of variable length and strength developing from anterior extremity of aperture.
Siphonal fascicle—Band of variable width formed by arched flexed growth lines marking previous position of anterior siphonal notch.

Tennessee and Mississippi

Teleoconch—Shell exclusive of protoconch.
Thread—Very fine elements of ornament, finer than costae or cords.
Turreted—Shell with whorls rising in steps as on Napolus.
Turriculate—(Turrited)—acute spire of shell commonly flattened. As in Turritella.

Measurements of Specimens

Measurements of individual specimens of many species are given under a sideheading following the specific descriptions. These are listed to indicate, to some degree, the range of variability in size, but are by no means an absolute indication. Where practicable only the best and most complete specimens were measured, but for some species only crushed or distorted specimens were available. Such specimens are noted under “Discussion.” Larger specimens were measured with vernier calipers, and the smaller forms were measured with the aid of a microscope equipped with a calibrated eyepiece. All measurements are in millimeters.

The conchological features measured vary with the individual groups. For instance, the Aporrhaidae develop an expanded outer lip, and the set of measurements used to indicate the relation of the lip to the shell must be different from that used to measure a less complex group. Thus, where it has been deemed important or informative, certain additional characters are measured.

Listed below are the abbreviations used as headings of the column of measurements and their definitions.

\begin{itemize}
  \item \textbf{D}—Diameter, measured normal to teleoconch axis of coiling.
  \item \textbf{DU}—Diameter of umbilicus, measured parallel to base of shell.
  \item \textbf{DA}—Diameter of aperture, measured normal to axis of coiling.
  \item \textbf{DW}—Diameter of fourth whorl, measured normal to axis of coiling.
  \item \textbf{MD}—Maximum diameter, measured normal to the teleoconch axis of coiling.
  \item \textbf{MD+MW}—Maximum diameter plus the length of an expanded outer lip or wing.
  \item \textbf{MinD}—Minimum diameter, used in cap-shaped shells for shorter diameter.
  \item \textbf{H}—Total height of shell, measured parallel to axis of coiling.
  \item \textbf{HA}—Height of aperture, measured parallel to axis of coiling.
  \item \textbf{HPW}—Height of penultimate whorl, measured parallel to axis of coiling.
  \item \textbf{HW}—Height of fourth whorl, measured parallel to axis of coiling.
  \item \textbf{HB}—Height of body whorl, measured parallel to axis of coiling.
  \item \textbf{HS}—Height of spire, measured parallel to axis of coiling.
  \item \textbf{H:D}—Ratio of height to maximum diameter.
  \item \textbf{Estimated H}—Total height of incomplete specimens estimated by projection of pleural angle.
  \item \textbf{L}—Length or long diameter of cupulate shells.
  \item \textbf{No. W}—Number of whorls, generally exclusive of nuclear whorls.
  \item \textbf{PA}—Pleural angle.
\end{itemize}
WA.—Width of aperture, measured normal to axis of coiling.  
WS.—Width of shoulder, measured normal to axis of coiling from suture to shoulder edge.

SYSTEMATIC DESCRIPTIONS

Order NEOGASTROPODA  
Superfamily MURICACEA  
Family MURICIDAE  
Subfamily RAPANINAE

Genus ECHORA Conrad, 1843

Type by monotypy, Fusus quadricostatus Say, 1824.

Diagnosis.—Small, moderately large subfusciform shells with a moderately low spire. Whorls strongly shouldered, with strong spiral carinations over periphery; basal constriction strong. Whorls may be loosely attached. Aperture ovate, produced to a narrow, generally elongate and curving siphonal canal terminating in a moderately strong notch; outer lip crenulate; inner lip moderately thick, free or partly attached over parietal surface. Umbilicus broad, open, deep, and margined by a serratate carina.

Discussion.—With the exception of the Cretaceous species, E. proquadricostata Wade, all the known species of Echora are from the Oligocene and Miocene. With such a restricted range the possibility of placing Wade’s species from the Ripley Formation in the genus Echora has been questioned. The possibility of the Ripley species being a homeomorph cannot be discarded but, in all shell features except size, it is a close analogue to the type species E. quadricostatus (Say) from the Miocene. Echora proquadricostata does possess nuclear whorls, ornament, aperitural features, umbilical characters, and growth lines so similar to those of the type species that it would be unwise to separate this species from the genus Echora purely on the basis of time lapse. In general the Tertiary species are all of medium or moderately large size. In the mature stages of these forms the whorls begin to deviate and frequently may lose contact completely with previous whorls. Most Echora species possess a translucent brown outer shell layer and a light-colored lamellar inner layer. The Cretaceous species, E. proquadricostata, is small and does not appear to possess such a translucent brownish outer shell layer. Such a shell layer, however, may be rather unstable and could have been replaced so that now there is no such differentiation.

Echora proquadricostata Wade

Plate 19, figures 1, 5


1926. Echora proquadricostata Wade, U.S. Geol. Survey Prof. Paper 137, p. 135, pl. 52, fig. 3.

Diagnosis.—Small, planeromphalous subpyriform shells with round-sided whorls marked by four strong raised broadly round topped spiral costae that are much narrower than their interspaces. Aperture subcircular, anteriorly produced to a slightly curved and narrow siphonal canal; outer lip denticulate within and crenulated at position of spiral costae.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

<table>
<thead>
<tr>
<th>No.</th>
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<td>5</td>
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<td>9.5</td>
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<td>21</td>
<td></td>
<td>10</td>
<td>8.3</td>
<td>7.6</td>
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</table>

Discussion.—E. proquadricostata is moderately abundant at its type locality on Coon Creek, Tenn., but in the Ripley Formation of Mississippi it is quite scarce. Only seven specimens have been recovered from four localities. Variations within the typotype lot is insignificant and specimens from the higher stratigraphic positions in Mississippi also compare very closely with the Tennessee specimens. The species also occur in the Ripley Formation at Mercers Mill on Tabanee Creek, Quitman County, Ga., (USGS colln. 25929).

Types: Holotype USNM 32920; hypotype USNM 130195.


Genus SARGANA Stephenson, 1923

Type by original designation, Rapana stantoni Weller, 1907.

Diagnosis.—Low-spired subpyriform shells with whorls that are strongly constricted anteriorly to a stout pillar. Aperture notched posteriorly, anteriorly drawn out to a very narrow curved siphonal canal; outer lip crenulate, inner lip with a single fold above siphonal canal. Sculpture ornate with spines or nodes developing at intersection of spiral and transverse elements. Umbilicus wide and deep, bordered by a serratate carina.

Discussion.—Stephenson (1923, p. 377) erected the new family Sarganidae to include Sargana and an undescribed genus from the Ripley Formation of the Chattahoochee River region of Georgia and Alabama. The undescribed genus was probably that which Wade...
later (1926, p. 177) described as *Schizobasis*. The primary features that Stephenson used for separating the Sarganidae from the Muricidae were the presence, in the former, of a columellar fold and the flattened spire. Some members of the Muricidae (*Murex* and *Morea*), however, have a similar fold in about the same position. Later, Stephenson (1952, p. 181) formally included *Schizobasis* Wade and *Hillites* Stephenson in the Sarganidae. The present author prefers to place *Hillites multilirae* Stephenson, the type species, closer to *Morea* Conrad than to *Sargana*, on the basis of its possession of a siphonal welt, an umbilical slit, and a short siphonal canal. Both genera also have some similar columellar plait above the siphonal canal. Not only do the shape and ornament distinguish *Schizobasis* Wade from *Sargana*, but it also has an umbilical plug. In other features *Schizobasis* lies close to *Hillites* and thus is here tentatively placed with *Hillites* in the Purpurinae.

*Sargana* itself is muricid in the character of its ornament and its siphonal canal. Other muricids, such as *Actinotrophon* Dall, *Echphora* Conrad, and *Rapana* Schumacher, have similar umbilical characters. In addition, *Rapana*, though having a more open siphonal canal, has a rather low spire. On the basis of these similarities *Sargana* is placed in the *Rapanae*. The relocation of the type genus makes the retention of the name Sarganidae superfluous.

In North America, *Sargana* ranges through the *Eogoyna ponderosa* zone and through most of the *E. costata* zone; it is known from Texas to New Jersey. The specimens from the youngest beds are poorly represented and may belong to a different species.

*Sargana* stan toni (Weller)
Plate 19, figures 7, 9, 11-25

1940. *Sargana* stan toni (Weller). Stephenson and Monroe, Mississippi Geol. Survey Bull. 40, pl. 9, figs. 6, 7, 8.

**Diagnosis.**—A *Sargana* ornamented by 7-9 spiral rows of nodes on the whorl sides.

**Measurements.**—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

**Discussion.**—Most specimens of *Sargana* stan toni are almost as high as they are wide. In other features there is, however, rather wide individual variation. In the early growth stages the upper whorl surface is flat and unornamented and the shoulder carination is sharp (pl. 19, figs. 7, 24). Between the third and fourth whorl stages, ornament begins on the upper whorl surface (pl. 19, fig. 24) and with increased size the shoulder rounds off (pl. 19, fig. 16). On mature individuals there are seven spinose or nodose spiral cords between the suture and the basal constriction. Two of these cords are on the upper whorl surface between the suture and the peripheral carination with the immediately subesatural cord developing at a later stage (pl. 19, figs. 13, 17). Normally there are four cords (pl. 19, figs. 18, 21) on the whorl side, with the upper one being developed later than the lower three. (Contrast pl. 19, figs. 21-23.) One large specimen from the Ripley Formation of Mississippi at locality 18, however, shows a development of nine spiral cords (pl. 19, fig. 14). This is not merely addition of spiral cords with size because an equally large specimen (USNM 130191), from the Ripley Formation on Coon Creek, Tenn., shows only the typical seven cords of the mature stage.

The strength of the spines at the intersection of the spiral and transverse elements is equally variable. Generally the spines are low, but in some specimens they are strongly spinose and close spaced (pl. 19, figs. 19, 20). The noded appearance of many specimens may be due to breakage and wear of these delicate fluting.

In general, where the species occurs at all, the specimens are rather abundant. Many of the occurrences in other areas listed below are based on incomplete specimens. When better preserved material is available, they may be found to represent new species.

**Pyropis generosi** Ronne (1930, p. 229), from the Senonian of Pondoland, South Africa, is very closely related and appears to differ only by the lack of the second spiral cord on the upper whorl face.
Types: Holotype USNM 21070 (Texas); hypotypes USNM 31866 (North Carolina); 32265, 130101–130194 (Tennessee); and USNM 26548, 130189–130190 (Mississippi).


Subfamily MOREINAE
Genus MOREA Conrad, 1860

Type by monotypy, Morea cancellaria Conrad.

Synonyms.—Pseudomorea Cossmann (1925, p. 265); Pinella Stephenson (1941, p. 324).

Diagnosis.—Low spired ovate to subglobose shells with a basal sulcus, a siphonal fasciole, a pseudumbilicus, and a surface marked by intersecting strong spiral ribs and weaker transverse ribs. Aperture notched posteriorly, anteriorly produced to a short broad canal ending in a siphonal notch; outer lip crenulate, columellar lip bounded below by one strong oblique fold immediately above the siphonal canal.

Discussion.—As defined above, this genus is restricted to the Campanian and Maestrichtian of the Gulf and Atlantic Coastal Plain. Since Morea was first proposed its placement in a family has been controversial. Tryon (1883, v. 2, p. 181) placed the genus in the family Cancellariidae. Later Cossmann (1925), followed by Wade (1926), assigned Morea to the Purpuridae. Stephenson (1941, p. 325) decided a separate family was warranted but included no other genera. Wenz (1941) placed the genus in the subfamily Drupinae of the Muricidae. Wenz includes a rather wide grouping of genera within the Drupinae (= Purpurinae) and perhaps the splitting off of Morea in a separate subfamily is justified, but full familial rank of a form in many respects so similar to such genera as Nucella Bolten [Roeding] and Thais Bolten [Roeding] does not seem justified.

Previous to this writing only three species of Morea had been named, Morea cancellaria Conrad, from the Ripley Formation of Alabama, M. naticella Gabb, from New Jersey, and M. marylindica Gardner, from the Monmouth formation of Maryland, although Stephenson has proposed several subspecies. Subsequent descriptions of specimens from the Late Cretaceous of the coastal plain by Wade, Gardner, and Stephenson have been referred to one of these species.

M. cancellaria Conrad, M. naticella Gabb, and M. naticella Gabb of Gardner (1916, pl. 18, fig. 12) are all similar in being round-whorled low-spired shells with evenly curving concave columellas. M. marylandica, in contrast, is a higher spired form with a narrower umbilical area and a more sharply excavated columnella. These differences caused Cossmann (1925, p. 265) to hesitatingly propose the name Pseudomorea for the later species as follows:

Il est done probable qu'il trouvera separer une nouvelle section de Morea, dont le génotype serait M. marylindica: on pourrait lui donner le nom Pseudomorea "nobis," si les différences signeaules ci-dessus sont constantes, ce que je ne suis pas affirmé, d'après d'uniques spécimens.

Cossmann gave no formal statement of differences nor any diagnosis for his subgenus. However, Wenz (1941, p. 115) accepted the name as a subgenus based primarily on shells with relatively greater concavity of the columnella and stronger columellar fold. The latter character appears to have little or no validity in separating the species into supraspecific groups, but the former may be more valid. There appears to be little basis or need for such a separation and until better criteria for separation appear it is here not accepted.

Morea appears to be a plexus beginning in the Campanian and consisting of two major branches. One branch, typified by M. cancellaria, tended to more obese shells having lower spires, which culminated in Morea rotunda. The second branch, as typified by M. marylindica, possesses shells that are higher spired and slimmer. The exact point of diversification is not definitely known. The earliest recorded occurrence of the genus is that of a small unnamed M. cancellaria-type of specimen collected in the Blufftown Formation (lower Eoogyra ponderosa zone) in eastern Alabama. In the upper part of the E. ponderosa zone both branches are present. Thus, as recorded, the diversification appears to have occurred by at least the middle of the E. ponderosa zone.

Pinella reticulata Stephenson (1941, p. 324), the type species of Pinella, from the Kemp Clay of Texas, appears to be based upon an immature specimen of a species of Morea related to M. marylindica. (Compare pl. 20, figs. 2, 3.) The generic name Pinella is accordingly placed in the synonymy of Morea.

Morea cancellaria Conrad

Plate 20, figures 7, 13


1899. Morea cancellaria Cossmann, Essais Paléonconchologie Comparée, v. 3, p. 6, pl. 2, fig. 16.

Diagnosis.—Slightly ovate low-spired moreids with 7–8 spiral ribs that are noded at the intersection of
the transverse elements; spiral ribbons arise from a ridge immediately above siphonal fasciole.

**Measurements.**—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

<table>
<thead>
<tr>
<th>Loc.</th>
<th>H</th>
<th>MD</th>
<th>HB</th>
<th>Rows of nodes</th>
<th>H:D</th>
<th>HB:H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eufaula, Ala. USGS 279 (topotype)</td>
<td>26.5</td>
<td>17.6</td>
<td>22.7</td>
<td>8</td>
<td>1.0</td>
<td>0.8</td>
</tr>
<tr>
<td>Topotype</td>
<td>25.9</td>
<td>16.0</td>
<td>13.7</td>
<td>8</td>
<td>1.6</td>
<td>0.8</td>
</tr>
<tr>
<td>Des.</td>
<td>20.9</td>
<td>12.9</td>
<td>16.4</td>
<td>7</td>
<td>1.5</td>
<td>0.8</td>
</tr>
<tr>
<td>USGS 417 (Alabama)</td>
<td>22.5</td>
<td>14.7</td>
<td>16.2</td>
<td>8</td>
<td>1.6</td>
<td>0.8</td>
</tr>
</tbody>
</table>

**Discussion.**—The holotype of this species is no longer present in the collections of the Academy of Natural Sciences of Philadelphia.

Conrad (1860, p. 290) cited the species as occurring both at Eufaula, Ala., and Tippah County, Miss. No definite statement as to the locality from which the holotype came is given. The specimen illustrated is slimmer than the Mississippi specimens from the Ripley Formation, but agrees well both with other specimens from Eufaula in the Geological Survey collections and with a specimen figured by Cossmann (1890, pl. 2, fig. 16) that was also from Eufaula. Stephenson (1941, p. 326) accepted Eufaula as the type locality, as it is mentioned first.

The assignment of specimens from other areas by Wade and Stephenson to *Morea cancellaria* appears to be erroneous. The *M. cancellaria* type of structure appears in a distinct, though as yet undescribed, species from the Coffee Sand of Mississippi and the closely related *M. corsicanensis coinensis* from Tennessee. Both these taxa differ from *M. cancellaria* s.s. by the development of a weltlike fasciole similar to that possessed by *M. marylandica* Gardner. In addition these, like other known forms, show no evidence of spiral addition from the upper margin of the fasciole. *Morea cancellaria corsicanensis* Stephenson is much more obese, lower spired, and has a narrower pseudomemblicus, except in its gerontic stages and appears worthy of separate specific designation. *Morea cancellaria crassa* Stephenson, from the Nacatoch Sand of Texas, is slim in outline and appears to be an actual subspecies of *M. cancellaria*, differing by its coarser ornament and slightly higher spire.

The form described by Stephenson (1941, p. 328) as *Morea marylandica lanciada* appears to belong in the cancellaria group rather than with *M. marylandica*. It possesses a flat, not erect protoconch, lacks distinct shouldering of the whorl, and has a low spire. In outline it is a slim shell closer to *M. cancellaria* than to *M. corsicanensis*.

Suites of *Morea cancellaria* from several localities in the Chattahoochee River region possess a constancy in outline and ornament. A complete transition from 7 to 8 spirals is seen in the topotype suite with the eighth spiral breaking off from the upper edge of the basal fasciole.

**Type:** Holotype lost; hypotype USNM 211109; hypotype, see Cossmann, 1899.

**Occurrence:** Alabama and Georgia (Chattahoochee River region): Ripley Formation.

*Morea corsicanensis corsicanensis* Stephenson

**Plate 20, figures 1, 8**


**Diagnosis.**—Medium-sized low-spired obese shells with 8–9 nodded spiral ribbons and a rather deeply channeled suture.

**Measurements.**—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

<table>
<thead>
<tr>
<th>Loc.</th>
<th>H</th>
<th>MD</th>
<th>HB</th>
<th>Rows of nodes</th>
<th>H:D</th>
<th>HB:H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Texas (holotype)</td>
<td>35.1</td>
<td>27.6</td>
<td>28.1</td>
<td>8</td>
<td>1.3</td>
<td>0.8</td>
</tr>
<tr>
<td>Texas (paratype)</td>
<td>20.7</td>
<td>20.6</td>
<td>20.4</td>
<td>8</td>
<td>1.3</td>
<td>0.8</td>
</tr>
<tr>
<td>6 (Mississippi)</td>
<td>24.7</td>
<td>16.4</td>
<td>19.6</td>
<td>8</td>
<td>1.5</td>
<td>0.8</td>
</tr>
<tr>
<td>6</td>
<td>22.4</td>
<td>16.9</td>
<td>18.4</td>
<td>9</td>
<td>1.2</td>
<td>0.9</td>
</tr>
<tr>
<td>6</td>
<td>21.7</td>
<td>16.1</td>
<td>20.3</td>
<td>8</td>
<td>1.4</td>
<td>0.8</td>
</tr>
<tr>
<td>6</td>
<td>18.0</td>
<td>12.0</td>
<td>15.0</td>
<td>8</td>
<td>1.3</td>
<td>0.8</td>
</tr>
<tr>
<td>6</td>
<td>20.8</td>
<td>15.4</td>
<td>16.5</td>
<td>8</td>
<td>1.3</td>
<td>0.8</td>
</tr>
</tbody>
</table>

**Discussion.**—The holotype of this species from the Nacatoch Sand of Texas (Stephenson, 1941, pl. 61, figs. 7–8) is the largest known specimen and exhibits a distinctively wide umbilical area. A paratype (Stephenson, 1941, pl. 61, fig. 9) is smaller in size and compares very favorably with specimens of *Morea* from the Ripley Formation of Mississippi. The wide umbilical area of the holotype is considered a gerontic feature. On the basis of comparison with the paratype the Ripley specimens are assigned to the species *M. corsicanensis*.

In Mississippi this species, although not abundant, occurs at a number of localities all within that part of the Coon Creek Tongue above the *Exogyra cancellata* zone. The measurements indicate that these specimens show some variation in body proportions. Compared with the type material from Texas their ornament is less coarse and the body proportions range from forms similar to those of Stephenson’s paratype to those like the hypotype (pl. 20, fig. 1), which are slimmer. Compared with *Morea cancellaria* Conrad from Alabama, this species is more obese, has a higher number of spiral ribbons at an earlier growth stage, commonly has a less broad umbilical area, has
a less sharply delimited upper border to the siphonal fasciole, and has a channeled suture.

**Types:** Holotype USNM 77022 (Texas); paratype USNM 77023 (Texas); hypotype USNM 130196 (Mississippi).

**Occurrence:** Texas: Nacatoch Sand. Mississippi: Ripley Formation, locs. 6, 15, 16, 18.

*Mora* corsicanensis coonensis Sohl, n. subsp.

Plate 20, figure 9


**Discussion.**—This subspecies differs from *M. corsicanensis corsicanensis* Stephenson by its more constricted base and in its raised, weltlike fasciole band on the base of the body. This subspecies occurs in the zone of *Exogyra cancellata*, in a lower stratigraphic position than that occupied by *M. corsicanensis*. Few specimens of the subspecies are known, but they appear to be close in character to similar undescribed specimens present in the Coffee Sand of Mississippi.

**Type:** Holotype USNM 32917.

**Occurrence:** Tennessee: Ripley Formation, loc. 1.

*Mora rotunda* Sohl, n. sp.

Plate 20, figures 11, 12

**Diagnosis.**—Medium-sized moreids with a very low spire, a globose outline, 10 or 11 spiral ribs, and a broad fasciole area.

**Description.**—Shell of medium size, globular in outline, slightly longer than wide; spire low about one-fourth total shell height. Whorls few in number, plumply rounded, and expanding rapidly. Protoconch unknown, but its scar is small and regularly coiled. Suture impressed, becoming channeled on later whorls. Body well rounded, almost globose, and slightly constricted anteriorly to a basal sulcus. Surface ornamented by 10 to 11 spiral ribs that are narrower than their interspaces and that are accentuated to elongate nodes where they override the poorly defined rather broad almost flat topped collabral ribs. Growth lines numerous, fine, close spaced, overriding both spiral and transverse elements; their overall trend is somewhat prosocline, but a sharp sinus is formed on the raised spiral rib at the suture; they are slightly flexed over each spiral rib and form a deep sinus on the base, marking the position of the siphonal notch, then they curve upward into the pseudoumbilicus. Aperture ovate, slightly notched posteriorly, and bearing a slightly twisted deep and wide anterior siphonal notch; outer lip thin at edge and crenulate where interrupted by the spiral ribs; inner lip broadly rounded; parietal lip with a callus that extends out onto body a short distance; columnar lip reflexed somewhat over the umbilical area; columnella with a strong very oblique fold above the siphonal canal.

**Measurements.**—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

<table>
<thead>
<tr>
<th>Loc.</th>
<th>H</th>
<th>MD</th>
<th>HB</th>
<th>Num. of species</th>
<th>H:D</th>
<th>HB:H</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>35.5</td>
<td>27.8</td>
<td>20.4</td>
<td>11</td>
<td>1.2</td>
<td>0.9</td>
</tr>
<tr>
<td>18</td>
<td>35.6</td>
<td>27.8</td>
<td>20.2</td>
<td>8</td>
<td>1.4</td>
<td>0.9</td>
</tr>
<tr>
<td>Arkansas (paratype)</td>
<td>35.5</td>
<td>24.4</td>
<td>27.5</td>
<td>10</td>
<td>1.1</td>
<td>1.0</td>
</tr>
</tbody>
</table>

**Discussion.**—This species is represented in the collections under study by four specimens that all bear the typical low spire and globose outline that distinguish this species from *M. cancellaria* Conrad and *M. corsicanensis* Stephenson. The holotype is the largest and best preserved specimen, but the features of the species are well displayed on younger specimens.

**Types:** Holotype USNM 130197 (Mississippi); paratypes USNM 130198 (Mississippi); USNM 22922 (Arkansas).

**Occurrence:** Mississippi: Ripley Formation, locs. 16, 18, Arkansas: Nacatoch Sand.

*Mora marylandica* marylandica Gardiner

Plate 20, figures 4–6, 10, 19–22, 23, 26


**Diagnosis.**—Medium-sized moreids with a spire proportionally high, an outline slim for the genus, and a raised weltlike siphonal fasciole.

**Measurements.**—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

<table>
<thead>
<tr>
<th>Loc.</th>
<th>18</th>
<th>6</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of specimens measured</td>
<td>8</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Range of shell height</td>
<td>14.7–21.8</td>
<td>18.3–28.8</td>
<td>13.8–28.8</td>
</tr>
<tr>
<td>Average</td>
<td>16.7</td>
<td>18.3</td>
<td>19.9</td>
</tr>
<tr>
<td>Range of maximum diameter</td>
<td>9.8–12.5</td>
<td>10.4–12.8</td>
<td>8.4–18.7</td>
</tr>
<tr>
<td>Average</td>
<td>10.3</td>
<td>10.4</td>
<td>12.2</td>
</tr>
<tr>
<td>Range of height of body</td>
<td>10.3–15.0</td>
<td>10.4–12.8</td>
<td>8.5–20.2</td>
</tr>
<tr>
<td>Average</td>
<td>11.5</td>
<td>11.9</td>
<td>15.0</td>
</tr>
<tr>
<td>Range H:D</td>
<td>1.4–1.7</td>
<td>1.5–1.6</td>
<td>1.5–1.8</td>
</tr>
<tr>
<td>Average</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Range of HB:H</td>
<td>7.5–8.5</td>
<td>7.5–8.5</td>
<td>7.5–8.5</td>
</tr>
<tr>
<td>Average</td>
<td>7.5</td>
<td>7.5</td>
<td>7.5</td>
</tr>
</tbody>
</table>
Discussion.—The holotype of *Morea marylandica* Gardner is from the Monmouth Formation of Maryland. This formation includes beds of both Ripley and Owl Creek age. The type locality of the species, 2 miles south of Oxon Hill in Prince Georges County, is not definitely placed in the section. Thus, whether the type species came from Ripley Formation equivalents or from younger equivalents is not known.

The holotype itself is broken and incomplete and close comparison between the Mississippi Ripley specimens and the holotype is difficult. Instead of assigning new names to specimens showing minor differences, Gardner's species is here used in a broad sense with the understanding that subdivision of the species will probably be possible when better material from the type locality is available.

*M. marylandica* is distinguished from *M. cancellaria* in its slender outline, higher spire, well-like siphonal fasciole, and its erect smooth trochoid protoconch. Species related to *Morea marylandica* appeared on the Gulf and Atlantic Coastal Plains during the Campanian. The earliest occurrence is that of an unnamed species in the Wolfe City Sand Member of the Taylor Marl of Texas.

The species is well represented in the Ripley formation of Mississippi and Tennessee and shows considerable variation both in size and ornament. The specimen figured by Wade (1926, pl. 51, figs. 3, 8) is the largest known specimen of the species. Compared with the type specimen Gardner (1916, pl. 18, fig. 13), it has a somewhat more constricted base and wider spaced transverse and spiral elements and has a less excavated more drooping shoulder. Compared with the specimens from the Ripley Formation of Mississippi its proportions fall within the range of variability, but it has wider spaced ornament than is the general rule.

The Mississippi specimens show a considerable range of variability. This species occurs most abundantly at locality 18 from which 98 specimens are available. This suite shows forms with low sloping shoulders (pl. 20, fig. 26) grading to those with excavated shoulders (pl. 20, fig. 29). The number of spiral ribs varies from 8 to 11 and their width and spacing also ranges greatly. Variation in body proportions can be exhibited by contrasting the figured specimens from locality 18 shown on plate 20, figures 4, 19, 25, with the specimen figured on plate 20, figure 10 that is from a somewhat higher stratigraphic position at locality 5 and is more similar to the holotype in its proportions.

*Morea transenna* Stephenson (1955, p. 129) from the Owl Creek Formation of Mississippi is closely related and is probably gradational to the Ripley species.

Of the two varieties of *M. marylandica* named by Stephenson from the Nacatoch Sand of Texas, one, *M. marylandica longuida* Stephenson (1941, p. 328), belongs to the *M. cancellaria* group and is based on immature specimens. *M. marylandica bella* Stephenson (1941, p. 327) is so closely similar to the Mississippian specimens that I am hesitant to make any distinction.

**Types:** Holotype Gardner collection USNM (Maryland); hypotypes USNM 32513 (Tennessee), USNM 20549, 130260–130264 (Mississippi).


*Morea marylandica halli* Sohl, n. subsp.

Plate 20, figures 14, 15

Discussion.—This subspecies is distinguished from *Morea marylandica marylandica* Gardner by possessing a strong sharp shoulder, which lends the body a truncate upper whorl outline.

The type locality (No. 12), C. R. Hall's farm near Molino, Union County, Miss., is in the lower part of the Ripley Formation. Only two specimens have been collected, but both possess the distinctive sharply angular shoulder typical of the subspecies and no specimens of *M. marylandica marylandica* have been recovered.

**Types:** Holotype USNM 130265.

**Occurrence:** Mississippi: Ripley Formation, loc. 11.

*Morea transenna* Stephenson

Plate 20, figures 23, 24


Diagnosis.—Medium-sized finely ornamented morels with a steeply sloping narrow shoulder in mature stages.

Discussion.—Stephenson (1955, p. 129) stated:

This species is more similar to *Morea marylandica* Gardner (1916, p. 498) than it is to any available species of *Morea*. Compared with the Maryland species *M. transenna* has more numerous and closely spaced axial thus producing a finer sculpture pattern at the same growth stages, and its shoulder droops at a much steeper angle.

This species is based on the holotype and paratype from Owl Creek, Tippah County, Miss. Stephenson also assigned some specifically indeterminable poorly preserved specimens from the Owl Creek Formation of Missouri to this species. As might be suspected...
this species is difficult to distinguish from the variable *M. marylandica* of the Ripley Formation, but in general the shoulder appears to be steeper sloping in the late stages of *M. transennia*. This sloping leads to a more broadly rounded outline. In other respects, for example ornament, there appears little basis for differentiation. *M. transennia* is probably transitional to the types of *M. marylandica* from the lower part of the Ripley Formation through some upper Ripley form like the specimen figured on plate 20, figure 10.

*Types:* Holotype and paratype USNM 29433; paratype USNM 128199 (Missouri).
*Occurrence:* Mississippi: Owl Creek Formation, locs. 45, 46. Missouri: Owl Creek Formation.

**Morea** sp.

**Plate 20, figures 16, 18**

**Discussion:** One internal mold collected from the Prairie Bluff Chalk suffices to show the probable presence of *Morea* in the chalk facies. The shell is moderately large for the genus and comparable in size to *M. rotundata*, but the height of spire is more compatible with that of *M. marylandica* type.

*Type:* Figured specimen USNM 130200.
*Occurrence:* Mississippi: Prairie Bluff Chalk, loc. 87.

**Morea?** sp.

**Plate 20, figure 17**

**Discussion:** One specimen from the Ripley Formation, 2.5 miles northwest of Blue Springs, Union County, Miss., preserved as an internal mold, may belong to *Morea*. The mold bears the reflection of noded spiral ribbons, a crenulate outer lip, and a rounded body typical of the *M. cancellata* type. This is the highest occurrence of the *M. cancellata* type known in Mississippi.

*Types:* Hypotype USNM 130207.
*Occurrence:* Mississippi: Ripley Formation, loc. 27.

**Genus PARAMOREA** Wade, 1917

Type by original designation, *Paramorea lirata* Wade.

**Diagnosis:** Shell moderately small, ovately fusiform. Spire truncated, less than half total shell height; body proportionally large, shouldered above periphery and rounding down to a siphonal fasciole. Sculpture of raised spiral ribbons. Aperture notched anteriorly; outer lip crenulate; inner lip loosening anteriorly and opening up an umbilical chink; columella bearing a fold above the siphonal canal.

**Discussion:** Wenz (1941, p. 1199) placed *Paramorea* as a subgenus of *Cantharus*, but the presence of a distinct umbilical slit and short siphonal area in the former necessitates separation. Only one species, *Paramorea lirata*, is known and that only from its type locality on Coon Creek, McNairy County, Tenn. Wade considered the genus to be near *Morea*, but *Paramorea* has a proportionally larger protoconch, a less reflected inner lip, only spiral ornament, a narrower umbilical chink, and lacks as strong a fold on the columella immediately above the siphonal canal. Wenz (1941, p. 1199) placed these two genera, *Morea* and *Paramorea*, in separate families. Although admittedly they are distinctly different, they do, as Wade pointed out, show similarities in shape, fasciole and apertural features that would lead one to place them within the same family.

**Paramorea lirata** Wade

**Plate 19, figures 2-4, 6, 8, 10**


**Diagnosis:** Moderately small sized shells having shouldered whorls and a well-rounded periphery; whorls ornamented by raised spiral ribbons that are broader than their spiral interspaces.

**Measurements:** Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 172).

<table>
<thead>
<tr>
<th>Loc.</th>
<th>H</th>
<th>MD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Holotype</td>
<td>7.3</td>
<td>4.7</td>
</tr>
<tr>
<td>Topotype</td>
<td>7.7</td>
<td>5.0</td>
</tr>
<tr>
<td>D1</td>
<td>10.1</td>
<td>6.0</td>
</tr>
</tbody>
</table>

**Discussion:** The holotype of *Paramorea lirata* from Coon Creek, Tenn., is not perfectly preserved and some of the ornament has been spilled from the earlier whorls. This no doubt led Wade (1926, p. 135) to state that the protoconch scar was small. Actually, the protoconch is proportionally large and consists of a little more than three whorls, which are smooth and well rounded. The junction with the teleoconch is gradual and accompanied by addition of spiral ribbons on the whorl sides. After about half a turn the first teloconch whorl becomes shouldered. There appears to be little variance in significant characters in these shells, except that on the larger shells the spacing of the ribbons over the shoulder is greater and at the latest developmental stages some individuals begin to develop a subdued shoulder.
Paramorea lirata is the only species within the genus and is unlikely to be confused with any other taxon in the fauna.

**Types**: Holotype USNM 32019; hypotypes USNM 130208–130210.

**Occurrence**: Tennessee: Ripley Formation, loc. 1, Alabama and Georgia (Chattahoochee River region): Ripley Formation.

**Genus Schizobasis** Wade, 1916

Type by original designation, *Schizobasis depressa* Wade.

**Diagnosis**.—Medium-sized depressed neritaform shells with a strong and deep basal constriction and whorls ornamented by strong nodose spiral cords. Aperture subovate, notched posteriorly, and anteriorly drawn out to a narrow, moderately long, curving siphonal canal that is strongly bent back and pressed against the shell base; outer lip simple, prosocline in profile; inner lip bearing a sharp fold at base of columnella and immediately above the siphonal canal.

**Discussion**.—Wade (1916, p. 408) proposed this genus to include the type species *Schizobasis depressa* from Coon Creek, Tenn., and an undescribed species from the Ripley Formation at Eufaula, Ala. In 1926, Wade described a second species, *S. immera*, from Coon Creek and the Eufaula specimens may be included thereunder.

The genus has been variously classified in the Turbinidae and Modulidae, but the presence of the distinctive siphonal canal allies it to the Muricacea along with *Hilites* Stephenson.

The genus is known only from the *Esoxyra costata* zone of the East Gulf Coastal Plain.

*Schizobasis depressa* Wade

**Plate 20, figures 27–30, 33, 34; plate 21, figures 1–4**


**Diagnosis**.—A *Schizobasis* with seven coarsely noded wide strong spiral cords.

**Measurements**.—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

<table>
<thead>
<tr>
<th>Loc.</th>
<th>H</th>
<th>MD</th>
<th>H-D</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (holotype)</td>
<td>18.3</td>
<td>22.2</td>
<td>0.8</td>
</tr>
<tr>
<td>1 (hypotype)</td>
<td>20.0</td>
<td>22.8</td>
<td>.9</td>
</tr>
<tr>
<td>3o</td>
<td>20.6</td>
<td>22.2</td>
<td>.9</td>
</tr>
<tr>
<td>39</td>
<td>21.5</td>
<td>20.7</td>
<td>.8</td>
</tr>
</tbody>
</table>

**Discussion**.—Only one specimen of *Schizobasis immera*, the holotype, is known from the type locality on Coon Creek, McNairy County, Tenn. Two other specimens in the collections of the U.S. Geological Survey and labeled as being from “two miles below Eufaula, Alabama” also appear to belong to the species. This places the specimen at a higher stratigraphic position within the Ripley Formation in Alabama.

*Schizobasis immera* differs from *S. depressa* by its finer spiral cords that are more numerous, less coarsely noded, and closer spaced. In addition, the spire is lower and the body whorl suture occurs higher on the whorl sides of the penultimate whorl.
Type: Holotype USNM 73108.


Family MAGILIDAE

Genus LATIAxis Swainson, 1840

Type by monotypy, Pyura mariae Gray, 1834.

Synonymy.—Hippocampoides Wade, 1916.

Diagnosis.—Medium-sized shells with a low to moderately low spire; whorls possess a coarsely spinose peripheral carina and a serrated umbilical margin; aperture subovate, siphonal canal elongate, narrow outer lip notched at peripheral carination; umbilicus strong and open.

Discussion.—The species herein placed in Latiaxis Swainson was originally described as the type species of a new genus Hippocampoides by Wade in 1916. The genus, as originally proposed (Wade, 1916, p. 467), was monotypic. In 1926, Wade described and assigned a second species H. triatus to Hippocampoides. The later species is here designated the type of the new genus Lovenstenia, which includes forms differing from Hippocampoides serratus by having an erect protoconch, heavy spiral ornament, a flaring aperture with a wide short anterior canal, and lacking the serrated umbilical margin and elongate notch at the shoulder of the outer lip.

Probably because Wade failed to illustrate the aperture of his species Hippocampoides serratus, subsequent authors (Cossmann, 1925; Wenz, 1938; Stephenson, 1941; Knight and others, 1922), followed him in placing this genus in the Euomphalacea. However, the presence of a siphonal canal and a notched outer lip alone suffice for separation from that group. Because of the remarkable similarity of H. serratus compared to the low-spired forms of Latiaxis such as L. pilebsrihirsae (pl. 21, fig. 9), it is here placed within that genus. Published accounts restrict Latiaxis to the Pliocene and Recent, which leaves a considerable gap in the Tertiary record. Retention of the name Hippocampoides appears justifiable only on the basis of time lapse, which in my opinion is a negative approach.

Latiaxis serratus (Wade)
Plate 21, figures 5-7, 11-13


1925. Nummoacolae (Hippocampoides) serratus (Wade), Cossmann, Essais Paléoncologique Comparée, v. 13, p. 284, pl. 11, figs. 3-5.


Diagnosis.—Moderately small shells with a flat upper whorl surface, protoconch depressed, and whorl sides unornamented save for growth lines.

Description.—Shell moderately small, spire low or flattened and slightly stepped above the body; apex frequently depressed below whorl surface in its earliest stages. Protoconch depressed, small, consisting of about 1½ smooth well-rounded whorls. Demarcation from teleconch accompanied by an abrupt increase in whorl diameter and a flattening of the upper whorl surface, followed by a development of whorl angulations and appearance of growth lines. Protoconch and first teleconch whorl generally depressed, occasionally lying at a slight angle to teleconch axis. Suture deeply impressed, whorls three in number. Body whorl occasionally overlaps penultimate whorl to a slight degree, and is peripherally angulated by a sharp serrate carina; below peripheral carina body slopes steeply adaxially to a slight spiral constriction. Below constriction, whorl expands slightly to the edge of the serrate umbilical carina. Sculpture limited to growth lines that are slightly prosocline in trend over the upper whorl face, very gently prosocline on the whorl sides, becoming more strongly prosocline near the aperture of the large forms. Aperture subcircular to subovate, interrupted anteriorly by a narrow siphonal canal that runs the length of the serrations of the umbilical margin. Outer lip with an elongate narrow channel that runs the length of the serrations on the shoulder carination. Inner lip curved with a tendency toward losing contact with body at edge. Umbilicus wide and deep extending to apex and bordered by a serrate umbilical carina.

Measurements.—The holotype, the most complete specimen, measures 11 mm in height and 20 mm in diameter.

Discussion.—Latiaxis serratus (Wade) is restricted to its type locality on Coon Creek, McNairy County, Tenn., where it is quite common. Although well represented in numbers, well-preserved individuals are infrequently recovered due to the thin fragile nature of the shell. Variation is slight and, for the most part, affects the strength of the serrations and the amount of elevation of the early whorls. The holotype as figured by Wade (1926, pl. 54, fig. 11) indicates a specimen possessing a smooth spiral profile, but more commonly the spire is slightly stepped with the peripheral carina overhanging the suture on all but the body whorl. The apertural view of the holotype on plate 21, figure 6, shows a thickened interior. This is a geronic development and specimens of earlier developmental stages show thin lips (pl. 21, fig. 6).
There are no other known related Cretaceous species, but the recent species L. pilibryi (pl. 21, figs. 7-9), from the Indo-Pacific realm, is a startling homeomorph. It differs by its less rapidly expanding whorls and stronger serrations as well as having a proportionally longer body and bears the faintest of spiral lirae.

*Types*: Holotype USNM 73069; hypotypes USNM 130214, 130215.

*Occurrence*: Tennessee: Ripley Formation, loc. 1.

**Genus LOWENSTAMIA** Sohl, n. gen.

**Type species**, *Lowenstamia funiculus* Sohl, new species.

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

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

*Discussion*—This genus is erected to include three known species, *Lowenstamia funiculus* Sohl, from the Coffee sand of Mississippi; *L. cucullata* Sohl, from the Owl Creek Formation of Mississippi; and *Hippocampoides tiratus* Wade, from the Ripley Formation of Mississippi and Tennessee. In addition, internal molds occurring in the Prairie Bluff Formation of Mississippi and Alabama may also be referable to species of this genus. The presence of *Lowenstamia* in the Coscicana Marl of Texas may be recorded by a specimen figured as *Hippocampoides* sp. by Stephenson (1941, pl. 47, figs. 14, 25).

*Hippocampoides* Wade, to which several forms here included in *Lowenstamia* were originally assigned, is considered a synonym of *Latiasis* Swinson of the Coralliophillidae. *Lowenstamia* probably lies close to that group in having a roughened surface like that of *Coralliophila* and a shape much like the low-spired forms of *Latiasis*, such as *L. servatus* (Wade) and *L. pilibryi* Hirsae. However, the short, wide, siphonal canal and flared aperture serve to distinguish the genus.

*Lowenstamia* shows a distinctive trend in its development through time.

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**Figures 14**—Development of the species of *Lowenstamia* in the Upper Cretaceous of the Mississippi embayment region.

As is illustrated in figure 14, through its range, *Lowenstamia* shows a reduction in the number of spiral cords on the whorl sides between the peripheral carination and the umbilical margin. The earliest species, *L. funiculus*, possesses two cords, the Ripley species, *L. tiratus*, only one cord, and the Owl Creek species, *L. cucullata*, has none.

**Lowenstamia funiculus** Sohl, n. sp.

Plate 21, figures 23, 26

*Diagnosis*—A *Lowenstamia* of medium size bearing two nodule to subspinose spiral cords upon the whorl sides between the peripheral and umbilical carinations.

*Description*—Medium-sized very low spired phaneromphalous shells. Protoconch unknown. Suture impressed with an irregular trace. Whorls with flattened upper surface that may develop wells and bumps and a coarse surface in later developmental stages; whorls peripherally angulated by a strong nodule to subspinose carina; whorl sides slope adaxially but are broadly concave. Sculpture coarse; spiral ornament consisting of fine rather flat topped irregular spiral lirae that cover the shell surface and that override the two strong spiral cords of the whorl sides. Transverse sculpture poorly developed on upper whorl face and restricted to broad swellings on the whorl sides. Growth lines prosocline and more steeply inclined on the upper whorl face than on the whorl sides. The transverse elements increase in strength near the aper-
ture and form a rugose imbricate surface. Aperture subovate and flaring, interrupted anteriorly by a somewhat curved broad V-shaped siphonal canal. Outer lip thin at edge slightly crenulate where intersected by the peripheral carination and the cords of the whorl sides; inner lip thin, flexed anteriorly, and loosening from body on gerontic individuals. Umbilicus broad, deep, bordered by a serratate subspinose carinate margin.

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

**Discussion.**—The holotype of *Lowenstania funiculus* is the only known specimen of the species and is the only species of the genus to retain a relatively complete aperture of a mature individual. Although the specimen is from the Coffee Sand of Mississippi, its description is inserted here for comparison with the Ripley and Owl Creek species.

One of the main reasons for the retention of the thin fragile outer lips on the holotype is that an adhering worm tube supports the shell. The photographs (pl. 21, figs. 23, 26) have been retouched to opaque out the distracting distortion of shape the attached tube gives.

**Type:** Holotype USNM 130216.

**Occurrence:** Mississippi: Coffee Sand near Ratliff, Lee County, Miss. (USGS colln. 26338).

**Lowenstania liratus** (Wade)

Plate 21, figures 10, 14, 15, 18-20, 22, 25


**Diagnosis.**—A medium-sized *Lowenstania* bearing a single nodose spiral cord upon the whorl sides between the peripheral and umbilical carinations.

**Description.**—Medium-sized very low spired planorophidial shells. Protoconch of about two erect well-rounded smooth whorls that stand up above the plane of teleoconch solution; junction with teleoconch whorls rather abrupt as whorls flatten and become peripherally carinate. Suture impressed and irregular in trace. Upper whorl face flat to hummocky, whorl sides broadly concave below the strong peripheral carination. Sculpture of numerous rather flat topped irregular spiral lirae that cover the surface and are even incised upon the one strong spiral cord that occurs on the whorl side. Transverse ornament restricted to low ribs of variable strength on the whorl sides. Growth lines prosocline on the upper whorl face and sides. Aperture incompletely known, but bearing a broad V-shaped siphonal canal and an angular notch in the outer lip at the peripheral carination. Umbilicus broad, deep, and margined by a strong carination that becomes noded in later developmental stages.

**Measurements.**—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

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**Discussion.**—*Lowenstania liratus* (Wade) is well represented in the collections from the Ripley Formation of both Mississippi and Tennessee. In general, the shells are fragile, and all specimens bear an incomplete aperture. In comparison to the specimens from the type locality on Coon Creek in McNairy County, Tenn., the specimens from the Ripley Formation of Mississippi appear to be proportionately higher but compare well in other respects. (Compare pl. 21, figs. 15, 19.)

The single strong spiral cord on the whorl sides distinguishes *L. liratus* from the other members of the genus.

**Types.** Holotype USNM 73100; hypotypes USNM 130217-130220.

**Occurrence:** Tennessee: Ripley Formation, loc. 1. Mississippi: Ripley Formation, locs. 5-9, 17, 18, 32(?). Georgia and Alabama (Chattahoochee River region) Ripley Formation.

**Lowenstania cucullata** Sohl, n. sp.

Plate 21, figures 24, 27

**Diagnosis.**—A *Lowenstania* with a shell that is small for the genus and having whorl sides that are marked only by broadly rounded topped spiral lirae.

**Description.**—Moderately small low-spired broadly planorophidial shells. Protoconch erect with smooth round-sided whors. Suture impressed and irregular in trace. Upper whorl surface flattened, sides broadly concave and peripherally angulated by a nodose carina. Sculpture consisting of numerous broadly round topped spiral lirae that cover the surface and are narrower than their interspaces. Transverse elements poorly developed and restricted to broad collabral swellings. Growth lines prosocline. Aperture incompletely known. Umbilicus broad and deep, bordered by a circumbilical carination.

**Measurements.**—The holotype measures 12.5 mm in diameter and 5.5 mm in height.

**Discussion.**—Only two specimens of *Lowenstania cucullata* are present in the Owl Creek Formation of Mississippi. They can easily be distinguished from the other members of the genus in their lack of a
strong cord upon the whorl sides and in their more widely spaced spiral lirae.

Types: Holotype USNM 20455; paratype USNM 20456.

Occurrence: Mississippi: Owl Creek Formation, locs. 42, 46.

Lowestemia cf. L. subplanus (Gabb)
Plate 21, figures 16, 17, 21

Sci. Jour., 2d ser., v. 4, p. 300, pl. 48, figs. 4a, b.
cf. 1914. Weeksea subplanus (Gabb). Stephenson, Texas Univ.
Bull. 4191, p. 268.

Discussion.—The holotype of Gabb’s species Strapro-
lopus subplanus is an internal mold from the Prairie
Bluff Chalk of Alabama and is preserved in the col-
lections of the Academy of Natural Sciences of Phi-
delphia (ANSP 15419). Internal molds from the
same formation in Mississippi are here tentatively
compared with Gabb’s species.

The molds are those of a low-spired shell having a
wide umbilicus that loosens somewhat in coiling on
larger specimens. Besides shape, some of the molds
also reflect an aperture having a broad V-shaped
siphonal canal and a notch at the peripheral angula-
tion. Occasional small patches of ornament and one
specimen retaining the external mold of the umbilical
walls (pl. 21, fig. 21) indicates the shell surface bore
strong spiral lirations. All these features taken to-
gether indicate a close affinity to Lowestemia.
Weeksea, to which Stephenson (1941) assigned Gabb’s
species, is a discoidal form lacking pronounced spiral
ornament and a siphonal canal.

Types: Figured specimens USNM 130221 and 130222.

Occurrence: Mississippi: Prairie Bluff Chalk, locs. 54, 57,

Superfamily BUCCINACEA
Family BUCCINIDAE

Genus STANTONELLA Wade, 1928

Type by original designation, Stantonella subnodosa
Wade.

Synonymy.—Allofusus Stephenson, 1941 (in part).

Diagnosis.—Medium-sized strong fusiform shells
with a turreted spire; whorls posteriorly constricted
to a nodose collar, shoulder strong, and body sharply
constricted anteriorly to an elongate twisted siphonal
channel that is bordered above by a distinct oblique
swelling at the base of the columnar lip.

Discussion.—Wade (1926, p. 127) proposed this
genus for two species, Stantonella subnodosa Wade
from the Ripley Formation of Coon Creek, Tenn., and
Chesnitiia interrupta Conrad from the Owl Creek
Formation. Both these species are based upon incom-
plete holotypes that lack the siphonal canal. This led
Wade to assume the columella was smooth. The
specimen of S. ripleyana (Conrad) figured on plate
22, figure 18, indicates the anterior canal to be long
and twisted and bordered by a low oblique swelling
or fold at the base of the columella. This misunder-
standing led to the introduction by Stephenson (1941,
p. 336) of the name Alloliusus. He stated

Specimens in the collections of the U.S. National Museum from
the Ripley formation, Eufaula, Alabama, and from Union
County, Mississippi, labeled Strapsidura interrupta Conrad
and Fusus sp. probably belong to this genus (Alloliusus).

These specimens (USNM 21161, 20550, 20925, 20500)
al so belong to Strapsidura ripleyana Conrad a species
here included in Stantonella. Stephenson (1941, p.
336) also included Pyritisus mornouthensis Gardner
(1916, p. 459) in Alloliusus, but this form appears to
be a Stantonella also. Alloliusus Stephenson is prob-
ably a related form of which not all the features of
the anterior extremities are known. Alloliusus lacks
the distinctive posterior nodular collar of Stantonella,
has a sloping rather than an excavated shoulder area,
and is more truly fusiform in outline. In the char-
acter of the protoconch, general trend of the growth
lines, and in possessing a twisted siphonal canal the
two genera are similar. Alloliusus reaganii subtilis
Stephenson even shows a few faint rudimentary nodes
at the suture, which support a close relationship. It
is entirely possible that Alloliusus deserves no more
than subgeneric separation, but until the two taxa
are more fully understood it appears wise to keep them
separate.

As here defined the earliest occurrence of a described
species of Stantonella appears to be in the Snow Hill
Marl Member of the Black Creek Formation of North
Carolina, where it is represented by Fasciolaria?
rugosa Stephenson. At about the same level in the
Coffee Sand of Mississippi (USGS colln. 25483) there
are incomplete specimens of a very similar species.
Other species occur as high in the section as the Owl
Creek and Providence Formations. Among other un-
described species the oldest occurrence lowers the
range of Stantonella to the late Coniacian or San-
tonian where specimens have been found in the Eutaw
Formation of Russell County, Ala. (USGS 27065).
The following is a list of species that should be
assigned to Stantonella Wade.

Stantonella subnodosa Wade, Ripley Formation, Tennessee
Fasciolaria? rugosa Stephenson, Black Creek Formation, North
Carolina
Strapsidura ripleyana Conrad, Ripley Formation, Mississippi
interrupta Conrad, Owl Creek Formation, Mississippi
Pyritisus mornouthensis Gardner, Monmouth Formation, Maryland
Stantonella sp., Providence Sand, Georgia
et S. rugosa Stephenson, Coffee Sand, Mississippi
sp., Escombio Formation, Texas

Fasciolari? lyelli Stephenson, Black Creek Formation, North
Carolina (assignment questionable)

Wade (1926, p. 127) assigned Stantonella to the
Fusidae. Stephenson (1941, p. 332) questionably assinged
it to the Bucinidae. Wenz (1941, p. 1190) was also of the opinion that Stantonella should be
placed in the Bucinidae. It is here placed in the
Bucinidae close to Tryonella Stephenson and Ario-
fusus Stephenson as those genera also possess the
twisted siphonal canal and the strongly shouldered
whorls that are posteriorly constricted to a collar.

Stantonella subnodosa Wade

Plate 22, figures 14, 15

Paper 137, p. 127, pl. 45, figs. 7, 8.

Diagnosis.—A large Stantonella with elongate
whorls; subsutural collar covered by numerous thin
sharp transverse ribs that die out at the shoulder.

Measurements.—The holotype (USNM 32887) is
missing both the apical and anterior extremities, but as
preserved, measures 43.5 mm in height and has a
maximum diameter of 25.1 mm.

Discussion.—The holotype is the only specimen of
this species available for study. The siphonal canal
of this specimen is broken, but the beginnings of a
curved siphon and the highly oblique but abrupt upper
border of the siphonal canal can be seen (pl. 22, fig.
15).

This species, which occurs only in the Exogyra
cancellata zone, is more closely related to the species
occuring below this zone than those above. Like
Fasciolari? rugosa Stephenson, from the E. ponder-
osa zone of North Carolina, the subsutural collar bears
thin transverse ribs (pl. 22, fig. 14), but Stephenson's
species has a shoulder that is more coarsely nodded by
strong and less continuous transverse ribs. All the
species occurring above the E. cancellata zone in the
Ripley and Owl Creek Formations and their equiva-

tents develop strong nodes on their collars in place of
the more numerous fine riblets of S. subnodosa.

Harbison (1945, faunal list) cites this species as
occurring in the Ripley Formation at Union County
Lake, Union County, Miss. (loc. 18). Her collections
are preserved at the Academy of Natural Sciences of
Philadelphia and the Stantonella referred by her to
S. subnodosa Wade belongs in S. ripleyana (Conrad).

Type: Holotype USNM 32887.

Occurrence: Tennessee: Ripley Formation, loc. 1.

Stantonella ripleyana (Conrad)

Plate 22, figures 8, 9, 18-21

Sci. Jour., 2d ser., v. 4, p. 286, pl. 40, fig. 12.

Diagnosis.—Medium-sized stantonellas with a
strongly noded posterior collar and a very elongate
twisted siphonal canal.

Description.—Shell of medium size with a turreted
spire slightly less than one-third total shell height;
pleural angle near 50° on mature specimens but
greater on immature forms. Protoconch of 3½
smooth trochoid round-sided whorls expanding at a
lesser rate than teleoconch whorls; initiation of orna-
ment gradual; close-spaced broad transverse ribs with
spiral ribbons in the rib interspaces present on the
first teleoconch whorl. Suture impressed. Typical
shouldered whorls do not develop until the second
teleoconch whorl. Teleoconch whorls number 6-7 and
are posteriorly constricted to a strong subsutural col-
lar below which is a strongly excavated band leading
to the nodose shoulder; below the shoulder the body
is very broadly rounded over the periphery, then
slopes moderately to the anterior canal that is long
and twisted. Sculpture on earlier whorls differs from
that on later whorls; transverse sculpture consists of
course ribs that are direct and continuous suture to
suture on the round sides of the first teleoconch whorl;
with the development of the shoulder on the second
whorl the ribs retract from the suture to the shoulder
and become more widely spaced; on the third tele-
conch whorl, nodes on the collar develop in harmony
with the ribs, but have an excavated area between
shoulder and suture that is barren of transverse orna-
ment save for growth lines and occasional connective
swellings; on the body the transverse ribs decrease in
strength below the shoulder and die out on the basal
slope; transverse ribs number 16-20 on the body
whorl. Spiral sculpture on early whorls is composed of
broad spiral ribbons with very narrow interspaces
that are absent on the excavated band between shoul-
der and collar and strongest on the shoulder angula-
tion where they are accentuated to nodes; on later
whorls spiral development varies, but commonly is
restricted to spiral cords on the basal slope. Aperture
incompletely known, subovate, notched posteriorly and
produced anteriorly to a moderately long and twisted
narrow siphonal canal. Inner lip curved, celled
over both the parietal and columellar lips to the
siphonal canal entrance. Columella bears a swollen
ridge just above siphonal canal.
**Measurements.**—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

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**Discussion.**—The holotype of *Strepsidura ripleyana* Conrad is in the collections of the American Museum of Natural History in New York (AMNH 9063). This specimen (pl. 22, fig. 9) lacks the last one-quarter of the body whorl and has a more twisted siphonal canal than is indicated on Conrad's illustration. A comparison of the illustration and the type specimen indicates the former to have been somewhat idealized although the last part of the body whorl has evidently been subsequently lost due to breakage as the remnants of repair work remain.

One specimen in the collections of the Academy of Natural Sciences of Philadelphia (ANSP 14561) is labeled as the type of *Strepsidura ripleyana* Conrad. However, this specimen, although belonging to this species, does not compare in size and detail to that figured by Conrad (1860, pl. 46, fig. 12), but was probably only a supplementary type.

Specimens of this species are not abundant at any given locality, but individuals have been recovered from most all of the collecting localities. Generally, the shells, owing to their stoutness, are recovered in a good state of preservation, but, with the exception of the specimen on plate 22, figure 18, all lack the extreme anterior tip of the siphonal canal. Variation in shape is restricted to minor fluctuations of obesity, but variation in the strength of ornament is greater. Some specimens retain spiral ornament until a late stage (pl. 22, fig. 20), although generally such ornament is best developed only on the younger specimens (pl. 22, fig. 9) and becomes obsolete and restricted to the base at maturity (pl. 22, fig. 19). Transverse ornament is more stable, but the length of the ribs are variable to a minor degree. Differences in the strength of the nodes of the collar are present but also minor.

*Stantonella ripleyana* (Conrad) is distinguished from *S. subnodosa* Wade and its allies by having more abruptly constricted whorls, having nodes on the collar and by having a somewhat more strongly sinuous growth line. *Chemnitzia interrupta* Conrad from the Owl Creek Formation is larger, has a stronger columnar welt, and has more continuous transverse ribs, which are bowed over the periphery rather than directly opisthoclone.

**Type:** Holotype AMNH 9063; paratype ANSP 14561; hypotypes USNM 130223-130225.

**Occurrence:** Mississippi: Ripley Formation, locs. 6, 7, 9, 9a, 12, 18, 23, 27, 29, 32. Alabama and Georgia: Ripley Formation.

*Stantonella interrupta* (Conrad) Plate 22, figures 33, 34, 35


**Diagnosis.**—Shell large for genus; subsutural collar noded, transverse ribs acutely bowed over whorl sides; spiral ornament suppressed or wanting on periphery.

**Description.**—Shells stout but of medium size; spire turreted, less than one-third total shell height; pleural angle about 70° at maturity. Protoconch unknown. Suture impressed. Whorls strongly shouldered, constricted posteriorly to a strongly nodose subsutural collar; below shoulder, body is broadly rounded down to a strongly constricted base with a strongly curved siphonal canal. Sculpture dominated by strong transverse ribs that are closer on the earlier whors and number 20–24 per whorl; ribs are subdued above shoulder, but a subsutural row of nodes occurs in harmony with rib position; below, shoulder ribs continue over periphery with diminished strength, dying out on basal slope. Spiral ornament consists of four faint lirae that override ribs on early whors, but on body whors are restricted to wide-spaced weak to moderately strong cords on the basal slope and siphonal canal. Growth lines sinuous, prosocline between suture and shoulder, arcuate to almost orthocline between shoulder and basal slope. Aperture moderately broad, posteriorly notched and anteriorly drawn out to a moderately long siphonal canal that is strongly flexed to the left. Outer lip incomplete, thickened at edge, angulated at shoulder. Inner lip curved, callus moderately thin. Columella with a swollen ridge immediately above siphonal canal.

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**Discussion.**—The holotype figured by Conrad (1858, pl. 35, fig. 15) is not in the collections of the Academy of Natural Sciences of Philadelphia nor in the collections of the American Museum of Natural History.
and it is presumed to be lost. Conrad's figure is of an incomplete specimen that preserves only the penultimate whorl and part of the body whorl and lacks the anterior canal. The specimen figured on plate 22, figure 22, is a much more complete specimen that agrees well with Conrad's description.

The species is widely distributed in the Owl Creek Formation of Mississippi and is represented by a considerable number of specimens in various states of preservation. In Tennessee, specimens have been recovered from the reworked zone at the base of the Clayton Formation. In Georgia, the species occurs at several localities in the Providence Sand.

Within suites of topotypes the greatest variation is in the strength of spiral ornament, which ranges from total absence, save for the cords of the base, to specimens having broad low spiral ribbons over the periphery.

Stantonella interrupta (Conrad) is closely related to Stantonella ripleiana (Conrad), differing in its higher apical angle, its larger size, and in its more continuous more arcuate transverse ribs that are almost orthocline in trend below the shoulder (pl. 22, fig. 21). Pyrifuus mormouthensis Gardner (1916, pl. 16, figs. 5, 6) is closely similar but is based on a single incomplete specimen. Its proportions and characters are such that it is questionable if Gardner's species should be considered distinct, but better preserved material from Maryland is necessary before a decision can be reached. At the same level in the Providence Sand of Georgia, (USGS colln, loc. 855), an unnamed species occurs that is distinguished by having close-spaced axial ribs on the spire that become restricted and finally disappear on the body whorl.

Types: Holotype ANSP lost (?); hypotypes 130226-130228.
Occurrence: Mississippi: Owl Creek Formation, loc. 44, 46. Tennessee: Clayton Formation (reworked Owl Creek at base), loc. 40. Georgia: Providence Sand.

Stantonella? sp.

Plate 22, figures 12, 13; plate 23, figures 18, 19, 26

Discussion.—Among the Geological Survey collections from the Prairie Bluff Chalk, a large number of phosphatic internal molds of mollusks conform in size and shape to Stantonella. Some specimens bear the reflection of strong external transverse ribs that trend much the same as the ribs of S. interrupta (Conrad) (pl. 22, figs. 12, 13). Their apertural outline indicates a posterior notch and the presence of a shoulder. Other molds although similar to Stantonella in shape, reach the very considerable size of 72 mm in length (pl. 23, fig. 26), much larger than any known member of the genus and make their classification here tenuous.

Types: Figured specimens USNM 130223-130224.
Occurrence: Mississippi: Prairie Bluff Chalk, locs. 71, 82, 83, 90, 91, 92, 94.

Genus ALIOFUSUS Stephenson, 1941

Type by original designation, Aliofusus reaganii Stephenson.

Diagnosis.—Sub fusiform shells with a spire less than half total shell height. Suture impressed, bordered by a narrow poorly defined collar below which body slopes to a shoulder; body broadly rounded below shoulder and becoming more steeply sloping over base. Sculpture of moderately strong collabral transverse ribs on shoulder and periphery; spiral sculpture of numerous close-spaced spiral lines of variable strength. Aperture subhomboidal in outline; outer lip notched at shoulder in harmony with the growth line sinus; columella smooth, slightly twisted.

Discussion.—Stephenson (1941, p. 336) proposed this genus for one species and two varieties from the Nacatoch Sand of Texas. He also included Pyrifuus mormouthensis and specimens labeled Strepsidera interrupta Conrad and Fusus sp. from the Ripley Formation of Mississippi and Alabama in the collections of the Geological Survey. As noted under the discussion of the genus Stantonella, all the species cited save the type species Aliofusus reaganii Stephenson belong in Stantonella. It should be pointed out that Aliofusus reaganii Stephenson and the two varieties A. reaganii subtilis and A. reaganii tumidus are all from the same collection and same locality and should not be considered as separate subspecies, but mere varietal differences of no provable taxonomic significance. Stephenson (1952, p. 184) later assigned shells from the Woodbine Formation of Texas to Aliofusus.

Aliofusus is superficially similar to shells of several other genera occurring in the Ripley fauna of the embayment region. The species Wade (1926, p. 131-132) assigned to Cryptorchyris possess a similar outline, shoulder, ornament, and growth line but possess plications on the columella. Woodella Wade (1926, p. 129) has coarser transverse ornament and a thicker contorted columella that is swollen above the anterior canal.

Aliofusus stamineus Sohl, n. sp.

Plate 22, figures 10, 11

Diagnosis.—Shell small for genus with narrow high sharp transverse costae that are accentuated to sharp nodes at the shoulder.

Description.—Shell of medium size, sub fusiform; spire turreted on early whorls becoming less pro-
nouncedly so on later whorls as shoulders begin to droop; pleural angle 45°–50°. Protoconch trochoid and erect consisting of about 3½ smooth round-sided whors; junction of conch abrupt with addition of transverse ribs. Whors number 5–6; body constricted posteriorly to a poorly defined subsutural collar, below which it slopes somewhat concavely to a strong sharp shoulder; periphery rounding down to a steep basal slope. Sculpture of first teloconch whorl consists of a few broad strong but low transverse costae that are continuous suture to suture; a shoulder develops on the second teloconch whorl and becomes accentuated on the third whorl; on the fifth whorl the trend of the ribs across the slope between suture and shoulder becomes obscure; on the latter part of the body the transverse costae are restricted to the shoulder and periphery, only low swellings mark their position over the subsutural area and are accentuated at the shoulder to sharp nodes; 13 transverse ribs are present on the body whorl of the holotype. Spiral ornament consists of broad low almost flat-topped lirae that alternate with thinner secondary lirae. Growth lines proscline above shoulder, form a moderately strong sinus over the shoulder and become opisthoclone over the periphery. Aperture angularly subovate, angulated posteriorly, and anteriorly produced to a narrow elongate slightly twisted subsutural canal; outer lip thin at edge, indented at shoulder; inner lip excavated, thinly calcified.

Measurements.—The holotype, missing the extreme anterior tip of the shell, measures 23.7 mm in height and 12.5 mm in diameter.

Discussion.—This species is based on two specimens from the lower part of the Ripley Formation of Mississippi. Compared with Allofusus reynardii Stephenson, A. stamineus is more sharply shouldered, has fewer sharper more widely spaced transverse ribs, a less distinct collar, and a more strongly constricted body.

Types: Holotype USNM 130232; paratype USNM 130233.

Occurrence: Mississippi: Ripley Formation, locs. 6, 18.

Genus BUCCINOPSIS Conrad, 1857
(not Buccinopsis Deshayes, 1845, not Buccinopsis Jeffreys 1867, not Buccinopsis (Bayle) Mayer, 1876)


Type by monotypy, Buccinopsis perryi Conrad, 1857.

Diagnosis.—Globose low-spired shells with well-rounded to well-shouldered whors that are constricted posteriorly to a subsutural collar and anteriorly to a twisted short pillar. Pillar bounded above by a deep sulcus that terminates in a tooth on the outer lip. Siphonal notch deep and fasciole corrugated. Sculpture variable, of both transverse and spiral elements.

Discussion.—Conrad (1857, pt. 2, p. 158) described an internal mold, from what is now known as the Escondido Formation (Dumble, 1911), under the name Buccinopsis perryi. The holotype is preserved in the collections of the U.S. National Museum. Better preserved specimens from the Escondido Formation in the collections of the U.S. Geological Survey (pl. 28, fig. 25) show this species possesses the typical shape and fasciole characters of the better known genus Seminola. As Buccinopsis Conrad has priority it must supplant Seminola Wade. Although Wade (1926, p. 144) stated he was proposing the genus Seminola for five species, he listed six,

two from Coon Creek (S. crassa Wade and S. solida Wade), one from Owi Creek, and two from the Ripley formation of Texas * * * and one species from Pataula Creek, Ga., described under the name Nassa globosa.

The type locality of this latter species is actually in the Snow Hill member of the Black Creek Formation of North Carolina (Stephenson, 1938, p. 375) and the two species from the “Ripley” (= Nacatoch Sand) of Texas probably belong to S. crassa Wade (Stephenson, 1941).

The earliest known occurrence of Buccinopsis is an undescribed species in the uppermost part of the Eutaw Formation in Alabama (USGS colln. 27065), but the genus is better represented near the top of the Eozogyra ponderosa zone by Nassa globosa Gabb and S. greenensis Stephenson, from the Snow Hill Marl Member of the Black Creek Formation of North Carolina. An undescribed species occurs at about this same stratigraphic level in the Wolfe City Sand Member of the Taylor Marl in Texas. Seminola crassa Wade, S. solida Wade, Buccinopsis dorothiella Sohl, Fasciolia crassissimata Gabb (1877, p. 282), an undescribed species from Pataula Creek, Ga., and Buccinopsis perryi Conrad all occur within the Eozogyra costata zone. As known, Buccinopsis is restricted to the Gulf and Atlantic Coastal Plains and ranges through the Eozogyra ponderosa and Eozogyra costata zones (Santonian to Maestrichtian).

Although not abundant at any given locality, specimens of Buccinopsis are found well distributed and
owing to their stout strong shell, are usually well preserved.

**Buccinopsis crassa** (Wade)

Plate 22, figures 1, 2


**Diagnosis.**—Large buccinopids with a highly inclined broad siphonal fasciole bordered above by a narrow deep slit; ornament becoming increasingly obsolete with growth.

**Measurements.**—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

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</table>

**Discussion.**—With the exception of *Buccinopsis perryi* Conrad this is the largest of the buccinopids. The large strong shells of *B. crassa* are known only from the Ripley Formation at the type locality on Coon Creek, McNairy County, Tenn., and from the Nacatoh Sand of Texas. The younger individuals are proportionally broader than the more mature forms and in addition possess a less corrugated siphonal fasciole. (See pl. 22, figs. 1, 2; Stephenson, 1941, pl. 63, fig. 3.) The strongest development of ornament comes with the medial stages (Wade, 1926, pl. 50, figs. 10, 11). On the specimens from the Ripley Formation in later stages the ornament becomes more subdined and the siphonal fasciole more coarsely ridged. On the largest Nacatoh specimens (USNM 77029) the spirals continue well on to the advanced stages, but the transverse ribs become mere swellings and the growth lines strengthen.

In its mature form, *B. crassa* is not likely to be confused with other species. In its earlier stages it differs from *B. solida* in lacking a distinct collar below the suture as well as in the character of the siphonal fasciole. In addition, *B. solida* has narrower transverse ribs and wider spaced but more uniform spiral ribbons. *Buccinopsis dorothea* possesses a more poorly developed tooth on the lower outer lip, is slimmer in outline, has a more distinct collar, and is almost devoid of spiral ornament on the medial part of the whorl. *Buccinopsis crassioratus* of the Owl Creek shows poorly developed ornament at a very early stage and a complex fasciole area.

**Types:** Holotype and paratype USNM 3291; hypotypes USNM 77029 and USNM 130254.

**Occurrence:** Tennessee: Ripley Formation, loc. 1. Texas: Nacatoh Sand.

**Buccinopsis solida solida** (Wade)

Plate 22, figures 4, 5


**Diagnosis.**—Medium-sized globose low-spired buccinopids with equispaced moderately strong slightly prosocline transverse costae that are overridden by numerous spiral ribbons. Spiral ribbons cover all the shell surface but the sutural collar and siphonal fasciole.

**Description.**—Shells of medium size, thick, globose, and low spired; pleural angle 80°–95°; protoconch unknown. Suture impressed, trace irregular. Whorls about six; body constricted above to a short sub-sutural collar that is followed below by a narrow shoulder. Body well rounded over the periphery and base and finally becomes constricted to the siphonal fasciole, which is separated from the body by a spiral sulcus. Sculpture strong; collabral transverse costae about as wide as their interspaces, crossing the whorls from the shoulder to the spiral sulcus but are only faintly developed on the collar; growth lines slightly prosocline over body but markedly reflexed over the spiral sulcus and forming a sharp parasigmoidal curve over the siphonal fasciole. Spiral ribs numerous on body (12 on largest specimen) and not as wide as interspaces but absent on collar. Aperture subovate, posteriorly notched, anteriorly produced to a short, broad, notched recurved anterior canal; outer lip thin, crenulate at position of spirals with a toothlike projection at the anterior termination of the spiral sulcus; inner lip medially excavated with a calyx extending out over parietal lip onto body and down over columnellar lip. Columella bears a heavy oblique fold bordering anterior canal.
Measurements.—Explanations of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 172).

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<td>25.5</td>
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</table>

1 Estimated.

Discussion.—The globose shells of this species range from the base to near the top of the Ripley Formation. A closely related subspecies is present in the Owl Creek Formation. The specimens from the Coon Creek member in Tennessee are small, but with the exception of being slightly narrower they compare well with specimens of a similar size from the Ripley Formation of Mississippi. The total size attained by some individuals from the Ripley Formation of Mississippi is several times that of the type specimens from the Eozoa cancellata zone.

Buccinopsis solida is distinguished from B. cassa Wade, with which it occurs at the type locality in Tennessee, by its smaller size at maturity. In specimens of the same size (see pl. 22) it differs by its proportionally shorter more rounded body, sutured collar, less obtuse spire, less lenticular aperture, longer and less wide transverse costae, lack of secondary spirals, and fasciolar characters. B. dorothiella Sohl from the Ripley Formation is slimmer and lacks spirals on the whorl periphery. B. cassicoesta (Gabb) has finer closer spaced spirals and coarser but less continuous transverse costae.

Types: Holotype and paratype USNM 22912; hypotype USNM 130235.

Occurrence: Tennessee: Ripley Formation, at loc. 1. Mississippi: Ripley Formation, locs. 3, 6, 18, 22, 32.

Buccinopsis solida sulcata Sohl, n. subsp.
Plate 22, figures 6, 7

Diagnosis.—Medium-sized buccinopside with a narrow crenulate moderately deep channeled suture.

Measurements.—The holotype measures 29.6 mm in height, 23.8 mm in diameter, with a body whorl 23 mm high.

Discussion.—Only two specimens are known, both were recovered from the reworked marl of the Owl Creek at locality 30, Hardeman County, Tenn. They differ from Buccinopsis solida solida Wade by having a suture lying at the base of a narrow moderately deep channel, which is highly irregular in trend because it is molded around the transverse ribs of the preceding whorl. In addition, spirals are more numerous on B. solida sulcata and the transverse costae proportionately broader.

Type: Holotype USNM 130236.

Occurrence: Tennessee: Clayton Formation (reworked Owl Creek), loc. 40.

Buccinopsis dorothiella Sohl, n. sp.
Plate 23, figures 9–13

Diagnosis.—Shell small for a buccinopside with almost flat-sided whorls that bear few or no spirals on the periphery of the whorls.

Description.—Shell of medium size, subglobose in outline; spire low, less than one-third total shell height; pleural angle 75°–85°. Protoconch incompletely known, smooth, trochoïd and erect, with a lesser pleural angle than conch; ornament developed early and consists first of transverse ribs. Whorls four to five in number, increasing rapidly in size; suture impressed, irregular. Body whorl constricted below suture to a moderately narrow collar that is followed by a strong shoulder; the body is very broadly rounded over the periphery and is constricted below to a siphonal fasciole bordered above by a strong spiral sulcus. Transverse sculpture consists of collateral ribs that are broader than their interspaces and strongest at the shoulder but become faint over the basal slope. Spiral sculpture consists of cords of variable strength; three weak cords occur on the collar followed by five strong cords over the shoulder; the periphery lacks all but the faintest traces of spiral ornament; strongest spiral cords occur on the basal slope where they number three to five. Growth lines faint, prosocline over the collar, orthocline over the periphery, sharply reflexed back over the basal sulcus and forming a broad 5-shaped trend over the siphonal fasciole. Aperture subovate, notched posteriorly, and interiorly produced to a short, broad, recurved siphonal canal. Outer lip thin at edge, crenulate at intersection of spiral cords, with a toothlike projection above siphonal canal at the termination of the impressed sulcus that borders the siphonal fasciole. Inner lip medially excavated with a callus extending over parietal lip onto body and down over columellar lip and fasciole. Columella bears a strong oblique fold immediately above the anterior canal.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 172).

Discussion.—The holotype of Buccinopsis dorothiella is from the Ripley Formation at the former site
of Mercers Mill on Tabannoo Creek, Quitman County, Ga. (USGS 25923). The Mississippi specimens occur presumably at about the same horizon. The holotype (pl. 23, fig. 10) is somewhat more obese than the para-
type (pl. 23, fig. 13) from Mississippi, but similar variation in proportions can be found among the
topotypes. The strength of the spiral cords on the shoulder and the number of spiral cords on the base
is variable; some specimens show fine spirals on the periphery.

_Buccinopsis dorotheilla_ is distinguished from all
other species of the genus by the general lack of
spirals on the periphery and its less obese body.

**Types:** Holotype USNM 139237; paratypes USNM 139238,
139239.

**Occurrence:** Mississippi: Ripley Formation, locs. 87, 15,
16, 18. Alabama and Georgia (Chattahoochee River region):
Ripley Formation.

_Buccinopsis crassicostata_ (Gabb)

Plate 23, figures 14, 15, 16, 17


1876. _Fasciolaria_ (Cryptothyris) _crassicostata_ Gabb, Philadel-

**Diagnosis:** Medium-sized buccinopsids characterized
in adult stage by a very globose shell and poorly
developed spiral and transverse ornament.

**Description:** Shell of medium size, globose and thick;
spire about one-third total shell height; pleural
angle 95°, protoconch unknown. Whorls about five
in number, expanding rapidly in size. Whorls of
spire shouldered, but body whorls of larger specimens
are well rounded and globose; body constricted an-
teriorly to a spiral suture that borders the siphonal
canal. Suture impressed. Ornament on early whorls
consists of thick very broad but rather low trans-
verse ribs that are strongest on the shoulder and die
out on base; numerous spiral ribs, broader than
their interspaces, override the ribs. On larger shells
the transverse ribs decrease in strength until only ir-
regular broad low swellings are present; spirals on
the larger shells are also subdued and wider spaced,
becoming very faint on the last half whorl; even on
the latest whorls, however, the basal spiral ribion
remains strong. Aperture incomplete, subovate, poste-
riorly angulated and anteriorly produced to a short
twisted canal; inner lip medially excavated, bearing a

thick callus on the parietal lip that extends down
across the columellar lip. Columella bears a strong
oblique fold bordering the siphonal canal.

**Measurements.**—Explanation of measurements and
symbols used in the following table appears in the
section “Measurements of specimens” (p. 173).

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1 Estimated.

**Discussion.**—Gabb (1877, p. 282) proposed and
described _Fasciolaria_ (Cryptothyris) _crassicostata_ from
the Providence Sand of Georgia but did not figure
his type. Fortunately the holotype is present in the
collections of the Academy of Natural Sciences of
Philadelphia. The holotype is a small immature com-
pressed specimen. Better preserved specimens from
the type locality in the collections of the U.S. Geo-
logical Survey indicate the nature of the mature stage
to be that of the specimens from Mississippi de-
scribed and discussed here. The holotype of _Nassa
globosa_ Gabb has been figured by Stephenson (1923,
pl. 53, figs. 8, 9) and belongs to this genus. This
specimen comes from the Snow Hill Marl Member of
the Black Creek Formation of North Carolina and is
not conspecific with the specimen Gabb mentions un-
der that name from the Providence Sand of Georgia.
The latter specimen is only a fragment of a large
specimen of _Buccinopsis crassicostata_ (Gabb) and is
a topotype of that species.

This species is restricted to the Providence Sand
and Owl Creek Formation. Although the species is
not uncommon, no complete specimens have been
found. Variation within the available specimens is
restricted primarily to ornament and that, in itself,
differs in relation to the maturity of the shell. The
larger specimens (pl. 23, figs. 14, 15) show that all
except the basal spiral ribbons are poorly developed.
These, however, become stronger, more raised, and
sharper at maturity. In addition the siphonal area
also increases rugosity (pl. 23, fig. 15). Broken spec-
imens indicate that the earliest whorls of this species
are completely filled with shell material.

This species is differentiated from other buccinop-
sids by its obesity as well as its lack of transverse
ribs in the mature stage and by suppression of spiral
ornament at that stage. In ornament it is not too
far removed from _B. dorotheilla_, but it loses its sub-
sutural collar in the mature stage and it reaches a
much larger mature size. The shape is most like *B. solida* but again differs by its suppressed ornament.

**Types:** Holotype ANSP 13931; hypotypes USNM 130240-130242.

**Occurrence:** Mississippi: Owl Creek Formation, locs. 42, 43, Tennessee: Clayton Formation (reworked Owl Creek), loc. 40.

*Buccinopsis* sp.

Plate 22, figure 3

**Discussion.**—A number of internal phosphatic molds from the Prairie Bluff Chalk are similar to artificially produced molds made from fillings of well-preserved shells of *B. solida* Wade. These specimens are of the size and shape typical of *Buccinopsis* and possess the reflection of the columinellar fold that border the siphonal canal.

**Type:** Figured specimen USNM 130243.

**Occurrence:** Mississippi: Prairie Bluff chalk, locs. 56, 71, 80, 87, 88(?), 90.

*Buccinopsis* sp.

**Discussion.**—One specimen, an internal mold from the upper part of the Ripley Formation in Union County, Miss., may belong in *Buccinopsis*. It possesses a low spire, an obese body, shouldered whorls, and the reflection of strong but narrow transverse ribs similar in general aspect to *B. solida*.

**Occurrence:** Mississippi: Ripley Formation, loc. 56.

**Genus ODONTOBASIS** Meek, 1876

**Type species,** *Odontobasis humerosa* Meek, 1876 (*= Fusus constrictus* Hall and Meek of Meek, 1876, nomen dubium).

**Diagnosis.**—Meek (1876, p. 351) described this genus as follows:

Shell buccinoid-fusiform; spire more or less produced; body whorl visible, and separated below from the short, narrow beak, by a sharply defined, narrow revolving sulcus, that terminates below at the connection of the outer lip with the canal in a small tooth like projection; outer lip thin, smooth within and nearly straight in outline; inner lip not thickened, but well-defined; coluina a little twisted, slightly flattened, and bearing two oblique plaits below * * * *.

**Discussion.**—*Odontobasis ventricosa* (Meek, 1876, p. 354) is similar in shape and fasciolar character but lacks evidence of the coluinae plications evident in the holotype and thus it may not belong to the genus.

*Odontobasis australis* Wade (1926, p. 146) is slimmer with a proportionally higher spire and has some features such as a denticulate outer lip that lend some doubt as to its placement.

Meek (1876, p. 351) cited *Fusus constrictus* Hall and Meek, as the type species of the genus *Odontobasis*; however, he did this with the reservation that *Odontobasis constricta* Hall and Meek of Meek (1876, p. 352) would stand as the type, as he stated in a footnote on p. 351.

In order to prevent the possibility of any uncertainty in regard to the type of this genus, I would state that *Fusus constrictus*, Hall and Meek, is cited as such, because it is believed to be the same as the species hereinafter described under that name. Should the latter prove distinct, however, it must be considered the type, as the character, on which the genus was founded were observed in this shell, which has not been compared with the typical specimen of *Fusus constrictus*.

On p. 333 he stated further:

I am not positively sure that this shell is specifically identical, in all respects, with the type of *F. constrictus*, Hall and Meek.

He then noted some difference between the two but rationalizes these with the fact that the type of *F. constrictus* is a smaller specimen. On the following page he suggested that if the two shells turn out to be different species, the name *Odontobasis humerosa* (pl. 29, figs. 7, 8) be used.

A search has been made for the holotype of *Fusus constrictus* Hall and Meek, but it has not been located. In addition, the holotype of that species came from the Pierre Shale, whereas Meek's specimen of 1876 came from the Fox Hills Sandstone. Therefore, it appears best to put the type species on a firm basis by treating *Fusus constrictus* Hall and Meek of Meek, 1876, as a nomen dubium and accepting *Odontobasis humerosa* Meek, 1876, as the type species.

**Odontobasis australis** Wade

Plate 23, figures 5, 6


**Diagnosis.**—Small subfusiform shells with a basal sulcus, denticulations on the interior of the outer lip and three oblique plications on the columns.

**Measurements.**—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

<table>
<thead>
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<tr>
<td>3 (pl. 22, fig. 5)</td>
<td>9.0</td>
<td>3.1</td>
<td>4.3</td>
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</table>

**Discussion.**—This species is restricted to its type locality in the Ripley Formation on Coon Creek, McNairy County, Tenn. Eight specimens are available for study in the collections of the U.S. National Museum and U.S. Geological Survey and although in general they all are well-enough preserved to retain the protoconch, none possess the extreme anterior part.
of the outer lip. It is therefore impossible to determine if the basal sulcus developed a terminal projection.

*Odontobasis australis* differs from the type species, *Odontobasis constrictus*, by having three primary plications on the columella instead of two, a denticulate outer lip, and a much slimmer more fusiform outline. For these reasons I am hesitant to place this species in Meek’s genus. Meek’s concept of the genus, though hazy, was also wide. He included *O. ventricosa* Meek, a species that evidently has no colunnellar plications. If the genus is accepted in this broad sense *Odontobasis australis* Wade can validly be retained in *Odontobasis*.

**Types:** Holotype USNM 32018; paratype USNM 32018; hypotype USNM 130244.

**Occurrence:** Tennessee: Ripley Formation, loc. 1.

*Odontobasis sulcata* Sohli, n. sp.

**Plate 23, figures 1–4**

**Diagnosis.**—Shell of average size for genus with denticulate outer lip and strong oblique fold on columella bordering the siphalon canal, followed by three weaker folds within the aperture and higher on the columella.

**Description.**—Shell moderately small, bucciniform; spire about half total shell height; pleural angle 48°. Protoconch not well known but consists of several whorls that, in their late stages, develop transverse wrinkles. Whorls three to four in number; suture impressed. Body whorl rounded peripherally, constricted both anteriorly and posteriorly; base of body delimited from siphalon fasciole by an oblique spiral sulcus. Sculpture strong; transverse ribs occur as strong round-topped ridges that die out on basal slope; costae number 11 on body and 15 on penultimate whorl of holotype. Spiral ornament consists of strong spiral ribs as wide or wider than their interspaces that override the ribs; there are 6 spiral ribs on the penultimate whorl and 12 on the body above the sulcus. Surface of body covered by growth lines of moderate strength that are reflected in the interspiral spaces, over the sulcus, and on the siphalon fasciole. Aperture slightly angulated posteriorly, anteriorly produced to a short oblique slightly twisted siphalon canal; outer lip denticulate within and toothed at intersection of the basal sulcus; inner lip sharply excavated; callus on parietal lip thin. Columella twisted and marked by a low fold bordering the siphalon canal that is followed immediately above by a strong oblique fold and still higher by three to four weaker folds that begin farther back from the aperture.

**Measurements.**—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

<table>
<thead>
<tr>
<th>Loc.</th>
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<tbody>
<tr>
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<td>4.7</td>
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<tr>
<td>18 (paratype) (pl. 23, fig. 3)</td>
<td>7.8</td>
<td>4.1</td>
</tr>
</tbody>
</table>

**Discussion.**—*Odontobasis sulcata* Sohli compares well in shape and ornament with the western interior species described by Meek but possesses more numerous colunnellar plications and a dentate interior of the outer lip. The latter feature may be present on *F. constrictus*, the type species, but the lip of the holotype is not preserved intact (pl. 23, fig. 1). The fold arrangement of the lower columella is much like that of the type species. In addition there is a toothlike projecting termination of the spiral sulcus on the paratype of *O. sulcata* (pl. 23, fig. 4). This is a feature mentioned as diagnostic of *Odontobasis* by Meek but is not preserved on the specimen figured by Meek (see pl. 23, figs. 7, 8) in 1876 (p. 352, figs. 41, 42). *O. sulcata* differs in ornament from either *O. ventricosa* Meek or *F. constrictus* Hall and Meek by having stronger transverse ribs and wider spaced spiral ribbons.

**Types:** Holotype USNM 130245; paratype USNM 130246.

**Occurrence:** Mississippi: Ripley Formation, loc. 18.

**Family MELONGENIDAE**

*Protobusycyon* Wade, 1917

Type by original designation, *Busycyon (Protobusycyon) cretaceum* Wade.

**Diagnosis.**—Pyriform shells of medium size; whorls with one to two rows of nodes, the upper of which occurs at the shoulder; a distinct impressed narrow constriction or sulcus occurs below inflated part of body. Aperture with a rather elongate siphalon canal and a posterior notch; outer lip notched at intersection with the nodded rows and toothed where the spiral sulcus intersects outer lip.

**Discussion.**—The relationship of the species here placed in *Protobusycyon* Wade to *Busycyon* Bolten is much clouded. Wade believed *Protobusycyon* to be a forerunner of the present day *Busycyon*. However, we know little or nothing of the character of the nuclear whorls of *Protobusycyon* and as can be seen in figure 15 there is a striking difference in the character of the growth lines between the two genera.

In spite of their many similarities the presence of the basal sulcus terminating in a toothlike extension of the aperture merits serious reservation in assigning these Cretaceous species to *Busycyon*. *Busycyon* (*Busy-
**TENNESSEE AND MISSISSIPPI**


**Diagnosis.**—A *Busbycon* with a low turreted spire and low row of nodes below the shoulder that die out near the aperture.

**Measurements.**—The holotype measures 63.2 mm in height and 38 mm in diameter.

**Discussion.**—Both Wade's description and illustrations minimize the strength of the spiral ornament. The only known specimen, the holotype, is worn and thus the spiral elements are not obvious, but a less worn spot near the aperture shows strong spiral cords covering the surface between the shoulder and the basal sulcus.

*Protobusbycon binodusum* Sohl, from the Ripley Formation of Mississippi, differs by having an evenly tapering spire and has a second row of nodes that are strong and continuous up to the aperture. The outer lip is notched at the position of both rows of nodes instead of only one and has weak spiral ornament over the whole whorl surface. In addition, the siphonal canal of *P. cretaceum* is more strongly curved.

**Types:** Holotype USNM 32837.

**Occurrence:** Tennessee: Ripley Formation, loc. 1.

*Protobusbycon binodusum* Sohl, n. sp.
*Plate 24, figures 23, 24, 26, 27*

**Diagnosis.**—A *Protobusbycon* with a low but evenly tapering spire and a body whorl bearing two strong rows of nodes.

**Description.**—Shell of medium size, pyriform; spire low, tapering; pleural angle of 90°-95°. Protoconch unknown; suture impressed and irregular in trace. Whorls shouldered by a strong row of nodes; whorls concave above shoulder, periphery relatively flat, bounded below by a second strong row of subspinose nodes; body constricting strongly below lower row of nodes to an incised spiral sulcus below which the body tapers anteriorly over a broad strong pillar. Sculpture dominated by the two strong rows of nodes, but faint spiral lirae and cords cover body and are especially strong below the spiral sulcus. Transverse ornament suppressed with occasional broad swellings extending between the rows of nodes. Growth lines
strong, prosocline on upper whorl face with a sinus developing over the shoulder, trending slightly opisthocline on periphery and again sinused over lower row of nodes; growth lines prosocline below nodes with an acute adaperturally directed sinus at the spiral sulcus; below, sulcus growth lines follow a gently prosocline trend until they reach the slightly raised siphonal fasciole. Aperture incompletely known, broadly subovate, posteriorly angulated, and interrupted anteriorly by a rather long broad siphonal canal that terminates in a shallow notch. Growth lines indicate the outer lip is deeply notched at the intersection of the rows of nodes and bears a tooth-like projection at the termination of the spiral sulcus. Inner lip callused; parietal lip with a moderately thick callus extending out onto body and continuing down but thinning over the broadly flattened columellar lip. Columella smooth.

**Measurements.**—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

<table>
<thead>
<tr>
<th>Loc.</th>
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</tr>
<tr>
<td>17 (paratype)</td>
<td>62.4</td>
<td>37</td>
</tr>
</tbody>
</table>

Discussion.—*Protoxycon binodatum* is an extremely rare species known from only three specimens, all of which come from the lower part of the Ripley Formation in Mississippi. All the available specimens agree well in size, shape, and ornament and, as previously noted, differ from *P. cretaceum* (Wade) by having a well-developed second row of nodes and a smoothly sloping rather than turreted spine. In addition, Wade's species also possesses a more curved siphonal canal and lacks the stronger spiral cords on the anterior slope.

**Types:** Holotype USNM 130247; paratype USNM 130248.  
**Occurrence:** Mississippi: Ripley Formation, loc. 7, 18.

*Protoxycon* sp.  
Plate 23, figures 20–22

Discussion.—Two specimens from the Ripley Formation of Mississippi (loc. 16) lacking the anterior extension of their shells appear to be related to Wade's species *Protoxycon cretaceum* from Coon Creek, Tenn. Like that species they have a turreted spire and a single row of nodes but differ by having very strong spiral ornament (pl. 24, figs. 21, 22). Both shells are broken along the line of the basal sulcus, but even though poorly preserved, they appear to be distinct from either *P. cretaceum* (Wade) or *P. binodatum* Sohl.

**Genus LOMIROS Stephenson, 1941**

Type by original designation, *Lirosoa cretacea* Wade, 1926.

**Diagnosis.**—Medium-sized subfusciform shells with plump well-rounded whorls that are ornamented by strong spiral cords or ribbons, peripheral nodes, and an occasional varix. Aperture subovate with a rather broad curved moderately short siphonal canal; inner lip seemingly devoid of callus, columellar lip sharp edged and reflexed along the edge of the siphonal canal, thus forming a siphonal slit above.

Discussion.—Only one species, *Lomirosa cretacea* (Wade), from the Ripley Formation of Tennessee and the Nacatoch Sand of Texas, is known. *Lomirosa* Stephenson differs from *Lirosoa* Conrad, of the Mioocene, by its proportionally higher spire, the development of an umbilical slit, and by lacking callus on the inner lip.

*Lomirosa cretacea* (Wade)  
Plate 24, figures 13, 19


**Diagnosis.**—A *Lomirosa* with strong spiral ornament but transverse sculpture reduced to elongate peripheral nodes on early whorls and discontinuous ribs on the later whorls.

**Measurements.**—The holotype measures 45 mm in height and has a maximum diameter of 27 mm.

Discussion.—*Lomirosa cretacea* is a rare species and, due to its fragile shell, is always found distorted or incomplete. With increased size the transverse nodes lengthen to discontinuous ribs of variable strength. The larger specimens also have a proportionally shorter siphonal canal. Variation in proportional height of spire and obesity likewise is considerable.

**Types:** Holotype and paratype USNM 32598; hypotype USNM 77088 (Texas).  
**Occurrence:** Tennessee: Ripley Formation, loc. 1. Texas: Nacatoch Sand.

**Genus PYRIFUSUS Conrad, 1958**

Type by monotypy, *Pyrifusa subdensatus* Conrad.  
**Diagnosis.**—Low-spired pyriform shells with subshoudered whorls; sculpture of strong spiral cords and transverse costae; aperture elongate subovate and posteriorly notched, siphonal canal tapering and curved, columella thick and smooth.
Discussion.—Meek (1876, p. 343) redefined the genus and included, besides Conrad’s species, an additional group of species from the Upper Cretaceous of the western interior that differed in the height of the spire and in the character of the aperture. His hesitation at including these western interior species in Pyrifusus is displayed by the erection of a new subgenus Neptunella (not Neptunella Gray, 1855). Gardner (1916, p. 456) supplied the name Rhombopsis to replace Neptunella Meek. Of the species from the Cretaceous of Maryland referred to Pyrifusus by Gardner, P. monmouthensis belongs in Stantonella, P. marylandicus is probably a Rhombopsis, and P. vitatus is probably either a Pyrifusus or a Lupira but is so crushed that the columellar characters are not visible and thus it cannot be definitely placed. The species assigned to Pyrifusus by Whitfield (1892) and Weller (1907) from New Jersey are based upon internal molds too poor for confident placement. For the most part the spires of these forms, as exhibited by the molds, are too high for the genus, but it is conceivable that some may represent Pyrifusus. The holotype of Hercorhyclus mundum Stephenson (1941, p. 322) lacks the basal sulcus of that genus but represents the only known specimen of Pyrifusus in the Navarro Group of Texas.

The genus appears to be restricted to the Late Cretaceous (Campanian-Maastrichtian). In a geographical sense, similar forms have been noted from other areas (Wade, 1926, p. 143; Meek, 1876, p. 344) such as Germany and India, but the available information does not seem to warrant definite placement of these forms in Pyrifusus.

In ornament and shape Pyrifusus is close to Lupira Stephenson, but that genus possesses columellar plications high on the columella.

Pyrifusus subdensatus Conrad

Plate 24, figures 1–4


Diagnosis.—Shell slimmer and smaller than average for the genus with strongly shouldered whorls and with the transverse ribs continuing to the satureal swelling.

Description.—Medium-sized pyriform shells with a spire about one-third the total shell height. Protoconch unknown; pleural angle increasing greatly with size and at maturity reaching 90°. Suture impressed, trace irregular. Teleconch whorls number five to six. Body whorl bears a raised weltlike area immediately below the suture; below the welt the whorl face is acutely excavated and is followed by a shoulder formed by the accentuation of the transverse ribs; periphery moderately rounded; basal slope gradually tapering anteriorly. Sculpture ornate, consisting of close-spaced collabral transverse ribs that number 12–14 on the body whorl, and that begin as nodes on the subsutural welt, decrease in strength over the excavated area above the shoulder, but are strong from the shoulder over the periphery and die out on the basal slope. Spiral ornament consists of broadly round topped cords that override the transverse ribs and are narrower than their interspaces; cords number 14–16 on body; in addition, several spiral lines occur above the shoulder and a few more are present on the surface of the spiral cords of the periphery. Aperture elongate, subovate, distinctly notched posteriorly, and produced anteriorly to a slender siphonal canal; inner lip calloused with calis of parietal and columellar lips extending out onto body. Columella smooth, proportionally broad, and flattened.

Measurements.—Explanation of measurements and symbols used in the following tables appear in the section “Measurements of specimens” (p. 172).

<table>
<thead>
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<td>45</td>
<td>28</td>
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<td>1.7</td>
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Discussion.—The holotype of Pyrifusus subdensatus Conrad is not listed by Johnson (1905) as being present in the collections of the Academy of Natural Sciences of Philadelphia and a subsequent search of those collections by the author has failed to locate it. As illustrated by Conrad (1858, pl. 35, fig. 12) the holotype is missing both the anterior and apical ends of the body plus a part of the body whorl. The holotype as figured is a larger specimen than the topotypes available for study but does show that the specimen had numerous and close-spaced spiral cords like those of the other Owl Creek specimens. The specimen figured by Conrad (1860, pl. 47, fig. 2) as belonging to Pyrifusus subdensatus is here referred to P. crassus Sohl.

Wade (1926, p. 143) assigned some Coon Creek specimens to this species, but the Coon Creek specimens differ from P. subdensatus by having a broader excavated area below the suture that lacks spiral ornament. In addition, the Coon Creek forms have less shouldered whorls, fewer spiral cords, and more numerous transverse ribs that do not carry up to the subsutural welt. The sinuous growth lines, inflated body, umbilical chink, fewer and wider spaced spiral cords, and broad gently excavated area below the shoulder of Pyrifusus sublitatus Wade serves to dis-
tistinguish this species from *P. subdensatus*. *P. crassus* Sohl from the Ripley Formation has fewer spiral cords, more numerous transverse ribs, a broader excavated area, and a less slim outline.

**Types**: Holotype lost; hypotypes USNM 130249–130251.

**Occurrence**: Mississippi: Owl Creek Formation, locs. 43–46, USGS Mesozoic loc. 26354. Clayton Formation (Cretaceous reworked into base), USGS Mesozoic loc. 26358.

**Pyrifusus crassus** Sohl, n. sp.

Plate 24, figures 12, 16, 17


**Diagnosis**.—Low-spired *Pyrifusus* with a peripherally inflated body whorl that is constricted below and bears a moderately strong excavated band below the sutural welt.

**Description**.—Medium-sized pyriform shells; spire low, about one-sixth of the total shell height; pleural angle 87°–99°. Suture impressed, irregural in trace where it overrides the transverse ribs of the preceding whorl and bordered below by a subsutural welt. Teleoconch whorls number about six, protoconch unknown. Body whorl with a moderate to strongly excavated band immediately below the subsutural welt, periphery rounded, constricting rapidly below to a strong pillar. Transverse collateral ribs are continuous suture to suture on early whorls but are absent over the excavated subsutural area on the body and die out on the basal slope, ribs are of moderate strength and number 14–17 on body. Spiral sculpture of 11–13 broad wide-spaced cords that form elongate nodes where they override the axial ribs; secondary lirae absent or restricted to the excavated area. Growth lines strong, opisthocline over the excavated band, forming a broad sinus over the shoulder and upper periphery, opisthocline over the upper basal slope and gradually swinging back to almost orthocline over the pillar. Aperture elongate, subovate, with a strong narrow posterior channel and an elongate somewhat curved anterior siphonal canal; outer lip thin at edge and crenulate where intersected by the spiral cords; inner lip with a well-defined heavy callus, with the callus of the parietal lip extending out over the body a short distance; columellar lip smooth, flattened somewhat where it borders the siphonal canal.

**Measurements**.—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

**Discussion**.—In earlier growth stages this species possesses sharp transverse costae and numerous spiral lirae on the subsutural excavated area. With increasing size the excavated area broadens, generally loses its spiral lirae, and the transverse elements increase in breadth and become less continuous. Variation in height of spire ranges between ⅛ and ⅜ of the total shell height and is reflected in the spread of 120° (87°–99°) in the pleural angle. The number and spacing of the transverse ribs on the body is variable, but the ribs are always wider than the interspaces.

In shape this species closely approximates *Pyrifusus subliratus* Wade but differs most noticeably by having more numerous spiral cords, less sinuous growth lines, and a lower spire. *P. subdensatus* is slimmer, has a less constricted body, closer spaced, more prominent and continuous transverse ribs, and a stronger shoulder.

**Types**: Holotype USNM 130252; paratypes USNM 130233–130255.

**Occurrence**. Mississippi: Ripley Formation, locs. 5, 6, 10, 17, 18.

**Pyrifusus subliratus** Wade

Plate 24, figures 11, 21


**Diagnosis**.—Shell above average size for genus, body whorl inflated and bearing a broad shallowly excavated band below the suture; spiral ornament strong, but cords wider spaced and secondary lirae common; growth lines very sinuous.

**Measurements**.—All specimens measured are missing their apical tip. Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

<table>
<thead>
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<th>Loc.</th>
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<tr>
<td>D.</td>
<td>26.0</td>
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</table>

**Discussion**.—*Pyrifusus subliratus* was described in detail by Wade (1926, p. 143) and as known is restricted to the Ripley Formation at Coon Creek, Tenn. It is perhaps the most obese of the species here assigned to *Pyrifusus* and variations are small within the suite of topotypes available. Secondary spiral lirae are common both between and superimposed upon some of the 10 spiral cords. (See pl. 24, fig. 11.)
In comparison with the other species of *Pyritus* dealt with here, *P. subiratus* has more sinusuous growth lines (pl. 24, fig. 11), fewer and wider spaced spiral lirae, and has a broader and less excavated slope between the subsutural welt and the first spiral cord. Wade also noted an umbilical chink as being characteristic of *P. subiratus*, but this chink, although present on the holotype, is sealed by the callus of the columnellar lip on several topotypes. In addition to the above characters the transverse ribs are lower and not continuous to the sutures as in *P. subdensatus* Conrad; the posterior notch is not so narrow as in *P. erossus* or *P. ejundicus*, nor do the primary spiral cords begin as high on the whorl as on *P. subdensatus*.

**Types**: Holotype USNM 32910; hypotypes USNM 130258 and 130257.

**Occurrence**: Tennessee: Ripley Formation, loc. 1.

*Pyritus ejundicus* Sohl, n. sp.

Plate 24, figures 22, 25


**Diagnosis**.—A *Pyritus* of slim outline; shell gently tapering below the periphery and bearing a strongly excavated band below the subsutural welt; transverse ribs restricted to periphery of body.

**Description**.—Medium-sized pyriform shells of slim outline; spire about one-sixth total shell height, but moderately high for genus; pleural angle 80°–90°. Suture impressed, irregular in trace, and bordered below by a noded subsutural welt. Teleoconch whorls number about five, protoconch unknown. Body whorl bears a strongly excavated band below the subsutural welt and may or may not be shouldered below this band; periphery moderately rounded, tapering gradually over the basal slope. Sculpture ornate; collabral transverse ribs strong on periphery and following a broadly arcuate trend but dying out above on the excavated band and below on the basal slope; ribs number 17–18 on body. Twelve to fourteen rounded-topped spiral cords cover the surface of the body whorl with the exception of the excavated band. Growth lines moderately strong, gently prosocline across the subsutural welt and excavated band, broadly arcuate over periphery, becoming very gently prosocline to orthocline over the basal slope. Aperture subovate with a very narrow posterior notch and a rather slightly curved siphalonal canal; outer lip thin and crenulated where intersected by the spiral cords; inner lip calloused. Columella smooth.

**Measurements**.—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 172).

<table>
<thead>
<tr>
<th>Loc.</th>
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<tr>
<td>Hypotype</td>
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**Discussion**.—Wade (1926, p. 143) placed specimens of this species in *Pyritus subdensatus* Conrad, but they can be distinguished on a number of characters. *P. ejundicus* has more numerous transverse costae that are not continuous to the suture and that have a straight trend. In addition, *P. ejundicus* is larger and has fewer, but broader, spiral cords than *P. subdensatus*. *P. subiratus* Wade has fewer spiral cords, a more obese and basally constricted body whorl, and very sinusuous growth lines. *P. ejundicus* also is more obese, has more sinuose growth lines and transverse ornament, and a lower spire.

**Types**: Holotype USNM 32909; paratypes USNM 130258, 130259.

**Occurrence**: Tennessee: Ripley Formation, loc. 1.

*Pyritus sp.*

Plate 24, figures 8–10, 15, 20

**Discussion**.—Internal molds that have the outline of *Pyritus* and bear a reflection of an aperture with a posterior notch and crenulate outer lip are present in the Prairie Bluff Chalk. In addition, one specimen (pl. 24, fig. 10) also bears a part of the shell material, which shows the typical spiral cords of *Pyritus*. The molds are rare but are found at many localities.

**Types**: Figured specimens USNM 38354, 130260–130262.

**Occurrence**: Mississippi: Prairie Bluff Chalk, locs. 66, 71, 74, 75, 80, 82, 84, 86–88, 90–92, 94.

**Genus RHOMBOPSIS** Gardner, 1916

Type by original designation, *Fusus newberryi* Meek and Hayden, 1857.

**Diagnosis**.—Pyriform shells of medium size, whorls moderately shouldered and posteriorly constricted to a broad subsutural collar or inclined ramp; aperture sublenticular, produced anteriorly to a moderately long, rather straight, siphalonal canal; sculpture of discontinuous collabral ribs and numerous spiral lirae or cords.

**Discussion**.—Meek (1876, p. 344) proposed *Neptunella* Meek (not Gray) as a subgenus of *Pyritus* to include three species from the Cretaceous of the western interior: *Fusus newberryi* Meek and Hayden, *Fusus subiratus* Meek and Hayden, and *Fusus intertexitus* Meek and Hayden. As *Neptunella* Meek is preoccupied by *Neptunella* Gray, Gardner (1916, p. 486) substituted the name *Rhomboopsis*. Meek's concept of the genus was broad. The type species *F. new-
**NEOGASTROPODA, OPISTHOBRANCHIA, AND BASOMMATOPHORA**

*berryi* has a much lower spire than the other two western interior species included in the genus. Meek (1876, p. 344) also thought that such species as *Fusus bellaliratus* Conrad from the Ripley Formation of Mississippi belonged here. That species, however, belongs in *Deusenia* Stephenson which, on the basis of growth line, shape, and apertural features, appears to be very closely related to *Rhombopsis* but differs by having a strongly developed subsutural collar. In *Rhombopsis* there is a poor development or total lack of such a collar. *Pyritofusus* Conrad has a much lower spire, an aperture with a strong posterior notch, and a less sinuous growth line.

*Rhombopsis orientalis* Wade appears closest to *Rhombopsis intertextus* (Meek and Hayden) and its placement in *Rhombopsis* is only feasible when the genus is considered in the broadest sense. When so considered the possibility of gradation to *Deusenia* has to be considered. For the present, however, the two genera will be treated as distinct, based primarily upon the development of the subsutural collar.

The genus has also been cited as occurring in the Cretaceous of the Paita region of Peru by Olsson (1944, p. 99). His species *Rhombopsis meridionalis* has a siphonal canal that is much more strongly curved than is typical of the genus and the assignment in Gardner's genus appears questionable.

### Rhombopsis molinoensis Sohl, n. sp.

**Plate 24, figures 14, 15**

**Diagnosis.**—A *Rhombopsis* with a broad subsutural collar or band that bears weaker spiral lirae than those of the whorl sides; transverse ribs discontinuous, strongly nodded at the low shoulder.

**Description.**—Shell medium-sized, fusiform, and moderately stout. Protoconch of about 2½ smooth whorls; junction with conch gradual with addition of low riblets. Suture impressed, irregular in trace. Whorls posteriorly constricted to a broad subsutural collar that is bounded below by a low nodose shoulder; below shoulder, body tapers rather gradually to the siphonal canal. Spiral sculpture of moderately strong spiral lirae that are narrower than their interpaces, cover the shell surface, but are finer above the shoulder than below. Transverse sculpture of collabral transverse ribs that are accentuated to nodes at the shoulder, but die out above on the collar and below on the basal slope. Growth lines moderately strong, with a broadly arcuate opisthoclinal trend on the subsutural collar, slightly flexed at the shoulder, and gently opisthoclinal immediately below, but swinging to slightly prosocline on the whorl base. Aperture incompletely known; inner lip lightly callused; columella smooth, somewhat curved.

**Measurements.**—The holotype, which lacks the anterior extremity, measures 38.4 mm in height and 20.8 mm in diameter.

**Discussion.**—*Rhombopsis molinoensis* is only known from its type locality in the lower part of the Ripley formation near Molino, Union County, Miss. It differs from *R.? orientalis* Wade by its broader collar, lower shoulder, and less coarser spiral ornament. *R. intertextus* (Meek and Hayden) has coarser ornament and a slimmer outline, but in other respects, the two species differ only to a minor degree.

**Type:** Holotype USNM 20474.

**Occurrence:** Mississippi: Ripley Formation, loc. 12.

**Rhombopsis? orientalis** Wade

**Plate 24, figures 5**


**Diagnosis.**—Shell elongate, fusiform, slim for genus; ornament of rather low discontinuous collabral transverse ribs that are raised to nodes at shoulder and of numerous spiral lirae that cover shell surface.

**Discussion.**—*Rhombopsis orientalis* is a poorly known species. The holotype lacks the entire anterior section of the shell. The only available topotype is also incomplete but shows (pl. 23, fig. 5) an elongate, straight, siphonal canal. This species most closely approaches *R. intertextus* (Meek and Hayden) but differs by its finer spiral ornament and narrower subsutural constriction.

**Types:** Holotype USNM 32204; hypotype USNM 130263.

**Occurrence:** Tennessee: Ripley Formation, loc. 1.

**Genus Deusenia** Stephenson, 1941

**Type** by original designation, *Deusenia cibolensis* Stephenson.

**Diagnosis.**—Shell fusiform, spire of moderate height. Whorls constricted posteriorly to a moderately broad subsutural collar. Sculpture ornate, consisting of strong spiral cords or ribbons on whorl sides and spiral lirae on collar; transverse ribs accentuated to nodes at shoulder, dying out above and below. Growth lines prosocline on collar, strongly sinuous at shoulder, and broadly arcuate below. Aperture notched posteriorly, siphonal canal curved to left, outer lip crenulate, columella smooth.

**Discussion.**—Stephenson (1941, p. 330) proposed *Deusenia* to include four species from the Kemp Clay of Texas. Some of the Kemp Clay names may be synonyms as they are distinguished on minor differences in shape and ornament, and are all from the
upper part of the formation. In addition, three of the species occur in close proximity. The holotypes are incomplete and the number of available specimens is so few that one is unable to note whether the differences cited are constant.

Although not recognized by Stephenson, species from other faunas of Late Cretaceous age may well be assigned from here. The following is a list of known species assignable to *Deusenia*.

*Deusenia echolena* Stephens. Kemp Clay of Texas
*corbis* Stephens. Kemp Clay of Texas
*transiens* Stephens. Kemp Clay of Texas
*multitrace* Stephens. Kemp Clay of Texas

*Fusus (Afor) bellalirata* Conrad. Owl Creek Formation
*Deusenia ripleyana* Harbison. Ripley Formation of Mississippi
*Rhombopsis microstria* Wade. Ripley Formation of Tennessee

*Volutella rigidus* Bailey. Senonian, Pondoland, South Africa (questionable)
*Cryptophyteae pseudogidaea* Rennie. Senonian, Pondoland, South Africa (questionable)

**Deusenia bellalirata bellalirata** (Conrad)

**Plate 25, figures 8, 9**


**Diagnosis.**—A *Deusenia* of slim outline with only three primary spiral ribbons visible on the penultimate whorl.

**Description.**—Medium-sized fusiform shells with a spire about one-third total shell length. Pleural angle 66°–71°. Protoconch consists of about 2½ smooth whorls. Suture impressed. Body constricted posteriorly to a subsutural collar, slightly swollen below the moderately subnodose shoulder, and tapering anteriorly. Sculpture ornate; 3 spiral lirae occur on the collar with about 18 spiral ribbons that are narrower than their interspaces and which occur upon the whorl sides, but only 3 of them are visible on the penultimate whorl; secondary lirae may occur between some primary ribbons. Transverse ribs number 13–14 per whorl, but they do not carry across the collar, and they die out on the basal slope. Growth lines proso- cline over collar, sinuated at junction with the shoulder, becoming slightly opisthoclinal to orthocline over periphery and base. Aperture incompletely known, notched posteriorly in harmony with the collar; anterior canal elongate, slightly twisted, and inclined to the left; inner lip lightly calloused.

**Measurements.**—The holotype measures 39.2 mm in height and 17.5 mm in diameter.

**Discussion.**—*Deusenia bellalirata* (Conrad) differs from *D. ripleyana* Harbison by having fewer and thinner spiral ribbons on the body of which only three are visible on the penultimate whorls. In addition, Conrad’s species is smaller in size.

This species differs from the species of the Kemp Clay of Texas in its finer ornament and size.

The holotype (AMNH 9066) is preserved in the collections of the American Museum in New York and is here illustrated (pl. 25, fig. 8). The holotype is more strongly shouldered, has closely spaced narrower spiral lirae, and a less well rounded body than is indicated on Conrad’s illustration (1858, pl. 35, fig. 17).

*Meek* (1876, p. 344) thought this species referable to his *Neptunella* (not Gray), which has been supplemented by *Rhombopsis* Gardner. However, the type of *Rhombopsis* lacks the distinctive subsutural collar.

Stephenson (1914, faunal list) assigned it to *Pyritetus* from which it differs in its shape and subsutural collar.

**Type:** Holotype AMNH 9066.

**Occurrence:** Mississippi: Owl Creek Formation, loc. 46, Prairie Bluff chalk, questionably present at loc. 54.

**Deusenia bellalirata costata** Sohl, n. subsp.

**Plate 25, figures 3, 4**

**Diagnosis.**—A *Deusenia* with numerous (18–21) close-spaced low transverse ribs.

**Discussion.**—A number of specimens from the Owl Creek Formation, although similar to *Deusenia bellalirata bellalirata* in size and by having three primary spiral cords exposed on the penultimate whorl, differ by lacking secondary lirae on the whorl sides, and by having more numerons and closer spaced transverse elements. In addition, the spiral ribbons are wider and the shell outline is usually broader.

**Types:** Holotype USNM 130264; paratype USNM 130265.

**Occurrence:** Mississippi: Owl Creek Formation, locs. 45, 46. Tennessee: Clayton Formation (reworked sand of the Owl Creek at base), loc. 40.

**Deusenia ripleyana** Harbison

**Plate 25, figures 1, 2, 5–7, 11–13**


**Diagnosis.**—A *Deusenia* with close-spaced spiral cords, four or five of which are visible on the penultimate whorl.

**Description.**—Medium-sized fusiform shells with a spire about one-third total shell height. Pleural angle 50°–70°. Protoconch consisting of 2–2½ smooth rounded regularly coiled whorls; junction of teleoconch abrupt, accompanied by addition of direct and continuous transverse ribs, spiral ornament added after about half a whorl and the posterior whorl constriction develops on the second teleoconch whorl.
Suture impressed. Teleconch whorls five or six in number, constricted posteriorly to a subsutural collar that is bordered below by a rather strong and subnodose shoulder; below shoulder, body broadly rounded down to a gentle anterior slope. Sculpture ornate; spiral lirae number four to five on the collar with 18–22 spiral ribbons that are broader than their interspaces, occurring over the whorl surface, but lessen in strength anteriorly; collabral transverse ribs continuous on earliest whorls but die out on collar and on basal slope of body whorl; ribs accentuated to nodes at shoulder and number 13–14 on body whorl. Growth lines prosocline over collum, sinused at shoulder, anastomose over inflated body, and orthocline to gently prosocline over base. Aperture elongate subovate, angulated posteriorly in harmony with collar, and anteriorly drawn out to a curving and slightly twisted siphonal canal. Outer lip thin at edge, notched in harmony with sinus at shoulder, and crenulate below where intersected by the spiral ribbons. Inner lip very lightly calloused. Columella smooth.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

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<td>18 (hypotype)</td>
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Discussion.—Deusenella rileyana is abundant at its type locality at Union County Lake, Union County, Miss. (loc. 18). It occurs less abundantly at a number of other Ripleys localities in Mississippi and in the Chattahoochee River region of Georgia and Alabama. With the relatively large suites available for study it is easily seen that the species is quite variable. A comparison of the figures illustrated on page 25 shows that slimmness of the outline, height of spire, degree of constriction of the collar, and the strength of the shoulder all are variable. Sculpture varies similarly in some instances the spiral ribbons are broad and close spaced (pl. 25, fig. 6), but in others the interspaces are equal to, or greater than, the breadth of the ribbons (pl. 25, figs. 1, 2). Although the strength of the transverse ribs may vary, their numbers appear to remain constant and the spiral lirae of the collar also are constant in number.

Compared with Deusenella bellatrix (Conrad) from the Owl Creek Formation, this species has less numerous transverse ribs, usually has a more obese outline, and usually has thicker and closer spaced spiral elements as well as lacking any secondary spiral development on the whorl sides.

Types: Holotype ANSP; hypotypes USNM 130266–130269, 130720.

Occurrence: Mississippi: Ripleys Formation, locs. 5, 6, 9a (?), 18, 29. Alabama and Georgia: Ripleys Formation.

Deusenella sp.
Plate 25, figures 14, 16

Discussion.—Several specimens from the Ripleys Formation at Union County Lake, Union County, Miss. (loc. 18), although only fragmentary, indicate that one or more large species of Deusenella may be present. These specimens differ from D. rileyana not only in size but by their greater pleural angle, coarser nodings, and lesser posterior whorl constriction. In addition, they bear more numerous spiral lirae upon the collar, and one specimen (pl. 25, fig. 14) has broader and less sharp collaral ribs.

Types: Figured specimens USNM 130270, 130721.

Occurrence: Mississippi: Ripleys Formation, loc. 18.

Deusenella cf. D. travisiana Stephenson
Plate 25, figure 10

Discussion.—One incomplete and moderately large specimen from the Owl Creek Formation on Owl Creek, Tippah County, Miss., although not identical with, nonetheless, compares moderately well with Deusenella travisiana Stephenson, from the Kemp Clay of Texas. Both have strongly constricted collars and a few secondary lirae but the holotype of the Texas species has somewhat broader spiral elements.

Type: Figured specimen USNM 130722.

Occurrence: Mississippi: Owl Creek Formation, loc. 46.

Deusenella microstriata (Wade)
Plate 24, figures 6, 7

1926. Rhombopsis microstriata Wade, U.S. Geol. Survey Prof. Paper 137, pl. 50, figs. 1, 2.

Diagnosis.—Fusiform shells with a rather strongly twisted siphonal canal, a moderately strong collar and shoulder, and numerous fine spiral lirae covering the whorl surface.

Discussion.—This species is based solely upon the holotype from the Ripleys Formation on Coon Creek, McNairy County, Tenn. The strong posterior constriction of the whorls to a collar is more typical of Deusenella than Rhombopsis to which Wade assigned the species. Its fine spiral ornament distinguishes D.? microstriata from the other known species of Deusenella, and the callus of the inner lip is somewhat stronger than is typical of the genus. In shape it is not unlike the Ripleys species assigned to Cryptorthys,
but it lacks the columellar plications distinctive of that genus.

**Type:** Holotype USNM 32907.

**Occurrence:** Tennessee: Ripley Formation, loc. 1.

**Deussenia?** sp.

**Discussion.**—A number of internal molds from the Prairie Bluff Chalk of Mississippi may represent specimens of *Deussenia*. These molds are of fusiform gastropods that lack columellar plications. In addition, the impression of external ornament is also present as ribs bearing a trend similar to those of *Deussenia*.

**Occurrence:** Mississippi: Prairie Bluff Chalk, locs. 71, 75, 81, 84, 87, 88, 92.

**Family FASCIOLARIDAE**

**Subfamily FASCIOLARINAE**

**Genus BELLIFUSUS** Stephenson, 1941

Type by original designation, *Odontofusus curvicostata* Wade, 1926.

**Diagnosis.**—Medium-sized fusiform shells; spire a little more than one-third total shell height. Whorls generally inflated above midheight, constricted posteriorly to a transversely-wrinkled collar, and bearing a sharp to well-rounded shoulder. Ornament of strong collabral transverse ribs that die out on basal slope and spiral cords and lirae that cover surface or are restricted to lower body slope. Aperture sublenticular, siphonal canal moderately long and open. Columella slightly twisted with a strong plication anterior to a weaker fold.

**Discussion.**—Stephenson (1941, p. 338) proposed *Bellifusus* for a number of fusiform species from the Navarro Formation of Texas and the type species from the Ripley Formation of Tennessee that are characterized by their wrinkled subcylindrical, their strong collabral transverse ribs, and their twisted plicate columella. As the type, Stephenson chose a species previously assigned by Wade to *Odontofusus* Whitfield. He pointed out that *Odontofusus* was based upon generically indeterminate molds from New Jersey and that the type species would have to be *O. typicus* not *Fasciolaria slackii* Gabb as cited by Johnson (1905, p. 24). *O. slackii* as figured by Whitfield (1892, pl. 6, figs. 8, 9) has a reflection of transverse ribs that do not possess the trend typical of *Bellifusus*. *Odontofusus typicus* appears to be the mold of a shell having a more inflated body and less continuous ribs than that of *Bellifusus*. *O. medians* Whitfield (1892, pl. 8, figs. 18–21; Weller, 1907, pl. 90, figs. 1–4) could conceivably belong to *Bellifusus* but is specifically indeterminate, and Weller's assignment (1907, pl. 90, fig. 6) of well-preserved shells from the Ripley For-
of 2½ smooth trochoid round-sided whorls; junction of conch begins with addition of continuous rather broad transverse ribs and after about one-quarter turn of the first teleconch, whorl spiral ornament appears. Whorls number six or seven, constricted posteriorly to a collar that develops on the fourth or fifth teleconch whorl and increases in strength, becoming wrinkled by coarse growth lines in mature stages of growth; shoulder generally sharpest in earlier stages, whorl sides rounding down to a moderately steep basal slope then tapering to the siphonal canal. Sculpture dominated by 12–14 strong collateral ribs that become increasingly sinuous and less strong with increased shell size; ribs continuous on earliest whorls but on body begin below the subsutural collar and die out on basal slope. Spiral ornament generally confined to fine faint spiral lirae on the periphery but coarsen to moderately strong cords on the basal slope. Growth lines vary somewhat with stage of growth but are orthoclone on collar, sinuous over shoulder and periphery, and swing back to prococline on basal slope. Aperture sublenticular, angulated posteriorly in harmony with subsutural collar, but produced to a moderately wide and elongate somewhat twisted siphonal canal; outer lip incompletely known, but sinuous in profile with a sinus at the shoulder; inner lip very lightly callused with callus being strongest over columellar lip. Columella with one strong oblique plication followed posteriorly by two weaker lower folds.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172). Most of the specimens lack a small part of the anterior extremity.

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Discussion.—Bellifusus curvicostatus (Wade) is well represented in the Ripley Formation of the Gulf Coastal Plain both geographically and in number of individuals per locality. The shells are strong and generally well preserved. Variation within a given suite of specimens is such that without large lots one would be tempted to recognize several species. Variation in the amount of sinuosity of the transverse ribs is well illustrated by contrasting figures 24 on plate 25 with figure 19 on plate 26. The holotype and paratype figured by Wade (1926, pl. 42, figs. 7, 8, 9) show extreme sinuosity, but a toptotype figured herein (pl. 25, fig. 23) shows only gently curving ribs. Specimens from the Ripley Formation of Mississippi at locality 6 (pl. 25, fig. 24; pl. 26, fig. 23) exhibit similar variations within a single population. Spiral ornament on the periphery likewise may be sporadic, being extremely faint (pl. 25, fig. 23) or moderately strong (pl. 26, fig. 23).

The specimen Weller illustrated (1907, pl. 90, fig. 6) in his New Jersey monograph is from the Ripley Formation at locality 12, not from the Owl Creek Formation as stated by Wade (1926, p. 130). Bellifusus tenuistratus Stephenson from the Nacatoch Sand of Texas fits well within the range of variation of B. curvicostatus.

No other species of Bellifusus exhibit such strongly flexed transverse ribs. Bellifusus angulicostatus is further differentiated by its sharp shoulder and strong spiral sculpture. B. coronatus Stephenson lacks the strong collar and has a coronate shoulder. B. spinus from the Owl Creek Formation also has a spinose shoulder and more continuous ribs. Available specimens of B. dentavillensis Stephenson from the Kemp Clay have a similar trend to the transverse ribs but are too poorly preserved for close comparison.

Types: Holotype USNM 32875; hypotypes USNM 20460, USNM 130271, 130272, 130274, 130275.


Bellifusus curvicostatus crenulatus Sohl, n. subs. Plate 26, figures 11–13

Discussion.—This subspecies differs from Bellifusus curvicostatus (Wade) by having fewer narrower transverse ribs and a more strongly crenulate but slightly narrower subsutural collar. In general, the spiral ornament carries up higher on the whorl and may cover the surface (pl. 26, fig. 10). The subspecies is restricted to the Owl Creek Formation of Mississippi.

Types: Holotype USNM 130276; paratypes USNM 130277, 130278.

Occurrence: Mississippi: Owl Creek Formation, locs. 43, 45, 46. Prairie Bluff chalk, loc. 56.

Bellifusus spinosus Sohl, n. sp.

Plate 25, figures 17, 21, 22

Diagnosis.—A Bellifusus having a narrow and non-wrinkled subsutural collar; transverse ribs direct with strongly sinused imbricate spines at the shoulder.
Description.—Shell fusiform, spire slightly less than half total shell height, pleural angle 45°–50°, suture impressed, irregular in trend. Protoconch incompletely known. Whorls six or seven in number, constricted posteriorly to a narrow subsutural collar, shoulder rather sharp on early whorls, moderately rounded on body whorl; body rounded below shoulder with a rather gentle basal slope. Sculpture dominated by raised strong collateral transverse ribs that are rather widely spaced and number about 10 on the body whorl; ribs die out on collar but continue down across base; at upper end of each rib an imbricate spine is present. Spiral ornament much subdued to lacking over upper whorl surface, but broad close-spaced ribs and cords are present over the anterior part. Growth lines with flexure at shoulder that periodically develops an imbricate spine; growth lines orthocline over periphery and basal slope. Aperture faintly notched posteriorly and anteriorly developing a broad siphonal canal; outer lip incomplete, crenulate on lower part, inner lip very lightly callused. Columella with a strong plication anterior to three weaker folds.

Discussion.—This species is restricted to the Owl Creek Formation and is rare. Compared with Bellifusus curvicoelatus Wade it differs by its shorter broader siphonal canal, in its more continuous and direct ribs, and by the peculiar spinose growth line reflections on the shoulder. It is perhaps closest to B. angulicostatus Sohl but differs in strength and trend of the ribs and lacks the strong spiral ornament.

B. coronatus Stephenson, from the Nacatoch Sand of Texas, has a stronger shoulder, flexed and less continuous ribs, and almost lacks a collar, although the holotype gives an indication of bearing spines on the shoulder.

Types: Holotype USNM 130270; paratype USNM 130280.
Occurrence: Mississippi: Owl Creek Formation, locs. 45, 467, 487. Tennessee: Clayton Formation (base containing reworked Owl Creek fossils), loc. 40.

Bellifusus angulicostatus Sohl, n. sp.
Plate 25, figures 15, 18–20, 25, 26

Diagnosis.—A Bellifusus ornamented by close-spaced fine spiral lirae and collateral transverse ribs that are angulated above and sharp crested on early whorls.

Description.—Fusiform shells with a spire a little less than half the total shell height. Pleural angle 30°–35°. Suture impressed, irregular in trend. Protoconch consists of about 2½ smooth round-sided whorls; junction with conch accompanied by appearance of continuous prosocline transverse ribs. After one-quarter turn, ribs become orthocline and a shoulder develops. Whorls number six or seven, constricted posteriorly to a narrow subsutural collar that is most strongly constricted on the early whorls. Shoulder formed by the truncate upper ends of the transverse ribs but rounds off on body whorl. Sculpture ornate, consisting of numerous spiral lirae that override the transverse elements and are narrower than their interspaces. Transverse ribs strong, truncate to subnodose at upper ends on early whorls, less strong and nonproloculate on body; crest of ribs angulated by a thin raised extra strong growth lirae. On early whorls, growth lines prosocline on collar, then orthocline across periphery; on body whorl, trend is prosocline on collar, arcuately opisthocline over periphery, swinging back to prosocline on base. Aperture incompletely known, narrowly angular posteriorly, siphonal canal moderately broad, inner lip lightly calloused and bearing a strong plication anterior to a much weaker fold.

Measurements.—The holotype is the only nearly complete specimen but is somewhat compressed dorso-ventrally. It measures 47.5 mm in height and 19.5 mm in diameter.

Discussion.—The available specimens of Bellifusus angulicostatus are incomplete and all lack at least the extreme anterior tip of the shell. In spite of incomplete shell preservation, identification is relatively easy due to the distinctive transverse ribs and strong spiral ornament of the periphery, which is unknown on other species. Although the ribs of the early whorls are always sharp crested, they do not always bear the accentuated growth line so well displayed on the paratype from Alabama (pl. 25, fig. 17). The spiral ornament likewise is subject to some variation in strength.

The characteristic ribs and spiral ornament make confusion of this species with other species of Bellifusus unlikely.

Types: Holotype USNM 130281; paratypes USNM 130282, 130283.

Bellifusus spp.
Plate 26, figures 3–7

Discussion.—The specimens figured on plate 26, figures 1–7, probably represent several species of Bellifusus. All are internal molds from the Prairie Bluff Chalk of Mississippi. Similar molds are not uncommon in the chalk facies, not only through its extent in Mississippi but in Alabama. The molds exhibit
a shape compatible with Bellifusus, round-sided whorls that are posteriorly angulated and that reflect a probable subsutural collar. They also bear the reflection of strong transverse ribs and possess a columnellar plication. The specimen figured on plate 26, figure 4, is one of the most common forms assumed and is closely similar to Odontofusus medians Whitfield.

Types: Figured specimens USNM 130254-130257.
Occurrence: Mississippi: Prairie Bluff Chalk, locs. 67, 72, 80, 82, 87, 88, 91, 92, 94.

Genus DRILLUTA Wade, 1916

Type by original designation, Drilluta communis Wade.

Diagnosis.—Rather slender fusiform shells with a spire about half total shell height. Whorls posteriorly constricted to a roughened subsutural collar. Sculpture usually dominated by strong collabral transverse ribs; spiral sculpture well developed on basal slope, less frequently on periphery. Aperture notched posteriorly, siphonal canal of moderate length and slightly inclined to left. Inner lip callus thin; columnella with a strong plait anterior to one or two weaker folds.

Discussion.—The stout strong fusiform shells of this genus are well represented in the Upper Cretaceous of the gulf coast by several species. At some localities these are among the most common gastropods in the fauna. Intraspecific variation appears to be great.

Drilluta has been placed among the volutes by Wade and Stephenson. Pillsby and Olsson (1954, p. 15) placed it within their new subfamily Athletinae of the Voluitidae, but Wenz (1943, p. 1418) placed it in the Conacea. The spire in Drilluta is rather high for those families. In this respect it appears to be closer to such genera as Bellifusus Stephenson, which also possesses a subsutural collar and similar apertural features. On this basis Drilluta is placed in the Fasciolariidae.

The following species are here accepted as valid species of Drilluta.

Drilluta communis Wade, Ripley Formation of Tennessee, Mississippi, and Texas
Drilluta distans Conrad, Ripley Formation of Texas to Georgia
Drilluta major Wade, Ripley Formation of Tennessee
Rostellites marylandicus Gardner, Bluebeat Formation of Maryland
Fusus novemciratus Conrad, Owl Creek Formation of Mississippi
Drilluta buboanus Sohl, Owl Creek Formation of Mississippi
lemniscata Sohl, Owl Creek Formation of Mississippi
sp. Sohl, Prairie Bluff chalk of Mississippi

Species questionably assigned to Drilluta:
Fasciolari?, sp. Gardner, Monmouth Formation of Maryland
Anchura? momouthensis Gardner, Monmouth Formation of Maryland

Described species of Drilluta that are here reassigned:
Turbonilla (Cheninitia) laqueata Conrad = Drilluta distans (Conrad)
Drilluta brevispira Stephenson = Drilluta distans (Conrad)
crassicostata Stephenson = Drilluta communis Wade
dimoropus Wade = Drilluta major Wade

Several species from Africa may also belong in Drilluta. Wade (1926, p. 116) believed that Cerithium krafrarium Griesbach (1871, p. 64) and Woods (1906, p. 325) belonged to Drilluta. This species is based upon only a single incomplete specimen that retains only a part of the spire and is too inadequate to definitely assign to this genus. Drilluta biplicata Riedel (1932, p. 117) from the Coniacian of the Camerouns is probably not a Drilluta. Collignon (1949a) assigned an internal mold from the Senonian of Madagasac to this genus, a placement certainly based on insufficient evidence.

Pchelintsef (1953, p. 265) described Drilluta curta from the Upper Cretaceous (Cenomanian) of Russia. The species is based on incomplete specimens possessing strong transverse ribs and a single columnellar plication. Better preserved material is necessary before this species can be accepted in the genus.

The specimens Gardner (1916, p. 429, 438, pl. 15, fig. 1; pl. 14, fig. 11) assigned to Rostellites marylandicus and Fasciolari? sp. perhaps belong to the same species and have a columnellar plication and ornament like that of Drilluta. They are most similar to Drilluta major Wade. Anchura? momouthensis Gardner (1916, p. 476) the second questionably assigned form, is based on an internal mold that bears the impression of a columnellar plication impressed on the interior of the whorls of the spire. This obviates the possibility of its belonging to Anchura and its size and reflection of coarse transverse ornament is highly reminiscent of the specimens assigned to Fasciolari? sp. by Gardner.

Drilluta communis Wade
Plate 27, figures 12, 13, 20–22
Diagnosis.—A high-spired moderately slender Drillita with flattish to convex whorl sides; 17–18 transverse ribs per whorl on larger specimens; spiral ornament absent or very faint on periphery, strong on base.

Discussion.—At its type locality on Coon Creek, Drillita communis Wade is one of the more common gastropod species. The same holds true where it is found in the Nacatoco Sand of Texas. Drillita communis Wade is a quite variable species. Variation in size is considerable with the larger shells developing flatter sided whorls in their late stages of development. Likewise, the number of transverse ribs is greater on the larger specimens, and they generally number about 17 on the body, but at about four whorls earlier, the number of ribs per whorl is reduced to ten or eleven. The pleural angle also changes with growth, being 40° or less on the larger shells. Spiral ornament on the spire is usually poorly developed and frequently is absent on the periphery of the body, but some shells have moderately strong cords appearing high on the body. Several varieties could be proposed on the basis of shape and ornament, but they are gradational and the names would be superfluous.

D. crassicostata Stephenson from the Nacatoch Sand of Texas appears to fall within the range of variation exhibited by the specimen from Coon Creek. In general they fall closer to the slimmer type of D. communis figured on plate 27, figure 20, than to the holotype, which has more convex sides and a greater curvature of the transverse ribs.

Drillita distans (Conrad) has a shorter spine and fewer wider spaced and generally less coarse transverse ribs.

Types: Holotype USNM 32860; hypotypes USNM 77100–77104 (Texas) and USNM 130288–130291 (Tenn.).

Occurrence: Tennessee; Ripley Formation, loc. 1. Texas: Nacatoco Sand.

Drillita distans (Conrad)

Plate 27, figures 1–7, 14, 15, 23, 24, 27, 28


1941. Drillita paucicoastata Stephenson, Texas Univ. Bull. 4101, p. 333, pl. 67, figs. 1, 2.


Diagnosis.—A Drillita with plump convex-sided whorls and 12–14 transverse costae per whorl.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 172).

<table>
<thead>
<tr>
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</tr>
<tr>
<td>18</td>
<td>37.3</td>
<td>13.3</td>
</tr>
</tbody>
</table>

Discussion.—Drillita distans is one of the best represented gastropod species in the Ripley Formation and, due to its strong shell, it is generally found well preserved.

The holotype of Drillita? distans Conrad is preserved in the collections of the American Museum of Natural History in New York (AMNH 9060). That specimen comes from the Ripley Formation at Eufaula, Ala. As Conrad’s figure (1860, pl. 46, fig. 49) is of a sinistral shell, evidently the figure was reversed during reproduction. The apical tip of the holotype has subsequently been lost (pl. 27, fig. 1). Topotypes in the collections of the U.S. Geological Survey afford better comparative material (pl. 27, figs. 5, 7) and Alabama shells compare very well with those from the Ripley Formation of Mississippi.

On the same plate, Conrad figured (1860, pl. 46, fig. 36) a shell possessing a posterior collar but missing the anterior part of the shell, which he reconstructed in his figure. This specimen, the holotype of Turboilla (Chemnitzia) laqueata, as a glance at the figure given herein (pl. 27, fig. 6) shows, belongs in Drillita distans. D. brevispira Stephenson is typical of D. distans as defined here.

The specimens from Mississippi here assigned to Drillita distans (Conrad) vary considerably. Some possess rather round-sided whorls (pl. 27, fig. 24); others possess whorls that are relatively flat (pl. 27, fig. 14). On most specimens spiral ornament on the spire is faint, but on a few specimens (pl. 27, figs. 2, 4) it is easily discernible. Strength of the transverse ribs likewise varies, in some instances they are so low that they are only slightly raised above the collar (pl. 27, figs. 3, 27); on other specimens they are strong enough to form a distinct shoulder.

Types: Holotype AMNH 9009; hypotype (= holotype Turboilla laqueata Conrad) AMNH 9051; hypotype (= holotype D. brevispira) USNM 77107; hypotype (= holotype D. paucicoastata) USNM 77105; hypotypes USNM 130292, 130293 (Ala-
Occurrence: Mississippi: Ripley Formation, at locs. 4-6, 12, 14, 15-18. Tennessee: Ripley Formation, at loc. 1(1). Alabama and Georgia: Ripley Formation.

**Drillita lemniscata** Sohl, n. sp.

Plate 27, figures 16-19

**Diagnosis.**—Outline slim for genus; subsutural collar narrow and bears strong increments; transverse ribs strong; strong spiral ribbons and cords cover entire whorl surface.

**Description.**—Medium-sized fusiform shells with a spire a little less than half the total shell length; pleural angle 30°–35°. Protoconch unknown. Suture impressed, undulatory in trend. Whorls sharply constricted posteriorly to a narrow subsutural collar that bears raised sharp-edged growth increments at irregular intervals; periphery broadly rounded and tapering below. Sculpture ornate and strong; 9 or 10 collabral broad strong transverse ribs occur on the body and are abruptly constricted posteriorly and diminish in vigor below the shoulder, dying out on the basal slope. Spiral ribs and cords cover the entire shell surface and override the transverse elements; ribs number 22–25 on the body whorl. Growth lines flexed on collar, orthocline to slightly opisthochline over the periphery, swinging back to prococline on the anterior extremity. Aperture elongate, lenticular, with a narrow posterior notch and a slightly twisted moderately long rather broad siphonal canal. Outer lip thin at edge, crenulate where intersected by the spiral ribs. Inner lip lightly calloused. Columella with a strong anterior fold and two weaker posterior folds.

**Measurements.**—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

<table>
<thead>
<tr>
<th>Loc.</th>
<th>H</th>
<th>MD</th>
</tr>
</thead>
<tbody>
<tr>
<td>46 (holotype)</td>
<td>72.2</td>
<td>38.5</td>
</tr>
<tr>
<td>46 (paratype)</td>
<td>43.2</td>
<td>15.4</td>
</tr>
</tbody>
</table>

**Discussion.**—*Drillita lemniscata* occurs in the Owl Creek Formation and is one of the more highly ornate species of *Drillita*. The strong spiral ornament and sharp increments of the subsutural collar are reminiscent of *D. major* Wade from the Coon Creek Tongue of the Ripley Formation. It differs from that species by its less coarse and sinuous transverse ribs, by its smaller size, and by its stronger spiral ornament. Neither *D. distans* (Conrad), *D. communis* Wade, nor *D. buboanus* Sohl have as broad ribs nor do they possess such strong spiral ornament or such a narrow subsutural collar with sharp increments.

Conrad (1858, p. 332) described and figured *Fusus novemviratus* from the Owl Creek Formation. This species bears a posteriorly constricted whorl, strong spiral sculpture, and transverse ribs. Its characters are much like those of *Drillita*. The type specimen is evidently lost and although Conrad’s figure (1858, pl. 35, fig. 18) simulates this species to some extent, the spire is shorter, the whorls are proportionally broader, and the columella is more twisted. The assignment of Conrad’s species to the genus *Drillita* is untenable in that the specimen illustrated is broken for more than one-quarter turn back from the aperture and no columellar plications are visible nor are any mentioned by Conrad. It would appear best to consider *F. novemviratus* a nomen dubium.

**Types.**—Holotype USNM 29428; paratype USNM 130399.

Occurrence: Mississippi: Ripley Formation at locs. 42, 46.

**Drillita buboanus** Sohl, n. sp.

Plate 27, figures 8-11, 25, 26

**Diagnosis.**—Medium-sized shells with a subsutural collar that is rather broad for the genus; transverse ribs strongly compressed to truncate above; spiral ornament moderately strong and may cover whorl surface.

**Description.**—Shell of medium size, spire a little less than half total shell height, pleural angle 30°–35°. Protoconch unknown. Suture impressed, irregular in trend. Whorls seven to nine in number, compressed posteriorly to a moderately broad and corrugated subsutural collar. Periphery broadly rounded to rather flat sided, anterior slope gentle. Sculpture dominated by strong broad collabral transverse ribs that are generally truncate at their upper end, strong over the periphery but die out on the basal slope; ribs under 9 or 10 per whorl. Spiral sculpture strongest on body whorl where numerous cords and lirae cover the whorl surface and override the transverse ribs and the corrugations of the subsutural collar; earlier whorls retain only the faintest traces of spiral ornament. Growth lines gently flexed on collar, orthocline to slightly arcuate opisthochline on periphery. Aperture incompletely known, notched arcuate posteriorly and anteriorly, developing a somewhat twisted siphonal canal of moderate length. Outer lip thin at edge, inner lip lightly calloused. Columella bearing a strong plication anterior to several weaker ones.

**Measurements.**—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).
Discussion.—Drillutula buponas is restricted to the Owl Creek Formation. Like D. communis and D. distans from the Ripley Formation this species shows considerable variation in form and ornament. The holotype is the largest specimen (pl. 27, fig. 23) and exhibits stronger spiral ornament of the later developmental stages, whereas the paratypes figured (pl. 27, figs. 8-11) show generally poor development of cords except for the basal slopes and pillar. The paratype from locality 46 shows (pl. 27, fig. 8) a more sinuous trend of growth lines than is typical and with the paratype from locality 46 (pl. 27, fig. 10) exhibits well the strongly truncated upper ends of the transverse ribs.

Drillutula buponas is most closely related to D. distans and D. communis, but it differs from these two species principally by the stronger development of spiral ornament and more strongly constricted sub-sutural collar.

Types: Holotype USNM 130301; paratypes USNM 130302–130304.

Occurrence: Mississippi: Owl Creek Formation at locs. 45, 46, 55.

Drillutula major Wade

Plate 26, figures 20-22


Diagnosis.—Shell large for genus, transverse ribs strongly opisthocline over periphery of body; sub-sutural collar with raised strong imbricate increments; spiral ornament of strong cords.

Measurements.—As all specimens are incomplete, two columns for height are inserted. The first is the actual height of the specimen, the second is the estimated height. The explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 172).

<table>
<thead>
<tr>
<th>Loc.</th>
<th>H</th>
<th>Estimated H</th>
<th>MD</th>
</tr>
</thead>
<tbody>
<tr>
<td>46 (holotype)</td>
<td>65</td>
<td>144</td>
<td></td>
</tr>
<tr>
<td>46 (paratype)</td>
<td>45.5</td>
<td>88.5</td>
<td></td>
</tr>
<tr>
<td>45 (paratype)</td>
<td>45.5</td>
<td>88.5</td>
<td></td>
</tr>
</tbody>
</table>

Discussion.—Wade (1926, p. 118) stated Drillutula dimororum differed from D. major "in the character of the posterior fasciole and in having a less ornate sculpture and a more prominent single columnar plate." The holotype of D. dimororum is a very imperfect specimen with a worn exterior that led Wade to believe the sculpture of the body and sub-sutural collar (fasciole of Wade) to be subdued. The sculpture of the topotype figured on plate 27, figures 20 and 21, shows a similar suppression due, at least in part, to wear. Although Wade mentions several plats being present posterior to the strong columnar plait on D. major, the author has noted only one strong plait on both the holotype and the topotypes. It seems reasonable therefore to include D. dimororum in the synonymy of D. major.

Types: Holotype USNM 32850; hypotype (= holotype of D. dimororum) USNM 32854; hypotypes USNM 130305, 130306.

Occurrence: Tennessee: Ripley Formation at loc. 1, Alabama and Georgia (Chattahoochee River region): Ripley Formation (questionable occurrence).

Drillutula cf. D. buponas Sohl

Plate 26, figures 8, 14

Discussion.—Three internal molds from the Prairie Bluff Chalk at locality 57 bear the crude reflection of their external shell surface sculpture preserved by internal molds of the boring sponge Clione. In strength of the transverse ribs and in their spacing and number they approximate Drillutula buponas Sohl from the Owl Creek Formation.

Types: Figured specimens, USNM 130307, 130308.

Occurrence: Mississippi: Prairie Bluff Chalk at loc. 57.

Drillutula sp.

Discussion.—Fragments of large specimens that possess a sub-sutural collar, a plicate columnella, and ornament typical of a Drillutula related to D. communis are present in the Ripley Formation. These specimens indicate either the presence of a new species or that a known species from the formation grows to a size considerably larger than any known specimen. The available material is too inadequate to figure.

Occurrence: Mississippi: Ripley Formation at locs. 6, 16, and 32.

Drillutula sp.

Plate 26, figures 1, 2, 15

Discussion.—Fusiform internal molds from the Prairie Bluff Chalk at a number of localities in Mississippi bear the impression of a strong columnar plication and occasionally the reflection of external ribbing. In addition, their size, shape, and outline agree with Drillutula.
Types: Figured specimens, USNM 130390, 130310.
Occurrence: Mississippi: Prairie Bluff Chalk at locs. 66, 71, 72, 73, 79, 81–84, 87, 90–92, 94.

Genus DOLICHOLATRUS Bellardi, 1884
Type by subsequent designation (Cossmann, 1901, p. 23), Turbinella bromii Michelotti, 1846.
Diagnosis.—Medium-sized elongate fusiform shells, with a high spire sculpture of coarse broad transverse ribs and numerous spiral cords. Aperture subovate, siphonal canal narrows and longer than aperture; inner lip weakly convolute, calcified, and bearing two low plications.

Discussion.—This is the first report of the genus in the Cretaceous, but it is well represented throughout the Tertiary and has a worldwide distribution. Compared to the type species from the Miocene of Italy, Dolicholatrus torquatus has stronger transverse ribs, whorls that are more strongly constricted posteriorly, and a slightly less straight siphonal canal. In these respects it more closely approaches such forms as Dolicholatrus perevetis (Conrad) (= Latirus harriisi Johnson) from the lower part of the Claiborne of Texas and Mississippi (Palmer, 1937, p. 345).

Dolicholatrus torquatus Sohl, n. sp.
Plate 26, figures 9, 10, 14, 17

Diagnosis.—A Dolicholatrus with strong transverse ribs and a narrow subsutural collar.

Description.—Medium to moderate large sized slim fusiform shells. Pleural angle about 30°. Protoconch unknown. Whorls constricted posteriorly to a narrow subsutural collar, flaring below to a well-rounded periphery, body constricted strongly below to an elongate siphon. Sculpture of seven to eight strong broad wide-spaced transverse ribs that are absent on the collar above and die out on the basal slope below. Spiral sculpture consists of fine lirae on the collar and widespread arranged narrow cords over the periphery and base. Growth lines prominent but fine in trend procline over collar, abaperturally arcuate over periphery and base, becoming mainly orthocline on pillar. Aperture broadly subovate, posteriorly angulate, and drawn out anteriorly to a narrow siphonal canal that is longer than the aperture; outer lip unknown; inner lip weakly excavated, calcified, and bearing two low oblique folds that do not reach the aperture on larger specimens.

Discussion.—This species is rare and restricted to the Owl Creek Formation of Mississippi. The holotype figured on plate 26, figure 9, is the largest known specimen. The breadth of its outline is considerably exaggerated due to compression of the specimen. There are no other species of the genus in the fauna with which to compare Dolicholatrus torquatus and no significant variation has been noted within the available material.

Types: Holotype USNM 130311; paratype USNM 130312.
Occurrence: Mississippi: Owl Creek Formation at loc. 41, 46. Tennessee: Questionably present as a reworked element in the base of the Clayton Formation at loc. 46.

Genus PALEOPSEPHA Wadie, 1926
Type by original designation, Paleopsepha tabulis Wadie.

Diagnosis.—Medium-sized fusiform shells with a spire about half total shell length. Whorls posteriorly constricted, anteriorly tapering to a siphonal canal of moderate length. Sculpture dominated by strong collabral transverse ribs on the swollen body; spiral sculpture infrequently well developed. Aperture lanceolate, acute angular posteriorly, siphonal canal slightly curved and inclined to the left. Columella generally bearing three oblique plications.

Discussion.—Paleopsepha resembles Driluta Wadie and Bellifusus Stephenson to some extent, but differs from the former primarily by its lack of a strong collar and from the latter by its less inflated and rounded whorls, its more subduced ornament, and its less strongly constricted whorls.

Wade (1926, p. 123) proposed the genus to include the two Coon Creek species herein redescribed, two species = Volutilithes subsimplicatus (d’Orbigny) of Wanderer and Volutilithes roemeri (Geinitz) of Wanderer from the Turonian of Saxony, and Volutilithes nana (Müller) of Holzapfel from the Vaals greensand of Aachen. Stephenson more recently (1955, p. 186–88) extended the range of the genus downward to the Cenomanian by describing several species from the Woodbine Formation of Texas. Two additional species Paleopsepha scalaris and Paleopsepha o’donelli were described by Rennie (1930, p. 228; 1945, p. 55) from the Upper Cretaceous of Pondoland, South Africa, and Angola. Voluta (Paleopsepha) sulcata Riedel (1932, p. 109) described from Mungofluss of the Cameroons should be assigned elsewhere as it appears to possess no posterior whorl constriction.

Paleopsepha mutabilis Wadie
Plate 28, figures 1–6
Diagnosis.—A Paleopsephaea with 9–11 strong collabral ribs but only the faintest traces of spiral sculpture on the body whorl.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

<table>
<thead>
<tr>
<th>Loc.</th>
<th>H</th>
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<th>H.D</th>
<th>Number of ribs on body</th>
</tr>
</thead>
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<tr>
<td>1 (paratype)</td>
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<td>2.8</td>
<td>9</td>
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<tr>
<td>1 (paratype)</td>
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<td>2.6</td>
<td>10</td>
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<td>12.5</td>
<td>2.9</td>
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<td>12.0</td>
<td>2.8</td>
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</tr>
<tr>
<td>1 (paratype)</td>
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<td>2.8</td>
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</tr>
<tr>
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<td>30.4</td>
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<tr>
<td>1 (paratype)</td>
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<td>10</td>
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<tr>
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<td>2.5</td>
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</tr>
<tr>
<td>1 (paratype)</td>
<td>29.5</td>
<td>10.0</td>
<td>2.9</td>
<td>11</td>
</tr>
<tr>
<td>1 (paratype)</td>
<td>32.7</td>
<td>10.5</td>
<td>2.8</td>
<td>9</td>
</tr>
</tbody>
</table>

Discussion.—Paleopsephaea mutabilis Wade is well represented at a number of localities in the Ripley Formation of both Mississippi and Tennessee. At its type locality, on Coon Creek, McNairy County, Tenn. (loc. 1), it is moderately common. As is the case with many other species, specimens from this locality exceed those from the higher levels in size. Shell proportions vary little and the number of transverse ribs is constant among the available suites. To some extent the number of transverse ribs appears to be proportional to size. Likewise the larger specimens appear to have more sinusous ribs although this feature is not constant. Spiral ornament is always faint, but variable both as to degree of strength and area covered. Although smaller in size the Mississippi specimens agree well with those from the type locality. One incomplete specimen from locality 6 (pl. 37, fig. 5), however, shows a suppression of the transverse ornament and a lack of a well-defined posterior whorl surface. The specimen is considered as an aberrant form as it occurs with numerous perfectly well developed specimens.

P. pergracilis Wade differs by having strong spiral ornament and fewer transverse ribs.

Types: Holotype and paratype 32806; hypotype ANSP; hypotypes USNM 1306313–1306316


Paleopsephaea pergracilis Wade
Plate 28, figures 9, 17

Diagnosis.—A Paleopsephaea of rather slender outline; sculpture consisting of about six transverse ribs per whorl and close-spaced spiral lae over the shell surface.

Discussion.—This species is based upon two incomplete specimens from Coon Creek, McNairy County, Tenn. It is reasonable that the two fragments belong to the same species as the number of ribs and the general ornament is similar. P. mutabilis is less slender, lacks the strong spiral sculpture of this species, and has more numerous transverse ribs.

Types: Holotype and paratype USNM 32806.

Occurrence: Tennessee: Ripley Formation at loc. 1.

Paleopsephaea tenulirata Sohl, n. sp.
Plate 28, figures 7, 8, 15, 16

Diagnosis.—A Paleopsephaea whose sculpture is dominated by about eight strong collabral ribs that are overridden by the numerous close-spaced spiral lae that cover the shell surface.

Description.—Shell medium-sized, fusiform; spire half total shell height; pleural angle about 30°. Protoconch consisting of about 2½ round-sided whorls; junction with teleconch accompanied by flattening of the whorl sides plus addition of opisthionine transverse ribs that, after one-quarter of a turn, become orthionine; spiral ornament appears on the last part of the first teleconch whorl. Body whorl posteriorly constricted, subshouldered, rounding down below to a tapering siphonal canal. Sculpture of about eight collabral transverse ribs that die out above and below, but are accentuated in height near their upper end; spiral lae number about 21 on the penultimate whorl and are close spaced and crowded, covering the total surface of the body. Aperture incompletely known, narrowly angulated posteriorly, and possessing a narrow siphonal canal. Inner lip lightly calloused. Columella bearing four rather weak plications.

Measurements.—The holotype, missing both the extreme anterior and posterior tips, measures 29 mm in height and 11 mm in diameter.

Discussion.—Paleopsephaea tenulirata appears to be most similar to P. pergracilis in ornament, but that species has fewer and coarser growth lines and fewer more widely spaced spiral lae. P. mutabilis Wade has more numerous and less coarse transverse ribs, extremely subdued spiral lae, and stronger columellar plications.

This species is rare and is restricted to the Ripley Formation of Mississippi.

Types: Holotype USNM 1306317; paratype USNM 1306318, 1306319.

Occurrence: Mississippi: Ripley Formation at loc. 18.

Genus GRAPHIDULA Stephenson, 1941

Type by original designation, Graphidula terebriformis Stephenson.
Diagnosis.—Slender elongate fusiform shells of moderate size. Spire equal to or greater in length than the body. Sculpture ornate to rather subdued, consisting of either transverse ribs or spiral lirae or both. Aperture lanceolate, posteroi.dly angulated, siphonal canal elongate and straight. Columella generally with one moderately strong plait that is not visible at the aperture.

Discussion.—Stephenson (1941, p. 345) erected this genus to include, besides the type species, two species from the Ripley Formation of Coon Creek, Tenn., described by Wade as *Piestochilus cancellatus* and *Mesorhytis obscura* and two questionably assigned species, *Graphidula balteata* Stephenson and *G.? gabiellensis* Stephenson, from the Kemp Clay of Texas. In addition, the same author proposed, but did not diagnose, the family Graphidulidae, in which he also included the genus *Lamornia*. The latter genus is not closely related to *Graphidula*. Separate familial designation for *Graphidula* does not appear necessary.

*Piestochilus* Meek is a closely related genus. If *Piestochilus* is to be used in the broad usage of Meek, *Graphidula* should be included as a synonym. The type species, *Piestochilus scarboroughi* (Meek and Hayden), is rather short spired and broad, but *Piestochilus culbertsoni* (Meek and Hayden) is an elongate species much like *Graphidula*. The coiled plait placement of these forms is similar and a distinction is only feasible on the basis of shape.

When thus distinguished, the species assignable to each genus is as follows:

To *Graphidula*:

*Graphidula cancellata* Wade, Ripley Formation of Tennessee

*Graphidula terebriformis* Stephenson, Nacatoch Sand of Texas

*Graphidula balteata* Stephenson, Kemp Clay of Texas

*Graphidula gabiellensis* Stephenson, Kemp Clay of Texas

*Piestochilus pergracilis* Wade, Ripley Formation of Tennessee

*Mesorbtytis obscura* Wade, Ripley Formation of Tennessee

*Fusus culbertsoni* Meek and Hayden, Fox Hills Sandstone of western interior

*Graphidula tippahensis* Harbison, Ripley Formation of Mississippi (= *Graphidula melanopsis* (Conrad))

*Fasciolotaria cretacea* Meek and Hayden, Fox Hills (questionably assigned)

*Turbonilla (Chenmitzia) melanopsis* Conrad, Ripley Formation of Mississippi

To *Piestochilus*:

*Fusus scarboroughi* Meek and Hayden, Fox Hills Sandstone of western interior

*Piestochilus? levis* Stephenson, Kemp Clay of Texas

*Rimella curviflata* Conrad, Owl Creek Formation of Mississippi

*Graphidula cancellata* (Wade)

Plate 28, figures 28, 29


Diagnosis.—A *Graphidula* of medium size, bearing subcancellate surface ornament; spiral ribs broader than interspaces and number about seven on penultimate whorl.

Measurements.—The holotype measures 38.8 mm in height, 9.6 mm in diameter, and has a pleural angle of about 25°.

Discussion.—This species is very uncommon at its type locality in the Ripley Formation at Coon Creek, McNairy County, Tenn. The single coiled plait fold is barely visible at the aperture. This species differs from *Graphidula obscura* (Wade), with which it occurs, by number of plications, their visibility at the aperture, and by having broader unpaired spiral ribs. *G. terebriformis* Stephenson, from the Nacatoch Sand of Texas, is closely related but appears to have more subdued ornament with the spiral ribs of the body whorl being quite indistinct.

Type: Holotype USNM 32891.

Occurrence: Tennessee: Ripley Formation at loc. 1.

*Graphidula pergracilis* (Wade)

Plate 28, figures 19–22, 30, 31


Diagnosis.—Shell of medium to moderately large size for genus. Spiral sculpture dominant on spire; penultimate whorl bearing eight to nine spiral ribs with interspaces wider than ribs; ornament much subdued on body whorl of larger specimens.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 172).

<table>
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</tr>
<tr>
<td>1 (topotype) (pl. 28, fig. 31)</td>
<td>18.8</td>
<td>42.8</td>
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Discussion.—With increased size, both the spiral and the transverse elements of sculpture decrease in strength. First to be affected, however, are the transverse ribs, which are strong on the early part of the spire (pl. 28, fig. 21), but by the ninth or tenth whorl are quite low and irregularly developed. On about the eleventh whorl the spiral ribs begin to fade (pl. 28, fig. 30). Figures 22 and 30, plate 10, show a body whorl of the largest available specimen and the ex-
treme change the ornament has undergone. Although
on the mature whorls the development of colomellar plaits
is restricted to a moderately strong to weak anterior plaits and, occasionally, a faint second plaits behind it, on the earlier whorls (pl. 28, fig. 21)
three or four rather strong plaits may be present.

**Graphidula tippahensis** Harbison is, perhaps, the
closest ally of *G. perigracilis* (Wade), but that species
has stronger transverse ribs as well as a less slim spire.

**Types:** Holotype USNM 32888; hypotypes USNM 130638–
130640.

**Occurrence:** Tennessee: Ripley Formation at loc. 1.

**Graphidula obscura** (Wade)

**Plate 28, figures 11–14**

1926. *Mesorhytis obscura* Wade, U.S. Geol. Survey Prof. Pa-
per 137, pl. 46, figs. 2, 6.

Bull. 4101, p. 346.

**Diagnosis.**—Shells medium sized for genus, ornament
subcancellate, with spiral ribs clustered in double-rowed bands and with secondary cords inter-
vening occasionally; colomellar plications weak.

**Measurements.**—Explanation of measurements and
symbols used in the following table appears in the
section "Measurements of specimens" (p. 172).

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<td>Topotype</td>
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<td>Dv.</td>
<td>16.6</td>
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</tr>
<tr>
<td>Dv.</td>
<td>16.5</td>
<td>5.0</td>
</tr>
</tbody>
</table>

**Discussion.**—The shells of this attractive species
are distinguished from those of *Graphidula cancellata*
by their greater number of spiral ribs on the penultimate whorl. In addition, the ribs of *G.
cancellata* are discrete whereas those of *G. obscura*
are grouped into bands of two ribs each that are
raised over the interspiral spaces (pl. 28, figs. 12, 14).

On a few specimens, secondary spiral cords are inter-
polated between the bands of paired ribs. On the
smallest paratype of the type species, *G. terbriformis*
Stephenson, from the Nacatoch Sand of Texas, a faint
tendency for such banding was noted on an early
whorl, but in general that species has much more sub-
duaded ornament with the transverse elements being
proportionally stronger. The colomellar plaits of
*G. obscura* are not visible at the aperture and even
when the spire is sectioned some specimens have only
the faintest traces of folds. Generally two weak folds
occur (pl. 28, fig. 14), the anterior one being the
stronger. Wade's illustration (1926, pl. 46, fig. 2) is
retouched and gives an erroneous impression both of
the strength of the folds and their inclination. Actu-
ally the folds are seen only in highly inclined light
and are highly oblique rather than low spirals as
shown by him.

**Types:** Holotype USNM 32888; hypotypes USNM 130638–
130640.

**Occurrence:** Tennessee: Ripley Formation at loc. 1.

**Graphidula terbriformis** Stephenson

**Plate 28, figures 24–26**


**Diagnosis.**—Shell slim and small to medium sized
for genus; ornament subcancellate, spiral ribs close
spaced, low, subdued, broad, and generally bearing a
fine incised line mediately that divides the ribbon,
colomellar plications weak and not visible at aperture.

**Discussion.**—Compared with the type specimens
from the Nacatoch Sand of Texas, the ornament of
the Mississippi specimens is much sharper and the
spiral ribs are of the same strength as the transverse
elements, although frequently broader. This
lends the surface a rectangularly checkered pattern.
Part of the difference in sharpness in the Mississippi
specimens is believed due to the different type of
preservation exhibited by specimens from the two
areas.

**Graphidula obscura** (Wade) from the *Exogyra can-
cellata* zone of Tennessee is similar but has more
strongly developed ornament, is more robust, has
rounder sided whors, and has secondary lirae be-
tween the double-rowed primary ribs.

**Types:** Holotype USNM 77085 (Texas); paratype USNM 21078 (Texas); hypotypes USNM 130641, 130642 (Mississippi).

**Occurrence:** Mississippi: Ripley Formation at loc. 18.
Texas: Nacatoch Sand.

**Graphidula melanopsis** (Conrad)

**Plate 28, figures 18, 23, 27, 32–35**

1850. *Turbonilla (Chemnitzia) melanopsis* Conrad, Philadel-
phia Acad. Nat. Sci. Jour., 2d ser., v. 4, p. 287, pl. 46,
fig. 35.

Sci. Proc., v. 97, p. 85, pl. 5, figs. 33, 34.

**Diagnosis.**—Shells moderately large for genus;
sulpture strong on spire, consisting of numerous
strong transverse ribs with seven or eight spiral ribs
visible in the rib interspaces.

**Description.**—Shells medium to moderately large in
size, elongate fusiform in shape; spire rather evenly
tapering, pleural angle 20°–25°. Protoconch consists
of about 2½ smooth whors, the first of which is low
and the second has well-rounded sides; junction with
conch gradual with low transverse swellings appear-
ing, that later strengthen to strong continuous collabral transverse ribs. Suture slightly impressed. Telonch whorls number about 12 and are almost flat sided on spine; body tapering rather gently to the siphonal canal. Sculpture of spire consists of strong collabral ribs that are most strongly curved on early whorls; spiral sculpture of equispaced spiral ribbons that number eight or nine on spire whorls; ribbons override ribs on early whorls but on later whorls are interrupted on rib tops, and they are visible only in the rib interspaces. Sculpture on the last several whorls becomes increasingly subdued until, on the body, only faint traces of the ornate sculpture of the spire remains. Aperture lanceolate, posteriorly angulated, anteriorly drawn out to a straight narrow elongate canal; outer lip incompletely known; inner lip moderately to lightly calloused, callos thickness on upper surface of parietal lip. Columella smooth at aperture but interiorly bearing a single moderately strong oblique plication; the earliest whorls of the spire, however, show four plications of which are lost after about the ninth whorl.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 179).

<table>
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<th>Loc.</th>
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<th>Estimated H</th>
<th>MD</th>
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</thead>
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<tr>
<td>18 (hypotype) (pl. 28, fig. 34), 19 (hypotype) (pl. 28, fig. 33)</td>
<td>78.5</td>
<td>82.0</td>
<td>21.5</td>
</tr>
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</table>

Discussion.—The holotype of Graphidula melanopsis (Conrad) (pl. 28, fig. 27) is present in the collections of the American Museum of Natural History (AMNH 9050) and is an incomplete and immature specimen from the “Ripley group, Tippah County, Mississippi.” The exact type locality is unknown, but the specimen compares very well with the holotype of Graphidula tippahensis Harbison, another immature specimen, from the Ripley Formation at locality 18. The two species are considered to be synonyms.

The species is especially abundant in the Ripley Formation at the Union County Lake locality (loc. 18). Here sufficiently large individuals have been collected to indicate the great change in type of ornament with size. (Contrast pl. 28, fig. 32 and pl. 10, fig. 23.) With increasing size, strength of ornament diminishes, but the beginning of suppression varies with the specimen, as does the strength of ornament of the early whorls. Although most specimens possess only 7 or 8 spiral ribbons on the spire, a few show as many as ten ribbons. Usually the ribbons are wider than the interspaces, but sometimes they are narrower. Variation in swelling of the whorls is also present. (Contrast pl. 28, fig. 34 and pl. 10, fig. 32.) In some individuals, whorls are almost flat and in others whorls are quite convex or subsuturally swollen. Similar variations are seen at other localities. At locality 6 the average number of ribbons (pl. 28, fig. 18) is higher than at locality 18, and some specimens show the addition of secondary spiral lirae between the ribbons.

G.† multicostata Stephenson, from the Kemp Clay of Texas, most closely approaches this species but differs in maintaining its ornament even on the larger sized specimens. G.† gabrieleni Stephenson, also from the Kemp Clay, has more numerous thinner and closer spaced transverse ribs.

**Types:** Holotype AMNH 9060; holotype of G. tippahensis, ANSP 16255; hypotypes USNM 130849-130850.

**Occurrence:** Mississippi: Ripley Formation at locs. 5, 6, 19-18, 23, 29. Georgia and Alabama: Ripley Formation.

Graphidula cf. G.† multicostata Stephenson
Plate 28, figure 10


Discussion.—The specimen here tentatively assigned to Graphidula? multicostata Stephenson comes from the Owl Creek Formation of Tippah County, Miss. (loc. 45), at about the same level as the holotype from the Kemp Clay of Texas. Like the holotype, this specimen has well-developed spiral ribbons on the body whorl that cover the entire surface and override the transverse elements. However, as this specimen is smaller and incomplete, definite assignment to Stephenson’s species cannot be made.

**Type:** Figured specimen USNM 130847.

**Occurrence:** Mississippi: Owl Creek Formation at loc. 45.

Graphidula sp.
Plate 29, figures 1-8

Discussion.—A number of internal molds from the Prairie Bluff Chalk preserve the shape of Graphidula. Some of the molds preserve the reflection of rather strong continuous transverse ornament and indicate the presence of a form similar to a species from the Kemp Clay of Texas. The specimen figured on plate 28, figure 2, suggests G.† gabrieleni Stephenson.

**Type:** Figured specimens USNM 130848-130850.

**Occurrence:** Mississippi: Prairie Bluff Chalk at locs. 66, 67, 72, 82, 83, 85, 87, 88, 90, 91.

**Genus PIESTOCHILUS** Meek, 1864

Type by original designation, *Piuspicus (Pleurotomaria) scarboroughi* Meek and Hayden, 1858.
Diagnosis.—Fusiform shells of moderate size that have rather plump convex-sided whorls. Spire about half total length. Sculpture dominated by strong collabral ribs, but occasionally it is very subdued. Columella bearing a strong plait that begins just behind aperture.

Discussion.—The affinities with and confusion between Piestochilus and Graphidula have been discussed under the latter genus. The genus appears to be restricted to the late Upper Cretaceous beds of the gulf coast and western interior where it is represented by only a few species.

Both the species Fasciolaria (Piestochilus) senecta White (1888) from Brazil and that assigned to Piestochilus laevigatus by Nagao (1939) from the Upper Cretaceous of Japan have a form more reminiscent of Graphidula. Neither species is represented by well-enough preserved specimens for positive placement.

Piestochilus curvillatus (Conrad)
Plate 29, figures 20, 21, 25, 27

Diagnosis.—A Piestochilus bearing numerous strong rather close spaced, collateral transverse ribs and strong spiral lirae or ribs appearing in the rib interspaces.

Description.—Fusiform shells of medium size; spire probably somewhat less than half total shell height; pleural angle about 50°. Protoconch unknown. Suture impressed. Whorls somewhat convex to flat-sided; body strongly constricted below to the tapering pillar. Sculpture consisting of strong collabral rather close spaced transverse ribs that diminish in vigor on the basal slope until they die out on the siphonal canal prolongation. Spiral ornament consists of close-spaced flat-topped spiral ribs that are wider than their interspaces and override the transverse ribs on the early whorls, but are wider spaced and restricted to the rib interspaces on later whorls. Aperture incompletely known; inner lip strongly excavated, lightly callused with callus strongest on the upper parietal lip near the suture. Columella bears two plaits that are visible about one-third turn back of the aperture with the lower plait being the strongest.

Discussion.—The holotype of Rimella curvillata Conrad is not present in the collections of the Academy of Natural Sciences of Philadelphia and is presumed lost. As illustrated by Conrad, it was a larger specimen than either figured herein (pl. 29, figs. 20, 26). Conrad’s description (1858, p. 331) is as follows:

Fusiform, ribbed longitudinally; ribs somewhat curved, slightly sinuous, about twenty-three in number on the body whorl; interstices transversely striated; beak produced?

The topotype, from Owl Creek, Tippah County, Miss., figured on plate 29, figures 20, 21, is not only smaller in size than the holotype but also bears only 14 transverse ribs. Another specimen from the same level within the Providence Sand of Georgia, however, exhibits closer spaced ribs, which number 22 on the body whorl (pl. 29, fig. 26), indicating a wide variation in rib spacing within the species. As indicated by the illustrations, there is, likewise, a strong difference in the strength of the spiral ornament with the Georgia specimen exhibiting less strong but broader spiral elements.

Neither the holotype, as illustrated, nor the other two available specimens possess a full extension of the siphonal canal, but in general the shape and characters of the shell more closely approach those of Piestochilus than they do those of Graphidula.

Piestochilus levis Stephenson, from the Kemp Clay of Texas, is based on shells that have surface features poorly preserved. The holotype (USNM 77092) differs from P. curvillatus by its smooth shell surface, but a part of the surface of the paratype (USNM 77093) shows close-spaced collateral transverse ribs similar to Conrad’s species. These features suggest that if better preserved specimens of the Texas species were available, they might prove to be conspecific with the Mississippi species. The type species, Piestochilus scowborough (Mesk and Hayden), from the sand of the Fox Hills of the western interior, lacks the strong transverse ribs of P. curvillatus and in this sense is closer to P. levis Stephenson.

Types: Holotype, lost; hypotypes USNM 130531, 130532.
Occurrence: Mississippi: Owl Creek Formation at loc. 46. Georgia: Providence Sand.

Piestochilus? sp.
Plate 29, figure 18

Discussion.—Two specimens from the Prairie Bluff Chalk of Mississippi (loc. 71) may belong to this genus. The specimen figured on plate 29, figure 18, has broadly convex sided plump whorls like those of Piestochilus curvillatus and, in addition, the remnants of external ribs that are not interrupted by a posterior collar as in Drillata are preserved.

Type: Figured specimen USNM 130533.
Occurrence: Mississippi: Prairie Bluff Chalk at loc. 71.
Genus ORNOPSIS Wade, 1916

Type by original designation, Ornopsis glenni Wade.

Diagnosis.—Fusiform to subfusiform shells of medium to moderately large size that are very variable in thickness and strength and have a turreted to turriculate spire. Whorls posteriorly constricted to a collar, inflated medially, and anteriorly elongated to a narrow twisted pillar. Ornament of both spiral and transverse elements of variable strength. Aperture subovate, posteriorly constricted to a sharp channel, siphonal canal elongate, narrow, deep, and twisted; colunnella bears a thin but strong raised plication immediately above the anterior canal.

Discussion.—Wade (1916, p. 463) proposed this genus to include two species he described from Coon Creek, Tenn., Ornopsis glenni and Ornopsis elevata. In 1936 (p. 127) he added O. digressa Wade from the same locality. Stephenson (1941, p. 542–544) described O. solistella, O. pulchra, and O. mazeyi from the Navarro Group of Texas. Stephenson stated that the forms from Texas and O. elevata and O. digressa from Tennessee differed significantly from the type species in size, shape, shoulder excavation, and thickness of shell and might well be split into another genus or subgenus. Harbison (1945, p. 84) erected the new genus Ripleysella for Ornopsis elevata, as it differed from the type species O. glenni by its less inflated body, by having an anterior canal larger than the “oval orifice,” and by lacking the narrow posterior notch. Contrary to her view, O. elevata does have a posterior notch (pl. 29, fig. 22), but another, and perhaps more important, difference is that the growth line is less sinuous in the type species O. glenni.

All the species are related in that they possess a twisted siphonal canal with a strong plication above the canal, have at least a tendency for the formation of a posterior collar, and possess a corresponding posterior siphonal notch. In addition, the protoconch and the early whorl development of sculpture is very similar. These features indicate a close, and I believe, congeneric relationship, but they can be differentiated into three subgenera on the basis of shell shape and growth line trend and may be distinguished as follows:

Ornopsis n. s. Subfusiform; whorls strongly collared posteriorly; growth lines prosocline on collar, almost orthocline on periphery and base. Ornopsis (O.) glenni Wade. (See fig. 16.)

Ripleysella. Slim, high spired, fusiform; anterior canal very elongate; posterior collar and shoulder excavation moderate; growth lines sinuous, developing a strong sinus over posterior excavation, becoming opisthocline over periphery, and almost orthocline on the pillar. Ornopsis (R.) elevata Wade and O. (R.) pulchra Stephenson (fig. 16).

Pornoisia. Fusiform, body inflated, constricted posteriorly to a weak collar or subsubtural welt, columellar plication low for genus; growth lines highly sinuous, developing a rather deep sinus over the excavated collar and shoulder, opisthocline on the periphery, becoming prosocline on the base. O. (P.) digressa Wade, O. (P.) solistella Stephenson, and O. (P.) modica Sohl (fig. 16).

With the exception of an undescribed species from the Eutaw formation of Alabama, the genus is restricted to the Ripley and Owl Creek Formations in Tennessee and Mississippi and to its equivalents in Texas. Pyriformus marylandicus Gardner, from the Monmouth Formation of Maryland, is suggestive of Ornopsis, but the holotype is entirely too poorly preserved for confirmation. Rennie (1945, p. 56) and Dartonville and Brebion (1956, p. 82) have reported the genus in the Upper Cretaceous deposits of Africa, but these reports are based on internal molds of questionable affinities.

Ornopsis is easily distinguished from such genera as Bollifusus by its twisted siphonal canal and the position of its columellar plait. The latter feature also serves to distinguish it from Woodella Wade and Cryptorkytis Meek of Wade.

Subgenus ORNOPSIS Wade

Ornopsis (Ornopsis) glenni Wade
Plate 29, figures 8–10, 15, 16


Diagnosis.—Shells subfusiform in outline; whorls inflated peripherally, but constricted posteriorly to a strong subvalvular collar; transverse ornament of strong ribs on the shoulder dying out above and below; spiral ornament covers entire surface and consists of strong ribs that are wider than their interspaces; siphonal canal almost as long as the ovate aperture.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

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1 Estimated.

Discussion.—Ornopsis glenni occurs not only at its type locality on Coon Creek, McNairy County, Tenn., but at the same level in the Saratoga Chalk in Arkansas. Its shell is thick and strong and is found well preserved and abundant. A moderate amount of variation in shape and ornament is present in the suite of almost a hundred topotype specimens. Of all the members of the genus, this species reaches the largest size. Most of the specimens fall within the size range of 32 to 50 mm in length, but a few incomplete specimens indicate a length of at least 75 mm was attained. Differences in proportions especially in the slimmness of the spire and obesity of the body is exhibited by variation in the pleural angle from 50° to 75° on specimens at the same stage of growth. On the larger specimens the transverse ornament becomes erratic and subdued (pl. 29, fig. 16) and the spiral ribs proportionally broader. The number of transverse ribs per body whorl ranges between 11 and 14 and the number of spiral ribs on the penultimate whorl ranges between 9 and 13.

The large hypotype figured by Wade (1926, pl. 44, fig. 12) has been dorsoventrally compressed and thus considerably accentuates the obesity of the whorls. The specimen herein figured on plate 29, figure 16, is of approximately the same size and gives a more accurate picture of the outline of the species at this stage of growth.

Types: Holotype and two hypotypes USNM 32883; hypotype USNM 130354, 130555.

Occurrence: Tennessee: Ripley Formation at loc. 1, Arkansas: Saratoga Chalk (USGS 13031).

TENNESSEE AND MISSISSIPPI

Ornopsis sp.

Discussion.—In the collections from the Prairie Bluff Chalk there are many internal molds that have the low-spired fusiform outline and plump whorls of Ornopsis (Ornopsis), and these may belong to the genus, but as preserved they can only be placed here very hesitantly.

Occurrence: Mississippi: Prairie Bluff Chalk at locs. 71, 82, 87, 88, 90.

Subgenus RIPLEYELLA Harbison, 1945

Type by original designation, Ornopsis elevata Wade.

Discussion.—Very elongate fusiform shells with whorls posteriorly constricted to a subvalvular collar and anteriorly constricted to a very elongate narrow siphonal canal immediately above which, on the columnella, is a narrow strong oblique plicature. Sculpture consists of collabral transverse costae, which are noded at the shoulder, and numerous spiral lirae. Growth lines sinuous, developing a strong sinus on posterior excavation, and becoming opisthoclaine over periphery and almost orthoclaine on the pillar.

Discussion.—Harbison (1945, p. 84) in proposing the genus Ripleyella stated Ornopsis elevata Wade differs materially from the genotype Ornopsis glenni Wade. The genotype has a much inflated body and the aperture is narrowly channeled above. The anterior canal is far shorter than the oral orifice. These striking characters are not found in Ornopsis elevata which has a more slender spire and the anterior canal is larger than the oral orifice.

As noted under the preceding generic discussion of Ornopsis, although Ripleyella does possess a posterior apertural notch, it has a more sinuous growth line. Ripleyella is herein treated as a subgenus of Ornopsis.

The subgenus is restricted to the Late Cretaceous of Mississippi, Tennessee, and Texas.

Ornopsis (Ripleyella) elevata Wade

Plate 29, figures 22-25


Diagnosis.—Slim fusiform shells possessing numerous close-spaced fine spiral lirae covering the shell surface, but weak over the collar area of the body whorl; siphonal canal very elongate.
Measurements.—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

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<th>Loc.</th>
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<tr>
<td>Topotype</td>
<td>28.5</td>
<td>12.4</td>
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<td>6 (26, fig. 22)</td>
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<tr>
<td>6</td>
<td>36.4</td>
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<tr>
<td>6</td>
<td>37.5</td>
<td>15.4</td>
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</table>

Discussion.—The type locality of this species on Coon Creek, McNairy County, Tenn., has yielded but few specimens. At a slightly higher stratigraphic position, in the lower part of the Ripley Formation of Mississippi, O. (Ripleyella) elevata is more abundant and is well preserved at several localities. As the measurements indicate, the Mississippi specimens appear to be somewhat smaller than those from the type locality. In addition, the spiral lirae of the posterior part of the early whorls are more strongly developed on the Tennessee than on the Mississippi specimens. In other details they are similar.

Ornopsis (Ripleyella) pulchra Stephenson, from the Nacatoch Sand of Texas, is a closely related species having less well developed but more numerous transverse ribs. In addition, fine primary spiral lirae alternate with finer secondaries that are lacking on Wade's species.

Types: Holotype USNM 32884; hypotype ANSP 16183; hypotypes USNM 109056, 120357.

Occurrence: Tennessee: Ripley Formation at loc. 1, Mississippi: Ripley Formation at locs. 4, 6, 14–16, 18.

Subgenus POLNOSIS Sohl, n. subgen.

Type species, Ornopsis digressa Wade, 1996.

Etymology.—By anagram from Ornopsis, a genus of gastropods.

Diagnosis.—Elongate fusiform shells, whorls posteriorly constricted to a weak collar and anteriorly to a moderately twisted narrow siphonal canal, columellar plication low for genus and growth lines very sinuous, developing a rather deep sinus over collar and shoulder.

Discussion.—In shape this subgenus represents a middle ground between Ornopsis (Ornopsis) and Ornopsis (Ripleyella). Three species and one subspecies, all occurring in the Exogyra costata zone of Texas and Mississippi, can be assigned here. These are, Ornopsis (Pornosis) digressa Wade and O. (Pornosis) modica modica Sohl from the Ripley Formation in Tennessee and Mississippi and O. (Pornosis) solistella Stephenson from the Corsicana Marl of Texas and, in addition, O. (Pornosis) modica levis Sohl, from the Owl Creek Formation of Mississippi.

Ornopsis (Pornosis) digressa Wade

Plate 29, figures 12–14


Diagnosis.—Shells with strong collabral transverse ribs that are prominent on the shoulder and periphery of the body but die out rapidly below.

Description.—Medium-sized fusiform shells; pleural angle about 40° at maturity and 50°–60° on earlier whorls. Protoconch consisting of from 3–3½ smooth round-sided whorls; junction with conch rather abrupt, initiated by the addition of low transverse ribs. Whorls, exclusive of protoconch, number five to seven, are well rounded and somewhat inflated over the periphery, and are slightly constricted in the vicinity of the suture. Sculpture is initiated on the first teloconch whorl by the introduction of low close-spaced transverse ribs. The spiral elements appear about half a turn later. The collabral ribs are continuous suture to suture on the early whorls but become restricted to the periphery on the last whorl where they are accentuated near their upper limit to subnodings. Spiral sculpture consists of both spiral lirae and ribbons. In general, the lirae occur near the suture and the ribbons over the lower two-thirds of the whorl. On the body the spiral ribbons are strongest and broadest on the basal slope. Growth lines are thin and very close spaced and are strongest on the body; growth line trend on the earliest whorls is nearly orthoclinal but develops an increasingly arcuate opisthoclinal trend later. On the body the growth lines are prosocline over the posterior whorl constriction, swing sharply to an opisthocline trend over the periphery, and then swing back to gently prosocline in a broad arcuate path over the basal slope. Aperature subovate, somewhat angulated posteriorly, and anteriorly drawn out to a narrow moderately long and twisted siphonal canal; inner lip lightly culated. Columella bears a plait that is weak and of low obliquity for the subgenus.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172). All specimens measured lack the extreme tip of the siphonal canal.

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<thead>
<tr>
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<td>14</td>
<td>30.6</td>
<td>13.3</td>
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</table>
Discussion.—*Ornopsis* (*Pornosis*) *digressa* Wade is rare at its type locality on Coon Creek in McNairy County, Tenn., but southward in Mississippi it occurs at several localities and at one (loc. 18) it occurs in some profusion. The holotype (USNM 32885), although lacking a fair part of its siphonal canal, is still the largest specimen. By virtue of certain changes in ornament with size, it is difficult to compare with the Mississippi specimens. Fortunately several topotypes in the collection are more comparable to the size attained by the Mississippi specimens. In general, the specimens from the Ripley Formation of Mississippi show a stronger development of spiral sculpture, but otherwise they compare very favorably with the Coon Creek specimens. Variation within a given population is not great and is mainly confined to a fluctuation in obesity of the whorls. A few specimens show suppression of ornament on part of a whorl (pl. 29, fig. 14) much in the style of *O. (Pornosis) modica* Sohl, but after about half a turn the normal pattern of ornament is resumed.

*Ornopsis* (*Pornosis*) *modica* differs from *O. (Pornosis) digressa* primarily by its much subdued ornament and lesser posterior constriction, but the characters of the early whorls indicate that the two species are closely related.

*Ornopsis* (*Pornosis*) *digressa* Wade is restricted to the Ripley Formation of Mississippi and Tennessee, but an incomplete specimen from the Ripley Formation in the Chattahoochee region of Alabama, in the collections of the U.S. Geological Survey, indicates that a closely related if not conspecific form is present there.

Types: Holotype USNM 32885; hypotypes USNM 130358–130361.

Occurrence: Tennessee: Ripley Formation at loc. 1. Mississippi: Ripley Formation at locs. 6, 18, 12, 27. (? Alabama: Ripley Formation.

*Ornopsis* (*Pornosis*) *modica* Sohl, n. sp.

Plate 29, figures 4–7

Diagnosis.—Shells with ornament like that of the type species on the early whorls, but which becomes suppressed on later whorls and almost lost on the body whorl.

Description.—Medium-sized fusiform shells with a spire of a little more than one-third total shell length; pleural angle 47°–53°. Protoconch trochoid and consisting of about three smooth whorls. Whorls five to six in number; body whorl plump, somewhat constricted posteriorly, well rounded over the periphery, and steeply sloping over basal slope. Suture impressed. Sculpture begins with sharp close-spaced collabral transverse ribs that are continuous suture to suture on early whorls and then become entirely suppressed, or restricted to poorly developed collabral ribs on the periphery. Spiral sculpture consists of spiral ribbons of variable width, sharply defined on the early whorls but becoming obscure on later whorls. Growth lines sinuous, prosocline below the suture, reflexed to opisthocline over the shoulder, and swinging back to prosocline over the basal slope, but becoming mainly orthocline on the pillar. Aperture subovate, posteriorly angulated, anteriorly drawn out to a narrow slightly twisted siphonal canal that is about two-thirds as long as the aperture; outer lip unknown; inner lip lightly washed with callus; columella bearing one low oblique fold immediately above the siphonal canal.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 172). Most of the measured specimens lack the anterior extremity.

<table>
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<th>Loc.</th>
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<tr>
<td>5</td>
<td>29.0</td>
<td>14.5</td>
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</table>

Discussion.—Variability in ornament within given populations of *O. (Pornosis) modica* Wade is relatively great. The point at which the transverse ornament is lost or becomes subduced varies with the individual specimen. On some specimens sculpture is lost by the third whorl, whereas on other specimens it is retained until the body whorl. On the body the ribs may be of moderate strength and elongate (pl. 29, figs. 6, 7) or may be restricted to somewhat elongated nodes restricted to the periphery (pl. 29, figs. 4, 5). Spiral ornament of the later whorls is always obscure with the exception of that on the upper part of the periphery. On two specimens (pl. 29, fig. 6), a node-like pad of callus is present near the upper edge of the parietal lip, which further constricts the posterior notch of the aperture.

*Ornopsis* (*Pornosis*) *modica* differs from *O. (Pornosis) digressa* Wade by its subduced transverse ornament that is more widely spaced, more obscure, and by its subduced less fine spiral sculpture. It is also less slender, rounder, and has plumper whorls that lack the shouldering of Wade's species, but it is closely related as is seen by its early whorl characters. *Ornopsis* (*Pornosis*) *solistella* Stephenson, from the Corsicana Marl of Texas, is a related species but is difficult to compare. The holotype is laterally compressed and lacks a well-preserved surface. However,
the transverse ribs are more accentuated than on O. (Pornosis) modica and the whorls are more constricted posteriorly.

**Types:** Holotype USNM 130062; paratypes USNM 130063, 20454.

**Occurrence:** Mississippi: Ripley Formation at locs. 5, 6, 18.

**Ornopsis (Pornosis) modica laevis Sohl, n. subsp.**

Plate 29, figure 19

**Discussion.**—One specimen from the Owl Creek Formation on Owl Creek, Tippah County, Miss. (loc. 46), differs from the typical O. (Pornosis) modica modica by having its body sculpture extremely subdued. The smoothness of the whorl surface is interrupted only by the faintest of transverse swellings. In addition, the spiral elements consist of fine lirae rather than broad ribbons and the growth lines appear less strongly flexed below the suture. This subspecies appears to be an end product of the trend for subdued ornament started in early Ripley time (fig. 17).

**Type:** Holotype USNM 20409.

**Occurrence:** Mississippi: Owl Creek Formation at loc. 46.

**Ornopsis (Pornosis?) sp.**

Plate 29, figures 11, 17

**Discussion.**—Numerous internal molds from the Prairie Bluff Chalk can tentatively be assigned to this genus. They not only assume the shape of *Ornopsis*, but some also show traces of ornament typical of the subgenus O. (Pornosis). The specimen illustrated here (pl. 29, fig. 17) appears to compare most closely to the *Ornopsis (Pornosis)* shape and possesses strong reflections of transverse costae on the penultimate whorl, but on the body these costae are lacking in the manner of O. (Pornosis) modica. In addition, the mold also retains the impression of the oblique columellar fold.

**Type:** Figured specimen USNM 130064.

**Occurrence:** Mississippi: Prairie Bluff Chalk at locs. 66, 71, 75, 84, 87, 88.

**Genus LATIRUS Montfort, 1810**

Type by original designation, *Latirus aurantiacus* Montfort.

**Diagnosis.**—Thick fusiform shells with a siphonal welt terminating in a siphonal notch. Ornament consisting of strong round-topped transverse ribs and strong to subdued spiral sculpture. Aperture lenticular, siphonal canal short, terminating in a notch. Columella with three strong medially placed plications.

**Discussion.**—*Latirus* is typically a Tertiary genus. Besides *Latirus keownvillensis* described below, *La-

*Figur 17.—Development of the species of the subgenus Ornopsis (Pornosis).*

*Latirus tribulus* Olsson from the Maestrichtian of Peru (Olsson, 1944, p. 100) is the only other species from the Cretaceous of the Western Hemisphere that has been assigned to *Latirus*. 
Latirus keownvillensis Sohl, n. sp.

Plates 30, figures 6, 7

**Diagnosis.**—Shell rather small for genus and bearing about eight broad strong transverse ribs per whorl but lacking spiral ornament.

**Description.**—Medium-sized fusiform thick shells. Spire about half total shell height. Whorls subshoudered above by termination of the transverse ribs, sides rounded and constricted below to a broad and twisted pillar. Sculpture of strong round-topped collabral transverse ribs that begin slightly below the suture and die out a short distance above the siphonal well. Growth line very faint and very gently prosocline between suture and siphonal well, but strongly sinuous over well. Aperture lenticular, siphonal canal broad and short, terminating in a notch; outer lip arcuate, thick inner lip moderately callused. Columella bear three strong plaits that are above an incipient fourth spiral fold located immediately above the siphonal canal.

**Measurements.**—The holotype is missing the apical tip but is 22 mm in height and 10 mm in diameter.

**Discussion.**—Only the holotype of the species from the Prairie Bluff Chalk in the vicinity of Keownville, Union County, Miss., is available for study. No other species occur in the Mesozoic rocks of North America. Compared with *Latirus tribulus* Olsson from the Cretaceous of the Paíta region of Peru, this species is smaller, is less obese, and has stronger transverse ribs.

**Type:** Holotype USNM 190995.

**Occurrence:** Mississippi: Prairie Bluff Chalk at USGS loc. 25507.

**Subfamily Fusininae**

*Boltenella, Hercorhyncus* (Hercohrhyncus), and *Hercohrhyncus* (Haplovoluta) appear to be related in both shape, apertural features, and growth line. They differ distinctly, in these and other features, from the other genera here placed in the subfamily Fusininae and may be worthy of setting up a separate suprageneric category. In addition, *Euthrio fusus* Cossman may also belong in the above. Cossman (1925, p. 249) assigned *Haplovoluta* as a subgenus of *Euthria fusus*, and later Wenz (1943, p. 1247) placed *Boltenella* as a further subgenus. If these two genera are to be subgenera they should become subgenera of *Hercohrhyncus*, which then would also include *Euthrio fusus* as a subgenus by priority. It is considered best here to maintain all but *Haplovoluta* as separate genera as they can be distinguished readily.

**Genus HERCOHRHYNCS Conrad, 1868**

Type by monotypy, *Fusus tippana* Conrad, 1860.

**Diagnosis.**—Fusiform shells with a spire a little less than one-third total shell height. Whorls peripherally swollen, constricted above a tuberculated shoulder that is of variable strength, and rather strongly constricted below sinus on base of body. Ornament consists of coarse transverse ribs that are strongest at the shoulder but that die out below on periphery and on collar above; spiral ornament weak on collar, strong below. Aperture posteriorly notched, anteriorly drawn out to a narrow elongate siphonal canal; outer lip crenulate; inner lip rather heavily callused with an umbilical chink developing opposite the beginning of the siphonal canal.

**Discussion.**—*Hercorhyncus* has been considered by Cossman (1901, p. 73) as a synonym of *Streptospho* Gill and by Wenz (1943, p. 1306) as a subgenus of *Afer* Conrad, but the growth line trend and apertural features, plus the lack of columellar plications, negates either placement.

*Hercorhyncus*, as used in this paper, may be subdivided into two sections treated as subgenera; both are restricted to the Upper Cretaceous. The first, *Hercorhyncus* (*Hercorhyncus*), differs from *Hercohrhyncus* (*Haplovoluta*) by its less well developed transverse ornament and by its unornamented basil sulcus.

*Hercohrhyncus* (*Hercohrhyncus*) is restricted to the latest Cretaceous beds in the Gulf coastal region and is probably represented in the Upper Cretaceous of the Aachen area by *Rapa nonheimi* Müller (Holzapfel, 1888, p. 106; Cossman, 1901, p. 73). Cossman (1901, p. 74) also assigned several species from the Upper Cretaceous of India to *Hercohrhyncus*, but these do not appear to belong in the genus.

The holotype of *Hercorhyncus mundum* Stephenson (1941, p. 4101, USNM 77012), from the Neylandville Marl of Texas, does not possess the basal sulcus typical of the genus and appears to more properly belong in *Pyri fusus* Conrad. On the other hand, the paratype (USNM 77013) does possess a basal sulcus typical of *Hercorhyncus*, but the small immature specimen appears to be specifically indeterminable.

**Hercorhyncus** (*Hercorhyncus*) tippana Conrad

Plate 30, figures 8-10, 13-16


1901. *Streptospho* (*Hercohrhyncus*) tippana (Conrad). Cossman, Essais Paléonconchologie Comparée, v. 4, p. 73, fig. 22.

1941. *Hercohrhyncus coronal* Stephenson, Texas Univ. Bull. 4101, p. 323, pl. 61, figs. 12, 13.
1941. *Hercorhynus vadousum* Stephenson, Texas Univ. Bull. 4101, p. 322, pl. 61, figs. 18, 19, 20.


**Diagnosis.**—A robust proportionally broad *Hercorhynus* with generally 12 or 13 nodes at the shoulder.

**Description.**—Fusiform shells with a spire about one-third total shell height; pleural angle varies with size from 85° in normal-sized forms to 80° on larger individuals. Protoconch of about three smooth rounded whorls; junction with conch abrupt and accompanied by the addition of moderately wide spaced transverse ribs that are direct and continuous suture to suture. Whorls posteriorly constricted to a rather strong and broad subsutural collar that is bordered below by an excavated to sloping ramp that terminates in a nodose shoulder; body flat and sloping somewhat adaxially below shoulder to a strong proportionally broad sulcus below which the body is strongly constricted to the elongate slender pillar. Early transverse sculpture consists of wide-spaced direct continuous ribs that increase in strength; after almost two turns the ribs become accentuated to nodes at shoulder and pull away from the suture becoming discontinuous; as the subsutural collar develops, these nodes form the shoulder. There are 12–13 transverse ribs on the body and these frequently bear spines at the shoulder, but ribs are absent on the collar and generally die out downward on the flat whorl sides above the sulcus. Spiral sculpture appears after the first appearance of transverse ribs; on the early whorls it consists of broad flat-topped close-spaced ribbons that cover the surface and override the ribs; on later whorls, spiral elements above the shoulder are restricted to faint wider spaced cords. The body whorl below the shoulder is covered by strong spiral cords. Aperture posteriorly notched and anteriorly drawn out to a moderately elongate narrow siphonal canal that is inclined to the left. Outer lip thin at edge, angulated at shoulder, crenulate where intersected by cords. Growth line trend strongly prosocline on collar, swinging back to gently opisthocline on the shoulder and whorl sides, developing a sharp adaperturally directed sinus over the basal sulcus and becoming almost orthocline over the basal slope; inner lip heavily callused; callus strongly margined over parietal lip but losing contact with columellar lip at entrance to siphonal canal, thus developing an umbilical chink and channel bordering the canal.

### Measurements

Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 172).

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**Discussion.**—Conrad (1860, p. 286) cited Tippah County, Miss., as the type locality of this species. The type specimen is preserved in the collections of the Academy of Natural Sciences of Philadelphia (ANSP 13928); a second specimen accompanies the holotype in the same tray. Both specimens are somewhat incomplete, but a comparison of the type specimens with specimens of *Hercorhynus* from the Ripley Formation of Mississippi shows them all to be conspecific.

At any given locality where specimens are abundant, the species show considerable variability in some features of ornament. Spiral ornament above the collar ranges from almost total absence to numerous fine lire on to a few wide-spaced moderately coarse cords. On the whorl sides, four to six spiral cords develop between the basal sulcus and the strong spiral cord at the shoulder. Ribs vary from strong nodes that are restricted to the shoulder to ribs continuing almost to the basal sulcus. The shoulder nodes may be sharp and crowned by spines that are formed by the accentuation of growth lamellae or that are merely raised but blunted nodes.

Harbison (1945, p. 83) described *Hercorhynus gracilis* from the Ripley Formation at locality 18. Comparison of more than 100 topotypes of *H. gracilis* shows this species to be conspecific with Conrad's *H. (H.) tippanus*. Stephenson (1941, p. 321), in discussing *H. malleiforme* from the Kemp Clay, stated that the type species of *Hercorhynus* comes from the Owl Creek Formation on Owl Creek, Tippah County, Miss., but, as stated before, a comparison of the type specimens shows them to be a Ripley species and not from the Owl Creek locality. The holotype of *H. (H.) vadousum* Stephenson, from the Nacatooch Sand of Texas, compares well with the larger specimens of *H. (H.) tippanus* from Mississippi. *Hercorhynus coronale*, also from the Nacatooch Sand of Texas, is likewise a synonym of *H. (H.) tippanus* Conrad, being merely an immature individual.

*Hercorhynus* (*Hercorhynus*) *pagodiiformis* Sohl, from the Owl Creek Formation, differs by having
fewer ribs per whorl and by being proportionally smaller and higher spired.

**Types**: Holotype (H. tippanus) ANSP 13828; hypotype (holotype H. coronate) USNM 17368; hypotype (holotype H. vadusom) USNM 77009; hypotype (paratype H. vadusom) USNM 77010; hypotypes USNM 130996–130972.

**Occurrence**: Mississippi: Ripley Formation at locs. 5, 6, 12, 14–19, 24, 30. Texas: Nacatoch Sand. Georgia and Alabama: Ripley Formation.

**Hercorhynchus (Hercorhynchus) pogodiformis** Sohl, n. sp.

Plate 30, figures 1-5

**Diagnosis**.—A **Hercorhynchus** with a slim outline, proportionally high spire, and a shoulder bearing 8–10 nodes per whorl.

**Description**.—Medium-sized high-spired shells; spire somewhat more than one-third total shell height; pleural angle 50°–65°. Whorls strongly constricted posteriorly to a moderately broad strong subumbilical collar; shoulder strong, formed by the truncate upper ends of the transverse ribs; whorls below shoulder flat sided, sloping rather steeply adaxially to a well-like fasciolar band; below this band the body is strongly constricted to the anterior pillar. Transverse sculpture consists of strong broad wide-spaced ribs forming nodes at the shoulder and dying out shortly below on the whorl sides; 8–10 nodes on the body whorl. Spiral sculpture of strong cords over the periphery and base but diminished in vigor above the shoulder on later whorls. Growth lines prosocline over collar, swinging to opisthoncine over shoulder and flat whorl sides, but adaperturally flexed over the well-like band at the base of the body. Aperture incompletely known; notched posteriorly in harmony with the subumbilical collar and anteriorly drawn out to an elongate siphonal canal that is inclined to the left. Outer lip angulated at the shoulder and crenulate where intersected by the spiral cords. Inner lip calcified moderately, with an umbilical chink developed opposite the beginning of the siphonal canal.

**Measurements**.—All available specimens are incomplete. The holotype, which is missing its anterior extremity, measures 30.5 mm in height and 17.1 mm in diameter.

**Discussion**.—This species differs from **Hercorhynchus** (Hercorhynchus) tippanus Conrad from the Ripley Formation and H. (Hercorhynchus) mailiforme Stephenson, from the Kemp Clay of Texas, by having a thinner outline, proportionally higher spire, lower pleural angle, and fewer wider spaced and less continuous transverse ribs.

The species is restricted to the Owl Creek Formation.

**Hercorhynchus** (Hercorhynchus) tennesseensis (Wade)

Plate 30, figures 11, 12


**Discussion**.—Only two specimens are available for study. Considering the range of variability of H. (Hercorhynchus) tippanus Conrad and the similarity of this species to it, actual separation into two species is open to doubt. However, both the holotype (Wade, 1926, pl. 50, figs. 3, 4) and the hypotype figured herein, possess a less strongly constricted collar and a more sloping less excavated area between collar and shoulder than is typical of H. (Hercorhynchus) tippanus. For this reason separate names are maintained with the realization that when more specimens from the type locality on Coon Creek, Tenn., become available they may prove to be conspecific.

**Type**: Holotype USNM 32908.

**Occurrence**: Tennessee: Ripley Formation at loc. 1.

**Subgenus** HAPLOVOLUTA Wade, 1918

1920. **Brucea** Cossmann, Rev. Critique Paléontologie et Paléobotanique, v. 21, p. 137.

Type by original designation, **Haplovoluta bicarinata** Wade.

**Diagnosis**.—Fusiform shells possessing shouldered peripherally swollen whorls and a proportionally low spire. Sculpture dominated by nodose peripheral carinations. Aperture broadly subovate, notched posteriorly; siphonal canal, elongate, narrow, and inclined to left. Umbilical chink moderately broad.

**Discussion**.—Wenz (1943, p. 1247) placed **Haplovoluta** as a subgenus under **Euthrophus** but that genus lacks peripheral carinations. As discussed before, this subgenus appears to belong closer to **Hercorhynchus** from which it differs primarily in its more continuous transverse ornament and subdued shoulder nodes.

The subgenus ranges through the upper part of the **Esoxyra ponderosa** zone and through the **E. costata** zone.
Diagnosis.—A *Haplovoluta* having two strong spiral cords that form a biconical periphery.

Measurements.—All specimens, except the second one listed, are missing a part of the anterior extension, plus the extreme apical tip. Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

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</tr>
<tr>
<td>Do.</td>
<td>33.7</td>
<td>23.5</td>
</tr>
</tbody>
</table>

Discussion.—*Hercorynchus* (*Haplovoluta*) bicornatus is moderately common at its type locality on Coon Creek, McNairy County, Tenn. Variation is minor and generally affects a character only in degree of its development, not in its presence or absence. One specimen in the U.S. Geological Survey collections (USGS 17254), from the Coffee Sand of Mississippi, appears to belong to this species but is somewhat lower spired than average and has four strong spiral cords on the basal slope instead of three, as is normal. Additional specimens from this locality must be collected in order to determine if such differences are constant and worthy of setting aside this form as a new species. *Hercorynchus* (*Haplovoluta*) triliratus from a higher level in the Ripley Formation in Mississippi is another closely related species and probably a direct descendant, but which differs by, among other features, having three primary spiral cords on the periphery.

Types: Holotype USNM 32899; hypotypes USNM 130376-130378.

Occurrence: Tennessee: Ripley Formation at loc. 1, Mississippi: Coffee Sand (questionable).

Diagnosis.—Haplovolutids with three primary spiral cords upon the whorl periphery.

Description.—Medium-sized fusiform shells having a spire a little less than one-third total shell height; pleural angle 80°-90°. Protoconch incompletely known, smooth surfaced and round sided; junction with teleconch abrupt, accompanied by the addition of strong continuous transverse ribs that, on subsequent whorls, pull away from the suture, become nodosely terminated above, and form the shoulder. Whorls expanded medially and bicornate; upper whorl area constricted to a poorly defined subsutural collar, below which the whorl is concevally excavated to the shoulder. Below the lower carination the body restricts rapidly to the tapering pillar. Sculpture ornate; transverse collarial ribs arise on the body just above the shoulder and are either noded or incrementally spinose at the shoulder and are nodded again where they cross the medial cord on the whorl side and on the lower carination; rib strength diminishes over basal slope; ribs number 19-21 per whorl. Spiral elements dominated by the three strong cords on the whorl periphery, the upper and lower of which carinate the whorl; no spiral cords are present above the shoulder, but two or three are present on the basal slope and several more on the pillar. Growth lines have a prosocline trend above the shoulder, may be sinused to a spinose incremental projection at the shoulder, then trend opisthochlinely to the lower carination where they swing back to prosocline over the basal slope. Aperture broadly ovate; notch posteriorly and anteriorly drawn out to a narrow canal of moderate length; outer lip angulated at shoulder and notched in harmony with shoulder spines and crenulate where intersected by the spiral cords.

Inner lip with callus adnate above, but loosening opposite entrance to siphalon canal leaving an umbilical chink of variable width. Columella smooth.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

<table>
<thead>
<tr>
<th>Loc.</th>
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</tr>
<tr>
<td>Do.</td>
<td>33.8</td>
<td>20.7</td>
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</table>

Discussion.—*Hercorynchus* (*Haplovoluta*) triliratus Sohl represents a species close to and probably directly derived from *H. (aplovoluta) bicornata*. 

Plate 30, figures 17-20, 23, 24
(Wade) from the *Exogyra cancellata* zone of the Ripley Formation in Tennessee. It differs from that species by having three primary cords on the whorl sides, a higher spire, less inflated whorls, less prominent cords on the basal slope, and growth lines that are less prosodine in the intercarina area.

The species is especially abundant at locality 18, at a position in the Ripley Formation somewhat lower than that from which the holotype came. Here the intraspecific variability of the species is well displayed. The umbilical chink on one specimen (pl. 30, fig. 23) is strong, open, and broad, whereas on another specimen from the same locality, (pl. 30, fig. 18) the chink is limited to the anterior tip. The sharpness of the shoulder and the excavated area above are likewise variable, from a gently sloping concave subsutural area (pl. 30, fig. 24) to a strongly excavated surface. The spiral cords of the basal slope number two or three, with the upper one, the variable cord, being equal in strength (pl. 30, fig. 17), weak (pl. 30, fig. 19), or absent (pl. 30, fig. 20). Though generally quite strong, a few specimens show the cord between the two carinations of the periphery to be suppressed.

This species ranges through the Ripley Formation from the top of the *Exogyra cancellata* zone to near the base of the Owl Creek Formation, but has not been found in the Chiwapa Sandstone Member of the Ripley Formation at the very top. *Hercorhynchus* (*Haplovolvula*) *quadriquiratus* occurs in the overlying Owl Creek Formation. Although it is virtually indistinguishable in its early stages from *H. triliratus*, at maturity it possesses four spiral cords on the whorl sides, several cords above the shoulder, and a different arrangement of spirals on the basal slope.

**Types:** Holotype USNM 130379; paratypes USNM 130880-130883.

**Occurrence:** Mississippi: Ripley Formation at locs. 5, 13, 18-18. Alabama and Georgia (Chattahoochee River region): Ripley Formation.

*Hercorhynchus* (*Haplovolvula*) *quadriquiratus* Söhl, n. sp.

**Plate 30, figure 22**

**Diagnosis.**—A hapolvolvulid bearing two strong cords plus secondary spiral lirae between the whorl carinations.

**Description.**—Medium-sized fusiform shells with a spire about one-third total shell height. Pleural angle 60°-70°. Whorls peripherally bicarinate, constricted posteriorly to a strong to moderate collar, anteriorly constricted below the lower carina. Transverse sculpture of collabral ribs that are strongest at their upper ends and die out above the noded shoulder and on the basal slope; ribs number about 20 per whorl. Spiral ornament absent or very faint above shoulder on early whorls, but several low broad cords may be present on later stages; a strong cord forms the shoulder carination and is followed below on the periphery by two cords equal to or weaker than the shoulder cord; these are followed by a very strong broad basal carinating cord; on the basal slope there are generally three cords, the medial one being the strongest and finally several more occur on the pillar. Aperture incompletely known, medially inflated, notched posteriorly, and anteriorly drawn out to an elongate siphonal canal. Inner lip calloused, columella smooth.

**Measurements.**—All specimens are incomplete. Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

<table>
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</tr>
<tr>
<td>46</td>
<td>36.3</td>
<td>16.9+</td>
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</table>

**Discussion.**—In its early growth stages *Hercorhynchus* (*Haplovolvula*) *quadriquiratus* is scarcely distinguishable from *H. (Haplovolvula) triliratus*, but with increased size the specimens take on distinctive features. Spiral ornament is added to the area immediately above the shoulder, the excavated subsutural band and collar become more pronounced than on the Ripley species and four instead of three spiral cords are present on the inflated part of the whorl. Even at an early stage secondary spirals are present between the carinations, a condition present in *H. (Haplovolvula) bicornutus* but not to be seen in *H. (Haplovolvula) triliratus*.

*Hercorhynchus* (*Haplovolvula*) *quadriquiratus* is the end product of the line of descent beginning with the bicarinate form in the upper part of the *Exogyra ponderosa* through *Exogyra cancellata* zones, and which was followed by the trilirate species of the Ripley. *H. (Haplovolvula) quadriquiratus* is restricted as far as known to the Owl Creek Formation of Mississippi.

**Types:** Holotype USNM 130384; paratype USNM 130385.

**Occurrence:** Mississippi: Owl Creek Formation at locs. 44, 46.

**Genus BOLLENELLA** Wade, 1917

Type by original designation, *Boltenella excellens* Wade.

**Diagnosis.**—Fusiform medium-sized shells having a spire of less than one-third total shell length. Whorls posteriorly constricted to a subsutural collar, shoul-
der strong and noded by transverse ribs that die out on lower part of periphery. Spiral lirae cover shell surface. Aperture posteriorly notched, anterior canal elongate; outer lip angulated at shoulder; inner lip with callus well defined but tapering on columnellar lip.

Discussion.—Boltenella Wade is a monotypic genus placed by Cossmann (1925, p. 247) and Wenz (1943, p. 1246) as a subgenus of Euthriofusus Cossmann. That genus, however, has a higher spire, a proportionally longer siphonal canal, and lacks the strongly constricted subbursal collar of Boltenella. Accordingly Boltenella is given full generic rank.

Boltenella excellens Wade
Plate 31, figures 31, 32


1943. Euthriofusus (Boltenella) excellens (Wade). Wenz, Handbuch der Paläontologie; Gastropoda, v. 6, p. 1247, fig. 3554.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

<table>
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<tr>
<td>(syntype)</td>
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</table>

Discussion.—Boltenella excellens Wade is rare and restricted to its type locality on Coon Creek, McNairy County, Tenn. The syntype figured on plate 31, figure 31, is a smaller individual than the holotype and lacks the full extension of the siphonal canal. The subbursal collar is just beginning to become well developed on this specimen.

Types: Holotype USNM 32900; syntype USNM 130386.

Occurrence: Tennessee: Ripley Formation at loc. 1.

Genus EUTHRIOFUSUS Cossmann, 1901

Type of original designation, Fusus burdigalensis Basterot, 1825.

Diagnosis.—Fusiform shells possess a globular protoconch and a spire shorter than the aperture. Whorls somewhat constricted posteriorly, periphery inflated, and subshouldered. Aperture posteriorly angulated, siphonal canal long and straight. Sculpture dominantly spiral.

Discussion.—As originally diagnosed by Cossmann Euthriofusus included not only the type species from the Miocene but several Eocene species as well. In 1925 he also cited Falsisusus mesozoiicus Wade from the Ripley Formation of Tennessee as belonging to Euthriofusus. Euthriofusus appears to be related in growth line character and form to Hecorhynchus Conrad and Boltenella Wade. The two Ripley species included here are done so with reservation as their nuclear characters are unknown.

Euthriofusus? mesozoiicus (Wade)
Plate 31, figures 27-28


1925. Euthriofusus mesozoiicus (Wade). Cossmann, Essais Paléontologique Comparée, v. 13, p. 246, pl. 8, fig. 3.


Diagnosis.—Moderately small slender fusiform shells with a long straight siphonal canal; surface covered by spiral lirae; strong transverse ribs occur on the periphery and are sharply noded at the shoulder.

Discussion.—This species is based upon a single specimen, the holotype, from the Ripley Formation on Coon Creek, McNairy County, Tenn. The shell is well preserved except for the protoconch and possesses an inflated body whorl and a straight, long, siphonal canal like that of Euthriofusus burdigalensis, the type species. Falsisusus convexus Wade, with which it occurs, has a lesser shoulder and more continuous transverse ribs.

Type: Holotype USNM 32886.

Occurrence: Tennessee: Ripley Formation at loc. 1.

Euthriofusus? convexus (Wade)
Plate 31, figures 33-36


Diagnosis.—Medium-sized fusiform shells have a poorly developed shoulder, 10 or 12 low transverse ribs restricted to periphery, and a surface covered by spiral lirae.

Discussion.—All the available specimens come from the Ripley Formation at the type locality on Coon Creek, McNairy County, Tenn. They all lack the siphonal canal and protoconch, which makes assignment to Euthriofusus tenuous, but they do possess a body whorl shape and a growth line trace very typical of the genus. Variation in the strength and continuity of the transverse ribs is considerable, ranging from specimens like the holotype that possess ribs continuous across the periphery (Wade 1926, pl. 45, fig. 11),
to specimens (pl. 31, fig. 33) whose ribs are narrower and restricted to the upper peripheral surface.

_Euthriophus? mesozoicus_ differs by having growth lines that lack the strong flexure present on the basal slope of _E. t. conveus_ and by having finer spiral lirae, a more pronounced shoulder, and sharply noded ribs.

**Types:** Holotype USNM 32889; hypotypes USNM 130387, 130388.

**Occurrence:** Tennessee: Ripley Formation at loc. 1.

**Genus REMERA Stephenson, 1941**

Type by original designation, _Remera microstriata_ Stephenson.

**Diagnosis.**—Medium-sized fusiform shells with the spire more than half total shell height. Whorls flat-sided, ornamented by strong collabral transverse ribs and subdivided overriding spiral ribs. Aperture lenticular, angulated posteriorly; siphonal canal moderately long and straight; columnella smooth.

**Discussion.**—The shells of _Remera_ are rather well represented by a number of species in the Upper Cretaceous rocks of the _Exogyra ponderosa_ and _Exogyra cancellata_ zones of the Gulf and Atlantic Coastal Plains. Two other genera, _Graphidula_ and _Beretra_, occur with it and possess shells akin in shape and ornament to _Remera_. _Graphidula_ differs by the possession of columnellar plications. _Beretra_ has a noded subsutural collar and a typical turrid sinuous growth line.

Specific differentiation within the genus is based, for the most part, on relatively minor differences in convexity of the whorl sides and sinuosity of the transverse ribs. Some forms such as _Remera decora_ Stephenson and _Remera microstriata_ Stephenson are based upon so little material that comparison is difficult and may, in the future, when the limits of their variation is known, prove to be synonyms of other species.

Gardner (1916, p. 438, 464) described two species from the Monmouth Formation at Brightseat, Md., _Fasciolaria? juncea_ and _Exilla cretacea_. Both species belong to _Remera_ and are synonyms. As first reviser I select _Remera juncea_ as valid by the criteria of pagination.

**Remera stephensi** Harbison

Plate 31, figures 17–19, 22, 23


**Diagnosis.**—A _Remera_ with transverse ribs rather wide spaced and straight for genus.

**Description.**—Medium-sized, fusiform shells; spire high and evenly tapering, about three-fifths total shell height, pleural angle about 30°. Protoconch trochoid, composed of about three smooth round-sided whorls; junction with conch gradual as whorl sides become flattened; develops discontinuous highly inclined ribs that are followed by the formation of normal ribs; spiral ornament appears when the normal ribs develop. Whorls flat sided, rounded down below periphery to a moderately long siphonal canal. Strong collabral transverse ribs number 14–16 per whorl and die out on the basal slope. Spiral sculpture of low spiral ribs that are much broader than their interspaces cover the whorl sides but become narrower over the basal slope and change to cords on the pillar. Growth lines are arcuately opistochline over the whorl sides and swing back to proloculine low on the basal slope. Aperture lenticular, posteriorly angulated, siphonal canal straight and of moderate length. Outer lip incompletely known, apparently broadly sinusoid above, inner lip lightly callused with callus of upper columnellar lip extending out of aperture and onto whorl surface a short way; columnella smooth.

**Measurements.**—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

<table>
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<th>Loc.</th>
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<tr>
<td>16</td>
<td>20.0</td>
<td>6.6</td>
<td>3.4</td>
</tr>
</tbody>
</table>

1 Estimated.

**Discussion.**—_Remera stephensi_ Harbison is a moderately common species in the Ripley Formation of both Mississippi and Tennessee. Wade originally referred the Tennessee specimens to _Anchura? pergracilla_ Johnson (1898, p. 463). Johnson's species is from the Woodbury Clay of New Jersey, which, according to Stephenson (1941, p. 345), is in the lower part of the _Exogyra ponderosa_ zone. Although I have not examined Johnson's type specimens, his illustrations of the holotype indicate a species much like _R. stephensi_, but which differs in having more convex whorl sides and less opistochline ribs that carry down farther on the whorl. Richards and Rambell (1962, p. 34) perpetuated the erroneous assignment of Johnson's species to _Anchura_. I am unable to differentiate the Tennessee specimens in the _Exogyra_
cancellata zone from those above that zone in the Ripley Formation of Mississippi. Variability in the species at a given locality is at a minimum, neither the ribs nor the spiral ribs vary much in either numbers, strength, or positioning. *R. flexiocostata* Soli from the overlying Owl Creek Formation at maturity has more highly sinuous transverse ribs and generally more numerous transverse ribs. *R. microstriata* Stephenson from the Neylandville Marl of Texas is slimmer, has less sinuous transverse ribs, and a lower pleural angle. *R. decora* Stephenson from the Nacatoch Sand of Texas is based upon a poorly preserved immature holotype but appears to be specifically distinct, having less flexed direct ribs and much rounder whorl sides.

**Types:** Holotype ANSP 16217; hypotypes USNM 130890–130891.

**Occurrence:** Mississippi: Ripley Formation at locs. 5, 6, 12, 14–18, 24, 29. Tennessee: Ripley Formation at loc. 1. Georgia and Alabama: Ripley Formation.

**Remera flexiocostata** Soli, n. sp.

Plate 31, figures 20, 21

**Diagnosis.**—A *Remera* with close-spaced ribs that became extremely sinuous in later developmental stages.

**Description.**—Medium-sized fusiform shells; spire high, evenly tapering; pleural angle 20°–25°. Protoconch unknown, sutures impressed. Whorl sides gently convex, rounding over base to a tapering pillar. Sculpture of moderately strong collateral ribs that become lower and more sinuous in latest growth stages; ribs number 18–20 per whorl. Spiral ornament consists of low close-spaced spiral ribbons on whorl sides that are weaker where they override the transverse ribs and become wider spaced lirae on the base. Growth lines almost orthocline near suture, becoming decidedly opisthocline over periphery, swinging acutely to strongly prosocline on basal slope. Aperture incompletely known; lenticular in outline as preserved, posteriorly angulated, siphonal canal of moderate length and straight. Inner lip callos Best developed over upper part of columellar lip. Columella straight and smooth.

**Measurements.**—The holotype, which is somewhat compressed, measures 32 mm in length and 10.2 mm in diameter.

**Discussion.**—*Remera flexiocostata* is restricted to its type locality in the Owl Creek Formation on Owl Creek, Tippah County, Miss. Immature shells of this species are similar to *R. stephensi* but can be distinguished by the greater number of ribs, their greater inclination, and their more convex sides. At maturity the ribs become very much more flexed than the Ripley species.

**Types:** Holotype USNM 130892; paratypes USNM 130893, 130894.

**Occurrence:** Mississippi: Owl Creek Formation at loc. 46.

**Remera microstriata** Stephenson

Plate 31, figure 16


**Discussion.**—One incomplete specimen from the lower part of the Ripley Formation of Mississippi, at locality 18, bears a distinct resemblance to Stephenson's species *Remera microstriata* from the Neylandville Marl of Texas. This species is slimmer and its transverse ribs are thinner and less inclined than those of *R. stephensi* from the Ripley Formation. In these respects the specimen under discussion agrees well with the Texas material, but the incomplete nature of the specimen makes definite placement questionable.

**Type:** Figured specimen USNM 130895.

**Occurrence:** Mississippi: Ripley Formation at loc. 18.

**Genus FUSINUS** Rafinesque, 1815

(=*Fusus* Lamarck, 1798, not *Fusus* Heilbing, 1779)

**Type** by monotypy, *Murex colus* Linnaeus, 1758.

**Discussion.**—*Fusus* as applied to Cretaceous shells has become a receptacle term for generally fusiform slender elongate shells of otherwise unknown affinities. Many species are based entirely upon internal molds presenting only a fusiform slender outline. Aside from having a common fusiform shape there is little reason for placing many of the better preserved specimens here.

The complex synonymy of *Fusus* has been discussed by many authors—(Dall, 1909, p. 36; Grabau, 1904; and Woodring, 1928, p. 385)—and the general consensus is that *Fusus* Rafinesque should supplant *Fusus* Lamarck. These same authors and others agree that *Fusinus* in its restricted sense is found only as early as the Eocene. This assumption then leaves numerous Cretaceous species that are probably related to that genus without generic assignment. *Fusinus* in the old sense has been subdivided by Grabau and others into a number of genera considered by Wenz (1943) to be subgenera. For such distinction Grabau (1904) used the nuclear characters for subdivision. The protoconchs of the Cretaceous forms herein discussed are either missing or obscured by wear. For that reason it appears unwise to define a new genus to receive the Cretaceous species or, on the other hand, to definitely assign the species to an existing
genus. Therefore the species are assigned with question to the typical form *Fusinus*, from which they differ primarily in having a less constricted body and a more curving siphonal canal.

*Fusinus? maunariensis* (Wade)
Plate 31, figures 24-25


Diagnosis.—Fusiform shells with a knife-edged columellar lip bordering a curved elongate siphonal canal.

Description.—Medium to moderately small fusiform shells possessing a spine of a little more than half the total shell height. Protoconch poorly known, consisting of about two to three trochoid round-sided whors. Suture impressed. Whors of spine round sided; body abruptly constricted below. Sculpture ornament; transverse ribs rather strong, numbering nine per whorl and overridden by the spiral elements, ribs diminish in vigor near the suture; on the penultimate whorl four strong spiral ribbons are followed above by three weaker cords; these are in turn followed subruturally by two weak larae which may, on the body, broaden and coalesce to form a subutural well; the ribbons of the whorl sides give way to spiral cords on the base; growth lines prominent in interspaces as thin sharp ridges but are subdued on ribbon tops. Aperture lanceolate; siphonal canal elongate narrow, broadly curved, and inclined to the left. Outer lip unknown; inner lip lightly callused on parietal lip, but tapering anteriorly to a sharp-edged columellar lip.

Measurements.—The holotype, on which only the body and penultimate whors are preserved, is 19.2 mm in height and 7.4 mm in diameter.

Discussion.—The holotype of *Fusinus? maunariensis* (Wade) from the Ripley Formation on Coon Creek, McNairy County, Tenn., is incomplete, and only the penultimate and body whors are preserved. Wade's illustrations (1926, pl. 43, figs. 13, 14) exaggerate greatly the strength of the spiral elements. The other specimens here assigned to this species are all smaller in size and lack the siphonal canal. The lack of this anterior part prevents the testing of the variability of the strikingly sharp edged columellar lip. These specimens, although lacking this feature, do possess the same type of ornament. The strength of the spiral elements and their succession on the whorl sides is the same. Among the available specimens there appears to be a minor amount of variation in the slimness of the shell, convexity of the whorl, and the strength of the transverse ribs, but no basis for distinguishing those from the *Exogyra concinna* zone from those of younger beds has been noted.

Types: Holotype USNM 32880; hypotype USNM 130396.


Genus *WoodSELLA* Wade, 1926

Type by original designation, *WoodSELLA typica* Wade.

Diagnosis.—Medium-sized fusiform shells that have rather strongly shouldered and subuturally constricted whors; aperture subovate, siphonal canal elongate, inclined to axis and somewhat twisted, columella smooth, thick, and strong. Sculpture of broad discontinuous transverse ribs accentuated at the shoulder and of numerous spiral cords.

Discussion.—Wade (1926, p. 129) erected this genus to include the type species from Coon Creek and *Voluta rigida* Bailey from the Senonian of Pondoland, South Africa; *Cryptothyris pseudorigida* Rennie (1930, p. 226-227) is thought to be a junior synonym.

Wade placed the genus in the family Fusinidae, and Wenz (1943, p. 1263) later placed it in the Fasciolariidae as a subgenus of *Fusinus* Rafinesque. However, *WoodSELLA* in its shape, ornament, apertural and columellar features appears, like *Stantonella* and *Alifusinus*, to be more closely similar to forms like *Kelletia* Fischer and may belong in the Buccinidae.

*WoodSELLA typica* Wade

Plate 31, figures 29, 30


1926. *Fusinus (WoodSELLA) typicus* (Wade). Wenz, Handbuch der Palaeontologie; Gasteropoda, v. 6, p. 1263, fig. 3595.

Diagnosis.—Fusiform strong shells of medium size, ornamented by discontinuous transverse ribs that are raised to strong rounded nodes at the shoulder and with low close-spaced spiral cords covering the surface.

Measurements.—The only specimen available for measurement is the holotype, which lacks the apex. It measures 42 mm in height and 23 mm in diameter.

Discussion.—This is the only species of the genus present in the fauna and is rare and known only from its type locality in the Ripley Formation of Coon Creek, McNairy County, Tenn. *Cryptothyris rigida* (Bailey) of Woods from Pondoland, South Africa, as figured by Woods (1906, pl. 30, figs. 2a, 2b), has a
less twisted siphonal canal, a weaker shoulder, and stronger spiral ornament.

**Type**: Holotype: USNM 32892.

**Occurrence**: Tennessee: Ripley Formation at loc. 1.

**Genus ANOMALOFUSUS** Wade, 1916

Type by original designation, *Anomalofusus substriatus* Wade.

**Diagnosis**.—Small to medium-sized fusiform shells with an apex bluntly by a proportionally large regularly coiled protoconch; sculpture ornate, varices range from absent to two per whorl, growth lines slightly opisthoclave, developing a sinus immediately below the suture; outer lip dentate within, anterior canal of moderate length and slightly curved.

**Discussion**.—*Anomalofusus* ranges through the Late Cretaceous *Eozogrya costata* zone of the gulf coast.

Wade (1926, p. 125) placed this genus in the Fusinidae. Wenz (1941, p. 1173) assigned it to the Buccinidae, and Stephenson (1941, p. 335) questioned its assignment to the Fusinidae. These assignments were based primarily on Wade's illustrations (1926, pl. 44, figs. 5–7) of the type species that represent a specimen lacking a part of the siphonal canal. *Anomalofusus* lacks the siphonal fasciolo and fold above the anterior canal, common to so many of the buccinids.

As figure 5 on plate 31 indicates, the siphonal canal is longer than previously supposed. The lack of any columbia plications distinguishes *Anomalofusus* from the Fasciolarinae and places it much closer to the Fusininae.

*Anomalofusus substriatus* Wade

**Plate 31, figures 1–4**


1925. *Anomalofusus substriatus* Wade. Cossmann, Essais Paléonconchologie Comparée, v. 13, p. 262, pl. 8, fig. 34.


**Diagnosis**.—Small to medium-sized shells with broadly and smoothly rounded whorls; ornament variable but transverse costae stronger than the fine spiral sculpture.

**Description**.—Small to medium-sized fusiform shells; spire about half total shell height and possessing broadly round sided whorls; protoconch proportionally large, consisting of about three smooth regularly coiled whorls, the first of which is submerged to the level of the second. Suture impressed. Body outline variable, but usually with a gently rounded shoulder and broadly rounded sides that slope rather gradually to the siphonal canal. Transverse sculpture of collare transverse costae of variable strength that diminish in strength on the basal slope; varices common; spiral sculpture finer and weaker, but overriding the transverse sculpture and consisting of thin spiral ribbons that cover the shell surface with the exception of the area between the suture and the weak shoulder. Growth lines sinuous in trend with a sinus developing over the shoulder between the suture and periphery. Aperture lancesolate, produced anteriorly to a moderately short broad slightly curved siphonal canal; outer lip sinuous in profile, dentate within, may be thickened by a varix; inner lip excavated, parietal lip bearing a callus extending out a short distance onto body; columellar lip smooth.

**Measurements**.—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

<table>
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<th>Loc.</th>
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<tr>
<td>37</td>
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<td>11.0</td>
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**Discussion**.— *Anomalofusus substriatus* Wade is moderately abundant. Shells of the species are usually well preserved and generally retain their protoconch but frequently possess an incomplete siphonal canal. Wade (1916, p. 461) chose as holotype an immature specimen lacking the extreme anterior extension. The holotype is small, as the preceding measurements indicate. The largest type specimen studied, although missing most of the spire, measures 42.4 mm of which 28 mm is the length of the body. Total height thus would be much more than 50 mm or at least 3 times the size of the holotype. Variation in obesity and ornament is considerable. Some specimens (pl. 31, fig. 2) show fine close-spaced transverse costae that die out shortly below the periphery. Others (pl. 31, fig. 1) show wider spaced stronger transverse costae. In general those specimens with the finer costae also possess the finer spiral ribbons. Variety of shape is also present among the suites of topotypes with specimens both slimmer and broader than those illustrated. Stephenson (1941, p. 335) stated that his species *A. bellulus* differed from *A. substriatus* Wade in being "**" less slender and more finely sculptured." *A. bellulus* is very close to the
obese types of *A. substriata* and distinction of the two is extremely difficult.

*Anomalofusus subnodosus* Sohl, from the Ripley Formation of Mississippi, is a smaller species possessing rather distinctly shouldered whorls that are more constricted below.

*Types*: Holotype USNM 32882; hypotype USNM 130307–130400.

*Occurrence*: Tennessee: Ripley Formation at loc. 1.

*Anomalofusus subnodosus* Sohl, n. sp.

Plate 31, figures 5, 6

*Diagnosis*.—A small anomalofusid with strong transverse ribs that are subnodose at the shoulder.

*Description*.—Shell moderately small in size, fusiform, spire about half total shell height. Protoconch proportionally large, consists of about 3½ normally coiled smooth whorls; the first whorl depressed to about the same level as the second; ornament begins with 4 spirals that later develop into the primary spiral ribbons of the spire. Suture impressed. Whorls number four to five; body whorl elongate, shouldered, constricted posteriorly and tapering below to the moderately broad pillar. Sculpture of both transverse and spiral elements; transverse ribs are strong, elevated, collabral and continue from suture well down on body but are strongest on the shoulder and periphery; varices are common with one or two per whorl. Spiral sculpture dominated by thin ribbons that develop at an early stage and number 4–5 on whorls of spire and 11–12 on the body whorl; secondary fine spiral threads occur in the spiral ribbon interspaces and both ribbons and threads override the transverse ribs; uppermost ribbon occurs at shoulder and frequently is accentuated to low nodelike protuberances. Aperture lenticular, produced anteriorly to a slightly curved siphonal canal of moderate length; outer lip sinuous in side profile, developing a sinus over the shoulder area, lip dentate within aperture; inner lip medially excavated with a thin callus extending over parietal lip onto body. Columella smooth and slightly curved.

*Measurements*.—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 172).

<table>
<thead>
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<tr>
<td>16</td>
<td>12.2</td>
<td>6.3</td>
<td>6.7</td>
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</table>

*Discussion*.—The strongly shouldered transverse ribs with their subnodose character distinguish this species from both *A. substriatus* Wade and *A. bellulus* Stephenson. In addition, *A. subnodosus* is small and the sutures are more impressed than on the other two species.

This species is widespread in the Ripley Formation of northern Mississippi. Individual variation does not appear to be as great as in *A. substriatus* Wade, but some variation in the strength of the transverse ribs and in the number of secondary spirals is noticeable between suites from different localities.

*Types*: Holotype USNM 130406; paratypes USNM 130406a–c.

*Occurrence*: Mississippi: Ripley Formation at locs. 5, 6, 15, 16, 18, 29.

*Anomalofusus lemnicatus* Sohl, n. sp.

Plate 31, figures 7, 8, 11–13

*Diagnosis*.—A medium-sized anomalofusid with smoothly rounded whorls, weak transverse ribs on the body, and few secondary spirals.

*Description*.—Small to medium-sized fusiform shells having a spire somewhat less than half total height. Protoconch proportionally large, consists of about 3½ whorls, the first of which is low; junction of conch abrupt with addition of both spiral and transverse elements that form a cancellate pattern on the first teleconch whorl. Suture impressed. Teleconch whorls number about four; body whorl rather evenly rounded with only a faint suggestion of a shoulder. Sculpture ornate, consisting of both transverse ribs and spiral ribbons and threads; transverse ribs collabral, thin and continuous on spire but dying out on basal slope; spiral sculpture dominated by thin spiral ribbons numbering 12–14 on body whorl, with 1–3 secondary spiral threads of variable strength appearing between the ribbons. Aperture lenticular, incompletely known; outer lip sinuous developing a sinus just below the suture.

*Discussion*.—This species is thin shelled and fragile and thus is generally incompletely preserved. *Anomalofusus lemnicatus* is restricted to the Owl Creek Formation and is known from several localities.

In outline, *A. lemnicatus* is similar to *A. bellulus* but has whorls that are proportionately shorter, growth lines that are strong, and it has less numerous secondary spirals. *A. subnodosus* differs by having stronger transverse ribs and shouldered whorls. *A. substriatus* differs primarily by the more numerous secondary spirals. In addition, these two species have spiral elements developing on the first teleconch whorl before the transverse ribs. On *A. lemnicatus* both elements develop at the same time.

*Types*: Holotype USNM 130407; paratypes USNM 130406, 130724, 130725.
Described and assigned three species of Cryptorhytis: Fasciolariia (Cryptorhytis) crassicosta, from the Providence Sand of Georgia, and Fasciolariia (C.) kerri and F. (C.) obliquecostata from the Ripley Formation of North Carolina. The latter species is based on indeterminable material, but the name was later retained by Weller for a generically indeterminable external mold from New Jersey. Fasciolariia (C.) kerri lacks the shape, growth-line trend, ornament, and columnar plications of Cryptorhytis and, although questionably referred by Stephenson (1923, p. 381) to that genus, appears to be more closely related to some form like Lomiroso Stephenson. Gabb never illustrated the first named species, F. (C.) crassicosta, but his holotype is retained at the Academy of Natural Sciences of Philadelphia and it has been assigned elsewhere herein to Bucinopsis Conrad.

Wade (1926) added two further species from Coon Creek, Tenn., to this list, and they are discussed below and assigned to Cryptorhytis with hesitation.

A number of references have been made to the presence of Cryptorhytis in the Upper Cretaceous deposits of Africa (Pervinquière, 1912; Rennie, 1929; Riedel, 1932; Darteville and Casier, 1943; and Darteville and Brebrin, 1956), but they are all based upon indeterminable internal molds whose assignments here must be treated with the utmost question.

Cryptorhytis nobilis Wade

Plate 32, figures 2, 3


1926. Cryptorhytis toria Wade, U.S. Geol. Survey Prof. Paper 137, p. 132, pl. 49, figs. 9, 10.

Diagnosis.—Medium-sized fusiform shells with ornament of numerous thin spiral lines that cover the shell surface and of strong collabral transverse ribs over the periphery; siphonal canal slightly to moderately flexed.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

<table>
<thead>
<tr>
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<td>C. nobila (holotype)</td>
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<td>14</td>
<td>2:1</td>
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<td>12</td>
<td>2:1</td>
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<tr>
<td>Do</td>
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<tr>
<td>Do</td>
<td>25</td>
<td>9</td>
<td>2:1</td>
</tr>
</tbody>
</table>

Discussion.—In the suite of 14 specimens from the type locality on Coon Creek, Tenn., at hand there are several specimens that bridge the gap between Crypt-
torhytis nobilis and C. torta. Wade (1926, p. 132) stated C. torta
is represented in the present collection by a single individual.
In outline and sculpture it greatly resembles Cryptorhytis nobilis
but differs from that form essentially in having a much
more strongly curved shoulder of Cryptorhytis torta and the stages of the
marginal notch on the shoulder are better defined.

With the number of specimens available that represent the various growth stages, a trend from less
strongly flexed collabral transverse ribs in earlier stages to more strongly flexed in the adult stages is clear.
Variation in the strength of spiral ornament over the periphery is present at all stages and the increased
twisting of the columella is here viewed only as a matter of stage of growth. This is, in part, borne
out by the specimen intermediate in size between the holotypes of Wade’s two species (pl. 31, fig. 2). On
the basis of the above statements Wade’s two species appear to be one intergrading species.

Types: Holotype USNM 32894; hypotype (holotype of C. torta) USNM 32896; hypotypes USNM 130411 and 130412.
Occurrence: Tennessee: Ripley Formation at loc. 1.

Family XANCIDAE
Subfamily XANCININAe

Genus LUPIRA Stephenson, 1941

Type by original designation, Xancus variabilis
Wade, 1926.

Diagnosis.—Medium-sized pyriform shells; spire
moderately low, pleural angle increases greatly with
increased size. Body inflated peripherally, constricted
rapidly below to a moderately long curving siphonal
canal and becoming subsuturally excavated on later
whorls. Sculpture of strong peripheral ribs and coarse
spiral cords. Aperture posteriorly notched; outer lip
crenulate; inner lip heavily calloused and parietal lip
bearing two to four plications.

Discussion.—Stephenson (1941, p. 360) proposed
this genus to include several Upper Cretaceous species
that differ from Xancus Bolten in their smaller and
more paucispiral protoconch. In addition to Xancus variabilis
Wade, from the Ripley Formation of Tennessee, and Lupira pyriformis
Stephenson, from the Nacatoch Sand of Texas, we may add Lupira poly-
cyma Harbison, from the Ripley Formation of Missis-
sippi, and L. turbinata Sohl (includes Xancus major
Wade, in part), from the Ripley Formation of Ten-
nessee.

As known, the genus is restricted to the Exogyra
costata zone of the Gulf Coastal Plain. Lupira poly-
cyma Harbison appears to be a direct descendant of
L. variabilis. Virtually the only change is the stabiliza-
tion of the number of columnellae plats to two in

TENNESSEE AND MISSISSIPPI

L. polyommata in the post E. cancellata of the beds Rip-
ley of Mississippi. Lupira turbinata Sohl, although similar in other respects, lacks the fasciole that is
present at the base of the body in the other two species
and evidently represents a divergent stock, or,
dependent upon how much emphasis is placed upon the
presence of the fasciole, may represent a different

Pyrisurus Conrad is similar to Lupira in ornament
and shape but lacks columnellar plications or any trace
of a fasciole band on the anterior slope of the body.

Lupira variabilis (Wade)
Plate 32, figures 14–16, 24, 25
1926. Xancus variabilis Wade, U.S. Geol. Survey Prof. Paper
137, p. 124, pl. 44, fig. 3, 4.
1926. Xancus major Wade, U.S. Geol. Survey Prof. Paper 137,
p. 124, pl. 44, figs. 1, 2 (not pl. 43, figs. 1, 2).

Diagnosis.—Large to medium-sized Lupira bear a fasciolelike band on the anterior slope on which the
growth lines develop an adapertural sinus and possess two to five plications on the columella.

Measurements.—Explanation of measurements and
symbols used in the following table appears in the
section “Measurements of specimens” (p. 172).

<table>
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<tr>
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<tr>
<td>1</td>
<td>35.9</td>
<td>23.8</td>
<td>98</td>
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</table>

Discussion.—Lupira variabilis Wade occurs well
preserved and in moderate abundance at its type locality
in the Ripley Formation on Coon Creek, McNairy
County, Tenn. As implied by the specific name, variabil-
ity within the species is manifold. Although most
specimens fall within the size range of 30–40 mm, one
specimen (pl. 32, fig. 24) selected by Wade (1926)
as the holotype of his new species, Xancus major,
would reach a length in excess of 90 mm if it were
complete. It is included as a synonym of L. variabilis
because of the possession of the typical fasciole band
and in addition possesses both spiral and transverse
ornament that falls within the range of L. variabilis.

The fasciolelike band on the anterior slope is present at
an early developmental stage and seems to develop
from the fusion of two low and poorly developed
broad spiral ribbons. It appears to increase in width
proportional to an increase in size, but it does not
increase in proportion to body width. Generally there
are six major spiral cords on the inflated part of the
body (pl. 32, fig. 16) above the fasciolar band, but some specimens may have only five. The excavated area between the shoulder and the suture varies much in depth from a gentle convex surface (pl. 32, fig. 14) to a strongly excavated area, lending the whorl outline a strongly shouldered appearance (pl. 32, fig. 15). Immediately above the shoulder on the excavated area there is generally at least one strong spiral cord. On some specimens there may be several cords that may carry up onto the subsutural collar that is developed on the more excavated forms. The transverse ribs vary much in strength but are restricted to the inflated part of the whorl and die out just above the shoulder. These ribs range from 13 to 18 per whorl. Growth lines are faintest on the early whorls but strengthen as shell size increases. Near the aperture of the mature specimen sinuosity of the lines increases across the excavated band above the shoulder, and their flexure, as they cross such spiral cords, also becomes more pronounced. These flexures give rise to the scalloped edge of the outer lip.

Compared with Lupira pyriformis Stephenson, this species is generally more slender, higher spired, and has more numerous coluromellar plications. Lupira turbinata Sohl has wider spaced spiral cords and lacks the fasciolar band of L. pyriformis.

**Types:** Holotype USNM 32881; Holotype of Kansas major Wade USNM 23874a; hypotypes USNM 77215; hypotypes USNM 130414, 130415.

**Occurrence:** Tennessee; Ripley Formation at loc. 1.

**Lupira pyriformis Stephenson**

Plate 32, figures 10, 11, 13, 19, 20


**Diagnosis.—**Medium-sized lupilids with a fasciolar-like band on the anterior slope, a proportionately low spire for the genus, and only two coluromellal plications.

**Description.—**Medium-sized pyriform shells with a moderately low spire; pleural angle 90°-96° on larger shells. Protoconch incompletely known, consisting of more than 1½ smooth round-sided whorls; junction with conch gradual, first developing transversely elongate peripheral nodes that lengthen to continuous ribs after about half a volute of first teleoconch whorl. Suture impressed, irregular in trace as it conforms to ornament of previous whorl. Early whorls expand slowly but later whorls expand disproportionately rapidly, lending the spire a concave-sided outline. Body whorl inflated above midheight, rapidly constricting anteriorly to the siphonal canal, and excavated between the suture and shoulder with a sub-sutural collar usually present. Sculpture strong, consisting of 13 to 16 strong collabral transverse ribs that are restricted to the inflated periphery. Spiral ornament above the shoulder absent or generally restricted to a few faint spiral cords; five or six strong cords appear on the whorl sides and override the transverse ribs; below these on the steep anterior slope is a broad fasciole-like band; growth lines adaperturally sinuous over fasciolar band, then swing back to a very slightly prosocline trend on the pillar. Aperture broadly subovate; posteriorly constricted to a short narrow deep notch and anteriorly extended to a rather narrow twisted siphonal canal of moderate length; outer lip thin at edge and crenulate; inner lip heavily calloused with edge of callus well defined over parietal lip and upper coluromellal lip but thinning and tapering anteriorly. Two strong plaits are present about one-quarter of a turn inside the aperture near the junction of the coluromellar and parietal lips, in places a third plait is present, but it is always weaker than the other two.

**Measurements.—**Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 172).

<table>
<thead>
<tr>
<th>Loc</th>
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<tr>
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<tr>
<td>18</td>
<td>30.0+</td>
<td>18.7</td>
<td>97</td>
</tr>
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</table>

**Discussion.—**Variation within the species is much like that described for *Lupira variabilis*, with the exception that *L. pyriformis* possesses at most three coluromellar plications, the lower two of which are the strongest. Further differences lie in the proportionately lower spire and higher pleural angle of *L. pyriformis*. No specimens of a size comparable to the maximum noted for *L. variabilis* have been found in the Ripley Formation of Mississippi.

Although Stephenson based *Lupira pyriformis* upon a small immature specimen from the Nacatoch Sand, the specimen possesses the features typical of immature specimens of *L. polycyma* Harbison from about the same stratigraphic level in Mississippi, and the two names are synonymized.

**Types:** Holotype USNM 20805 (Texas); hypotype (holotype of *L. polycyma*) ANSP 10003; (paratype L. polycyma) USNM 103758; hypotypes USNM 130416-130418.

**Occurrence:** Mississippi; Ripley Formation, locs. 4-7, 14-18. Alabama and Georgia (Chattahoochee River region): Ripley Formation.
**Lupira turbinata** Sohl, n. sp.

Plate 32, figures 18, 22, 23

1926. *Xancus major* Wade (in part), U.S. Geol. Survey Prof. Paper 137, p. 124, pl. 43, figs. 1, 2 (not pl. 44, figs. 1, 2).

**Diagnosis.**—Shell of medium size, lacking a fasciolar band on the anterior slope.

**Description.**—Medium-sized pyriform shells with a spire about one-sixth total shell length. Pleural angle of about 90°. Suture impressed, irregular in trace as it conforms to ornament of preceding whorl. Body whorl inflated above midheight, constricted anteriorly to a rather long siphonal canal, and posteriorly constricted to a subsutural collar. Sculpture of strong spiral cords of rather uniform strength, but which are more closely spaced on the anterior slope, and which are subdued on the excavated band below the subsutural collar. Transverse ribs confined to the inflated periphery of the early whorls but become subdued and lost on the largest forms. Growth lines prosocline on the collar and excavated band, swinging back to gently opisthoclone on the inflated periphery, then flexing back to gently prosocline on the anterior slope. Aperture broadly subovate, notched posteriorly, and produced anteriorly to an elongate curving siphonal canal; outer lip incompletely known, probably thin at edge and crenulate, inner lip callused, with callus boundary poorly defined on parietal surface, but well defined on columellar lip; callus loses contact at edge anteriorly and exposes a siphonal fasciole. Upper end of columellar lip bears three strong to six weak columellar plications.

**Measurements.**—The holotype measures 60.5 mm in height and 33.4 mm in diameter and has a pleural angle of about 90°.

**Discussion.**—Wade included the holotype of this species as a supplementary type under *Xancus major*. The holotype of that species, however, is a very large specimen of *Lupira variabilis* (Wade). *Lupira turbinata* differs from *L. variabilis* by lacking a fasciolar band on the base of the body and by having less coarse and wider spaced spiral cords. The growth lines differ from those of *L. variabilis* by being sinuose over the fasciolar band.

This species is rare at the type locality on Coon Creek in McNairy County, Tenn. At a higher level in the lower part of the Ripley Formation of Mississippi, a few small immature specimens bearing the typical columellar plications of the genus and lacking a fasciolar band have been collected. Although they are difficult to compare because of their size, they have been tentatively assigned to this species.

**Types:** Holotype USNM 328749; paratypes USNM 130419.

**Occurrence:** Tennessee: Ripley Formation at loc. 1. Mississippi: Ripley Formation at locs. 6, 18.

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**Lupira sp.**

Plate 32, figures 17, 21

**Discussion.**—Although no specimens assignable to *Lupira* have been discovered in the Owl Creek Formation, several internal molds from the Prairie Bluff Chalk appear to be assignable to the genus. These represent the highest stratigraphic occurrence of *Lupira* yet recorded. The molds have an inflated body and the reflection of transverse ribs that are strongest at the shoulder position. When the mold is broken back from the aperture (pl. 32, fig. 17), two strong plications high on the columella can be seen. The number and positioning of the plaits are much like those of *L. pyriformis* Stephenson from the Ripley Formation.

**Type:** Figured specimen USNM 130420.

**Occurrence:** Prairie Bluff Chalk at locs. 71, 87.

**Subfamily VASINAE**

**Genus PYROPIS** Conrad, 1860

**Type** by monotypy, *Tudicola* (*Pyropis*) *perlata* Conrad.

**Diagnosis.**—Medium to large-sized subpyriform shells having low to very low spires, peripherally expanded whorls that are shouldered and strongly constricted anteriorly, and a long, tapering, siphonal canal. Sculpture ornate, dominated by noded to spinose spiral cords. Aperture thickened within, inner lip heavily callused, columella smooth, except for a broad weak to strong swelling above the siphonal canal that leaves an umbilical chink at the upper edge of the columella lip.

**Discussion.**—The genus *Pyropis* has had a troubled history. Superficially it resembles *Tudicola*, and Conrad (1860, p. 288) originally assigned it as a subgenus of *Tudicola* Bolten. However, in 1869 he separated it and raised it to generic rank, because it differed from *Tudicola* by its possession of “a subtruncated apex, not papillated, and a smooth inner surface of the labrum, no fold on the columella, and the mouth more expanded and angulated.” Tryon (1883, p. 142) treated *Pyropis* as a distinct genus. On the other hand, most foreign authors have continued to treat *Pyropis* as a subgenus of *Tudicola* (Wenz, 1941, p. 1304) or as a synonym of *Tudicola* (Cossmann, 1901, p. 68; Theile, 1929, p. 342). As pointed out by Conrad, however, the lack of sharp columellar folds and the low flattened nucleus exhibited by the type species, *Pyropis perlata*, negates placement in *Tudicola*. Family placement has varied with almost every author and *Pyropis* has been placed at one time or another in: Volutacea, Vasiidae, Bucinidae, Turbinellidae, Turrididae, and Fulguridae. Stephenson (1941, p. 315) proposed
a new family name Pyropsidae but neglected to diagnose it. In it he included Pyrops and Hercorkynus Conrad plus two new genera he proposed, Medionapus and Napulus. Distinguishing Pyrops from Tudiola on a familial level appears to be much too drastic a step, especially when one notes the many similarities.

Even though Pyrops lacks sharp folds on the columella, there is a broad swelling on the inner lip above the siphonal canal that carries onto the earlier whorls. This swelling is a reflection of the separation of the inner lip from the columellar wall proper. On the basis of the close similarity of the two, Pyrops, though generically distinct from Tudiola, does not appear to warrant familial separation.

Stephenson (1941, p. 316 and 317) proposed a new genus Medionapus for Medionapus elongatus Stephenson and for the species referred to Trochifusus by Wade, of which the shell Trochifusus spinosus is a good example.

In differentiating Medionapus from Pyrops, Stephenson stated Medionapus differs from Pyrops in having a markedly higher spine, a much longer siphonal prolongation, a plumper body whorl below the shoulder angle, and a more completely sealed umbilical fissure; the protoconch is not quite so flat, is more slender and regularly coiled, and has at least one more volu-
tion.

Although the type species of Pyrops and Medionapus appear to be widely separated when compared, the other included species, variously assigned to Pyrops, Medionapus, or Trochifusus, seem to fill in the gap between the two end members. Therefore Pyrops and Medionapus are here treated as synonyms. The protoconch is virtually the same in both, being round topped, consisting of only about two whorls, and being somewhat raised above the plane of volution of the teleoconch. The length of the siphonal canal is generally longer in the higher spired forms, but this length is more of a specific character. The umbilical fissure, mentioned by Stephenson as distinctive of Pyrops, is present on some specimens which, on the basis of other criteria, would be assigned to Medionapus Stephenson and thus is a variable character.

Quite a number of species have been described and assigned to Pyrops. Unfortunately most species are incompletely known and many are based upon internal molds, which at best are determinable only upon a generic level.

Species assigned to Pyrops, but which are based upon specifically indeterminable internal molds. (Plus marks preceding the name indicate molds have the form of Pyrops.)

+Pyrops (Raca?) corrina Whitfield
+elevata Gabb
naticoides Whitfield
alabamensis Gabb

Pyrops? obova Whitfield
+Pyrops planimarginata (Whitfield) Weller
pyrualea (Gabb) Weller
+reitney Whitfield
+Richardsonii (Tuomey) Gabb
+septemirata Gabb
+trochiformis (Tuomey) Weller

Species assigned to Pyrops but in need of reassignment or herein reassigned:

Pyrops hancoeki Stanton
lenolensis Weller = Napulus
octolirata (Conrad) Whitfield = Napulus
whitfieldi Weller = Napulus
reitney (Gabb) Gardner
vernici Rennie = Sargana

In addition, Pelletins (1953, p. 220-222) described two species, Pyrops quinquecostata and Pyrops typica, from the Upper Cretaceous of Russia. Both species are based on internal molds of dubious generic affinities and cannot be accepted in Pyrops with any surety.

Species belonging in Pyrops:

Pyrops baikdi Meek and Hayden
coloradoensis Stanton
tanhani Stephenson
perlata Conrad
proxima Wade

Trochifusus perornatus (Wade)
Pyrops trochiformis (Tuomey) Gardner
cornutus Sohl
afriocana Woods
Trochifusus spinosus Wade
interstitialis Wade

In addition four species from the Upper Cretaceous of southern India may belong here: Rapa andoornensis Stoliczka, Rapa noditera Stoliczka, Tudiola exima Stoliczka, and Rapa cancellata Stoliczka. Several internal molds from the Aachen Cretaceous of Germany may belong in the genus as well as Pyrops patagonicus Wilcken's (= P. gracilis Wilcken's) and Tudiola gracilis (Wilcken's) of Collignon from Patagonia and Seymour Island.

Pyrops perlata Conrad
Plate 33, figures 1, 8, 11, 18, 20
1901. Tudiola perlata Conrad. Cossmann, Essais Paléonconcho-
logie Comparée, v. 4, p. 70.

**Diagnosis.**—A low- to flat-spired *Pyropsia* with a distinctly carinate and spineose shoulder below which the body is roundly constricted to the siphonal canal. Spiral ornament of wide-spreaded strong cords of almost equal strength below the carination.

**Description.**—Medium-sized low-spired pyriform shells. Protoconch raised above plane of teloconch evolution and generally resting at a slight angle; protoconch consists of 1½ or 2 broadly round-topped whorls that are spirally striate on the last one-third whorl, junction with teloconch relatively abrupt with upper and outer whorl faces flattening. Suture impressed, resting in a channel of square cross section. Teloconch whorls closely appressed, numbering about three, with upper whorl face flat on early whorls, but frequently very broadly convex on later whorls; shoulder sharply carinate and spineose; outer whorl face rounding down abruptly to the slim tapering pillar. Sculpture dominately spiral, consisting of spiral lirae of variable strength on the upper whorl face and 15–17 noded spiral cords that are of about equal strength over the upper body; the lirae are weaker on the pillar and rather widely spaced. Growth lines variable in strength, frequently wrinkling the shell surface near the aperture; in trend they are gently prosocline over the upper whorl face, form a sharp sinus over the carination, and are accentuated at intervals forming the irregularly spaced spines; they possess a gently opisthoclone trend over the rounded body, swing back to a prosocline trend on the body constriction, becoming almost orthoclone on the pillar. Aperture broadly ovate with a low notch near the suture and another at the shoulder that is accentuated when the spines of the carination intersect the outer lip; aperture anteriorly drawn out to a long, narrow, straight, siphonal canal. Outer lip is thick, angulated where intersected by the carinate shoulder, and crenulate where intersected by the spiral cords of the body; inner lip heavily callused; parietal lip rounded with callus extending onto body, upper edge adnate to parietal wall but free below; columellar lip free along length with a distinct swelling above the siphonal canal, which is reflected at the lip edge by a strong umbilical chink.

**Measurements.**—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 172).

**Discussion.**—In spite of its stout shell, without exception specimens of *Pyropsia peralta* Conrad have been found incomplete, lacking the full extent of the siphonal canal. Another 5–10 mm should be added to the length of the preceding measured specimens. Conrad's type is listed by Johnson (1905, p. 23) as being present in the collections of the Academy of Natural Sciences of Philadelphia, but I was unable to locate it there. The specimens from the Ripley Formation of Mississippi compare with the holotype (Conrad, 1860, pl. 46, fig. 39) quite favorably in size, shape, and apertural features. Among themselves, they show moderate variability in the height of spire and in the strength and nodding of the spiral cords. Some specimens, like the holotype, bear a stronger spiral cord just above the beginning of the body constriction, but most others show spiral cords of equal strength over the inflated parts of the body.

Compared with *Pyropsia procerina* Wade, this possesses a sharp carination that bears spines and lacks secondary spirals over the inflated body. Of the specimens Gardner (1916, p. 445) assigned to this species from the Matawan and Monmouth Formation of Maryland, most are internal molds related to *Pyropsia* but are specifically indeterminable. One specimen from near Brightseat, Prince Georges County, retains some shell material on the apex and is definitely a *Pyropsia*, but the spiral ornament on the upper whorl face consists of spiral lirae and two prominent spiral cords, the outer of which bears strong nodes. In *Pyropsia peralta*, three such upper whorl face cords develop on the body whorl, but no tendency is shown for nodding, and I believe that Gardner's specimen, although quite incomplete, represents another species. An incomplete external mold figured by Weller (1907, pl. 8, figs. 3, 4) is of a carinate *Pyropsia* bearing spines on the whorl angulation and appears close to this species, but the specimen is too incomplete for positive identification. *Pyropsia lanhamii* Stephenson, from the Kemp Clay of Texas, is very close to *P. peralta*, but the available specimens show a less constricted shell that matured earlier and has less rapidly expanded whorls. The other Ripley species are more highly ornate and bear higher spires. In the Owl Creek Formation another species of *Pyropsia* occurs that is poorly known but differs in having a highly ornamented upper whorl surface (pl. 33, fig. 6).

**Types**: Holotype ANSP lost?; hypotypes USNM 130421–130423.

**Occurrence**: Mississippi: Ripley Formation at locs. 15–17, 23.
Pyropsis proxima Wade
Plate 33, figures 7, 10, 14, 16, 22


Diagnosis.—A very low- to flat-spired Pyropsis with a shoulder angulation that bears low spines, below which the body is roundly constricted to the siphonal canal. Spiral ornament of strongly noded spiral cords below the shoulder angulation, with secondary cords between the primary cords over the inflated body.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

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<td>36.5</td>
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<tr>
<td>1 (hypotype)</td>
<td>37.2</td>
<td>32.3</td>
</tr>
</tbody>
</table>

Discussion.—Pyropsis proxima Wade occurs only at its type locality on Coon Creek, McNairy County, Tenn. In its general characters it is most closely allied to P. perlata Conrad from the Ripley Formation of Mississippi. That species, however, differs in possessing a sharply carinate shoulder angulation that, in addition, bears strong spines. P. proxima also bears secondary spiral cords inserted between the primary cords on the inflated part of the body. P. lanhamii Stephenson, from the Kemp Clay of Texas, is smaller, has less rapidly expanding whorls, and, as far as can be determined, lacks ornament on the upper whorl face and secondary spirals on the outer whorl face.

Types: Holotype USNM 32901; hypotype USNM 130424.
Occurrence: Tennessee: Ripley Formation at loc. 1.

Pyropsis sp. A.
Plate 33, figures 2, 6

Discussion.—Two specimens from the Owl Creek Formation on Owl Creek, Tippah County, Miss. (loc. 46) bear the low spire and angulated periphery of forms close to Pyropsis perlata Conrad. Below this angulation the body is rapidly and strongly constricted (pl. 33, fig. 2). In addition, it differs from P. perlata by its highly ornamented upper whorl face (pl. 33, fig. 6) that bears highly noded spiral cords. It can be distinguished from Pyropsis prolizza Sohl, also from the Owl Creek Formation, by having more numerous spiral cords on the upper whorl face that are noded instead of spinose and by having a lower spire.

Type: Figured specimen USNM 130425.
Occurrence: Mississippi: Owl Creek Formation at loc. 46.

Pyropsis cornutus Sohl, n. sp.
Plate 34, figures 7, 9, 10

Diagnosis.—Subpyriform shells with a moderately low spire for genus, strongly shouldered, well inflated whorls, and a siphonal canal of moderate length. Body bears three predominant spiral cords below the shoulder on the rounded body.

Description.—Medium to moderately large sized subpyriform shells with a moderately low spire and a siphonal canal of moderate length for the genus. Protoconch of 1½-2 round-topped whorls that grade to telococh whors by flattening of the upper whorl surface and by addition of a single spiral cord on the first telococh whorl. Suture impressed, becoming lowered to a troughlike depression on later whorls where the bordering subsutural row of nodes becomes spinose. Telococh whors expand moderately rapidly and number four to five. Whors peripherally inflated and angled above by a subcarinate shoulder that bears strong spines and rounds down below to a strong pillar. Sculpture ornate, dominated by nodose to spinose spiral cords and lirae; the first cord occurs bordering the suture and is noded on early whors but later becomes spinose with spines marking position of posterior canal; lesser lirae occur on the upper whorl face but become obsolete with growth; the cord at the shoulder is strongest and develops strong spines; three further nodose strong cords dominate the peripheral ornament, but secondary lirae occur between each, and lesser cords cover the basal slope and pillar surfaces. Aperture is notched posteriorly and anteriorly drawn out to an elongate siphonal canal. Outer lip incompletely known, angulated, and notched at the intersection of the spinose shoulder angulation, and it is crenulate where intersected by the major spiral cords of the periphery. Growth lines sinused over subsutural cord, aracately proscline or upper whorl face, bearing an adapertura directed sinus on the shoulder subcarination, and gently opisthoclene to orthoclene on periphery. Inner lip curving, callused; parietal lip highly callused, but with ornament reflected through callus that carries out onto body. Columellar lip free for most of its length and flexed at edge above siphonal canal; flexure carries inside aperture as a columellar swelling and anteriorly leaves an open umbilical fissure.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section on “Measurements of specimens” (p. 172). All specimens are incomplete but their dimensions are included to show size range.
Discussion.—As indicated by the measurements this species grows to quite a large size. Sculpture, especially that of the upper whorl face, becomes increasingly obscure on later whorls. Even on the earlier whorls of some specimens it is rather obscure or discontinuous.

This species, like *Pyropis bairdi* (pl. 33, fig. 9), is one which would rest at an intermediate position between *Pyropis* and *Medionapus* if the latter were to be accepted as a distinct genus. In general form and in ornament it approaches *Pyropis*, but its stepped spire and more rounded body is like that of *Medionapus*, as defined by Stephenson. Some other species of *Pyropis* have the sharp spino subcarinate shoulder of this species, but none have the peripheral ornament subdivided to three primary spiral cords with intercalated secondaries and tertiaries as exhibited by this species.

This species is scarce and is restricted to the Ripley Formation in Mississippi and generally specimens are incomplete.

*Types*: Holotype USNM 130426; paratype USNM 20531; paratype USNM 130427.

*Occurrence*: Mississippi: Ripley Formation at locs. 3, 5–7, 14, 177, 18.

*Pyropis spinosus* (Waive)

Plate 33, figures 19, 21; plate 34, figures 1, 5, 6


*Diagnosis*.—Subpyriform shells having an extremely long, thin, straight, siphonal canal. Below the substandard row of spines and above the shoulder is a broad unornamented concave excavated area that becomes deeply excavated in later growth stages.

*Description*.—Moderate to moderately large elongate subpyriform shells with rather low spire and an extremely long siphonal canal. Protoconch consists of about two round topped volutes that are raised above the plane of teleoconch whorls, junction with conch is accompanied by whorls becoming angulated; nodes develop on this angulation on the first teleoconch whorl. Suture impressed, resting in a narrow channel on early whorls that closes to a troughlike area that is bordered by a subsutural welt on later whorls. Teleoconch whorls expand moderately rapidly and number four to five; helical growth, in contrast, diminishes slightly with size. Whorls inflated peripherally and shouldered with an unornamented concavely excavated area between the subsutural row of spines and the siphonal spiral cord; this area becomes deeply excavated or lowered below the shell surface on the body; periphery below shoulder abruptly rounded down to the long pillar. Sculpture ornamented, dominated by siphonal spine to nodal spiral cords; subsutural cord and the cord at the shoulder form the strongest and most distinctly siphonal cords; cords may number more than 30 over the body and pillar but diminish in strength anteriorly. Growth lines are close-spaced threads that, at intervals, are accentuated to form spines marking the notches of the outer lip during growth; in trend the growth lines form a narrow sinus at the suture, are gently prosocline over the excavated area, arcuately opisthocrine over the periphery, and becoming almost orthocline over the pillar. Shape of aperture varies with developmental stage, when full grown it is flaring with a strong posterior channel and a long, narrow, siphonal canal. Outer lip thin at edge, developing a distinct notch at the intersection with the shoulder, and minor crenulations at the intersections of the spiral cords. Inner lip excavated, heavily callused, with the parietal calcar thickerened to a pad near the posterior channel and extending out of the aperture over the parietal wall; columellar lip thin at edge, curving the adapne only over upper edge, with a low swelling above the siphonal canal. Siphonal canal very long and narrow, slightly curved at the anterior end.

*Measurements*.—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

<table>
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<tr>
<td>3</td>
<td>144.6</td>
<td>71.6</td>
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</tbody>
</table>

Discussion.—The above measurements indicate the shells of this species reach a large size. The lengths of the larger specimens are subject to some error as the estimate is based on the assumption of a constant relation of height to width as measured on the most complete specimen, the holotype. That the length of the larger individuals may be less than estimated is suggested by the largest specimen, the paratype, whose angle of inclination of the suture, relative to the axis of coiling, lessens somewhat with the size of the individual and in that the last whorl is proportionally
more inflated. Even with corrections for these factors the total size of these individuals must be considerable.

These handsome ornate shells show distinct changes in their shape during growth and the smaller specimens look decidedly different than the adult individuals. These differences are accentuated by the fact that perhaps the most characteristic feature of the species, the extremely long siphonal canal, is broken in all the known large specimens, yielding a more massive shell that is difficult to relate to the delicate outline of the smaller specimens. These growth changes are well shown in the sequence of illustrations afforded herein and in Wade (1926, pl. 49, figs. 1–3). The holotype figured by Wade (1926, pl. 49, fig. 3) is a young individual and shows the full extent of the siphonal canal and a slim outline. A slightly later stage is shown herein on plate 33, figure 20. This specimen shows well the swelling within the aperture above the siphonal canal. The later stages, wherein the body becomes inflated and the subutural ornamented band continually more depressed, are shown by figures 5 and 6, on plate 34, and by Wade (1926) on plate 49, figure 1. The latter figure given by Wade is quite misleading in respect to the inner lip. The upper part of the columnar lip is thin and not adnate to the pillar, as shown, and the parietal lip is heavily callused and continuous upward in an arcuate path to the posterior canal, next to which, the callus is thickened to a distinct patch. Some of this callus has accidentally been broken off and the specimen is cracked and slightly offset at the junction of the parietal and columnar lips. In addition the depth of the excavated band between the posterior channel and the notch at the shoulder is accentuated by compression.

*Pyropis spinosus* (Wade) compares most closely with *P. elongatus* Stephenson from the Naatoch Sand of Texas, but the siphonal canal of that species is not so long at the same stage of growth and it has fewer, though perhaps, stronger spiral cords that bear somewhat more widely spaced nodes and spines.

*P. perornatus* (Wade), at the same stage of growth, possesses a lower spire, has a shorter siphonal canal, lacks the distinct Shouldering of the whorl, lacks an ornamented subutural band, and has a less constricted body. *P. cornutus* Sohl from the Ripley Formation has a shorter siphonal canal, stronger more distinctly shouldered whorls, and fewer spiral cords. *P. interstriatus* (Wade) has a shorter more curved siphonal canal and numerous fine secondary spiral lira in the spiral interspaces. *P. perlata* Conrad and *P. proxima* Wade both have lower spires with strong shoulders and fewer spiral cords.

**Types:** Holotype and paratype USNM 3206; hypotypes USNM 130423, 130429.

**Occurrence:** Tennessee: Ripley Formation at loc. 1.

*Pyropis interstriatus* (Wade)
Plate 33, figures 3–5


**Diagnosis.**—Subpyriform shells with an elongate and curving siphonal canal; numerous thin secondary spirals cover the surface of the body from the subutural row of spines to the whorl constriction below the periphery.

**Measurements.**—The holotype is the only specimen complete enough for measurement and is 39 mm in length and 25.7 mm in diameter but lacks the anterior tip of the shell.

**Discussion.**—This is a rather poorly known species but can be distinguished from *P. spinosus* and the other species by its curving siphonal canal and by the presence of the fine secondary lira present in the interspaces of the primary lira.

**Type:** Holotype USNM 3206.

**Occurrence:** Tennessee: Ripley Formation at loc. 1.

*Pyropis perornatus* (Wade)
Plate 54, figures 2–4, 11, 13


**Diagnosis.**—A pyrloid having a low spire outline, a poorly defined rounded shoulder, and a rounded periphery; upper whorl face ornamented by strong nodose spiral cords.

**Description.**—Medium to moderately large subpyriform shells with a low spire and a moderately long, siphonal canal. Protoconch incompletely known but lies above the plane of the teleoconch and has rounded whorls that grade to the flat-sided but round-topped first teleoconch whorl. Suture impressed on early whorls, lying in a slight trough on later whorls where it is bordered by a subutural row of nodes. Teleoconch whorls expand moderately rapidly and number four to five. Whorls inflated peripherally, constricted below to a moderately stout pillar. Sculpture ornate, dominated by 22–26 strong spiral cords that cover the whorl surface; on the early whorls the cords are nodded, but on the body they develop spines. Growth lines close spaced, strongest near the aperture of the larger specimens; in trend they form a sinus over the
subesutural row of spines, are prosocline over the upper whorl face, then gently opisthocline on the upper periphery, swinging back to prosocline on the lower part of the swollen body, and become almost orthocline on the pillar. Shape of aperture varies with shell development but is sublenticular in largest specimens with a strong curving posterior canal and an elongate inclined siphonal canal; outer lip thick, crenulate where intersected by the spiral cords; inner lip arcuate; parietal lip callus extending out of aperture over body and building up to a round-topped ridge bordering the posterior canal; columellar lip not in contact with body at edge, flexed rather strongly above the siphonal canal, thus, forming within the aperture a distinct swelling on the columella, and leaving a deep strong umbilical fissure.

**Measurements.**—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172). The width of the paratype is accentuated by compression.

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<tr>
<td>46 (paratype)</td>
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<td>34</td>
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**Discussion.**—All the available specimens of *Pyropis perornatus* are incomplete, lacking the extreme anterior tip, but the most complete specimen (pl. 34, fig. 4) indicates that the siphonal canal is proportionally shorter than that of *P. spinosus* (Wade). Variability within *P. perornatus* is most noticeable in its ornament and in the change in ornament with size. Smaller specimens lack spines (pl. 34, fig. 4) on the spiral cords, but spines become strongly developed with increased size (pl. 34, fig. 11). Some specimens bear few spars on the upper whorl face (pl. 34, fig. 3), but others (Wade, 1926, pl. 48, figs. 2, 6) bear close-spaced spars.

Among other differences, *P. perornatus* is lower spared and has a shorter siphonal canal than *P. spinosus* and is more highly ornamented and has a more poorly defined shoulder than *P. proxima*, *P. perlata*, or *P. cornutus*. *P. proliza* has a longer siphonal canal, higher spire, and a stronger shoulder.

**Types:** Holotype and paratype USNM 32962; hypotype USNM 130469.

**Occurrence:** Tennessee: Ripley Formation at loc. 1.

**Pyropis proliza** Sohl, n. sp.

Plate 33, figures 12, 13, 17; plate 34, figures 8, 12

**Diagnosis.**—A pyropid with a moderately low spire, a thin, long, siphonal canal, and an upper whorl surface and body covered by strongly spinose spiral cords with fine secondary threads in the cord interspaces.

**Description.**—Medium to moderately large subpyriform shells that possess a moderately low spire and a narrow siphonal canal that is above average length for the genus. Protoconch of about two raised round-sided whorls that grade to the teleoconch through a transition zone where the upper whorl surface flattens and a noded shoulder angulation develops. Suture impressed, resting on later whorls in a troughlike depression that is bordered by a raised subesutural row of spines. Teleoconch whorls number about four. Whorls shouldered, with early whorls having a flattened upper whorl surface that becomes increasingly sloping with increased size; periphery rounded and constricted below to the slim pillar. Sculpture dominated by strong spinose spiral cords that cover the body; three to four cords on the upper whorl face but about 20 on the body; cords decrease in strength anteriorly; secondary spiral cords and threads fill the cord interspaces over the inflated body. Growth lines prosocline over the upper whorl face, rather strongly opisthocline over the periphery, swinging back to gently prosocline to orthocline anteriorly. Aperture notched posteriorly and anteriorly drawn out to an elongate, narrow, siphonal canal. Outer lip incompletely known but bears a notch of moderate strength and has crenulations where the spiral cords intersect the outer lip margin. Inner lip only partly known, callus moderately thick and free at upper edge of columellar lip.

**Measurements.**—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 173).

<table>
<thead>
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<tr>
<td>46 (paratype)</td>
<td>55.5</td>
<td>34</td>
</tr>
</tbody>
</table>

**Discussion.**—This species is known only from the Owl Creek Formation on Owl Creek, Tippah County, Miss. (loc. 46). It is represented in the collections studied by seven specimens of which the holotype (pl. 33, fig. 12) is the most complete. One specimen (pl. 33, fig. 8), although poorly preserved, indicates the size attained by larger specimens of the species and also exhibits the nature of the upper part of the outer lip not seen on other specimens. The fragment illustrated on plate 33, figure 17, retains enough of the inner lip to indicate that the columellar lip edge was free and suggests that the typical columellar swelling above the siphonal canal was present. A larger un-
figured paratype (USNM) shows a rather strong swelling interiorly at this position.

_Pyropsis proliza_ is similar in its long canal to _P. spinosus_ but differs by having a stronger shoulder at an early stage and by having an ornamented upper whorl face. _P. perornatus_ is perhaps the most closely related species, but _P. proliza_ has a stronger shoulder at the same developmental stage, a proportionally higher and more stepped spire, possesses secondary spirals on the rounded body, and has a slimmer siphonal canal. Other species can easily be distinguished on the basis of ornament, their proportionally shorter siphonal canals, and in having a lower spire.

**Types:** Holotype USNM 130431; paratypes USNM 130432-130433.

**Occurrence:** Mississippi: Owl Creek Formation at loc. 48. Clayton Formation (Cretaceous reworked at base) at USGS loc. 4493.

**Pyropsis sp. B.**

Plate 33, figure 15

**Discussion.**—Several incomplete specimens indicate the presence of a form closely similar to _Pyropsis spinosus_ (Wade) in the Ripley Formation of Mississippi. Despite the similarities in shape of spire and body, these specimens possess ornament on the sloping upper whorl face that is not to be seen on Wade’s species.

**Type:** Figured specimen USNM 130436.

**Occurrence:** Mississippi: Ripley Formation at locs. 14, 23, 28, 29, 38.

**Pyropsis sp. C.**

Plate 32, figures 7–9

**Discussion.**—A rather large number of internal molds collected in the Prairie Bluff Chalk of Mississippi are characterized by having a very low spire and a sharply angulated to carnate shoulder, below which the body is constricted to a narrow pillar. The whorl sides characteristicly possess the impression of two additional strong spiral cords immediately below the carnation and several specimen (pl. 33, fig. 7) also bear the reflection of additional cords of lesser strength farther down on the body. Transverse swellings indicate that the cords were probably nodded. The aperture was slightly flared and notched posteriorly.

The specimens discussed above with their small size, low spire, and sharp shoulder show a relationship to _Pyropsis lanhami_ Stephenson. They also show similarities to, and may well be conspecific with, the specimen Weller figured (1907, pl. 86, fig. 2), from Atlantic Highlands, N.J., as an example of _Pyropsis richardsoni_ (Tuomey).

**Type:** Figured specimen USNM 130437.

**Occurrence:** Mississippi: Prairie Bluff Chalk at locs. 67, 71, 74, 70, 80, 82–94, 87, 88, 90–92, 94.

**Pyropsis sp. D.**

Plate 32, figures 1

**Discussion.**—A number of internal molds from the Prairie Bluff Chalk that have an outline much like _Pyropsis sp. C_ differ by their lack of reflections of spiral sculpture on the whorl sides and in size they are more comparable to _Pyropsis perlata_ Conrad.

**Type:** Figured specimen USNM 130438.

**Occurrence:** Mississippi: Prairie Bluff Chalk at locs. 71, 87, 94.

**Pyropsis sp. E.**

Plate 32, figures 6, 12

**Discussion.**—This grouping includes internal molds from the Prairie Bluff Chalk that are close in outline to those molds from New Jersey figured by Weller (1907) under the name _Pyropsis septembrirata_ Gabb. The spire is moderately low and lacks the angulated shoulder of _Pyropsis sp. C_ and _D_. Generally, the whorls are smooth, but on the latter part of the body whorl the surface bears reflections of rather coarse and noded spiral cords.

**Type:** Figured specimen USNM 130439, 130440.

**Occurrence:** Mississippi: Prairie Bluff Chalk at locs. 71, 74, 82, 84, 87, 88, 94.

**Pyropsis sp.**

**Discussion.**—A number of internal molds from the Prairie Bluff Chalk may well belong to the genus _Pyropsis_, but they do not fall within the categories set forth here. In general, individual types are represented by only one or two specimens and little advantage is seen in doing more than calling attention to their presence.

**Occurrence:** Mississippi: Prairie Bluff Chalk at locs. 71, 74, 82, 87, 90, 91.

**Genus NAPULUS** Stephenson, 1941

Type by original designation, _Napulus reesidei_ Sohl (= _Perissolax whitfieldi_ (Weller) of Wade, 1926).

**Diagnosis.**—Medium-sized low-spired pyriform shells have a moderately long siphonal canal comprising about one-third total shell length. Body whorl well rounded, inflated, shouldered to subshouldered, and marked by wide-spaced strong spiral cords or ribbons crossed by lower transverse ribs; columella smooth and straight.

**Discussion.**—The characters of the spire, the shape, and the presence of the long siphonal canal ally this genus to _Pyropsis_. _Napulus_, however, has a more erect bulbous protoconch with fewer whorls, and the
first teleoconch whorl is not shoulders. In addition, the columnella lacks the swelling above the siphonal canal typical of *Pyropsis* and has moderately well developed transverse sculpture. Shells of this genus have at times been assigned to *Perissolax* Gabb from the Eocene. That genus is based on *P. trivoluta* Gabb, which in turn is based on an internal mold of similar shape, but which has a proportionally longer canal and lower spire than *Napulus*. Well-preserved Eocene shells have been assigned to Gabb's genus (Stewart, 1930, p. 41), but they should be restricted. *Napulus*, if certain questionable New Jersey forms are included, ranges through the entire *Exogyra ponderosa* and *E. costata* zones from New Jersey through Texas.

Species to be included in *Napulus*:

*Napulus reesidei* Sohl, Ripley Formation, Tennessee  
*Ficus octoliratus* Conrad, Owl Creek Formation, Mississippi  
*Napulus fragilis* Sohl, Ripley Formation, Alabama  
*tuberolatus* Stephenson, Nacatoch Sand, Texas  
*Napulas retifer* Gabb, Wenonah Formation, New Jersey  
*Pyropis lelowskii* Weller, Mecherich Formation, New Jersey  
*whitfieldi* Weller, Navesink Formation, New Jersey

*Napulus reesidei* Sohl, n. sp.
Plate 25, figures 16–20, 24


**Diagnosis.**—Shell above average size for genus; shoulder strong, sharp and noded but begins to droop near aperture; body strongly constricted anteriorly; the strong primary spiral ribs of body are strongly noded where crossed by transverse ribs.

**Description.**—Shell medium-sized, pyriform; spire low, about one-sixth total shell height; pleural angle 90°–100°. Protoconch erect, consisting of about 1 ½ smooth well-rounded whorls that grade into the teleoconch gradually. Suture deeply impressed and sometimes weakly channelled. Whorls shouldered, well rounded, and inflated peripherally, bearing a flattened upper whorl face on early whorls that generally becomes an inclined ramp on the body; body whorl rapidly constricted below the periphery to a straight, narrow, siphonal canal. Sculpture ornate; ornament begins on first teleoconch whorl with two spiral cords, a shoulder angulation forms after about three-quarters of a volition; body bears six or seven wide-spaced strong raised noded spiral ribs or cords over the rounded outer whorl face; the lower ribbon is just above the pillar and weaker than the others; 8–10 lesser spiral cords and threads cover the pillar and decrease in strength anteriorly. Collabral transverse ribs override the stronger spiral ribbons and form nodes at their intersection and render a sub cancellate pattern. Growth lines strongest near aperture and may form incremental imbrications; growth lines are gently proscine in trend over the upper whorl face, gently opisthoclone over the rounded outer whorl face but swing back strongly over the whorl constriction becoming orthoclone on the base. Aperture subovate, flaring slightly, interrupted anteriorly by a narrow, elongate, siphonal canal. Outer lip thin and flaring at edge, well rounded, generally bearing five crenulations where the lip is intersected by the strong spiral cords of the outer whorl face. Inner lip lightly to moderately callused, callus of the parietal lip extending well out over the body; columnellar lip callus thin. Columella smooth and almost straight.

**Measurements.**—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

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<tr>
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**Discussion.**—*Napulus reesidei* is well represented and well preserved at its type locality on Coon Creek, McNairy County, Tenn. The specimens available for study include all stages of growth and the shell proportions appear to vary little. In all the larger individuals the late growth stages are characterized by a sloping of the upper whorl surface, a breakdown of the transverse ornament, and spiral ribs that become less flat topped and usually round off to cords. Although no specimens have secondary spiral lirae between the uppermost three ribs, their presence between the lower primaries is not rare. Although always remaining strong, there is variance in the width of the spiral ribs. The shape of the interspaces delimited by the elements of ornament varies from square to rectangular, but the latter shape is the most common.

*Napulus reesidei* is larger and has fewer primary spiral ribs than *N. tuberolatus* Stephenson. It has a more constricted body, stronger transverse ornament, and stronger nodings of the spiral ribs than *N. fragilis* Sohl. In addition the profile of the outer lip of *N. reesidei* shows a more pronounced sinuosity, with the opisthoclone trend over the lower periphery being stronger than on the other species of the genus (pl. 25, fig. 19). *N. whitfieldi* (Weller), to which Wade assigned this species, is based upon internal
molds from a slightly higher stratigraphic position in New Jersey. Weller's species, although doubtlessly belonging to *Napillus*, based as it is on internal molds, does not show growth-line features and the characters necessary for confident specific identification, and consequently the name should be restricted to the New Jersey specimens.

The species is named for the late J. B. Reeside, Jr., whose council was sought and freely given during the preparation of this manuscript.

**Types:** Holotype USNM 32905; paratypes USNM 130441–130443.

**Occurrence:** Tennessee, Ripley Formation at loc. 1.

*Napillus fragilis* Sohl, n. sp.

Plate 35, figures 12, 21–23

**Diagnosis.**—A *Napillus* of average size with a strong and moderately noded shoulder that begins to droop near the aperture on large specimens. Sculpture dominated by six primary spiral ribs that override much weaker or subdued transverse ribs.

**Description.**—Medium to moderately small sized thin pyriform shells. Spire low, about one-fifth total shell height; pleural angle 100°–110°. Protoconch consists of about two tightly coiled well-rounded smooth whorls that grade gradually to the teleoconch which is demarked by the presence of two spiral cords the upper of which forms a shoulder angulation after about one complete teleoconch solution. Suture deeply impressed to subchanneled. Whorls shouldered, peripherally well rounded, and bearing a flattened upper whorl face whose inclination may increase near the aperture; body constricted below to a straight siphonal canal of moderate length. Sculpture dominated by rather thin wide-spaced spiral ribs and cords; upper whorl face smooth save for faint microscopic spiral lirae; rounded whorl sides bear six or seven primary spiral ribs that are rather faintly noded; pillar covered by finer cords and lirae that diminish in strength with increased size of shells, becoming faint swellings near aperture of largest individuals. Growth lines fine, numerous, and strongest near aperture of mature forms; growth lines are very gently prosocline to orthocline over the upper whorl face, very gently opisthochline over the rounded whorl sides, and swinging back more strongly to prosocline below the fifth spiral ribbon. Aperture subovate, drawn out anteriorly to a narrow siphonal canal that is slightly inclined to the shell axis. Outer lip slightly flared at edge and crenulate where the major spiral ribs intersect the edge. Inner lip excavated in harmony with the body constriction; parietal lip lightly callused with callus extending well out onto body whorl; columellar lip more heavily callused, having a tendency to loosen anteriorly and may leave a narrow umbilical chink. Columella smooth.

**Measurements.**—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 172).

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**Discussion.**—The preceding figures indicate the magnitude of size range for normal individuals, but all specimens lack a small part of their siphonal canal.

The variation with size in the strength of nodding of the spiral ribs is well shown by comparing figures 12 and 21 in plate 35. The sloping shoulders of the late stages of development is exhibited in figure 12, a view of the largest known specimen of the species.

Compared with *Napillus reesidei*, from a lower stratigraphic position, *N. fragilis* is thinner shelled, has more numerous and less coarsely noded spiral ribs, less well developed transverse ornament, a less constricted body, and a less curving growth line. *Napillus octoliratus* (Conrad) from the Owl Creek Formation has more subdued ornament and virtually lacks nodings of the spirals except on the earliest whors. *Napillus tuberculatus* Stephenson, from the Nacatoch Sand of Texas, is based on small and probably immature specimens that are difficult to compare. The growth lines of this species are more nearly orthocline, the transverse ribs sharper at the same stage of growth, and the shoulder nodings appear to be stronger.

**Types:** Holotype 130444; paratypes 130445–130447.

**Occurrence:** Mississippi, Ripley Formation at locs. 6, 12, 16–18, 23, 33(?), 35(?), 39.

*Napillus octoliratus* Conrad

Plate 35, figures 7, 14


1941. *Napillus octoliratus* (Conrad) ?. Stephenson, Texas Univ. 4101, p. 320, pl. 60, figs. 7, 8.


**Diagnosis.**—A *Napillus* of average to rather small size with a noded to subnoded shoulder angulation. Body sculpture dominated by 5–6 wide-spaced and narrow spiral ribbons; transverse elements generally very weak. Siphonal canal rather long and narrow.

**Description.**—Medium to moderately small sized pyriform shells. Spire low with a pleural angle of
about 95°. Protoconch consists of about two low well-rounded smooth whorls that grade to the teloconch as three spiral cords appear on the rounded whorl sides. Suture deeply impressed. Earliest whorls rounded, but later whorls shouldered with a flat to gently inclined upper face and well-rounded sides that are constricted below to an elongate siphonal canal. Sculpture consists of from 5 to 6 spiral ribbons on the body that are very wide spaced and some are noded as they overtop weak collateral transverse swellings. Growth lines rather strongly prosocline over the upper whorl face, acutely opisthoclone over the periphery and orthoclone on the pillar. Aperture incompletely known, subovate, and anteriorly drawn out to a long, straight, narrow, siphonal canal; outer lip crenulate where intersected by the primary spiral lirae. Columella smooth.

**Discussion.**—All the available specimens of *Napulus octoliratus* are too incomplete for satisfactory measurement. In general, the poor development of tuberculations distinguishes this species from all others. In addition, *N. reesidei* has a more constricted body and transverse sculpture. *Napulus fragilis* also has coarser ornament and more numerous spiral ribbons.

*Napulus octoliratus* as here defined is restricted to the Owl Creek Formation in Mississippi and Missouri and to its equivalents in Texas. Reported occurrences elsewhere at different levels are based primarily upon specifically indeterminable internal molds.

**Types:** Holotype ANSP (lost?) (Mississippi); hypotypes USNM 128190 (Mississippi); hypotype USNM 76999 (Texas); hypotypes USNM 130445, 130450 (Mississippi); hypotype USNM 128191 (Missouri).

**Occurrence:** Mississippi: Owl Creek Formation at locs. 43, 45, 46. Missouri: Owl Creek Formation. Texas Kemp Clay.

*Napulus* sp.

Plate 35, figures 8–11, 13, 15

**Discussion.**—Internal molds assignable to the genus *Napulus* are rather widespread in the Prairie Bluff Chalk and at some localities are present in quantity. They occur at the same level as *Napulus octoliratus* (Conrad) of the Owl Creek Formation and may belong to that species. Reflections of the flat upper whorl surface and of five strong spiral cords as well as the reflection of transverse sculpture (pl. 35, fig. 10) is present, but in all instances the siphonal canal is broken off. These impressions of ornament are most strongly developed on the smaller specimens but are subdued on the larger ones. (Contrast fig. 8 and 13 on pl. 35.) The possibility of a second species of *Napulus* being present in this formation is raised by the specimen figured on plate 35, figure 15, that possesses more numerous closer spaced spiral elements and the reflection of rather fine close spaced transverse ribs.

**Types:** Figured specimens USNM 130449, 130451–130453.

**Occurrence:** Mississippi: Prairie Bluff chalk at locs. 53, 55, 57, 66, 67, 71, 80, 82, 87, 91, 92, 94.

**Superfamily VOLUTACEA**

**Family OLIVIDAE**

**Subfamily PSEUDOLIVINAE**

**Genus PYCHOSYCA** Gabb, 1877

**Type by monotypy, *Pychosyca inornata* Gabb.**

**Diagnosis.**—Medium-sized pyruliform shells have a smooth surface that is almost completely devoid of ornament and a double sulcus on the basal part of the body that is divided by a raised median band. Siphonal notch rather broad and deep; columella smooth.

**Discussion.**—Dall (1890, p. 73) suggested that *Pychosyca* might be a synonym of *Volutomorpha* Gabb. He stated no reasons for such a view, but his suggestion was followed by Cossmann (1899, p. 294) and Wenz (1944, p. 1314). *Pychosyca inornata*, however, bears utterly no resemblance to *Volutomorpha* in either shape or ornament but has distinct fasciolar characters as well as a lack of columellar plications. The fasciolar characters seem to ally it most closely to *Pseudolivinnae*, but even here no closely related genera are to be found and it stands alone. The genus is restricted to the *Eurytoma costata* zone of the east gulf coast except for an undescribed species occurring in the Hygiene Sand of Colorado.

**Pychosyca inornata Gabb**

Plate 35, figures 1–6


**Description.**—Shell medium-sized, pyruliform, spire very low, pleural angle 110°–120°. Suture indistinctly obscured by callus. Whorls five to six in number; early whorls of spire more steeply sloping and less rounded on upper surface than later whorls. Body well rounded over the inflated periphery; periphery constricted at its base by a broad deep sulcus that is followed by a broad raised flat-topped platform that borders a broad siphonal fasciole. Surface smooth, glazed by callus. Sculpture absent of obscure fine spiral lines. Growth lines opisthoclone in trend near the suture, swinging to gently prosocline over the inflated part of the whorl, abaperturally sinusod over the upper sulus, adaperturally sinusod over the platform, and again abaperturally sinusod in the position of the siphonal notch. Aperture broad, elongate, narrowly and slightly notched posteriorly; siphonal canal broad, open, slightly twisted, and inclined to the left. Outer lip unknown; inner lip outline excavate in harmony with the sulcus.
Columella bearing three or four faint to obscure plaits that carry out a short distance onto the body surface below the siphonal fasciole.

**Measurements.**—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

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**Discussion.**—The holotype Ptychopyca inornata Gabb, from the Providence Sand on Pataula Creek, Clay County, Ga. (pl. 35, figs. 3, 4), is preserved in the collections of the Academy of Natural Sciences of Philadelphia (ANSP 15155). The specimen is slightly compressed and is missing both the apical and anterior tips. Specimens from the Ripley Formation of Mississippi compare very well with the holotype in shape, size, ornament, and possession of a basal sulcus. P. inornata is scarce and in the Mississippi embayment region is represented by only six specimens, all of which are incomplete and come from a lower stratigraphic position than the type specimen.

**Types:** Holotype ANSP 15155; hypotypes USNM 130454, 130455.

**Occurrence:** Mississippi: Ripley Formation at locs. 6, 16, 23. Tennessee; Ripley Formation at loc. 1. Georgia: Ripley Formation and Providence Sand.

**Genus HYDROTRIBULUS** Wade, 1916

Type by original designation, *Hydrotribulus nodosus* Wade.

**Diagnosis.**—Medium-sized subpyriform shells; whorls shouldered, posteriorly constricted to a collar, and mediados inflated. Sculpture of strong wide-spaced spiral cords that override the transverse ribs of the periphery and basal slope. Aperture subovate, posteriorly notched; siphonal canal curved, narrow, and deep; siphonal notch shallow; outer lip crenulate and denticulate where it margins calceal inner lip with a parietal tooth, heavily callused, with a siphonal canal bounded above by a strong ridge on the colurnellar lip.

**Discussion.**—Wade (1926, p. 146) proposed this genus for the type species *Hydrotribulus nodosus* plus “an undescribed species from Owl Creek, Miss., and another from Brightseat, Maryland and a species in the Senonian of Aachen, Germany.” The latter is *Raps monheimeri* Miller, which elsewhere herein has been assigned to *Hercorynus*. I know of no species of *Hydrotribulus* to be found either in the Monmouth Formation of Maryland or in the Owl Creek Formation of Mississippi, although Stephenson (1941, p. 330) subsequently described a new species *H. asper* from the Kemp Clay of Texas. Judging by the Aachen species here referred to *Hercorynus*, Wade may have had in mind specimens of that genus from Owl Creek.

Morphologically, *Hydrotribulus* appears to be closest to *Strepsiduro* as typified by S. burgida (Solerander) from the Eocene of the Paris Basin. It differs from that genus not only in the typical strong spiral cords, but in the possession of a strong parietal tooth and in the appearance, on the first teleconch whorl, of spiral ornament before the transverse.

**Hydrotribulus nodosus** Wade

Plate 36, figures 19, 20

1943. *Hydrotribulus nodosus* Wade. Wenz, Handbuch der Paläontologie; Gastroidea, v. 6, pt. 6, p. 1271, fig. 3614.

**Diagnosis.**—Medium to moderately large sized hydrotribulids with a nodose subsutural collar.

**Measurements.**—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

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**Discussion.**—*Hydrotribulus nodosus* Wade is not common at its type locality in the Ripley Formation on Coon Creek McNairy County, Tenn. The suits of well-preserved topotypes available for study indicate the range of infraspecific variation to the moderate. The holotype, whose measurements are listed above, is the most nearly complete large specimen, but another incomplete topotype (USNM 130457) measures about 36 mm in diameter with an estimated shell length of about 55 mm. Though not reaching as large a size as *Hydrotribulus asper* Stephenson, from the Kemp Clay of Texas, which reaches an estimated size in excess of 80 mm, *H. nodosus* nonetheless reaches a moderately large size. The nodings of the collar generally strengthen with increased size and the thickening of the outer lip appears to be a gerontic feature. (Compare pl. 36, fig. 19 with Wade, 1926, pl. 51, figs. 6, 7.) The excavated band between the shoulder and the sub-sutural collar on some specimens is devoid of ornament (pl. 36, fig. 20), but generally there are several spiral lirae, and
on one specimen there is a flat-topped spiral ribbon of moderate strength. Generally between the four major strong spiral cords on the rounded whorl periphery there are only faint microscopic spiral lirae, but a few specimens show a moderately strong secondary cord that usually occurs between the uppermost two primaries. The transverse ribs vary not only in strength, but in number and spacing. The lowest number of ribs per whorl noted was 11 and the highest 17.

Hydrotribulus nodosus Wade most nearly resembles H. elegans Sohl from the stratigraphically higher Ripley Formation of Mississippi. That species, however, is not only smaller in size but lacks nodings on the subvertical collar. H. asper from the Kemp Clay of Texas is larger and has more numerous spirals on the whorl sides.

Types: Holotype USNM 32915; hypotypes USNM 130456; mentioned specimen USNM 130457.

Occurrence: Tennessee: Ripley Formation at loc. 1.

Hydrotribulus elegans Sohl, n. sp.
Plate 36, figures 13-16, 18

Diagnosis.—Shell small for genus and lacks a nodose collar.

Description.—Shell of medium size, spire somewhat less than half the total shell length; pleural angle 70°-80°. Protoconch consisting of about two regular smooth surfaced volutions; junction with conch gradual, accompanied by flattening of the upper whorl surface and addition of spiral cords to the whorl sides. Whorls shouldered with a well-rounded periphery, and constricted posteriorly to a moderately strong collar and constricted anteriorly to a curved pillar. Suture impressed. Sculpture strong; two broad strong spiral cords are visible on the penultimate whorl between shoulder and suture, these are the upper two of the four equispaced primary cords of the periphery; sometimes a few faint spiral lirae occur above the shoulder; on the basal slope and the siphonal canal progressively weaker cords appear; transverse ribs number 13-15 on the body whorl, are strongest at the shoulder, and pronouncedly diminish in vigor on the anterior slope. Growth lines prosocline between suture and shoulder, almost orthocline in trend over the rounded whorl sides with shallow minor sinuses formed where the lines cross the primary spiral cords. Aperture subovate, posterior notch broad and shallow, bounded by a parietal tooth, siphonal canal of moderate length, twisted, and inclined to the left; outer lip thin at edge, thickening within on later stages, crenulate at edge and bearing several teeth above the siphonal canal; inner lip callus well defined, narrowing on columellar lip, columella bearing a broad swelling immediately above the siphonal canal.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

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Discussion.—Hydrotribulus elegans Sohl occurs at only two localities in the Ripley Formation of Mississippi, but specimens are well preserved and in moderate numbers at each locality. Variation among the specimens is less than that for H. nodosus and affects the general strength of ornament and presence or absence of ornament on the subvertical collar.

Compared with Hydrotribulus nodosus Wade, from Coon Creek, Tenn., this species lacks nodes on the subvertical collar, is constantly smaller in size, and has more uniformly developed spiral ornament on the anterior slope. H. asper from Kemp Clay of Texas is also much larger in size and has more numerous spiral elements.

Types: Holotype USNM 130458; paratypes USNM 130459-130461.

Occurrence: Mississippi: Ripley Formation at locs. 5, 18.

Hydrotribulus? sp.
Plate 36, figures 11

Discussion.—The internal mold from the Prairie Bluff Chalk of Chickasaw County, Miss., figured on plate 36, figure 11, has the inflated body and posteriorly constricted whorls typical of Hydrotribulus. The reflection of strong transverse ribs on the inflated periphery and of several strong spiral cords is also present. These features suggest the genus Hydrotribulus and serve to indicate the possible presence of the genus in the youngest Cretaceous beds of the Mississippi embayment. However, neither in proportions nor in the character of ornament does this specimen suggest H. asper from the stratigraphically equivalent Kemp Clay of Texas.

Type: Figured specimen USNM 130462.

Occurrence: Mississippi: Prairie Bluff Chalk at loc. 66.

Genus Fulgerca Stephenson, 1941

Type by original designation, Fulgerca venusta Stephenson.

Discussion.—Small sub fusiform shells with an apical-
ly blunted spire of more than half total shell length. Protoconch consists of 3-3½ very rapidly expanding whorls. Whorls elongate, very gently rounded, tapering anteriorly, with a fasciolar band present low on base. Sculpture of intersecting fine spiral and transverse cords. Growth lines broadly sinuous high on whorl and more strongly adaperturally sinuous on fasciolar band. Aperture sublenticular; siphonal canal broad and open, notch shallow; outer lip thin at edge with a tooth at the termination of the fasciolar band.

Discussion.—Stephenson (1941, p. 372) proposed *Fulgera* to include the type species from the Neylandville Marl and *Pseudolivia attenuata* Wade from Coon Creek, Tenn. Undescribed species are present as early as the Eutaw Formation (Santonian) of Alabama.

Stephenson (1941, p. 372) stated:

Aside from the spiral sulcus on its base, this shell possesses no characters which would seem to ally it with the Bucinidae; its slender spire and broad notch in its outer lip below the suture suggest a closer relationship with the Turritidae.

The sinus spoken of above is not pronounced and is not a typical turrid sinus. The sulcus on the base that terminates in a tooth is, on the other hand, very typical of the Olividae. In addition the shape of the shell is similar to *Ancilla* and other genera of that family. Stephenson’s placement is understandable because none of the material available to him possessed a complete aperture with its toothed outer lip.

*Fulgera attenuata* (Wade)

Plate 36, figures 8, 12


Discussion.—All the specimens available for the study of this species are evidently immature. One of the primary criteria used by Stephenson for differentiating the type species *F. venusta* from *F. attenuata* was the larger size of the Texas form. He also noted that the Tennessee species is slimmer or less coarsely sculptured. Considering only the type specimens all these statements are true. Incomplete topotypes, even though smaller in size than the holotype, indicate that some specimens of *F. attenuata* were more obese (pl. 36, fig. 12). As both the Texas and the Tennessee material comes from the *Esogyra cancellata* zone the possibility of the names being synonyms is present, but this cannot be decided on the basis of the available material.

Types: Holotype USNM 32914; hypotypes USNM 130663.

Occurrence: Tennessee: Ripley Formation at loc. 1.

*Fulgera attenuata* (Wade)

Plate 36, figures 9

Discussion.—Both fragmentary and rather complete specimens have been collected from localities in the Ripley Formation of Mississippi. These specimens occur in the lower part of the Ripley formation at a higher level than those of the Coon Creek locality of Tennessee. Because of the incomplete nature of the specimens from Tennessee it is difficult to compare the two. In general no significant differences have been noted in a comparison of the immature shells. The specimen figured on plate 36, figure 9, is the only specimen of a *Fulgera* completely enough preserved to retain the tooth on the outer lip.

Type: Figured specimen USNM 130464.

Occurrence: Mississippi: Ripley Formation at locs. 5, 6, 15-18.

Subfamily OLIVINAE

Genus *ANCILLA* Lamarck, 1799

Type by monotypy, *Ancillaria candida* Lamarck, 1811 (= *Voluta ampla* Gmelin, 1792).

Diagnosis.—Small to medium-sized generally subcylindrical shells that have a smooth, glazed surface and callus covering the suture. Aperture elongate, posteriorly angulated, widening anteriorly; siphonal notch broad and deep.

Discussion.—This genus is practically unknown in the Cretaceous. Heretofore, only a few very questionable species have been assigned to any of its rather numerous subgeneric divisions (Cossmann, 1899, p. 60; Stewart, 1927, p. 411). Woodring (1928, p. 234) stated that no typical species of *Ancilla* (*Ancilla*) occur either as living or fossil forms in America. As far as is known, *Eoancilla acuta* Stephenson, from the Kemp Clay of Texas, is the only substantiated member of the genus in pre-Tertiary strata.

Subgenus *ANCILLUS* Montfort, 1810


Type by monotypy, *Ancilla buccinoides* Lamarck, 1803.

Diagnosis.—An *Ancilla* with a proportionally high spire that is covered by a callus glaze. Protoconch consists of a few rounded whorls. Body whorl moderately large and smooth with a broad median band that lacks callus glaze below whorl midheight; siphonal notch broad and rather deep; callus on parietal wall thick and ascending to spire.

Discussion.—*Ancilla* (*Ancilla*) differs from *A. (Ancilla)* most noticeably by having a proportionally higher spire and an aperture that is less broadly ex-
panded anteriorly. Stephenson (1941, p. 361) in proposing his new genus *Eoancilla* distinguished it from the type species of *Ancilla*, as follows:

> Compared with examples of *Ancilla ampla* (Gmelin): *Eoancilla* has a higher spire; a much shorter body whorl; a flatter and more sharply restricted band of calyx on the whors of the spire; greater obliquity of the flattened band on the anterior part of the columella and more numerous plications on this band; and a deeper notch at the end of the anterior canal.

Although Stephenson made comparisons with *Olivella*, none were made with other subgenera of *Ancilla*. The characters cited above, the proportions exhibited by *Eoancilla acetula*, its blunted apex, as well as the apertural features, and the character of the parietal calyx warrants assigning the species to *Ancilla* (*Ancillus*) and synonymising *Eoancilla*.

Anilla (*Ancillus*) acetula (Stephenson)
Plate 36, figures 1-7, 10

*Diagnosis.*—Shells small for genus; spire about half total shell height.

*Measurements.*—Percentage of total height = height of body to total height. Explanation of other measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

<table>
<thead>
<tr>
<th>Loc.</th>
<th>H</th>
<th>MD</th>
<th>HB</th>
<th>Percent of total H</th>
<th>H-D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Texas (holotype)</td>
<td>0.6</td>
<td>4.1</td>
<td>5.4</td>
<td>0.56</td>
<td>2.3</td>
</tr>
<tr>
<td>Texas (paratype)</td>
<td>8.7</td>
<td>2.6</td>
<td>5.0</td>
<td>0.57</td>
<td>3.4</td>
</tr>
<tr>
<td>46 (hypotype)</td>
<td>13.6</td>
<td>4.4</td>
<td>7.0</td>
<td>0.51</td>
<td>3.0</td>
</tr>
<tr>
<td>46, 47</td>
<td>3.1</td>
<td>3.1</td>
<td>5.1</td>
<td>0.50</td>
<td>2.3</td>
</tr>
<tr>
<td>47</td>
<td>7.4</td>
<td>3.0</td>
<td>4.7</td>
<td>0.50</td>
<td>2.5</td>
</tr>
<tr>
<td>48</td>
<td>5.3</td>
<td>5.5</td>
<td>4.7</td>
<td>0.51</td>
<td>2.7</td>
</tr>
</tbody>
</table>

*Discussion.*—Stephenson (1941, p. 362) gave a detailed description of this species. The species appears to be most abundant in the Owl Creek Formation of Mississippi. With the large numbers available, a moderate amount of variation can be noted. As indicated by the measurements, the ratio of height to width is moderately variable and indicates a variation in obesity regardless of size. On the other hand, the length of the body whorl in relation to total length is relatively uniform and quite typical of *A. (Ancillus)*. A comparison of figures 5 and 6 on plate 36 also indicates a variation in pleural angle. The specimens from locality 46 have a greater pleural angle, a longer body whorl, and have a band of calyx above the siphonal fascicule that is less well delimited at its upper margin. The upper margin occurs higher on the whorl in these specimens (pl. 36, fig. 5) than on the specimen from locality 45 (pl. 36, fig. 3). The latter also has a well-defined margin to this calyx band, a boundary formed by an incised groove that is normally covered by calx on the other specimens. This specimen (USNM 130465-13046) is closer to the holotype and paratype (pl. 36, figs. 4, 5) from Texas.

*Types:* Holotype USNM 77127 (Texas); paratype USNM 77126 (Texas); hypotypes USNM 130465-130467 (Mississippi).

*Occurrence:* Mississippi: Owl Creek Formation at locs. 45, 46, Tennessee: Clayton Formation (Owl Creek reworked into base) at loc. 40. Texas: Kemp Clay.

*Family MITRIDAE*

*Subfamily VEXILLINAE*

*Genus MITRIDOMUS* Sohl, 1963

Type species, *Fasciolaria? ripleysana* Wade, 1926.

*Etymology.*—Compounded from the Latin *mitr-*—genus of gastropod and *domus*—dwelling.

*Diagnosis.*—Fusiform shells of medium size. Whorls somewhat constricted posteriorly, broadly rounded over periphery. Sculpture of low but broad and sharp-crested collabral transverse ribs and close-spaced spiral lineae. Aperture elongate, posteriorly angulate; siphonal canal broad, slightly twisted back, and relatively short. Inner lip calyx thin and poorly defined, colurena bearing four strong oblique plications of about equal strength and spacing.

*Discussion.*—If the genus *Vexillum* were to be considered in its broadest sense, such as it is treated by Wenz (1943, p. 1287), *Mitridomus* Sohl might be included as a subgenus. *Mitridomus* is similar in a number of features to several forms usually considered subgenera of *Vexillum* such as *Latrionotus* Locard and *Uromitra* Bellardi. *Vexillum*, as Woodring (1928, p. 244) and others conceive it, is characterized in part by the presence of lirations on the interior of the outer lip. Such lirations are lacking in *Mitridomus*. Other differences distinguishing *Mitridomus* from *Vexillum* lie in its generally indistinct calyx and lack of any trace of a calyx ridge on the parietal lip. The lack of these same features would necessitate the distinction of *Mesorhitis* Meek, also from the Upper Cretaceous, from *Vexillum* where Wenz (1943, p. 1287) placed it. *Mesorhitis* can easily be distinguished from *Mitridomus* Sohl by its lack of posteriorly constricted whorls, by having only three, not four, columellar plications, and by having a longer siphonal canal. The species from Coon Creek, *Mesorhitis obscura*, tentatively placed in *Mesorhitis* by Wade, has here been reassigned to *Graphidula*.
Mitridomus ripleyana (Wade)
Plate 37, figures 5, 13


Description.—Medium-sized fusiform shells that possess a high evenly tapering spire; pleural angle about 30°. Protoconch incompletely known, consisting of about 2–2½ round-sided smooth whors. Teleoconch whors slightly constricted posteriorly, with a rounded periphery; anterior slope moderate. Sculpture of 20–25 low broad sharp-crested collateral ribs that are overriden by numerous low spiral lirae that are about as broad as their interspaces. Aperture elongate, lenticular, posteriorly constricted, and anteriorly produced to a rather straight moderately short siphonal canal. Outer lip incompletely known. Inner lip with a thin ill-defined layer of callus. Columella with four strong oblique plications the medial two being very slightly the stronger.

Measurements. — The only specimen available for measurement is the holotype, which measures 26.6 mm in height, 9 mm in diameter, and has a body whorl 13 mm in height.

Discussion.—The species is scarce, occurring only at its type locality in the Ripley Formation on Coon Creek, McNairy County, Tenn.

The Mitridae are poorly represented in the Mesozoic. Mitridomus ripleyana is one of the few Cretaceous representatives of the Mitridae that bears transverse ornament.

Type: Holotype USNM 32965. Occurrence: Tennessee: Ripley Formation at loc. 1.

Family HARPIDAe
Subfamily HARPINAE

Genus EOHARPA Stephenson, 1955

Type by original designation, Eoharpa sinuosa Stephenson.

Diagnosis.—Medium-sized shells of subpyriform outline. Protoconch unknown. Whors moderately plump, constricted posteriorly to a very narrow irregular subsutural collar, and anteriorly tapering to a sinuous pillar. Sculpture of strong rather narrow transverse ribs that are truncate above, and of low but broad spiral cords. Aperture produced anteriorly to a sinuous siphonal canal terminating in a moderately deep siphonal notch; outer lip unknown, inner lip broadly and heavily callused, bearing a pustulose surface over both parietal and columellar areas.

Discussion.—Eoharpa is based upon the holotype of E. sinuosa from the Owl Creek Formation of Mississipi and one incomplete external mold from Missouri. The holotype appears to be a true harpoid, but whether it represents a distinct genus or not is indeterminable. In size and in its most distinguishable characters, it closely approaches Eoecitharia Fisher (1883), but owing to the incomplete nature of the material, comparison is difficult. It is very tempting to synonymize Eoharpa with Ecitharia, but the pustulose surface of the inner lip callus is distinctive. What is most important is that this specimen marks one of the few known occurrences of a true member of the family in pre-Tertiary times.

Eoharpa sinuosa Stephenson


Diagnosis.—A harpoid with a pustulose inner lip surface.

Discussion.—The holotype of the species is incomplete, lacking its apex, outer lip, and parts of the shell surface. Nonetheless, future identification of specimens should not be difficult. The specimen figured by Stephenson (1955, pl. 23, fig. 6) from the Owl Creek Formation of Missouri is an incomplete external mold that shows lamellar transverse ribs that have a typical harpoid character.

Types: Holotype USNM 20400; paratype USNM 129205.
Occurrence: Mississippi: Owl Creek Formation at loc. 46. Missouri: Owl Creek Formation.

Subfamily MITRINAE

Genus PALEOFUSIMTRIA Sohl, 1963

Type species, Paleofusimitra elongata Sohl.

Diagnosis.—Medium-sized fusiform shells with an evenly tapering spire of a little more than half total shell length. Body whorl very broadly rounded, constricted anteriorly to a rather stout and elongate pillar. Sculpture confined to a few subsutural incised spiral lines and to spiral lirae on the pillar. Aperture lanceolate, angulated posteriorly, siphonal canal of moderate length terminating in a broad shallow notch; outer lip thin at edge; inner lip lightly callused and bearing two oblique plications.

Discussion.—In most characteristics this genus is much like Fusimitra Conrad, especially the species F. polita (Gabb) from the Eocene of the gulf coast; however, the Eocene forms generally have three plications, but on some specimens a fourth weaker colunnellar plication may be present. The genus, as here defined, is restricted to the Exogyra costata zone, but may represent a form ancestral to Fusimitra of the Eocene, which developed by the addition of a colunnellar plication and suppression of the subsutural ornament.
Paleofusimitrula elongata Sohl
Plate 37, figures 1-3, 6, 7

Description.—Medium-sized slender fusiform shells that have an evenly tapering spire of a little more than half total shell length. Whorls of spire almost flattened, pleural angle 20°-25°. Protoconch of moderate size, consisting of about 2½ normally coiled smooth round-sided whorls; junction with teloconch gradual, with whorls becoming progressively flatter sided through about three-quarters of a turn; subsutural incised spiral lines appear after the first teloconch whorl. Suture apparently. Body whorl slightly constricted anteriorly to a rather broad pillar. Sculpture restricted to three incised subsutural spiral lines, the upper two of which are closer spaced and to incised lines and spiral lirae on the basal slope and pillar. Growth lines arcuately prosocline over periphery, becoming gently opisthochline over anterior slope. Aperture lanceolate, posteriorly constricted, siphonal canal of moderate length and slightly twisted, siphonal notch shallow, outer lip thin at edge; inner lip very thinly callused and bearing two oblique colomellar plications that are weak near the aperture but strengthened interiorly.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

<table>
<thead>
<tr>
<th>Loc.</th>
<th>H</th>
<th>MD</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 (holotype)</td>
<td>20.7</td>
<td>6.3</td>
</tr>
<tr>
<td>12 (paratype)</td>
<td>25.9+</td>
<td>7.6</td>
</tr>
<tr>
<td>Pp.</td>
<td>28.2+</td>
<td>8.4</td>
</tr>
</tbody>
</table>

Discussion.—Paleofusimitrula elongata, although not common, is found at a number of localities, all at about the same stratigraphic position in the lower part of the Ripley Formation. That some individuals reached a larger size than those measured is well shown by one incomplete individual (USNM 130473) from locality 18, whose whorl diameter measures in excess of 10 mm and must have attained a length of at least 35 mm. This specimen also exhibits whorls that become somewhat more rounded with increased size.

Types: Holotype USNM 130468; paratypes USNM 130469-130472; mentioned specimen USNM 130473.

Occurrence: Mississippi: Ripley Formation at locs. 6, 12, 14, 16-18. Georgia: Ripley Formation, Alabama: Ripley Formation.

Family VOLUTIDAE
Subfamily VOLUTORIDINAEE
Genus LONGOCOENCHA Stephenson, 1941

Type by original designation, Volutoderma tennesseensis Wade, 1926.

Diagnosis.—Elongate slim subcylindrical shells that have an evenly tapering spire of 1/5-1/5 the total shell length; body very elongate, rather flat sided, with a subsutural constriction roughened by strong raised imbricate growth lines. Sculpture dominated by strong raised wide-spaced spiral cords. Growth lines sinuous posteriorly. Aperture elongate, channeled posteriorly and anteriorly expanded; outer lip crenulate; inner lip heavily callused, and callus spreads well out on body. Columella bearing three or more strong plications.

Discussion.—Longocoencha was originally proposed by Stephenson (1941, p. 357) as a subgenus of Volutoderma, but it differs by having a slender body and spire, by having a body that is more conspicuously flattened on the side, and by having an aperture that is more noticeably flaring anteriorly. In addition, one might add that with the exception of the early stages of growth, transverse ribs are almost entirely absent, the spiral cords are not noded, and perhaps most important of all, there is a distinct development of a corrugated subsutural collar and a heavy inner lip callus that does not appear on the type species of Volutoderma (V. navarroensis Gabb, not Shumard (1861) = Fusus averilli Gabb, 1864) from California.

Dall (1907) discussed Volutoderma in some detail but did not distinguish the species herein assigned to Longocoencha from Volutoderma s. s. He did, however, propose a number of subgenera (Rostellinda, Rostella, Rostellaca) that Pilsbry and Olsson (1954, p. 19) subsequently raised to generic rank.

The following species should be assigned to Longocoencha.

Rostellites angulus Whitfield, Navesink Formation, New Jersey
Volutoderma appressa Wade, Ripley Formation, Tennessee
Volutoderma (Longocoencha) dalli Stephenson, Navarro Formation, Texas
Voluta elongata Sowerby of d’Orbigny, Senonian, France (also reported, but unfigured, from Africa)
Mitra murchisoni Muller, Senonian, Aachen, Germany
Rostelletes nasutus Gabb, Navesink Formation, New Jersey
Volutoderma protracta Dall, Ripley Formation, Alabama
Volutillites navarroensis Shumard (= Volutoderma tennesseensis Conrad) Dall, in part
Volutoderma tennesseensis Wade, Ripley Formation, Tennessee
Rostellites texturatus Whitfield, Merchantville and Navesink Formations, New Jersey

Of the more than 50 Upper Cretaceous species that have, at one time or another, been assigned to the genus Volutoderma (or more than 70 if Volutomorpha is included as a synonym), only 10 can be assigned to the genus Longocoencha. The list shows that these species occur high in the Upper Cretaceous and that they are
predominantly gulf and Atlantic coast forms. Additional undescribed species, however, are known to occur as low as the Coniacian (Eutaw Formation) in Alabama. Typical Volutoderma, on the other hand, is best developed in the Upper Cretaceous rocks of the Pacific coast.

_Longoconcha tennesseensis_ (Wade)

Plate 36, figures 17, 21; Plate 37, figures 21, 22


_Diagnosis._—Shell large for genus; penultimate whorl generally bears two strong spiral cords just above sutures that are followed above by several weaker ones; secondary spirals on body are poorly developed.

_Measurements._—The holotype, the largest specimen known, measures 226.8 mm in height, 52.2 mm in diameter, and has a spire of 48 mm (Wade, 1926, p. 115).

_Discussion._—Specimens of this species occur abundantly at their type locality on Coon Creek, McNairy County, Tenn., and, aside from a slight compression of most of the larger specimens, they are well preserved. Variation appears to be considerable. The broad subsutural whorl constriction is well defined on some specimens, but others show an almost smooth curve continuous with the rest of the body. On some specimens, such as the holotype, the raised incremental corrugations at the suture carry down over the compressed area for some 15–20 mm, on other specimens they are restricted to the immediate subsutural area. The variance in spacing of the spiral elements of the body is well shown by contrasting pl. 36, fig. 17, with Wade's figure of the holotype (Wade, 1926, pl. 41, fig. 5).

In his original description Wade stated “columella marked by three or four well-defined oblique plaits, which terminate behind the margin of the aperture.” Three plaits are found most commonly, with two always being closer spaced and parallel. The third plication is always more widely separated, and when it is posterior to first pair it is almost parallel, but when the third plication is anterior to the close-spaced pair, it is more highly inclined. Only a few specimens show a complete set of four plications. Wade differentiated two other species, one he assigned to _Volutoderma protracta_ Dall and the other to the new species _V. appressa_. In both instances in contrasting these species with _Longoconcha tennesseensis_ he stated that the individuals had only three plications, instead of four or more, thus contradicting his description of _L. tennesseensis_. Both the holotype of his new species _V. appressa_ and the hypotype of _L. protracta_ are immature individual variants of _L. tennesseensis_.

Compared with _Longoconcha protracta_ L. _tennesseensis_ is larger, has less inclined spiral cords, is somewhat more obese, and has a less pronounced posterior whorl constriction. _Longoconcha navarroensis_ (Shumard) is also closely related but in general has a greater development of secondary spirals. Overall, _L. navarroensis_ appears to be the closest of all the species to _L. tennesseensis_.

_Types:_ Holotype USNM 32868; hypotype (holotype of _V. appressa_) USNM 32862; hypotype (_V. protracta_ Dall of Wade) USNM 32863; hypotypes USNM 130473, 130474.

Occurrence: Tennessee: Ripley Formation at loc. 1.

_Longoconcha quadrillata_ Sohl, n. sp.

Plate 37, figures 8, 9, 10, 17

_Diagnosis._—Shell average to small for genus, with four strong spiral cords visible on the whorls of the spire; secondary spirals very rarely present.

_Description._—Shell elongate, slim, subcylindrical. Spire slim, pleural angle 20°–25°. Protoconch unknown. Suture appressed. Whorls posteriorly constricted, very broadly rounded over the periphery, grading to a flat-sided anterior slope. Sculpture dominated by strong spiral cords that cover the surface of the whorl below the posterior constriction; over the subsutural constricted surface, four to five weaker lines occur; only four primary spiral cords are visible on the whorls of the spire. Transverse ribs are absent or very poorly developed on the body, but on the earlier stages of growth they appear as prominent broad ribs that number seven or eight per whorl and die out above on the constricted band. Growth lines form a distinct and strong sinus at the suture where they are raised to thin imbricate incremental flanges or spines; anteriorly the lines weaken over the constricted band where they have almost an orthocline trend. Aperture elongate, rather deeply notched posteriorly, siphonal canal broad; outer lip unknown; inner lip straight and lightly callused, with callus extending out well onto body surface. Columella bears three strong oblique folds.

_Measurements._—All available specimens are incomplete, but the largest specimen (USNM 130476), which bears a nearly complete body extension, has an aperture 83 mm long.
**Discussion.**—All known specimens of *Longocochna quadriplirata* are incomplete but show a constancy in bearing three columnar plications and in having four primary spiral cords that are visible on the whorls of the spire. The presence of secondary spirals on the whorls below the posterior constriction was not detected. The species is uncommon except at locality 18, the type locality, and is restricted to the Ripley Formation.

*Longocochna protracta* (Dall) from the Ripley Formation of Alabama occurs at about the same level as *L. quadriplirata* but differs by possessing only three cords on the penultimate whorl. *L. navarroensisa*, from the Navarro Formation of Texas, has a poorly defined posterior constriction, secondary spirals inserted between the primaries of the whorl sides, and is proportionally broader with a higher pleural angle. *L. tennesseensis* (Wade), from the *Eozygrya cancellata* zone in Tennessee, is less slim, has less broadly rounded whorls, has a poorly defined or absent posterior constriction, has generally only two strong spirals on the penultimate whorl, and has a higher pleural angle.

*Types:* Holotype USNM 130475; paratypes USNM 130476, 130478.

*Occurrence:* Mississippi: Ripley Formation at locs. 6, 18, 26, 33(17).

*Longocochna dalli* (Stephenson)

Plate 37, figures 15, 19, 20


*Discussion.**—Stephenson (1941 p. 359) proposed *Longocochna dalli* for specimens from the Kemp Clay which differ from *L. navarroensisa* primarily by being less slender and by having a more noticeable posterior constriction. The holotype is incomplete and difficult to compare with specimens of other species. In the Owl Creek Formation of Mississippi at about the same level at which the holotype of this species was collected a similar form was found. The largest available Owl Creek specimen (pl. 37, fig. 20) is compressed and incomplete. It does possess a broad constricted band on which there are a number of wide and weak spiral cords. Like the holotype of *L. dalli*, its sub-sutural imbrications of the growth lines are not as strong as those of either *L. protracta* Dall or *L. quadriplirata* Sohl from the Ripley Formation.

*Types:* Holotype USNM 21183; hypotype USNM 20430.

*Occurrence:* Mississippi: Owl Creek Formation at locs. 45, 46. Tennessee: Clayton Formation (Owl Creek reworked into base) at loc. 40.

**Longocochna spp.**

Plate 37, figures 10–12, 14, 18

*Discussion.*—Many internal molds, from the Prairie Bluff Chalk of Mississippi, in the collections of the Geological Survey, belong to the genus *Longocochna*. These molds appear to be separable into two distinct types. Bergquist (1943, faunal lists) has assigned such molds from Clay county, Miss., to definite species, but the molds fail to display features that would be diagnostic enough to insure specific identification. Distinction of the species of this genus even when they are represented by well-preserved specimens, is a difficult task, but with only internal molds the task becomes impossible. The molds assigned to type A (pl. 37 figs. 10, 14, 18) are characterized by a supramedial whorl constriction and many of them retain reflections of strong spiral ornament. Specimens of this type have been collected at localities 66, 71, 74, 75, 80, 82–84, 87, 88, 90, 94. The molds of type B (pl. 37 fig. 11) differ by having a more rounded whorl outline and a proportionately more obese body. Specimens of this type have been collected at localities 71, 87, 94.

*Types:* Figured specimens USNM 130669, 130672.

**Genus VOLUTOMORPHA Gabb, 1877**

Type by original designation, *Volutilites conradi* Gabb, 1880.

*Diagnosis.*—Large elongate subfusiform shells have a low to moderately low spire and a surface glazed by callus. Sutures indistinct because of a covering well of callus. Whorls constricted posteriorly and frequently shouldered; sides broadly rounded, tapering smoothly anteriorly. Sculpture of spiral cords and of strong transverse ribs that frequently are suppressed on the body whorl of larger specimens. Growth lines sinusized posteriorly. Aperture elongate, proportionately narrow, deeply notched posteriorly; siphonal canal broad, proportionately short, and terminating in broad shallow siphonal notch.

*Discussion.*—*Volutomorpha* has become well established in the literature of Cretaceous paleontology; however, much confusion surrounds the type species, *V. conradi*. The type species is based on the internal mold of a thin volutilites that bears the impression, on its spire, of strong transverse ribs and possesses a single highly oblique and strong plication on the columnella. The holotype is from the classic Atlantic Highlands locality of New Jersey and, although stated as having come from the Navesink Formation by Weller (1907), it more likely came from the Red Bank Sand that is well exposed at this locality. Subsequent authors such as Whitfield (1892) and Weller (1907) discussed the species and illustrated the holotype and, in
addition, assigned and figured other specimens from New Jersey. Weller (1907, p. 780) assigned internal molds to *Voluitomorpha conradi* from as low in the New Jersey section as the Cliffwood clay of the Mag- othy Formation, a range of Coniacian to Maestrichtian. Such a broad view of the species indicates the inadvisability of naming internal molds.

The confusion surrounding the nature of the holotype has led others to thoroughly discard the name *Voluitomorpha*, as was done by Pilsbry and Olson (1954, p. 19), who synonymized it with *Voluitoderma*. Wenz (1941) preferred to deal with it as a subgenus of *Voluitoderma*. *Voluitomorpha*, although based on such material as the holotype of the type species, can be distinguished generically, and although the name *V. conradi* Gabb cannot be related to well-preserved specimens, the features displayed by the mold do serve to distinguish the genus. *Voluitoderma* is moderately close in relationship, but in that genus transverse ornament is poorly developed, whorls are not shouldered, the shell is not fully glazed, and the columnar plications number three or more. In *Voluitomorpha* there is generally a complete shell of callus, whorls are usually moderately obese and shouldered, transverse sculpture is dominant over the spiral elements, and there is only one major plication on the columella with either no or one subsidiary plication and their obliqueness exceeds that of *Voluitoderma*. *Longoconecha* is much shallower, lacks surface glaze, and possesses three or more oblique columnar plications.

Numerous species have been assigned to *Voluitomorpha*. The following lists separate the named species into well-preserved forms that are definitely assigned, those based upon internal molds, and those not belonging in *Voluitomorpha*.

**A. Well preserved.**

*Voluitomorpha dumascens* Dall, Ripley Formation of Mississippi

*Voluitolithes eufaulensis* Conrad, Ripley Formation of Alabama

*Voluitomorpha liorea* Dall, Ripley Formation of Alabama

(retifera Dall, Nacatoch Sand of Texas

*gigantea* Wade, Ripley Formation of Tennessee

*mutabilis* Wade, Ripley Formation of Tennessee

*Voluitomorpha? noramericana* Herrick and Johnson, Fox Hills Sandstone of New Mexico

*Voluitomorpha valida* Sohl, Ripley Formation of Mississippi

**B. Internal molds:**

*Voluitomorpha conradi* Gabb, Navesink or Red Bank Formations of New Jersey

*gabbi* Whitfield, Navesink Formation of New Jersey

*ponderosa* Whitfield, Navesink Formation of New Jersey

**C. Assignment questionable:**

*Voluitomorpha turricula* Dall, Ripley Formation of Mississippi (holotype missing)

*perla* Gabb, Navesink Formation of New Jersey

Species not belonging in *Voluitomorpha*:

*Voluitomorpha macronuta* Gabb, Navesink Formation of New Jersey

*banai* Gabb, Navesink Formation of New Jersey

*aspra* Dall, Owl Creek Formation of Mississippi

(retifera)

*pronata* Gardiner, Monmouth Formation of Maryland

(Duenseenia)

*tarenus* Stephenson, Black Creek Formation of North Carolina

(Liopepsia)

*Voluitomorpha greysonensis* (Crain) Stephenson, Woodbine Formation of Texas

*Voluitomorpha similis* Riedel, Cameroons, Africa

*aspra* Dall, Reidel, Cameroons, Africa

*borra* Reidel, Cameroons, Africa

*borra* Riedel of Darville, Congo, Africa

*Voluitomorpha? munsonensis* Rementy, Nigeria, Africa

As can be noticed on the preceding list *Voluitomorpha* is restricted to the Upper Cretaceous of the Gulf and Atlantic Coastal Plains, with the exception of one species. The species assigned to this genus from Africa all have a curved siphonal canal and ornament more closely allied to such genera as *Deuesenia* Stephenson and *Tryonella* Stephenson.

In the Ripley and Owl Creek Formations and their equivalents of the Gulf coast, the species here assigned to *Voluitomorpha* can be broadly assigned to three groups on the basis of shape and ornament.

Group A: Body whorl rounded to subshouldered and either free of or with subdued ornament; columella with one strong plication.

*Voluitomorpha valida dumascens*

Group B: Body whorl rounded to subshouldered and bearing ornate sculpture; columella with two or three strong plications.

*Voluitomorpha gigantea mutabilis retifera*

Group C: Body whorl strongly shouldered and bears strong ornament dominated by transverse ribs; columella has two plications, but only the anterior one is visible at aperture.

*Voluitomorpha producta*

*Voluitomorpha valida* Sohl, n. sp.

Plate 38, figures 2–5, 8; Plate 39, figures 7, 11


**Diagnosis.**—Shell slim for genus; pleural angle 40°–45°; sculpture of strong transverse ribs that are nodded by low broad spiral cords on spire, but both
become subdued on body and are covered by callus glaze.

Description.—Shell large, elongate, thin, and thick; spire about one-third total shell height and turreted; pleural angle 40°-45°. Protoconch unknown, suture obscured by callus glaze, which covers entire shell surface. Whorls constricted posteriorly and strongly shouldered on spire, but on the body near aperture the whorl becomes rounded below the excavated subsutural band; periphery rounding down to an almost flat-sided tapering basal slope. Sculpture consisting of strong transverse ribs numbering 16-18 per whorl that appear on early whorls and are truncated posteriorly to form a sharp shoulder; ribs diminish in vigor on body, retracting until only nodes are present at the shoulder; the nodes also diminish until they disappear entirely near the aperture. Spiral ornament weak and greatly obscured by callus, consisting of three or four low broad spiral cords that node the ribs of the spire but are generally not visible on the body. Growth lines faint, strongest on the subsutural welt where an abapertural sinus of moderate depth develops; below the growth lines are opisthocl ine in trend, swinging back to mainly orthocl ine over the periphery but may become faintly opisthocl ine on the anterior slope. Aperture elongate lenticular with an acute posterior sinus, siphonal canal of moderate length, rather broad, terminating in a broad shallow siphonal notch; outer lip expanded slightly, thins somewhat at edge where it is denticulated by the terminations of the spiral elements; inner lip rather straight. Columella bearing one very strong highly oblique plane followed above by a slight swelling; plane obscure at aperture strengthening within; columnell flatters somewhat anteriorly on the apertural side of the siphonal fasciole.

Measurements.—The most complete specimen, the holotype, measures 160 + mm in length, has a maximum diameter at the expanded aperture of 61.5 mm, and has an aperture of 111 + mm in length.

Discussion.—Volutomorpha valida Sohl most nearly approaches those features noted as distinctive of the typical Volutomorpha. The holotype of V. conradi from New Jersey is an internal mold of a rather slim shell with the impression of strong transverse ribbing on the spire and a single columellar plication. In these features V. valida closely approaches the type species. Although it is reasonable to place the two in the same genus, it is impossible to compare the two species any more closely because of lack of knowledge of the New Jersey species. Volutomorpha valida is well represented in the Ripley Formation of Mississippi but is generally only recovered in an incomplete condition. Variability is slight and is usually restricted to strength of ornament. Even this feature is not initially variable to any great extent but is more a function of the thickness of callus glaze. The specimen, figured on plate 38, figure 2, from locality 13, possesses a thin veneer of callus that allows the spiral elements to become more prominent compared to the other specimens figured. This specimen (USNM 20534) appears to be proportionally broader than the other figured specimens, but this is due to extreme compression as it measures almost 66 mm in diameter at the aperture but only about 29 mm at right angles thereto.

Dall (1907, p. 19) assigned this species to Volutomorpha euthaulensis (Conrad) = V. cretacea (Conrad) Gabb, a species from the Ripley Formation of Eufaula, Ala., but the holotype of that species is lost and Conrad's figure (1860, pl. 47, fig. 18) shows a specimen having a well-shouldered body, well-developed transverse ribs, and a much less slim outline. In these features Conrad's species appears to more closely approach V. producta Sohl. Dall's figure of V. euthaulensis (1907, fig. 1) is an idealized composite constructed from the two specimens (USNM 20576, 20,534) here figured on plate 38, figure 2, and plate 39, figure 11.

In the Ripley Formation this species is most closely approached by V. dumasensis Dall, which differs in its lower spire, more obese body, higher pleural angle, and in having a less well-developed shoulder and transverse ribs. Both V. gigantea Wade and V. retifer Dall possess stronger spiral ornament that is retained on the more obese body and both have a lower spire.

Types: Holotype USNM 130673; paratypes USNM 20534, 20576, 130674-130676.

Occurrence: Mississippi: Ripley Formation at locs. 5, 6, 13, 18, 29, 31 (?).

Volutomorpha cf. V. valida Sohl

Discussion.—Fragments of large volutids have been recovered from a number of localities in the Ripley Formation. For the most part these fragments are indeterminable, but some show features akin to Volutomorpha valida. These fragments show parts of a smooth body whorl, a slim spire with strong ribbing, or on some broken parts of an aperture showing dentitions on the edge of the outer lip. They could also belong to V. dumasensis, and their insertion here is merely to record the presence of one or the other of these species at a given locality.

Occurrence: Mississippi: Ripley Formation at locs. 16-18.
Volutomorpha dumasesis Dall
Plate 38, figures 1, 6; Plate 39, figures 3, 5, 9;
Plate 40, figures 1, 2, 5

1907. Volutomorpha dumasesis Dall, Smithsonian Misc. Colln., v. 50, pt. 1, p. 16, fig. 4.

1907. Volutomorpha lioea Dall, Smithsonian Misc. Colln., v. 50, pt. 1, p. 16, fig. 4.

Diagnosis.—Shell with rather plump whorls; pleural angle 50°–55°; sculpture of rather strong transverse ribs that are crossed by weak spiral cords on spire but ornament weak to absent on body. Columella with one strong plication anterior to a weak subcylindrical fold.

Description.—Shell moderately large, elongate, thick, and plump; spire about one-third of total shell height and subturreted. Protoconch unknown. Whorls posteriorly constricted and bearing a welt of callus that obscures suture. Body slightly excavated below welt, well rounded over periphery, and constricting anteriorly to a moderately stout pillar. Sculpture very weak on body, but on spire transverse ribs are present and are strong on early whorls. Ribs number 14 or 15 and die out posteriorly below the excavated subsutural band. Spiral elements override the transverse ribs, which become very faint on later whorls but often visible through the callus glaze especially on the subsutural welt. Growth lines adapaterurally sinuous above, gently opisthoclinal over whorl sides and base. Aperture lenticular, deeply notched by a posterior sinus, siphonal canal of moderate length and width, terminating in a broad rather shallow siphonal notch. Outer lip thins at edge and is dentilicate where intersected by spiral elements; inner lip medially excavated. Columella bears a strong anterior plication and a weaker posterior one.

Measurements.—The holotype of Volutoderma lioea Dall (USNM 21127a) measures 113 mm in height and 44.4 mm in width. Other less complete specimens are wider.

Discussion.—Dall (1907, p. 6, fig. 4) based his species Volutomorpha dumasesis upon a single fragment of a spire which came from the Ripley Formation at locality 13. In the same paper (p. 19), Dall described a second species, Volutomorpha lioea, from the Ripley Formation at Eufaula, Ala., which is based on several nearly complete specimens that lack only parts of the spire. A comparison of the types of these two species with additional specimens from the U.S. Geological Survey collections, made both in Mississippi and Alabama, forced one to the conclusion that the two specific names are synonymous. Dall's figure of the holotype of V. lioea (1907, p. 18) is idealized (compare with pl. 39, fig. 9). This specimen (USNM 21127a) has an incomplete and broken outer lip and does not show the character of the posterior sinus as is seen on other specimens (pl. 40, fig. 5). The spire of the holotype is worn, but topotypes of V. lioea show the spire possesses moderately strong transverse ribs and terminates in a small sharply tapering protoconch (USNM 130679) but is not bluntly truncated as per Dall's illustration. These features are to be found on the holotype of V. dumasesis and on other Mississippi specimens assignable to that species. The holotype of V. dumasesis (Dall, 1907, fig. 4) shows exceedingly strong ornament for the species, but other specimens from the same level and area in the Ripley Formation of Mississippi show a more subdued sculpture (pl. 40, fig. 1) closer to that of V. lioea. Although the type material of V. lioea is better preserved than that of V. dumasesis the latter name has page priority and must stand for both.

The most similar species is Volutomorpha valida, which also possesses a body either smooth or with much suppressed ornament, but it differs by being slimmer, has a lesser anterior constriction, a more strongly turreted spire, a broader siphonal canal, stronger spiral cords, transverse ribs on the spire, a lower pleural angle, and a weaker secondary collumellar plication. V. retifera and V. gigantea reach a larger size, have well-developed ornament on the body, and have a lower spire. V. producta has well-developed ornament on the body, a narrower siphonal canal, and strong shoudering of the whorls.

Types: Holotype USNM 20053; holotype of V. lioea USNM 21127a; hypotype USNM 21127b (Alabama); hypotype USNM 130677 (Alabama); hypotype USNM 130678 (Mississippi).

Occurrence: Mississippi: Ripley Formation at locs. 5, 6, 13, 18. Alabama: Ripley Formation.

Volutomorpha mutabilis Wade
Plate 38, figure 7; plate 39, figures 1, 2, 6; plate 40, figure 6

1926. Volutomorpha mutabilis Wade. U.S. Geol. Survey Prof. Paper 137, p. 114, pl. 57, fig. 10, pl. 60, figs. 6, 8.

Diagnosis.—Shell large; spire low for genus; pleural angle about 70°; body generally strongly ornamented by spiral cords that are accentuated to subnodings as they override the close-spaced transverse ribs; subsutural collar bears strong spiral lirae and transversely elongate nodes in harmony with transverse ribs.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 172).

Discussion.—Volutomorpha mutabilis Wade is one of the more common gastropods at its type locality.
Discussion.—*Volutomorpha gigantea* is the largest *Volutomorpha* known. One fragmentary specimen, on which only parts of the body and spire are preserved, was figured by Wade (1926, pl. 38, fig. 1) and measures about 190 mm in length. An estimate of size based on proportion of height of spire to total height on smaller, but complete, specimens yields a measurement of close to 350 mm in length or about 44 inches for this specimen.

The imbricate structure of the subaspiral collar serves to distinguish *V. gigantea* from *V. mutabilis* and *V. retifera*. This structure, plus the body ornament, serves to distinguish it from the species of both groups A and C, cited under the generic discussion.

*Types*: Holotype and paratype USNM 32856; hypotype USNM 130681.

*Occurrence*: Tennessee: Ripley Formation at loc. 1.

*Volutomorpha retifera* Dall

Plate 40, figure 3; plate 41, figures 1, 2, 5, 7


*Diagnosis.*—Shell large, spire rather low; pleural angle 40°-50° on large specimens; body ornamented by both spiral and transverse elements; subaspiral collar with spiral lirae but lacking nodes.

*Measurements.*—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 172).

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*Discussion.*—The lectotype of *Volutomorpha retifera* Dall comes from the Navarro Formation in Texas. Specimens assignable to this species are present at about the same level in the Ripley Formation of Mississippi. The Mississippi specimens, however, appear to be somewhat shorter spired, more obese, have less strongly developed ornament, and show a tendency for loss of sculpture on the body of the larger specimens. The largest specimen assignable to this species (pl. 41, fig. 5) comes from the lower part of the Ripley Formation near Graham, Union County, Miss. This internal mold (pl. 41, fig. 7) shows one strong plication at the aperture, but the whorls of the spire exhibit a second, somewhat less strong fold posteriorly. The mold also shows that the earliest whorls were sealed off by a septum.
**Volutomorpha mutabilis** Wade from the *Exogyra cancellata* zone appears to be closely related but differs in its strong nodding of the subcolar collar and in its sharper and better defined ornament. The lack of imbrications upon the subcolar collar differentiates this species from *V. gigantea* Wade.

**Types:** Lectotype USNM 20096a; cotypes USNM 20096, 20096b, c; hypotypes 130685–130687.

**Occurrence:** Mississippi: Ripley Formation at locs. 7, 18, 23, 23?

**Volutomorpha cf. V. retifera** Dall

Plate 39, figure 4; plate 42, figure 10

**Discussion.**—Poorly preserved specimens from both the Owl Creek and the Prairie Bluff Formations, retain sufficient characters to give evidence of the presence of a volutomorphid allied to *V. retifera* in the youngest Cretaceous formations of the Mississippi Embayment area. The Owl Creek specimen figured here (pl. 39, fig. 4) exhibits the typical ornament of *V. retifera*, but it is more obese and has wider spaced transverse ribs.

**Types:** Figured specimens USNM 130688–130690.

**Occurrence:** Mississippi: Owl Creek Formation at loc. 46; Prairie Bluff Chalk at locs. 71, 87; Tennessee: Clayton Formation (Cretaceous reworked into base) at loc. 40.

**Volutomorpha producta** Sohl, n. sp.

Plate 42, figures 1, 9, 13, 15

**Diagnosis.**—Shell large; spire rather high for genus; whors strongly shouldered and constricted anteriorly; body ornamented by strong transverse ribs and numerous low broad spiral cords or ribs.

**Description.**—Shell large, moderately thick, spire slightly more than one-third total shell height, turreted; pleural angle 45°–50° on larger shells. Protoconch incompletely known, shelly, smooth, and erect. Whors posteriorly constricted to a subcolar collar, followed below by a concavely excavated area bounded by a strong shoulder; body slightly inflated over periphery, constricting rapidly below to the pillar. Sculpture strong, about 13 transverse widespread ribs per whorl; ribs interrupted above shoulder and dying out on anterior slope; spiral cords and ribs cover surface and become broader and weaker on the body; cords form low nodes as they override the ribs. Growth lines opisthocline on collar, becoming orthocline to slightly procline over the shoulder, then swinging back to opisthocline over the periphery. Aperture lenticular, moderately notched posteriorly, siphonal canal narrow for genus and terminating in a very broad siphonal notch. Outer lip unknown; inner lip excavated above midheight; columella bears one strong fold at the aperture, but two are present on earlier whors.

**Measurements.**—The holotype, the most complete specimen, measures 161 mm in length and 62.5 mm in diameter with an aperture 118 mm long.

**Discussion.**—This is perhaps the most distinctive member of the genus on the Gulf coast both in character of ornament and in its narrow siphonal canal. The species described by Conrad (1860) as *Volutomorpha eufaulensis* is quite similar. His figure (1860, pl. 47, fig. 18) is an outline sketch and very probably a reconstruction of a specimen which is of too poor a quality to afford close comparison.

**Volutomorpha producta** is quite rare in the Ripley Formation of Mississippi and the extent of intraspecific variation is unknown.

**Types:** Holotype USNM 130691; paratype USNM 130692.

**Occurrence:** Mississippi: Ripley Formation at locs. 5, 6, 18, 23?

**Volutomorpha sp.**

Plate 37, figure 4

**Discussion.**—One incomplete shell from the Ripley Formation at locality 18 may represent a new species of *Volutomorpha*. The strongly shouldered whors and very strong and sinuous transverse ribs that are overridden by broad spiral ribs are reminiscent of *V. producta*. However, the growth lines are raised to an imbrication on the subcolar collar and are continuous with the transverse ribs much in the manner of *V. gigantea*. Until more complete material is found the specific affinities of this specimen must remain in doubt.

**Types:** Figured specimen USNM 130693.

**Occurrence:** Mississippi: Ripley Formation at loc. 18.

**Volutomorpha spp.**

**Discussion.**—Specifically indeterminable molds of *Volutomorpha* are not uncommon in the Prairie Bluff Chalk. These molds probably represent several species, but their correlation to species based on well-preserved shells is impossible.

**Occurrence:** Mississippi: Prairie Bluff Chalk at locs. 53, 57, 67, 71, 72, 76, 90, 87, 88, 90. Ripley Formation at locs. 27, 37.

**"Volutomorpha" aspera** Dall

Plate 41, figures 3, 4, 6; plate 42, figures 11, 14

1907. *Volutomorpha aspera* Dall, Smithsonian Misc. Colln., v. 50, p. 17, fig. 5.


1941. *Volutomorpha aspera* sp. Stephenson, Texas Univ. Bull. 4101, p. 356, pl. 69, fig. 16.

**Discussion.**—Both the generic assignment of this species and the assignment of specimens from other localities than the type locality to this species is highly suspect. The holotype (pl. 41, figs. 3, 4) is from the
Owl Creek Formation of Tippah County, Miss., loc. 46. It is incomplete, only the body and penultimate whorl are preserved, and only parts of the surface adhere to the internal mold. The body proportions and height of spire are not typical of *Volutomorpha*, but it does appear to be a volute and until better preserved material allows definite placement it is provisionally assigned to *Volutomorpha*. Specimens from the Ripley Formation unquestionably assigned to *V. aspera* are too poorly preserved to help with the generic assignment. Differences are present in ornament and shape of the body whorl that, when better preserved specimens are available, will necessitate differentiation into several species. The character of the transverse ribs, the growth lines, and the posterior constriction of the whorls to a collar are similar enough to indicate close affinity and indicate that the *aspera*-like species of this group were present throughout the span of *Evoxgyra costata* zone.

Types: Holotype USNM 2904; hypotypes USNM 32855, 130684, 130686.

Occurrence: Mississippi: Owl Creek Formation at loc. 46. Prairie Bluff Chalk at loc. 35. Ripley Formation at locs. 9, 14, 18, 29. Tennessee: Ripley Formation at loc. 1. Texas: Kemper Clay.

**Subfamily ATHLETINAE**

**Genus LIOPEPLUM** Dall, 1890

Type by original designation, *Volutilitites* (*Athleta*) *leioderma* Conrad, 1860.

Synonymy.—*Lioderma* Conrad, 1865 (not Marseul, 1857).

Diagnosis.—Medium-sized strombine shells with a rather low spire. Ornament of transverse ribs generally restricted to early whorls. Shell covered by a bright glaze of callus; generally with a strong ridge of callus above the suture. Siphonal notch moderately deep, siphonal fasciole well developed. Columella with several pllications rather high.

Discussion.—Although perhaps present in west Africa, *Liopeplum* appears to be primarily an Upper Cretaceous Gulf and Atlantic Coastal Plain genus. The earliest known representatives of the genus in that area occur in the Snow Hill Marl Member of the Black Creek Formation of North Carolina (*Lioderma thoracicum* Conrad and *Volutomorpha tarensis* Stephenson), and *L. ruhleii* from the Woodbury Clay of New Jersey. Another species similar to *V. tarensis* occurs in the Coffee Sand of Mississippi at about the same or a slightly lower level within the *Evoxgyra ponderosa* zone. In the Coniacian of the Cameroons, however, Riedel (1932, p. 107) has described, as *Volutilitites guillemani*, a form very similar to *Liopeplum rugosum* Stephenson. That species if a true *Liopeplum* would extend the range of the genus farther down in the section. Elsewhere in Africa, Rennie (1945, p. 57) noted an unnamed questionable form in the Sononian of Angola and assigned it to *Liopeplum*. Dartonville and Bréhon (1956, p. 86) noted Riedel’s species as high as upper Sononian in the Congo. The specimens figured by these authors almost surely belong to *Liopeplum*. No Tertiary members of the genus are known, but certain of the species of *Athleta* from the Claiborne of Alabama that have suppressed ornament and poorly developed shoulders on the whorls come close to such forms as *Liopeplum tarensia* of the Owl Creek Formation, which lacks a strong callus ridge.

Several distinct types of *Liopeplum* are present in the Late Cretaceous of the Gulf and Atlantic Coastal Plains and one might divide them as follows:

Group 1. Transverse ribs restricted to early whorls; callus ridge well developed:

- *Volutilitites* *tarensia* Conrad (Includes, *Liopeplum monmouthensis* Gardner)
- *Volutomorpha* *tarensis* Stephenson
- *Liopeplum ruhleii* Richards

Group 2. Ribs restricted to early whorls; callus ridge suppressed:
- *Volutilitites* *tarensia* Conrad (Includes, *Liopeplum monmouthensis* Gardner)
- *Volutomorpha* *tarensis* Stephenson
- *Liopeplum ruhleii* Richards

Group 3. Ribs strong on spire, continue on shouldered body; callus ridge strong:
- *Liopeplum rugosum* Stephenson (=*L. subjugosum* Dall)
- *Volutomorpha turricula* Dall
- *Liopeplum subjugosum* (Gabb) of Wade (=*Liopeplum coronatum* Sohl)
- *nodosum* Sohl

The similarity of general shell features shows a close relationship of the noted forms. The subdivision noted is tentative and until more information is available as to the initiation of the groups and as to the morphology of the older species of these groups should not be formally used as subgenera. Graphically the inferred development of *Liopeplum* on the coastal plains may be shown in the manner illustrated in figure 18.

**Liopeplum leioderma** (Conrad)

Plate 42, figures 2–8, 12; plate 43, figures 1, 2, 6, 7


Figure 18.—Suggested phylogeny of *Lancephalus* in the Upper Cretaceous of the Gulf and Atlantic Coastal Plains.


1941. **Liopeplum lioidermum** var. **longum** Stephenson, Texas Univ. Bull. 4101, p. 250, pl. 67, figs. 11, 12.

1941. **Liopeplum lioidermum** var. **breve** Stephenson, Texas Univ. Bull. 4101, pl. 67, figs. 9, 10.


**Diagnosis.**—Shell of medium size, moderately slim; callus ridges of moderate development; body lacks a well-defined shoulder.

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**Discussion.**—**Liopeplum lioidermum** (Conrad) is a highly variable species. For this reason it is impossible to systematically subdivide it into consistent units. Stephenson (1941) proposed three varieties of **L. lioidermum**—**breve**, **longum**, and **tabulatum**—to cover the variation of the species in Texas. His **L. lioidermum tabulatum**, however, shows a constant shouldering and obesity of body much like **L. canalis** (Conrad) of the Owl Creek, and the specimen he figured (1941, pl. 67, fig. 13, 14) is not unlike that figured on plate 43, figure 23 from Mississippi. Consequently, the Texas form appears to be a distinct species. The other two varieties, however, are intergradational. Wade (1926) differentiated the **L. lioidermum**-type specimens from the *Esogyra cancellata* zone at Coon Creek, Tenn., into three species **L. canalis** (Conrad), *L. canalis* Wade, and **L. lioidermum** (Conrad). **L. canalis** (Conrad) of Wade definitely does not belong in Conrad’s species. In fact, suites of topotypes studies by me indicate that this is only another instance of the variation exhibited by the species at a single locality.

A search of the collections at the Academy of Natural Sciences of Philadelphia has not yielded the holotype of **Liopeplum lioidermum**. As figured by Conrad (1860, pl. 46, fig. 32), the holotype is close in size and character to the specimen from locality 17, figured on plate 43, figure 7. It is in the lower part of the Ripley Formation and in the area represented by localities 12, 15, 16, and 17, that the species is most common. As these localities were known in Conrad’s time, one of them may well have been the type locality.

The specimens here illustrated show considerable variability in obesity. In general the specimens with stouter shells have a more curved pillar and more obliquely inclined siphonal fasciole. (Compare pl. 42, fig. 8, and pl. 43, fig. 7.) The bluntness of spire exhibited by many specimens (pl. 43, figs. 2, 6) is due to wear and not to an inherently shorter spire. Though specimens from the upper part of the Ripley Formation are very similar to those from the lower parts of the Ripley Formation, there is a general tendency toward a slimmer outline and in some specimens an excessive deposition of callus on the callus ridges of the spire. The extreme of this is noted in the specimen figured on plate 43, figure 1. Yet, other specimens occurring side by side with this one have a perfectly normal spire.

In Texas there appears to be a trend toward greater proportional diameter as is shown in the measurements of the specimens from the Nacatoch Sand given above.

The specimen from the Ripley Formation illustrated by Dall (1907, pl. 6, fig. 12) and assigned to **Liopeplum spallmani** (Tuomey) belongs to **Liopeplum lioidermum**. Tuomey’s species, *Voluta spallmani*, which he did not illustrate, is based upon a poor description and came from “Columbus, Mississippi.” Columbus is situated in the Eutaw-Selma belt of outcrop where specimens, with the exception of the oysters, are usually preserved only as internal molds. Dall’s specimen, on the other hand, is a well-preserved shell from the Ripley Formation in Tippah County. In addition, there is no indication that Dall ever saw Tuomey’s types, which were probably destroyed by fire (Sohl, 1960) in the 1860’s. Because Tuomey’s types are lost, their stratigraphic and geographic position is uncertain, and the accompanying descriptions are unusable, this author can see no reason for perpetuating the names.

Gardner’s (1916, p. 430) referral of a specimen from the Monmouth Formation of Maryland to this species is highly questionable as it is based upon poorly preserved material. As preserved, the shoulder on this specimen is more pronounced than on **L. lioidermum** and more closely akin to **L. canalis** (Conrad), an interpretation which would be more in keeping with its association in Maryland with **L. eretacea** (Conrad) and *Sphenodiscus*.

**Liopeplum lioidermum** (Conrad) differs from the **L. rugosum** group by its lack of strong nodings on the body, by its lack of a well-developed shoulder,
by generally having only two columnellar plications, and by having thicker surface glaze. *L. cretacea* (Conrad) lacks the callus swellings of the whorls of the spire. *L. canalis* appears to be the most closely related species, but the callus ridges of the spire are more pronounced and sharper and the body is more strongly shouldered.

**Types:** Holotype lost; hypotype USNM 32999 (Mississippi) (=Liopeplum spilbani (Tuomey) of Dall); hypotype USNM 30471 (Mississippi); hypotype USNM 193069-130702, 130715 (Mississippi); hypotype USNM 32871 (Tennessee); hypotype USNM 32870 (Tennessee) (holotype of *L. carinatum* Wade); hypotype USNM 32872 Tennessee (=L. canalis (Conrad) Wade); hypotype USNM 77095 (Texas) (holotype *L. leioderma longum* Stephenson); hypotype USNM 77097 (Texas) (holotype *L. leioderma brevis* Stephenson).

**Occurrence:** Mississippi: Ripley Formation at locs. 6, 12, 15-18, 24, 27, 29, 32? Tennessee: Ripley Formation at loc. 1. Texas: Nacatoco Sand, Alabama and Georgia: Ripley Formation.

**Liopeplum canalis** (Conrad)

Plate 43, figures 4, 5, 17, 18, 23


**Diagnosis.—**Shell moderately large for genus, callus ridges strongly developed; body moderately to well shouldered.

**Measurements.—**Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

<table>
<thead>
<tr>
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<td>71.5</td>
<td>32.9</td>
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**Discussion.—**The holotype of *Liopeplum canalis* (Conrad) is not present in the collections of the Academy of Natural Sciences of Philadelphia and is evidently lost. Conrad’s description is short and his illustration is of an incomplete specimen. The specimen here figured on plate 43, figure 23, from the type locality on Owl Creek, Tippah County, Miss. (loc. 46), appears to be close to the type specimen as illustrated. Other specimens, however, show a gradation to a somewhat slimmer more elongate form, as is exemplified by the topotype figured on plate 43, figure 17. Despite the disparity in proportions these specimens all show affinities in the possession of the strong callus ridge that overhangs the shoulder of the succeeding whorl and thus develops a deep channel. The closest related form to this species appears to be *Liopeplum tabulatum* Stephenson, from the Nacatoco Sand of Texas, but that species is shorter and proportionally broader with a less well developed channel. Though *L. thoriscum* Stephenson, from the Black Creek Formation of Texas, has a deep channel and a well-developed callus ridge, its body is constricted anteriorly to a narrower siphonal canal and has a more strongly developed shoulder.

**Liopeplum canalis** (Conrad) is restricted to the Owl Creek Formation of northern Mississippi and Tennessee.

**Types:** Holotype (lost); hypotypes USNM 130703-130704; hypotype USNM 20947.

**Occurrence:** Mississippi: Owl Creek Formation at locs. 42, 45, 46. Tennessee: Clayton Formation (Owl Creek re worked at base) at loc. 40.

**Liopeplum cretaceum** (Conrad)

Plate 43, figures 3, 21, 22, 24, 25


**Diagnosis.—**Shell large for genus; spire proportionally high; whorls lack pronounced callus ridge and shouldering.

**Measurements.—**The most complete specimen from locality 40 measures 78 mm in height, 29 mm in diameter, and has a H:D ratio of 2.7.

**Discussion.—**The holotype is no longer in the collections of the Academy of Natural Sciences of Philadelphia and is presumed lost. However, the toptype from Owl Creek, Tippah County, Miss., figured on plate 43, figure 24, agrees well, both in size and shape, with Conrad’s illustration (1858, pl. 33, fig. 16). Although specimens of *Liopeplum cretaceum* vary moderately in the amount of callus deposited over the suture, there is never a pronounced ridge developed except for a low swelling at the aperture of the largest individuals. Likewise the body whorl always lacks anything but the faintest shoulder.

**Liopeplum monmouthensis** Gardner, from the Monmouth Formation of Maryland, appears to be an incomplete specimen, agreeing with *L. cretaceum* both in size, shape, growth line, and callus deposition. The internal molds from the Woodbury Clay assigned to
this species by Richards and Randall (1962, p. 83) are specifically and generically indeterminate. *Valutomorpha tarsensis* Stephenson, from the Black Creek Formation of North Carolina, occurs at a considerably lower stratigraphic position, but although smaller and less well known, it approaches *L. cretaeum* in form.

Gabb (1877) placed this species in the synonymy of *Liopeplum canalis*, but the two are decidedly distinct. *Liopeplum canalis* possesses a strong and overhanging calxus ridge, which is lacking in *L. cretaeum*.

**Types:** Holotype, lost; hypotypes USNM 130706-130707.

**Occurrence:** Mississippi: Owl Creek Formation at loc. 46; Tennessee: Clayton Formation (reworked Cretaceous at base) at loc. 40. Alabama and Georgia: Province Sand. Texas: Escondido Formation. Maryland: Monmouth Formation.

**Liopeplum coronatum** Sohl, n. sp.

**Plate 43, figures 13, 14, 19, 20**


**Diagnosis.**—Shell medium to moderately large for genus; transverse ribs restricted to elongate nodes coronating the whorls of the spire but absent to weak on the body; calxus ridge strong; body well shouldered; columella generally bears two strong folds.

**Measurements.**—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

<table>
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<td>62.3</td>
<td>26.6</td>
<td>28.6</td>
<td>2.2</td>
</tr>
</tbody>
</table>

**Discussion.**—*Liopeplum coronatum* is restricted to its type locality in the *Exogyra cancellata* zone of the Ripley Formation on Coon Creek, McNairy County, Tenn. There the species occurs in moderate abundance and is well preserved. *Liopeplum rugosum*, from the Owl Creek Formation, is in general, smaller, has less numerous but longer transverse ribs, and has more numerous columellar plications placed on a raised broad welt. *L. nodosum* Sohl, from the Ripley Formation in Mississippi and Alabama above the *E. cancellata* zone, is more similar to *L. coronatum* but has weaker wider spaced transverse nodes, a higher spire, weaker shoulders, and is almost devoid of a calxus ridge.

**Types:** Holotype and paratype USNM 32896; paratypes USNM 130708-130710.

**Occurrence:** Tennessee: Ripley Formation at loc. 1.
Types: Holotype USNM 128295; paratype USNM 128197–128199; holotype USNM 111801.

Occurrence: Mississippi: Owl Creek (reworked at base) at loc. 44, Clayborn Formation (Owl Creek rereckoned at base) at loc. 48, Prairie Bluff Chalk questionably present at loc. 93. Missouri: Owl Creek Formation.

*Loepeplum nodosum* Sohl, n. sp.

Plate 43, figures 9–12, 15, 16

**Diagnosis.**—Shell of medium size for genus; spire proportionally high; transverse ribs nodose, suppressed on body; callus ridge poorly developed; shoulder moderate; colurnella bears two moderately low folds.

**Description.**—Shell of medium size, substromboliform, rather slim; spire turreted and about half total shell height. Pleural angle 30°–40°. Protoconch unknown. Suture appressed. Whorls posteriorly constricted, strongly shouldered on spire with shoulder strength diminishing on body; body flat to broadly rounded peripherally, sloping gently anteriorly. Sculpture of strong transverse ribs on early whorls that diminish in vigor with size and are absent on body. Ribs are restricted to upper part of whorl, becoming nodose at shoulder, and dying out above. Growth lines adaperturally sinuous subsuturally and adaperturally arcuate over periphery to the moderately rugose siphonal fasciole. Shell surface washed by a callus glaze that is accentuated to a ridge above the suture on early whorls but ridge broadens to a low welt on later whorls. Aperture lanceolate; posteriorly notched, siphonal canal short, siphonal notch broad and shallow. Outer lip incompletely known, inner lip excavated above, callus thin. Colurnella bears two rather low oblique folds situated submarginally.

**Measurements.**—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

<table>
<thead>
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<th>Loc.</th>
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**Discussion.**—This scarce species fills a gap between *Loepeplum coronatum* of the Coon Creek Tongue and *L. rugosum* of the Owl Creek Formation. Only two specimens have been found in the Ripley Formation of Mississippi, but three specimens have been found at the type locality in the Ripley Formation on the Chattahoochee River, 2 miles below Eufaula, Ala. The available specimens show a reasonable amount of variation in ornament with some specimens, like the paratype figured on plate 43, figure 10, which possesses a rather strong callus ridge and strong nodes in comparison to the specimens figured on plate 43, figure 16. *L. nodosum* differs from both *L. coronatum* and *L. rugosum* by having a slimmer shell, longer spire, a lesser development of the callus ridge, and a weaker shoulder. In addition *L. rugosum* has more numerous columnellar plications and more continuous transverse ribs, where as *L. coronatum* has more numerous ribs.

*Loepeplum nodosum* appears to be restricted to the lower and medial parts of the Ripley formation, above the *Exogyra cancellata* zone.

Types: Holotype USNM 120711; paratypes USNM 120712–120714; paratype USNM 20472.


Genus *Pariolovoluta* Wade, 1926

Type by original designation, *Pariolovoluta concinna* Wade.

**Diagnosis.**—Small subufiform volutids with a shell surface marked by strong transverse ribs and finer spiral lirae. Aperture lenticular, siphonal canal short and open; colurnella bears two or three rather weak plications.

**Discussion.**—Besides the type species, *Wade* (1926, p. 122) included a specifically undeterminable specimen, also from Coon Creek, and questionably assigned *Voluitolithes orbignyanus* Mueller from the Aachen Cretaeous of Germany. No further specimens assignable to this genus have been found, either at the type locality of the type species on Coon Creek, Tenn., or higher in the section in Mississippi. Unfortunately, the specimen *Wade* assigned to *Pariolovoluta* are crushed and incomplete, which further clouds the relationship of the genus. *Wenz* (1943, p. 1318) assigned *Pariolovoluta* as a subgenus *Volutocorbis* to Conrad. Although uncertain of its rightful position the genus is here restricted to *Wade*’s type specimens and arbitrarily placed in the *Volutinae*. The type species is not illustrated here as the holotype is evidently more incomplete than when figured by *Wade* (1926, pl. 43, fig. 10).

Genus *Tectaplaga* *Wade*, *1916*

Type by original designation, *Tectaplaga simplicata* *Wade*.

**Diagnosis.**—Medium-sized thick low-spired shells. Whorls posteriorly constricted, weakly shouldered, periphery rounded and tapering gradually below. Sculpture consists of strong transverse ribs that weaken anteriorly and of close-spaced spiral lirae. Siphonal fasciole low and narrow. Aperture narrowly lenticular, siphonal canal narrow and of moderate
length; outer lip thin at edge, thickened within; inner lip callus with well-defined margin. Columella with three low weak plications that are not visible at the aperture.

Discussion.—Wade (1926, p. 121) viewed Tectaplica as a rather primitive volute originating in the Late Cretaceous and ancestral to Voluta florescens Harris from the Paleocene of Alabama. Subsequent studies have yielded no further species assignable to this genus in the Upper Cretaceous rocks of the coastal plains. Pchelintsev (1953, p. 264) has described Tectaplica armenica from the Upper Cretaceous of the Russian Caucasus. This species has a siphonal canal that is longer than that of the type species.

Wenz (1943, p. 1318) has assigned Tectaplica as a subgenus of Volutochorbis Conrad. Tectaplica does appear close to both Volutochorbis and Athleta Conrad but differs primarily in that its inner lip callus is well margined and thicker than is the rule in the previously mentioned genera. In addition, both of the previously mentioned genera possess strong columellar plications that are visible at the aperture, in contrast to the hidden folds present in Tectaplica.

Tectaplica simplicia Wade

Plate 44, figures 19–21

1943. Volutochorbis (Tectaplica) simplicia (Wade). Wenz, Handbuch der Paläontologie Gastropoda, v. 6, pt. 6, p. 1318, fig. 3750.

Discussion.—Subsequent collecting at the type locality on Coon Creek, McNairy County, Tenn., has failed to yield further material. Only Wade's two original specimens are available for study and afford little basis for the investigation of variation. They do show that during the last stages of growth the aperture expands, with a sinus developing at the suture as the body begins to embrace more of the penultimate whorl (pl. 44, fig. 20). In addition, both shells indicate that the last formed transverse rib is expanded in a varixlike fashion.

Types: Holotype and paratype USNM 32675.
Occurrence: Tennessee: Ripley Formation at loc. 1.

Subfamily SCAPHELLINAE!

Genus PARAFUSUS, Wade 1918

Type by original designation, Hyllus callilatarius Wade, 1917.

Synonymy.—(Hyllus Wade 1917, not Koch 1847; Wadia Cossmann, 1920; Haplovoluta Cossmann 1925, not Wade 1918).

Diagnosis.—Medium to large-sized subovoid shells; spire evenly tapering, one-third total height. Whorl rounded, unornamented, glazed by callus. Growth lines sinuous at suture and adaperturally arcuate below. Aperture broad, siphonal notch broad and shallow; columella thick with 1 or 2 strong sharp plications.

Discussion.—The name Hyllus, originally proposed for this genus by Wade (1917, p. 281), is preoccupied by Koch for an arachnid. Wadia Cossmann (1920) was proposed in ignorance of Wade's (1918) subsequent substitution of Parafusus. Cossmann later (1925) confused the names Haplovoluta and Parafusus.

Parafusus Wade appears to be most similar externally to such forms as Scaphella Swainson and, in some respects, Caricella Conrad or Gilivastia Iredale. From all these it differs by generally having only one strong plication or at the most two. All available specimens have worn protoconchs and it is difficult to state whether they are scaphelloid or not, but in view of the similarity of shell morphology, Parafusus is here tentatively placed in the subfamily Scaphellinae.

Parafusus is restricted to the several species discussed herein that occur in the Eozogrya costata zone of the Gulf Coastal Plain. Wade (1926, p. 122) assigned Ancilla cretaeensis Conrad (1860, pl. 47, fig. 14) to this genus. If Conrad's species does belong to Parafusus, its spire is lower than that of other members of the genus. Conrad, however, did not describe the species but only figured it. Unfortunately, the type is not present in the collection of the Academy of Natural Science of Philadelphia. Though the incomplete figured specimen has a shape like that of Parafusus and a single strong columellar plication, its placement is uncertain and the specific name is here restricted to the figured specimen. The other specimens described in Conrad's 1860 paper, range from Cretaceous to Eocene in age and come from Mississippi and Georgia, therefore, even the stratigraphic position is uncertain.

Stephenson (1941, p. 350), followed by Harbison (1945, p. 86), questioned the advisability of assigning species such as Parafusus callilatarius and P. coloratus to the same genus, as one species possessed one plication and the other two. In genera of such a group as the Volutidae, where variation in the number of plications is rampant, such a basis for generic separation is untenable, especially when the shells are so similar.
Parafusus callilatia Wade
Plate 44, figures 22, 23, 26

1926. Parafusus callilatia Wade. U.S. Geol. Survey Prof. Paper 137, p. 120, pl. 43, figs. 11, 12.
1943. Parafusus callilatia Wade. Wenz, Handbuch der Paläozoologie; Gastropoda, v. 6, pl. 6, p. 1352, fig. 3827.

Diagnosis.—Medium to moderately large parafusids of rather obscure outline, having a well-defined thick rounded ridge of callus on the side of the body opposite the aperture. Columella bears one strong plication.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

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<td>18.0</td>
<td>16.5</td>
<td>1.9</td>
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1 Estimated 25.

Discussion.—Compared with the holotype from the Rippley Formation at Coon Creek, McNairy County, Tenn., the specimens from the Rippley Formation of Mississippi appear to be smaller, as is indicated by the H:D ratio. This trend of slimming with progressively younger stratigraphic position appears to continue well up into the Owl Creek Formation as is displayed by Parafusus safordi Sohl (H:B 2.0-2.1). This latter species differs not only by having a higher spire and by being smaller but also by lacking the distinctive callus ridge on the side of the body. Instead it possesses a callus hump on the parietal lip opposite the posterior sinus. P. coloratus Wade from Coon Creek differs primarily by its possession of two columnar plications, the anterior of which is the strongest.

Types: Holotype USNM 32879; paratypes USNM 20096.

Parafusus safordi Sohl, n. sp.
Plate 44, figures 24, 25

Diagnosis.—Medium to moderately large sized shells with a spire high for genus; body bears a hump of callus on parietal lip opposite posterior sinus. Columella with a single plication.

Description.—Shells moderately large; spire high for genus and moderately slim. Protoconch unknown. Suture obscured by callus. Whorls of spire broadly rounded, faintly constricted posteriorly. Body rounding down below periphery to a gentle basal slope, terminating in a broad slightly corrugated siphonal fasciole. Sculpture lacking, except for growth lines that are adaperturally sinuous at suture but gently adaperturally arcuate below. Aperture broad and flaring below, posteriorly notched; siphonal canal very broad; siphonal notch broad and shallow. Outer lip thin at edge, sinuous posteriorly in harmony with growth lines. Inner lip callused, callus heaviest over parietal wall and built up into a hump on parietal lip, adjacent area of body opposite the posterior sinus. Columella bears one strong oblique plication.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

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Discussion.—Both the holotype and one paratype of Parafusus safordi were collected at locality 40 from the reworked Owl Creek at the base of the Clayton Formation in Hardeman County, Tenn. However, more poorly preserved specimens from the Owl Creek Formation at localities 45 and 46, fix the stratigraphic position of Parafusus safordi.

Parafusus callilatia Wade, a closely related species from the Rippley Formation, is more obese and also possesses a distinct callus ridge on the body, which is lacking in P. safordi. Parafusus coloratus Wade differs primarily by its possession of two strong columnar plications.

Types: Holotype USNM 130479; paratypes USNM 130480, 130481.

Occurrence: Tennessee: Clayton Formation (reworked Owl Creek) at loc. 40. Mississippi: Owl Creek Formation at locs. 45, 46.

Parafusus coloratus Wade
Plate 44, figure 18

1925. Haplopodota colorata Wade, Cossmann, Essais Paléoconchologie Comparée, v. 13, p. 342, pl. 11, fig. 17.
Diagnosis.—A *Parafusus* of small to moderate size bears two strong plaits on its columella.

Discussion.—The species is based upon two incomplete specimens from the Ripley Formation on Coon Creek, McNairy County, Tenn. Subsequently, Stephenson (1941, p. 339) noted the presence of an immature specimen of a *Parafusus* bearing two columellar plications in the Nacatoch Sand of Texas. Stephenson queried his assignment of this species to *Parafusus* because he believed parafusids bearing two instead of one plication might well belong to a new genus. The only other record of *P. coloratus* is an unconfirmed report of the species from locality 18 in the Ripley Formation of Union County, Miss., by Harbison (1945, p. 97). The extensive collections of the U.S. Geological Survey from this locality have yielded only specimens of *P. callilateris*.

*Parafusus coloratus* differs from the other species of *Parafusus* not only by bearing two columellar plications but by having a stronger siphonal fasciole and a more strongly constricted whorl base.

Types: Holotype and paratype AMNH 32877.


**Genus MYOBARBUSM** Sohl, 1963

Type species, *Myobarbusm laevigatum* Sohl.

**Diagnosis.**—From the Latin, elongate pointed drinking vessels; gender, neuter.

**Diagnosis.**—Shell small, oliviform in outline. Spire one-third to somewhat less than half total height. Surface smooth and glazed by callus that obscures the sutures. Whorls broadly rounded to subshoudered. Aperture lenticular; posteriorly sinuous; siphonal notch broad and shallow; columella with two strong plications, the lower of which margins the siphonal canal.

**Discussion.**—The small rather stout shells of this genus bear some resemblance to *Parafusus* Wade with which they occur, but their siphonal fasciole is less strong, they lack callus ridges or pads, and, most importantly, they have a strong fold bordering the siphonal canal at the base of the columella. Several Tertiary genera also compare to a greater or lesser extent. *Monotygmo* Lea of the Gulf Coast Eocene is similar but possesses a fascicilar band terminating in an outer lip tooth and lacks the truncate columella of *Myobarbusm*. *Myobarbusm* differs from such genera as *Ancilla* and *Olivella* by lacking the striate callused pad on the columella. Among the volutes to which it is here assigned, *Myobarbusm* resembles *Scaphellina* and *Amoria* most closely, but these forms bear more numerous plications and bear a longer siphonal canal that is not bordered by a columellar fold.

In its blunt paucispiral protoconch and in its general shell features, this genus appears to belong in the Scaphellinidae. *Myobarbusm* ranges through the Ripley and Owl Creek Formations and has been noted from Mississippi to Georgia.

**Myobarbusm laevigatum** Sohl

Plate 44, figures 15–17


**Description.**—Moderately small stout shells with an oliviform outline. Spire one-third to a little more of total length. Pleural angle about 60°. Protoconch blunt, obscured by callus coating, consisting of about two round-sided smooth whorls. Teloconch whorls number about three and are smooth and glazed by callus. Body slightly constricted posteriorly with a faint suggestion or total lack of shouldering, periphery high on whorl and broadly rounded with body tapering evenly below. Growth lines obscured by a callus covering, slightly sinuose posteriorly, very gently prosocline below. Aperture narrowly elongate, posteriorly channeled, siphonal canal open, inclined, siphonal notch shallow and broad. Outer lip posteriorly sinuose. Inner lip bears one strong columellar plication at midheight and a second one below, bordering the siphonal canal.

**Measurements.**—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

<table>
<thead>
<tr>
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<td>22</td>
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<tr>
<td>Do</td>
<td>10.9</td>
<td>5.5</td>
<td>1.9</td>
</tr>
</tbody>
</table>

1 Estimated.

**Discussion.**—The holotype of *Myobarbusm laevigatum* from the Owl Creek Formation on Owl Creek, Tippah County, Miss. (loc. 46) is a little more obese than the average specimen. At about the same stratigraphic position in Georgia, specimens of this species tend to be slimmer as do those from a lower level (Ripley Formation) in Mississippi (pl. 44, fig. 17). The columellar plications are not quite so strong on the smaller specimens as they are on the specimens representing the later growth stages. The more mature specimens also develop a stronger posterior whorl constriction.
With additional material for study, subdivision of this species eventually may be possible; however, the lack of ornament and the generalized features of the shell do not allow for division at present.

**Type**: Holotype USNM 130482; paratypes USNM 130483, 130484.

**Occurrence**: Mississippi: Owl Creek Formation at loc. 46, Ripley Formation at locs. 5, 22, Georgia: Providence Sand.

**Family CANCELLARIIDAE**

**Genus CANCELLARIA** Wade, 1916

**Type** by original designation, *Cancellaria elegans* Wade.

**Diagnosis**.—Medium-sized subglobose shells. Protoconch submerged. Sculpture restricted to spiral lirae. Siphonal canal rather short and inclined to left and twisted; outer lip denticle within; inner lip with two strong plications that begin slightly within the aperture and with several teeth low on the columella.

**Discussion**.—This very distinctive genus is like none other from the Cretaceous. Wade (1926, p. 109) stated:

> Probably *Cancellaria* is nearer the rare recent subgenus *Massyla*...

*Massyla* differs from *Massyla* in possessing a thicker, stouter, and more solidly built shell, in having a comparatively long recurved canal, and further in nuclear characters.

The genus is restricted to the Upper Cretaceous of the Gulf Coastal Plain and is represented by the type species *Cancellaria elegans* from the Ripley and Nacatoch Formations and by *M. subteres* Stephenson from the Nacatoch Sand of Texas. An additional undescribed species occurs in the Coffee Sand of Mississippi. Wade’s assignment of *Narona eximia* Stoliczka from the Ariolus group of India is untenable. That form has a parietal fold, lacks a recurved siphonal canal, has a well-defined margin to the inner lip callus, and strong transverse ornament. These features are not typical of *Cancellaria* although two immature specimens have been noted that possess a parietal tooth.

Wenz (1945, p. 1271) placed this genus in the Pseudovilinae of the Oliviidae and close to *Hydrotribulus*, but I believe the generic features fit better in the Cancellariidae, where it was placed by Wade.

**Cancellaria elegans** Wade

Plate 45, figures 20–27


**Diagnosis**.—Shell large for genus. Spiral sculpture variable by narrow close-spaced flat-topped lirae or ribbons with a broader subsutural spiral ribbon.

**Measurements**.—Explanation of measurements and symbols used in following table appears in the section "Measurements of specimens" (p. 172).

<table>
<thead>
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<td>1 (paratype)</td>
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</tr>
<tr>
<td>Do.</td>
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<td>Do.</td>
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</tr>
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<td>6.</td>
<td>14.1</td>
<td>8.7</td>
</tr>
<tr>
<td>6.</td>
<td>15.8</td>
<td>8.6</td>
</tr>
<tr>
<td>M. valida Stephenson (holotype)</td>
<td>16.7</td>
<td>9.8</td>
</tr>
<tr>
<td>M. valida Stephenson (paratype)</td>
<td>11.2</td>
<td>6.9</td>
</tr>
</tbody>
</table>

**Discussion**.—*Cancellaria elegans* Wade reaches its largest size and greatest numerical representation at its type locality in the Ripley Formation on Coon Creek, McNairy County, Tenn. All the closely similar specimens from higher stratigraphic positions in the Ripley Formation of Mississippi and from the Nacatoch Sand of Texas are smaller in size. Upon the basis of size difference as well as supposed minor differences in coarseness of sculpture and plumpness of shell, Stephenson (1941, p. 364) assigned the Texas specimens to his new species *M. valida*. The Mississippi specimens from the Nacatoch Sand, however, are plumper and more closely akin to the typical *M. elegans* of the *Exogyra cancellata* zone. Among the suites of totopotypes available, minor variation in shape, ornament, and height of protoconch are common. The totopotype on plate 45, figure 22, possesses a slim outline very similar to the type of *M. valida*. These variations lead to the conclusion that *M. valida* Stephenson is a synonym, being merely an individual variation of *M. elegans*.

**Types**: Holotype USNM 32846; hypotypes USNM 130485–130490.


**Genus TRIGONOSTOMA** Blainville, 1827

Type of monotypy, *Delphinula trigonostoma* Lamarck, 1822.

**Synonymy**.—*Trigona* Perry, 1811 [not Jurine, 1807]

**Diagnosis**.—Medium to large-sized loosely to tightly coiled shells with carinate to strongly shouldered whorls. Sculpture variable in both transverse and spiral elements. Aperture triangular, siphonal canal short and acute; outer lip lirate within; columellar lip with two to three plications. Umbilicus wide to narrow.

**Discussion**.—*Trigonostoma ripleysana*, described herein, lacks the loose coiling of the type species. If one
treats *Trigonostoma* in the strictest sense, *T. ripleiana* probably would not belong, yet it does have a narrow umbicus, and in its scaly transverse ornament and carinate whorls it is very similar to the type species. In these features it is much closer to *Trigonostoma s. s.* than many of the species included in that genus by such authors as Palmer (1937).

*Trigonostoma ripleiana* is the first species of the genus to be reported from the Cretaceous. Paleocene and Eocene representatives on the other hand are numerous and the genus is represented in the present seas by the type species.

*Trigonostoma ripleiana* Sohl, n. sp.

*Plate 44, figures 25, 27*

*Diagnosis.*—Medium sized trionostomids with a very narrow umbicus and bicarinate whorls bearing imbricate transverse sculpture between the carinations.

*Description.*—Shell of medium size; spire turreted and about one-third of the total shell length; pleural angle about 55°. Protoconch unknown; suture impressed. Whorls of spire exhibit only one carination, but body whorl bears two, the lower of which is less strong and extended than the peripheral carination. Body bears an inclined substatural ramp sloping to a peripheral carination; below carination body is concavely excavated to the second carination and then slopes steeply over the basal slope. Spiral sculpture dominated by the two raised carinae and a third strong cord on the basal slope; in addition, finer cords appear on the basal slope and finer spiral lirae over the shell surface and are superimposed on the strong cords. Transverse sculpture is weaker and takes the form of imbricate incrementalis that develop low small nodings where they override the spiral elements. Growth lines prosocline on ramp, bending to orthocline or gently prosocline on carination, slightly sinuous on excavated area, becoming rather steeply prosocline over basal slope. Aperture subtriangular; outer lip lirate within; inner lip strongly callused with edge of callosus loosening anteriorly; columella bears two strong plaits and anteriorly a third weaker rather obscure fold.

*Measurements.*—The holotype measures 16.6 mm in height and 12.5 mm in diameter.

*Discussion.*—The holotype is the only specimen available for study. It is incomplete, lacking both the last quarter turn of the body whorl and the protoconch. The characters of the shell, however, are so distinctive that the species should be easily recognizable. The only species in the fauna with which it might be confused is *Trichotropis mississippiensis*, and that species lacks columellar plications as well as differing in its ornament.

*Type:* Holotype USNM 130491.

*Occurrence:* Mississippi: Ripley Formation at loc. 18.

**Genus CANCELLARIA** Lamarck, 1799

*Type* by monotypy, *Voluta reticulata* Linnaeus, 1767.

*Diagnosis.*—Medium-sized stout low to moderately high spiral shells. Sculpture usually cancellate. Apex lenticular; siphonal canal narrow, short, and twisted; outer lip lirate within, thick; inner lip glazed by callosus. Columella with two to three folds with posterior fold strongest. Umbilicus perforate to imperforate.

*Discussion.*—Cossmann (1899), Gardner (1937), and others have pointed out the absence of *Cancellaria* in pre-Tertiary rocks. In fact, few species of any genus of the *Cancellariidae* are known from the Mesozoic. Wenz, 1943, listed only *Uxia Jousseaume, Bonnettilia Jousseaume*, and *Babylonella Conrad* as having a range extending down into the latest Cretaceous (Senonian-Maastrichtian). Several others occur in the Danian, which is now considered Paleocene instead of Cretaceous.

The species here tentatively assigned to *Cancellaria* possess several features that, although atypical of the type species, are found in other species of *Cancellaria*. In protoconch, character of the columellar plications and character of the outer lip it appears characteristic of the genus. In general, cancellariids have narrower transverse ornament, a more open umbilicus, and a more definite siphonal canal and therefore a stronger siphonal fasciole.

The shell Stephenson (1941, p. 362) described from the Kemp Clay of Texas as *Cancellaria matsoni* appears to be congeneric with *Cancellaria menaeryensis*, but his *Cancellaria?* sp. looks like a fusiform shell similar to *Hercothyrsus* or *Ornopsis* (*Ripleiana*) with the siphonal canal broken.

*Cancellaria? menaeryensis* Sohl, n. sp.

*Plate 44, figures 1, 2*

*Diagnosis.*—Small shells; spire a little less than half total shell height; transverse sculpture of broad ribs overridden by spiral ribs.

*Description.*—Shell small; spire a little less than half total shell height; pleural angle about 50°. Protoconch naticoid, consisting of about 2½–3 smooth rounded whorls; junction with conch abrupt with introduction of both fine transverse and spiral elements. Suture impressed. Body inflated, well rounded over periphery, and sloping steeply anteriorly. Transverse ribs broad, round topped, and numbering 9 or 10 on the body whorl, but not so well defined as on penulti-
mate whorl. Spiral elements consist of spiral ribbons that are strongest and broadest on the periphery, but narrow above and below, with secondary flares appearing in the broad interspaces on the basal slope; spiral ribbons number about 20 on body and 6 on the penultimate whorl. Growth lines prosocline on posterior quarter of body becoming orthocline over periphery and gently prosocline again on base. Aperture ovately lenticular, siphonal canal broad and short; outer lip thick and dentate within; inner lip glazed with three plications on columella, the upper two of which are strong and parallel, and the lower one bordering the siphonal canal is lower, weaker, and more oblique. Umbilicus restricted to a narrow slit, in part covered by the reflexed columellar lip.

Measurements.—The holotype measures 5.5 mm in height and 3.5 mm in diameter.

Discussion.—This species is known only from the holotype, from the Ripley Formation on Coon Creek, McNairy County, Tenn. Cancellaria matsoni Stephenson from the Kemp Clay of Texas appears to be the only closely related species but differs in its stronger narrower more numerous transverse ribs, its closer spaced but less numerous spiral ribbons, and in its tendency toward the development of a shouldered whorl.

Type: Holotype USNM 130492.

Occurrence: Tennessee; Ripley Formation at loc. 1.

Genus Caveola Stephenson, 1941

Type by original designation, Cancellaria acuta Wade, 1926.

Diagnosis.—Shell of medium size, spire longer than aperture. Protoconch of three to four round-sides whorls. Whorls well rounded over periphery and bearing one to three varices per whorl. Sculpture ornate, generally cancellate. Aperture sublenticular, siphonal canal short and broad; outer lip denticulate within; inner lip callus well margined, thin on parietal lip, thickening on columellar lip. Columella with two strong plications.

Discussion.—Stephenson (1941, p. 363) stated:
The characters which differentiate Caveola from Cancellaria are its exceptionally high spire, the presence of varices on the whorls, the absence of both an anterior fasciole and an umbilical fissure and the absence of a spiral sulcus at the base of the body.

Shells of Tertiary age having similar character are usually placed in either Sveolina Jousseaume or Svevella Cossmann. The many similarities shown by the Cretaceous species assigned to Caveola make it a great temptation to assign them to one of these genera and only the presence of a multiwhorled nucleus in this genus prohibits such a placement. The type species of Sveolina, S. varicosa (Brocchi), possesses an angulated body and a less well defined inner lip callus than do the species here assigned to Caveola. Cancellaria quantula Deshayes, the type species of Svevella, although small, differs primarily by its inner lip callus.

Stephenson (1941, p. 363) placed three other species besides the type species in Caveola: Cancellaria subalta Conrad from Haddonfield, N. J., Tritonium (Colubrinia) ceden Gardner from the Midway Group of Texas, and C. producta Stephenson from the Nacatoch Sand of Texas. Stephenson (1953, p. 190) later described two additional species of Caveola from the Templeton member of the Woodbine Formation of Texas, C. pinguis and C. bellina. Neither of the two last-named species conforms very well to the characteristics of the original generic diagnosis of Caveola. They do have cancellate sculpture, varices, and columellar plications; however, the height of the aperture is as much, or greater than, the height of spire in both species. The character of the protoconch is unknown and it is not known if denticulations are present on the interior of the outer lip. Both the Woodbine species also lack any well-defined marginal inner lip callus. All these features lead one to doubt the assignment of the Woodbine material to Caveola; if retained in Caveola these Woodbine species should be queried. Unfortunately, the hope of obtaining more and better preserved material is extremely small and at present the material does not appear to warrant the assignment of a new generic name.

Caveola acuta acuta (Wade)

Plate 44, figures 5–8


Diagnosis.—Largest of the caveolids; whorls plump with well-rounded sides; pleural angle about 25° at maturity to 40° on earlier whorls; ribs low or almost absent at maturity.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

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<th>Loc.</th>
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<tr>
<td>2b</td>
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<tr>
<td>2c</td>
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<td>7.4</td>
<td>2.1</td>
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<td>2d</td>
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<td>2.1</td>
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<tr>
<td>2e</td>
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<td>12.5</td>
<td>4.6</td>
<td>1.9</td>
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499–501 O – 64 – 6
Discussion.—*Caveola acuta* is represented in the U.S. Geological Survey collections by a large number of well-preserved topotypes from Coon Creek, McNairy County, Tenn. These specimens illustrate well the considerable variability present. Invariably the larger specimens have lost the protoconch or have had the surface exfoliated, but on the smaller specimens it is frequently preserved. In general the protoconch consists of about 3½ smooth round-sided whorls, with the first whorl being depressed to the level of the second protoconch whorl. The size of the protoconch appears to be somewhat proportional to the obesity of the shell. As either a comparison of the measurements given above or of figures 5 and 6, on plate 44, indicate, plumpness of the whorls of the spire and general outline of the shell vary significantly. With such variation at one locality the retention of *C. producta* Stephenson from the Nacatoch Sand of Texas as a separate species is questionable. Likewise, differences in the strength and spacing of both the transverse ribs and spiral ribbons is such, that by choosing different combinations of variations innumerable species could be made based on these features alone. Some specimens develop sharp nodes at the intersection of the transverse and spiral elements; others have blunt nodes or entirely lack such nodes. Some specimens possess spiral ribbons as wide as the interspaces and on others the interspaces may be at least twice as wide. Occasionally, especially on the early whorls, spiral ribs become accentuated, but only on one shell was any tendency toward the formation of a shoulder noted.

Specimens of *Caveola* from the higher stratigraphic positions of the Ripley Formation in Mississippi differ by some respects, but these differences are not deemed sufficient to indicate full specific differentiation. These specimens are consistently smaller in size, show spiral ornament that is wide spaced, and they have sharper transverse ribs that are better developed on the body. These specimens have been assigned to the subspecies *Caveola acuta speciosa*.

**Types**: Holotype USNM 130405; paratypes USNM 130406, 130523.

**Occurrence**: Tennessee: Ripley Formation at loc. 1.

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*Caveola acuta speciosa* Sohl, n. subsp.

Plate 44, figures 9–14.

**Diagnosis**.—*Caveola acuta speciosa* differs from *C. acuta acuta* by its consistently smaller size, its wider spaced narrower elements of spiral sculpture, and by sharp-crested transverse ribs that are stronger on the body whorl. These ribs are sometimes accentuated, forming a rugose surface.

**Measurements**.—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

<table>
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<tr>
<td>10,</td>
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<td>2.0</td>
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</table>

Discussion.—Like *Caveola acuta acuta* from Coon Creek, Tenn., the specimens from the post-*Exogyra cancellata* zone of the lower part of the Ripley Formation in Mississippi vary rather greatly in ornament and proportions. Although some specimens are quite thin (pl. 44, fig. 12) none reach the slimmness of *C. producta* of the Nacatoch Sand of Texas. It is questionable whether the specimen figured on plate 44, figure 9, should be assigned here. It does possess sharp transverse ribs, but there are more accentuated in strength than is normal and become rugose on the body. Only one specimen displaying these features is available, and until supplementary specimens are available this specimen which is doubtlessly closely related to *speciosa* is retained here.

In contrast to the Coon Creek subspecies the specimens assigned to this taxon usually retain their entire protoconchs.

Although scarce, the subspecies is present at several localities in the Ripley Formation of Mississippi.

**Types**: Holotype USNM 130405; paratypes USNM 130406, 130523.

**Occurrence**: Mississippi: Ripley Formation at locs. 6, 15–18.

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*Caveola* sp.

Plate 44, figures 3, 4.

**Discussion**.—A few incomplete and poorly preserved specimens that are present in the collections under study indicate the presence of *Caveola* in the Owl Creek Formation. These specimens probably represent a new species characterized by greatly suppressed ornament, rather subdued and wide-spaced transverse sculpture, and a shouldering of the body whorl.

**Types**: Figured specimens USNM 130407–130410.

**Occurrence**: Mississippi: Owl Creek Formation at locs. 41, 45, 46.

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**Family** PALADMETIDAE

**Genus** PALADMETE Gardner, 1916

Type by original designation, *Trichotropis cancerraria* Conrad, 1858.

**Diagnosis**.—Moderately small shells with a spire somewhat more than half total shell length. Protoconch of about three smooth rounded whorls. Sculpture reticulate, varices common. Aperture holostomes; outer lip
sometimes dentate within; inner lip excavated strongly above midheight, callus moderately thick. Columella curved anteriorly lacking plications.

Discussion.—Since Gardner’s erection of the genus Paladmete for the species Trichotropia cancellaria, from the Owl Creek Formation of Mississippi, the taxonomic position of the genus has been a matter of doubt. Gardner placed the genus in the Cancellariidae near Admete Kroyer, which she mistakenly believed lacked columnar plications. Both Cossman (1925) and Wenz (1949) placed this genus in the Trichotropidae. Stewart (1921, p. 424) placed Paladmete under the category of doubtful systematic position. Finally Stephenson (1941, p. 366) introduced the family Paladmetidae and placed it next to the Cancellariidae. He did not diagnose the family nor state any reason for the erection of the new family. In 1953, Stephenson (1941, p. 191) placed the genus in the Cancellariidae, ignoring his previous designation.

The lack of columnar plications and the common lack of frorinations or denticles on the interior of the outer lip makes a strong argument for distinguishing Paladmete from the Cancellariidae. Placement in the Trichotropidae, however, is not warranted as Paladmete lacks an umbilicus and differs by nuclear characters. In these features it is closer to the Cancellariidae. It seems best to place Paladmete in a separate family close to Cancellariidae.

The following is a list of described species of Paladmete. (Those prefixed by an asterisk are doubtfully placed in this genus.)

Paladmete alta Stephenson, Navarro Group of Texas
Trichotropia cancellaria Conrad, Owl Creek Formation of Mississippi
Paladmete corbiformis Stephenson, Navarro Group of Texas
canana Stephenson, Eutaw Formation of Mississippi
densata Wade, Ripley Formation of Tennessee
elegans Stephenson, Navarro Group of Texas
Cancellaria clandestina Gabb, Ripley Formation of Alabama
Paladmete gardnerae Wade, Ripley Formation of Tennessee
inaequalis Stephenson, Navarro Group of Texas
*Neptunia perforata Gabb, Cretaceous of California
Paladmete pectinata Harbison, Ripley Formation of Mississippi
pristina Stephenson, Raritan Formation of New Jersey
*Paladmete? turbiniformis Stephenson, Woodbine Formation of Texas

The preceding list indicates a total possible range for Paladmete of Cenomanian to Maestrichtian; however, the Cenomanian forms, P. pristina and P. turbiniformis, although related in lacking columnar plications, are much higher spired than is typical of Paladmete. The California species, P. perforata Gabb, is close in shape and ornament to Paladmete, and if truly a member of the genus it is the only one present outside of the Gulf and Atlantic Coastal Plains.

Paladmete cancellaria (Conrad)
Plate 45, figures 28-34

Diagnosis.—Shell large for genus; bears a rather sharply defined shoulder and strong transverse ribs that are overridden by spiral ribs and lirae. Coiling of whorls deviates in latest stages.

Description.—Shell of medium to moderately small size. Spire almost half total shell height, pleural angle about 80° on small shells, but lessening to 45° or 50° on larger shells. Protoconch consisting of 2½–3 rounded whorls, the first ⅔ of which are depressed level with the succeeding whorl; ornament begins on the third whorl with three faint sharp spiral lirae, followed, after a quarter turn, by fine transverse sculpture; ⅔ of a turn after the first appearance of the spirals, a flattened upper whorl surface develops between the suture and the uppermost spiral lirae. Whorls subshoudered and well rounded over the periphery. Body of large individuals deviates slightly in coiling. Transverse sculpture consists of 12–16 transverse ribs that are strongest on the shoulder, diminishing in size low on the base. Spiral ornament variable, dominated by seven to nine rather narrow spiral ribbons that are almost equispaced over the whole sides, but closer spaced on the base; secondary lirae occur irregularly in the broad interspaces and tertiary lirae occur crowded together over the interspace surfaces. Growth lines are strongly prosocline between shoulder and suture and gently prosocline below, but on larger shells they become gently sigmoidal over the whorl sides below the shoulder. Aperture holostomous, auriform in outline; outer lip denticulate within; inner lip strongly excavated above, callus with a well-defined margin extending only slightly out of the aperture. Columella smooth, inclined forward anteriorly.
Measurements.—Members of this species attain the largest size of any species of the genus. The largest specimen collected is that figured on plate 45, figure 22; it measures 19.0 mm in height and 12.2 mm in diameter. A wide range of size can be noted at any given locality, but the most common size range appears to be between 10 and 15 mm in height.

Discussion.—The holotype of *Paladmete cancellaria* (Conrad) is not present in the collections of the Academy of Natural Sciences of Philadelphia. Topotypes are available in the collections of the Geological Survey that compare well with Conrad’s illustrations. The Owl Creek specimen figured herein (pl. 45, fig. 28) is close to the holotype.

*Paladmete cancellaria* has the largest shell exhibited by the genus. Shells bearing the distinctive *cancellaria* type of ornament are found throughout the Gulf and Atlantic Coastal Plains in rocks ranging through the equivalents of the Ripley and Owl Creek Formations. With the exception of *Paladmete corbuliformis* Stephenson, which has much more subdued ornament, only the most minor differences can be distinguished at the various levels represented. At any given locality (compare pl. 45, figs. 29–33) variation in shape and ornament is considerable in detail, but the major features remain constant. The specimens from the type locality (loc. 46) and other localities (pl. 45, fig. 28) in the Owl Creek Formation cannot be distinguished from those in the Ripley Formation except when they have attained a very large size. With attainment of large size, gerronic characters develop. In the final growth stages the transverse elements diminish in vigor and their trend becomes more strongly sigmoidal, the shoulder becomes stronger, and one specimen shows a tendency for deviation in coiling. At localities where the species is abundant, the presence of denticulations on the interior of the outer lip is found to be highly variable. Some specimens possess them, others have a total lack. As this is the only criteria for distinguishing *P. densata* from *P. cancellaria* in the Ezogrya cancellata zone at Coon Creek (loc. 1), it appears justifiable to suppress the former name. At all levels, specimens show three primary spiral ribbons on the penultimate whorl with the suture of the body whorl resting on a fourth, but the presence of secondary spirals in the interspaces ranges from none (pl. 45, fig. 31) to specimens bearing several (pl. 45, figs. 33, 34). Transverse ornament may range from 10 to 18 ribs per whorl and their trend is from gently procoline to rather sigmoidal. (Compare pl. 45, figs. 31, 32 with pl. 45, fig. 29.) Height of spire, pleural angle, and strength of shouldering may all vary to a moderate degree.

The specimen figured by Gardner (1916, pl. 18, fig. 14) is not a toptype from the Owl Creek Formation as noted but is from the Ripley Formation at locality 7. In Gardner’s collections from the Monmouth Formation of Maryland, now at the National Museum, the specimens designated by her as belonging to *Paladmete cancellaria* are primarily internal molds. Some exhibit adhering fragments of shell that show the typical pattern of ornament, but several incomplete specimens of *Urecolabrum cf. U. tuberculatum* Wade are also included. Other specimens in these collections assigned to *Trichotrophi* sp. also appear to belong to *P. cancellaria*. Thus the species appears to be represented through equivalents of both the Owl Creek and Ripley Formation in Maryland.

In 1860, Gabb (p. 390) described a new species, *Cancellaria euphalaenisi*, from the Ripley Formation at Eufaula, Ala. The holotype (ANSP 14962) is present in the collections of the Academy of Natural Sciences of Philadelphia and is indistinguishable from *P. cancellaria* (Conrad).

**Types:** Holotype ANSP lost; holotype of *Cancellaria euphalaenisi* Gabb ANSP 14962; Hypotype Gardner collection USNM 20569 (Mississippi); hypotype USNM 32842 (Tennessee); holotype of *P. densata* Wade USNM 32845 (Tennessee); hypotypes USNM 130500–130506 (Mississippi).


*Paladmete gardnerae gardnerae* Wade

Plate 45, figures 43–45


**Diagnosis:** Small stout shells with well-rounded whorls that bear fine close-spaced spiral ribbons and lirae, numerous rather low transverse ribs and generally three varices per whorl.

**Description:** Shell moderately small, plump; spire a little more than one-third total shell height; pleural angle about 75°. Protoconch consists of about three smooth rounded whorls with the first whorl submerged below the plane of volutions. Suture impressed. Whorls round sided, plump, with a tendency to become flatter on larger specimens. Sculpture begins on the first teleoconch whorl by the development of a spiral lira high on the whorl with the whorl surface above this lira flattening; within one-eighth of a whorl two more lirae are added; transverse ribs are placed almost immediately after first lira appears and after the appearance of the first few on the upper whorl.
face they become continuous across the whorl. After the first teloconch whorl the shoulder formed by the first lira is rounded off and both spiral and transverse elements broaden to thin ribbons with low nodes forming at their intersection. On later whorls additional thin spiral ribbons are added and secondary lirae appear in the interspaces; the transverse ribbons coarsen to moderately strong ribs that become quite broad and low on the larger specimens. Varices common, generally three per whorl. Growth lines prosocline on upper whorl surface, orthocline on opisthocline on periphery and retracted strongly to prosocline on basal slope. Aperture holostomous, broadly selenostome with an incipient canal anteriorly; outer lip thickened and denticulate within; inner lip bears a narrow well margined strip of callus. Columella smooth.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

<table>
<thead>
<tr>
<th>Loc.</th>
<th>Number of specimens</th>
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<th>Average height</th>
<th>Range of MD</th>
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<td>7.9-8.0</td>
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<td>7</td>
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<tr>
<td>Average</td>
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<td>7.8</td>
<td>1.5</td>
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</tbody>
</table>

Discussion.—This species although similar in the ornament of its first teloconch whorl to *Paladmete cancellata* (Conrad), with which it occurs, differs decidedly at more advanced growth stages. The spiral ornament of *P. gardnerae* is much finer and closer spaced, the whorls are plumper, and the spire commonly is lower than on Conrad’s species.

*Paladmete inequalis* Stephenson from the Navarro Group in Texas is related to *P. gardnerae* but differs by its proportionally higher spire, its more closely spaced transverse ribs, its much finer and closer spaced spiral lirae, and in its general lack of varices.

Variation among the available suites of topotypes affects most features of ornament. The number of transverse ribs ranges from 16 to 24. In general the character of the spiral sculpture is less pronounced. In shape some specimens show a distinct subding of the transverse sculpture either in numbers or in strength of ribs (pl. 45, fig. 44). One specimen (pl. 45, fig. 43) shows a distinct welt developing at the suture and flattening of the body.

The species appears to be restricted to the *Ezogyra cancellata* zone.

*Types:* Holotype USNM 32843; hypotypes USNM 130052; 130053, 130055.


*Paladmete gardnerae pygmaea* Sohl, n. subsp.

Plate 45, figures 38-40

*Diagnosis.*—Shell small for genus, stout, with thin close-spaced spiral lirae and 25-30 close-spaced and narrow transverse ribs.

*Measurements.*—(Only largest and most complete specimens measured). Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

Discussion.—*Paladmete gardnerae pygmaea* differs from *P. gardnerae gardnerae* of the *Ezogyra cancellata* zone by its smaller size, more numerous thinner and lower transverse ribs, as well as by its finer spiral sculpture.

This subspecies is rather common at a number of localities in the Ripley Formation of Mississippi, above the *E. cancellata* zone. In general spiral ribs are absent, but a few specimens show narrow ribs like those of the form from Coon Creek. Although in general small, occasionally a larger specimen of *P. gardnerae pygmaea* may be found (pl. 45, fig. 36), but even on such specimens the ornament is finer than on typical *gardnerae* and there is less of a decrease in proportional strength of the transverse ribs and the varices remain stronger. For these reasons a new subspecies is erected.

*Paladmete inequalis* Stephenson, from about the same level in the Nacatoch Sand of Texas, is larger in size, lacks the strong and usually constant three varices per whorl, and has less sharply defined transverse ribs.

*Types:* Holotype USNM 130056; paratypes USNM 130057, 130058, 130059.

*Occurrence:* Mississippi: Ripley Formation at locs. 5-7, 15-18, 22, 24, 29, 32.

*Paladmete laevis* Sohl, n. sp.

Plate 45, figures 33, 41, 42, 46-48

*Diagnosis.*—Paladmetes whose ornament becomes suppressed and that develop a channelled suture and coarse subangular nodes on the body near the aperture in their later stages of growth.
Description.—Shell of average size for genus, spire almost half total shell height; pleural angle 45°–60°. Protoconch consists of 2½–3 smooth well rounded whorls; the first of which is even with the upper surface of the second whorl. Suture deeply impressed on first teleoconch whorl, becoming channeled on later whorls. Early whorls well rounded but tending toward flattening on later whorls; body distinctly constricted below the subangular periphery. Sculpture begins by the appearance of three spiral lirae immediately followed by the development of faint fine continuous transverse lines; generally both spiral and transverse elements become obsolete or suppressed after the second teleoconch whorl, but sometimes the close-spaced transverse ribs may continue for three whorls. The body is generally smooth, with a few faint spiral threads over the upper whorl and with low spiral cords on the base; the transverse ribs retract to form coarse subsutural nodes. Growth lines subsutural prosocline, retracting to orthocline or faintly opisthocline on the periphery and becoming prosocline on base. Aperture holostomous, broadly subovate and slightly flared anteriorly; outer lip at edge; inner lip with a well-margined callus. Columella straight, lacking plications.

Measurements.—Measurements and symbols used in the following table are explained in the section “Measurements of specimens” (p. 172).

<table>
<thead>
<tr>
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<td>12</td>
<td>11.5</td>
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<td>1.5</td>
</tr>
</tbody>
</table>

Discussion.—Paladmeta laevis differs from all other species of the genus by possessing a channeled suture and lacking varies. The species is, however, decidedly a Paladmeta in its early developmental stages as the channeled suture does not develop until after the first teleoconch whorl. It also differs from P. cancellaria and P. gardnerae in its type of ornament. P. inaequalis Stephenson is perhaps closest to this species in ornament, but possesses varies, lacks the channeled suture, generally retains transverse sculpture other than subsutural nodes, and has a distinctly curved columella. Paladmeta caveola Stephenson (1947, p. 184), from a deep well in the Eutaw Formation of Hinds County Miss., shows some affinities to this species but is more highly sculptured by coarse transverse ribs at a later growth stage. It does, however, possess a somewhat channeled suture as is shown by a large incomplete paratype (USNM 104111).

Paladmeta laevis varies considerably in its subdued sculpture. Some specimens possess strong transverse sculpture for several whorls (pl. 45, figs. 47, 48), and in others the transverse sculpture is weak and restricted to only the earliest developmental stages (pl. 45, figs. 35, 41). The subsutural nodes are generally best developed near the aperture, but other shells retain the nodes for the full body whorl (pl. 45, fig. 47).

The species is rare and is known only from the lower part of the Ripley Formation in Mississippi and the Chattahoochee River region of Georgia and Alabama.

Types: Holotype USNM 130500; paratypes USNM 130510–130513.

Occurrence: Mississippi: Ripley Formation at locs. 7, 9a 12, 13, 17, 18, Alabama and Georgia (Chattahoochee River Region): Ripley Formation.

Family TURRIDAE

Of the turrids herein described, three taxa, Amuletum, Lutema, and Remnita, previously assigned generic rank appear to be closely related. These three can be split into two basic types. Amuletum Stephenson and Lutema Stephenson have sculpture initiated by transverse ribs on the first teleoconch whorl and a columellar lip that narrows to a knife edge anteriorly. In addition, the relative positioning of the growth line appears to be the same. These two genera are differentiated only on the basis of type of sculpture on the later whorls. Because of the many similarities, Lutema is here treated as a subgenus of Amuletum. Remnita, on the other hand, begins its sculpture by introduction of spiral elements that remain strong through growth and the transverse elements are always minor in strength. In addition, the columellar lip does not appear to narrow to a sharp edge anteriorly and the collar sinus is proportionally lower on the whorl.

Genus AMULETUM Stephenson, 1941

Subgenus AMULETUM Stephenson

Type by original designation, Turricula macnairensis Wade, 1962.

Diagnosis.—Small rather slender shells with a spire about half total shell height. Protoconch proportionally large consisting of 3 to 4 smooth whorls. Whorls rounded, slightly constricted posteriorly to a sloping subsutural collar. Transverse and spiral sculpture is sometimes nodose. Siphonal canal elongate, slender, and curved somewhat; outer lip with a rather shallow subsutural sinus. Columella lacks plications and narrows to a thin edge at the anterior extremity.

Discussion.—Stephenson (1941, p. 369) proposed Amuletum for small fusiform turrids as typified by
Turricula macnairiensis Wade. In addition he described three additional new species from the Navarro Group of Texas, A. venustum, A. baylei, and A. curvoostatum. Of these, A. venustum appears to be based on an immature shell more closely related to Remnita. In addition, he suggested that Ezilia ripleysana Wade also belonged to Amuletum. The later species, for reasons cited under the discussion of A. macnairiensis, is deemed a synonym of the type species. Later Harbison (1945, p. 88) described an ornate Amuletum from the Ripley Formation of Mississippi as A. wadei.

Of those listed in the preceding paragraph, all except A. wadei appear to be very closely related with only relatively few characters or minor variations distinguishing them.

lutena Stephenson is based on material from the Navarro Group in Texas and differs from Amuletum primarily by its greater shoulder development, by its suppression of spiral sculpture, and by the strongly nodule character of the transverse ribs as they cross the shoulder. Lutena along with Remnita and Amuletum represent a related group of genera that blossomed in some profusion during the Late Cretaceous in the Gulf coast region. The relationships of these Cretaceous genera to similar turrids of the lower Tertiary of the Gulf coast are clouded by a great abundance of proposed turrid genera and species that are based on small relative differences.

Amuletum (Amuletum) macnairiensis macnairiensis (Wade)
Plate 45, figures 1-5
1926. Turricula macnairiensis Wade, U.S. Geol. Survey Prof. Paper 137, p. 113, pl. 36, figs. 8, 9.

Diagnosis. Moderately small slim fusiform shells with a weak posterior whorl constriction and numerous narrow low collabral transverse ribs that are overriden by low spiral cords that are about as wide as their interspaces.

Description. Moderately small slim fusiform shells with a spire half, to a little less, of total shell height; pleural angle 25°-35°. Protoconch proportionally large, consisting of 4-4½ smooth whorls that begin with a rather globose initial whorl, but becomes less round sided with increased size. Suture impressed. After the first teleconch whorl, whorls develop a weak posterior constriction below which the body inflates to a well-rounded periphery; whorls then constricts rapidly over the moderately steep basal slope to the extended tapering pillar. Sculpture ornate, initiated abruptly on first teleconch whorl by rather strong widely spaced transverse ribs that are followed by the development of broad close-spaced spiral cords on the second half of the first teleconch whorl. On later whorls the sinuosity of the ribs increases and the proportional spacing of the ribs is closer; on the body, ribs are strongest adjacent to suture and on periphery but die out on basal slope. With increased size the spiral cords become proportionally narrower and the interspaces increase until they exceed, by several times, the width of the spiral cords. Growth lines bear a moderately strong abapertural sinus over the collar, are opisthocline over the periphery, swing back arcuately to proscoline over the basal slope, and become gently proscoline to almost orthocline on the pillar. Aperture lanceolate, produced anteriorly to a moderately narrow elongate siphonal canal inclined slightly to the left and slightly bent. Outer lip incompletely known, thin, and evidently crenulated by intersection of cords; inner lip lacks callus on upper part of parietal lip, but bears a thin wash below. Columella smooth, thinning to a sharp edge at anterior extremity.

Measurements. Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 172).

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<th>Lec.</th>
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<th>HD</th>
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<td>2.2</td>
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<td>Ezilia ripleysana holotype</td>
<td>11.8</td>
<td>3.6</td>
<td>2.6</td>
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<tr>
<td>Topotype</td>
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<tr>
<td>Dr.</td>
<td>7.5</td>
<td>1.8</td>
<td>1.8</td>
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</table>

Discussion. This species is represented in collections from the type locality on Coon Creek, Tenn., by about 50 specimens in various states of preservation. Other toptypes of a size equivalent to the holotype are present, but they are too incomplete for measurement. Among the toptype suites, numerous minor variations can be seen both in shape and sculpture. Within this framework of variation fall both the specimens Wade assigned to Turricula macnairiensis and to Ezilia ripleysana. Wade's illustrations of the later species is misleading. His figure indicates the spiral cords to be very closely spaced, separated only by incised lines, whereas actually the interspaces are several times as wide as the spiral cords. On the other specimens the spacing of the cords varies from those in which the cords are as wide as the interspaces to those where it is less, but commonly the larger the
specimen the greater the spacing on the later whors. The maximum number of cords noted on a whorl of the spire is 13 and the minimum is 8. Transverse ribs vary both in strength and spacing and number from 20 to 26 per whorl. The posterior constriction of some specimens like the holotype is weak, but upon others it is moderately well developed.

The holotype of Amuletum (A.) curvicostatum Stephenson from the Neylandville Marl of Texas occurs at about the same level as A. macnairiensis macnairiensis in Tennessee. The holotype of the Texas species (USNM 77146) is indistinguishable from the holotype of Amuletum (A.) ripleyana (Wade), another synonymous name for that type species, except that the transverse ribs are a little stronger. An incomplete unfigured paratype of A. (A.) curvicostatum Stephenson (USNM 77147), however, is perhaps distinct, bearing very strong ribs and crowded broad spiral ribbons. Another paratype (USNM 77148) of the same species, but from the Nacatoch Sand, appears to be more closely related to A. macnairiensis torquatum.

**Types:** Holotype USNM 32852; holotype (E. ripleyana) USNM 32850; holotype (A. curvicostatum) USNM 77146; hypotypes USNM 136514, 136515.

**Occurrence:** Tennessee: Ripley Formation at loc. 1. Texas: Neylandville Marl.

**Amuletum (Amuletum) macnairiensis torquatum Sohl, n. subsp.**

**Plate 45, figures 6-9**

**Diagnosis.—**This subspecies differs from Amuletum macnairiensis macnairiensis by having a stronger posterior whorl constriction which develops a stronger subsutural collar. The transverse ribs also are stronger on the body and more sharply flexed on the collar.

**Measurements.—**Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

<table>
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<td>8</td>
<td>10.3</td>
<td>2.6</td>
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</table>

**Discussion.—**In addition to the more noticeable characters previously listed, Amuletum macnairiensis torquatum also differs from A. macnairiensis macnairiensis by having proportionally stronger spiral cords and a greater opisthoclino inclination of the transverse ribs.

Comparison with Amuletum (A.) venustum Stephenson from the Nacatoch Sand of Texas is difficult due to the poor state of preservation of the holotype of that species and to its immature stage of development. As known, that species has more rounded and obese whors and lower less flexed transverse ribs.

**Types:** Holotype USNM 136516; paratypes USNM 136517, 136518.

**Occurrence:** Mississippi: Ripley Formation at locs. 7, 16, 18.

**Amuletum (Amuletum) dumasensis Sohl, n. sp.**

**Plate 45, figures 10-15**

**Diagnosis.—**Moderately small fusiform shells with a moderately strong posterior whorl constriction. Transverse ribs strong and collbaral and overridden by close-spaced crowded spiral cords.

**Description.—**Moderately small slim fusiform shells with a spire a little less than half total shell height; pleural angle about 25°. Protoconch proportionally large, consisting of about 4½ smooth whors that become increasingly rounded with increased size. Suture impressed. Whors develop a moderate posterior constriction after the first teleconch whorl; body generally with a low shoulder below which the body inflates slightly and is well rounded over the periphery but constricts moderately rapidly below to a slim extended pillar. Sculpture begins gradually on first teleconch whorl with faint low arcuate opisthoclino transverse ribs that strengthen and become less opisthoclino on the second half of the first teleconch whorl; as the collar forms on the second teleconch whorl the ribs diminish in vigor over the collar and become sinuous; on the body they are strongest over the shoulder and periphery and die out on the basal slope. Spiral sculpture appears on the last half of the first teleconch whorl as faint broad cords; on later whors they cover the whorl surface and are broad, slightly round topped, and generally separated by only narrow impressed lines over the collar and periphery, but the spacing increases over the base. Ribs number 22-24 on larger specimens with cords numbering about 20 on penultimate whorl. Growth lines abaperaturasely sinuous over collar, gently opisthoclino over periphery, slightly prosocline on basal slope, and almost orthoclino on pillar. Aperture lanceolate, produced anteriorly to a moderately narrow elongate siphonal canal that is inclined slightly to the left and somewhat bent; outer lip unknown; inner lip lightly callused with callus lightest on upper part of parietal lip and narrowing anteriorly. Columella lacks plications and narrows to a thin edge at anterior extremity.

**Measurements.—**Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).
Discussion.—This is the most common species of *Amuletum* in the Ripley Formation of Mississippi, and it is restricted to the lowest part of that formation. Variation is not great, but to a minor degree affects the depth of the collar on the posterior sinus and the strength and spacing of the spiral and transverse elements.

*Amuletum macnairynsis torquatum* also occurs in the Ripley Formation but can be distinguished most readily in having wider spaced and generally broader spiral cords. In addition *A. dumasensis* has a stronger collar, a somewhat deeper sinus, and has more highly inclined initial transverse ribs. None of the other Ripley and Owl Creek species are likely to be confused with this.

Types: Holotype USNM 130519; paratypes USNM 130520–130523.

Occurrence: Mississippi: Ripley Formation at localities 4, 6, 7, 15, 16, 18–20, 29.

*Amuletum (Amuletum) wadei* Harbison

Plate 45, figures 16–19


Diagnosis.—A highly ornate *Amuletum* bears a strongly defined posterior whorl constriction and very sinuous collateral transverse ribs that are thin, except on the periphery, and that are frequently beaded where overridden by the transverse elements.

Description.—Shell of medium size and fusiform; spire truncated and less than half total shell height; pleural angle 25°–30°. Protoconch proportionally large, consisting of about four smooth convex-sided whorls that expand disproportionately to the rate of increase of the teleoconch. Suture impressed. Whorl strongly constricted posteriorly to a well-open collar that consists of a subsutural band that is bounded below by a moderately narrow slightly excavated band; body subshouldered with a well-rounded periphery and gradually constricting anteriorly to a slim elongate pillar. Sculpture begins gradually with low broad incomplete transverse ribs that, after a half turn of the first teleoconch whorl, become continuous suture to suture and are accurately orthocline. The subsutural collar and concurrent development of the sinuosity of the transverse ribs begins just before the completion of the first teleoconch whorl. Spiral sculpture begins after one-third of a turn of the first teleoconch whorl and consists of a few broad ribbons separated only by thin impressed lines; by the second teleoconch whorl these ribbons have narrowed proportionally to spiral cords that are separated by interspaces of varying widths. The transverse ribs, on later whorls of the spire, are moderately strong on the subsutural welt, weaker over the excavated band below, but intensified to coarse ribs over the shoulder. On the body whorl, where there are 5 or 6 rather narrow spiral cords on the periphery, the cords are strengthened and secondary lirae may occur in the spiral interspaces; spiral elements are noded or beaded where they override the transverse elements. Growth lines strongly prosocline on the subsutural welt, abaperturally sinuous on the excavated band, strongly opisthochline over the shoulder and periphery surging to moderately prosocline on the basal slope, then back to orthoconline on the pillar. Aperture lanceolate, produced anteriorly to an elongate narrow siphonal canal that is inclined slightly to the left and bent. Outer lip unknown, inner lip lightly callused except for the upper part of the parietal lip; columella smooth, tapering to a sharp edge at the anterior extremity.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

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</table>

Discussion.—*Amuletum (A.) wadei* Harbison has such a distinctive pattern of ornament that it is not likely to be confused with any of the other species. In addition the growth lines of this species are more sinuous than either *A. (A.) macnairynsis* (Wade) or *A. dumasensis* Sohl. Such differences make the assignment of the species to *Amuletum* subject to doubt, but the inner lip characters, the placement of callus, the thin columellar lip, and the protoconch are those of an *Amuletum*.

*Amuletum (A.) wadei* is a rather scarce species and is known from only a few specimens from two localities in the lower part of the Ripley Formation of Mississippi. Not all the specimens labeled *A. wadei* in the Harbison collections from locality 18 now in the Academy of Natural Sciences belong in that species.

Types: Holotype USNM 106750; paratype ANSP 10690; hypotype USNM 130524, 130525.

Occurrence: Mississippi: Ripley Formation at locs. 5, 6, 18, 19.
Amuletum (Amuletum) fasciolatum (Wade)
Plate 46, figures 1-3


Diagnosis.—A highly sculptured Amuletum with a moderate to well-defined posterior whorl constriction; transverse ribs generally poorly developed except on earliest whorls and noncollabral.

Discussion.—This species appears to be a forerunner of Amuletum wadei, from the higher parts of the Ripley Formation in Mississippi. The early development of ornament is virtually the same in the two species. Amuletum (A.) fasciolatum differs most distinctly by losing its ribs at an earlier stage of growth and by having ribs that cut across the growth lines, whereas the ribs are collabral in A. wadei.

Within given suites of topotypes the transverse nodes may be seen to continue for five telocoach whorls and are faint but present as late as the seventh whorl (pl. 46, fig. 3); on other specimens they may be lost on the third whorl. Convexity of the whorl profile is governed by the retention or suppression of the nodes. Where nodes are retained there is a tendency for the development of a shoulder (pl. 46, fig. 3); where no nodes are present (pl. 46, fig. 2) the whorls are well rounded.

Amuletum fasciolatum is restricted to the Exogyra cancellata zone.

Types: Holotype USNM 32849; homotypes USNM 130526, 130527.

Occurrence: Tennessee: Ripley Formation at loc. 1.

Subgenus LUTEMA, Stephenson, 1941

Type by original designation, Lutena simplosensis Stephenson.

Diagnosis.—Medium sized fusiform to sub fusiform Amuletum like shells that possess subdued ornament, with the transverse sculpture either suppressed or accentuated and having a tendency for stronger shouldering and a development of noding at the shoulder.

Discussion.—Stephenson (1941, p. 373) introduced this genus for four newly described species from the Nacatoch Sand. The number of described species seems excessive in as much as the primary types of three of the four species came from the same locality. Differentiation of the species in question are based on minor features as exhibited by the following excerpt from the description of Lutena geniculata Stephenson (1941, p. 374).

“...This species has the general form of the three preceding species except that it is less slender and more inflated in the body than any of them.” In distinguishing A. (L.) munda on the same page he stated: “This species is similar in form to Lutena simplosensis, but is more slender and has coarser axial ornament.” In the case of A. (L.) hubbardi (p. 373) he noted “In form this species is much like Lutena simplosensis, but has a less deeply excavated shoulder and duller more obscure sculpture, especially on the larger whorls.” In general, most of the turrid species allied to Amuletum have sculpture that diminishes in vigor in their latest stages of growth. Only in the case of A. (L.) hubbardi is there any supplemental material available for study and in that case the topotypes assigned to that species by Stephenson indicate a relatively strong development of transverse sculpture not seen on the primary types. Though some of the species are probably synonyms of one another, the lack of sufficient comparative material prevents the study of specific variability and gradation.

The record of Lutena outside of Texas is scant and restricted to the Ripley Formation of Mississippi.

Amuletum (Lutena) limbatum Sohl, n. sp.
Plate 46, figure 4

Diagnosis.—Shell large and moderately slim for genus, posterior whorl constriction very strong, shoulder sharply noded; transverse ribs strong on spire.

Description.—Medium-sized fusiform shells with a turreted spire that is a little less than half total shell length; pleural angle about 30°. Suture impressed. Whorls strongly constricted posteriorly to a moderately narrow subsutural channel below which they expand rapidly to a sharp shoulder, then constrict anteriorly to an elongate slender pillar. Sculpture consists of strong collabral transverse ribs that are absent on the collar but are raised to form nodes on the shoulder, then continue with a prosocline trend to the suture below. Such ribs are absent on the earliest known whorls. On the body whorl the ribs are almost restricted to the shoulder and are more highly inclined. Spiral sculpture consists of fine close-spaced spiral cords over the collar and broader ribbons separated by impressed lines over the periphery. Growth lines strongly prosocline over collar sinuated at shoulder, becoming opisthoclinal below, and swelling almost to orthoclinal on the basal slope. Aperture incompletely known; siphonal canal elongate, narrow, inclined slightly to left and bent; inner lip callus exceedingly thin. Columella smooth and narrowing to a thin edge at the anterior extremity.
Measurements.—The incomplete holotype is the only specimen available for study and it measures 30 (±) mm in height and about 10 mm in diameter.

Discussion.—Amuletum (Lutena) limbatum Sohl is known from only the holotype from the Ripley Formation on Davis Branch in Tippah County, Miss. (loc. 4) and one incomplete specimen from locality 9a. Other specimens assignable to this subgenus are found at the same locality within the formation in Mississippi, but they are all too immature to indicate their specific affinities. They do seem to represent a distinct species in that they lack the crenulate growth rugae on the collar and they have broader, less strongly defined spiral elements. The species of A. (Lutena) described from the Nacatoch Sand of Texas are all smaller and possess the exact inverse of ornament development of A. (L.) limbatum. They possess strong transverse ornament on the early whorls, which frequently is suppressed on later whorls. Amuletum (L.) limbatum on the other hand lacks transverse elements on the early whorls, then develops strong ribs. In addition, the ribs of the Texas species are all more strongly flexed.

Type: Holotype USNM 130528.
Occurrence: Mississippi; Ripley Formation at locs. 4, 9a.

Amuletum (Lutena) sp.
Plate 46, figures 5, 6.

Discussion.—Some small immature specimens from the Ripley Formation, none exceeding 10 mm in length, preserve the features characteristic of Lutena. Sculpture starts with continuous arcuate transverse ribs (pl. 46, fig. 5), which begin to develop a sinuous trend on the second whorl. On most specimens the ribs are suppressed to mere discontinuous undulations after the second teleconch whorl, but one specimen retains them at least to the fourth whorl where nodes form at the shoulder position. Spiral sculpture is restricted to broad spiral ribs separated only by incised spiral lines.

The immature stages of growth represented by these shells make it impossible to refer them to any of Stephenson’s Texas species.

Types: Figured specimens USNM 130529, 130530.
Occurrence: Mississippi; Ripley Formation at locs. 6, 15, 16, 27, 29.

Genus REMNITA Stephenson, 1941

Type by original designation, Turricula biacuminata Wade, 1926.

Diagnosis.—Medium-sized slender fusiform shells with a turriculate spire of less than half total length. Protoconch proportionally large, consisting of three to four smooth regular whorls. Whorls constricted posteriorly to a very narrow subsutural collar. Sculpture dominated and initiated by spiral cords. Siphonal canal narrow and generally longer than aperture. Columella smooth.

Discussion.—Although closely related to Amuletum, Remnita differs by having its ornament initiated by spiral, instead of transverse, elements and by never developing strong transverse ribbing; also the siphonal collar is narrower and the columellar lip does not thin to a knife edge anteriorly as in Amuletum.

Turricula fasciolata Wade, assigned to Remnita by Stephenson (1941, p. 379), is here reassigned to Amuletum (Amuletum) as it possesses the subsutural collar, early whorl ribbing, and columellar lip of an Amuletum although its body sculpture is like that of a Remnita.

Remnita is restricted to the Exogyra costata zone in Mississippi and Texas.

Remnita biacuminata (Wade)
Plate 46, figures 7, 8

Diagnosis.—Shell large for genus; posterior whorl constriction weak on spire, strong on body but relatively narrow; sculpture dominated by strong subequally spaced spiral cords that are weakest on the subsutural collar.

Measurements.—The incomplete holotype, missing the anterior tip of the shell, measures 42.8 mm in height and 10.2 mm in diameter.

Discussion.—This species like Remnita anomalofofusus begins its development gradually with very faint spiral cords appearing on the last half whorl of the protoconch. The first and second teleconch whorls are more flattened than the protoconch whorls, but a posterior collar begins faintly in R. biacuminata on the third whorl and does not become very well developed until near maturity. This sloping constriction begins earlier and becomes more pronounced on R. anomalo costata. The latter species also develops coarse transverse ribs that are nodded at the shoulder.

Types: Holotype USNM 32854; hypotype USNM 77173; hypotype 130531.

Remnita anomalo costata (Wade)
Plate 46, figure 9
1926. Turricula anomalo costata Wade, U.S. Geol. Survey Prof. Paper 137, p. 115, pl. 37, figs. 4, 8, 11.
Diagnosis.—Medium-sized fusiform shells; whorls with a subangular periphery at maturity that is nodded by coarse broad transverse ribs.

Measurements.—The holotype measures 28.5 (+) mm in height and 10.5 mm in diameter.

Discussion.—The subangular periphery, more distinct subcostal collar, and the presence of transverse sculpture all serve to distinguish Remnita anamalocostata from Remnita bicauminata.

The paratype figured by Wade (1926, pl. 37, fig. 8) is enlarged about 3½ times, though no indication of this is given on the plate. Figure 4 on the same plate, a back view of the holotype, lends the erroneous impression of smoothness between the suture and whorl angulation. This area is actually quite roughened by growth lines and low broad spiral cords. Both illustrations are retouched and are misleading as to growth line trend. The growth lines are strongly sinuous between the suture and whorl angulation, strongly prosocline over the upper periphery and swing back to orthoclone over the basal slope and pillar.

The species is not common and is known only from its type locality in the Eozygura cancellata zone on Coon Creek, McNairy County, Tenn.

Types: Holotype and paratype USNM 32857; hypotype USNM 130632.

Occurrence: Tennessee: Ripley Formation at loc. 1.

Remnita hastata Sohl, n. sp.

Plate 46, figures 10, 11

Diagnosis.—Medium-sized fusiform remnitiids that almost lack a posterior whorl constriction and bear rather subdued spiral ornament.

Description.—Shell medium-sized fusiform, slim; spire somewhat less than half total shell height, pleural angle 23°. Protoconch proportionally large, consisting of about four smooth round to convex-sided whorls, followed on the first teloconch whorl by the appearance of spiral sculpture and a corresponding flattening of the whorl sides. Suture impressed. Whorls of spire rather flat sided, becoming convex sided on later whorls and rather well rounded on body. Body whorl faintly constricted posteriorly, periphery well rounded, constriction below to an elongate pillar. Sculpture dominated by rather low spiral ribbons that are broader than their interspaces; about nine ribbons visible on the penultimate whorl. Transverse elements suggested only by a few faint nodings near the suture. Growth lines faint, with a broad and open sinus over the faint posterior constriction, strongly opisthoclone over the upper part of the periphery and swinging arcately back until they become gently prosocline low on the basal slope, then becoming virtually orthoclone on the basal slope. Aperture narrowly lenticular; siphonal canal narrow, slightly inclined to the left, and longer than the aperture. Outer lip thin, sinuous posteriorly, arcuate medially, straight below and crenulate where intersected by the spiral ribbons. Inner lip lightly calloused. Columella smooth.

Measurements.—The holotype measures about 21 mm in height and 4.4 mm in diameter.

Discussion.—Although evidently never reaching as large a size as that attained by Remnita bicauminata, this species parallels the development of that species. No related species occurs in the Ripley Formation of Mississippi, but the presence of a probable R. bicauminata has been noted by Stephenson (1941, p. 379) in the Nacatoch Sand of Texas. R. hastata of the Owl Creek Formation appears to have been derived from the R. bicauminata stock. R. hastata differs from Wade’s species primarily by its lack of a distinct posterior constriction, a slimmer outline, its lower proportionally broader and closer spaced spiral elements, and by its less acute posterior sinus.

The species is restricted to the Owl Creek Formation and aside from the nearly complete holotype is known from only fragmentary specimens.

Type: Holotype USNM 20410.

Occurrence: Mississippi: Owl Creek Formation at locs. 45, 46.

Genus GEMMULA Weinkauff, 1875

Type by subsequent designation (Cossmann, 1896), Pleurotomina gemmata Hinds (in Reeve), 1843.

Diagnosis.—Shell fusiform, spire high. Whorls posteriorly constricted to a subcostal collar and bearing a strong usually noded subangulate shoulder below which the body rounds down to the pillar. Transverse sculpture of later whors restricted to shoulder nodings. Growth line sinuous over shoulder.

Discussion.—One species in the Owl Creek Formation of Mississippi appears to be assignable to Gemmula and if correctly assigned is the first member of the genus recognized in the Cretaceous, although a number of species have been described from the Eocene. Although similar to Amuletum in general form, the growth line sinuses occurs at the shoulder and not on the constriction above as in Amuletum.

The type-species, Gemmula gemmata Hinds, as illustrated by Harris (1937, pl. 1, fig. 33), has a proportionally higher spire but bears growth lines, ornament, and a whorl profile similar to G. cretacea. The initial strong ribbing of the first protoconch whorl is seen on some species from the Eocene of the gulf coast assigned to this genus by Harris (1937), such as Gemmula childreni and G. ancilla. Such similarities appear
to warrant assignment of the Owl Creek species to *Gemmula*.

**Gemmula cretacea** Sohl, n. sp.

Plate 46, figures 12–14

**Diagnosis.**—Moderately small shells with a strong posterior collar and a strongly noded to subangular shoulder. Growth line sinus at shoulder.

**Description.**—Moderately small fusiform shells with a spire less than half total shell length, pleural angle 25°–30°. Protoconch of about 3½ or 4, smooth whorls. First teleoconch whorl convex sided but a subsutural welt, margined below by an excavated band, then develops which in turn is followed by the appearance of a strongly noded perihalional shoulder. On later whorls subsutural welt and band become less pronounced and merge to form a subsutural collar. On body the nodes become subhed and the body rounds off below the periphery to an elongate pillar. Sculpture begins by the appearance of several highly opisthochine incomplete sharp and narrow ribs that are followed by arcuate opisthoclinal ribs of lesser inclination. These, after the first ½–1 turn of the first teleoconch whorl, become complete from suture to suture. Faint wide-spaced spiral cords develop on the last quarter of the first whorl. A subsutural welt develops almost precisely at the beginning of the second teleoconch whorl and with its development the ribs begin to retrace until, on about the third teleoconch whorl, the transverse sculpture is restricted to strong nodes at the periphery. These nodes continue but usually become subhed on the body whorl. On the body whorl, spiral sculpture consists of spiral cords of moderate strength separated by broader interspaces and having a greater spacing on the collar than on the periphery or base. Aperture broadly subovate, siphonal canal longer than aperture, narrow, inclined to left, and somewhat bent. Inner lip lightly callused save for upper part of parietal lip. Columella straight, narrowing anteriorly to a knife edge.

**Measurements.**—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 172).

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</tr>
<tr>
<td>Paratype</td>
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**Discussion.**—*Gemmula cretacea* Sohl is known only from the Owl Creek Formation in Mississippi and is represented by three specimens in the Geological Survey collections. Determination of the full range of variation is not possible with the material at hand, but the specimens do show individual differences in the strength of nodings.

**Types:** Holotype USNM 130533; paratypes USNM 130534, 130535.

**Occurrence:** Mississippi: Owl Creek Formation at locs. 45, 46. Tennessee: Clayton Formation (reworked Cretaceous at base) at loc. 40.

**Genus BERETRA** Stephenson, 1941

Type by original designation, *Beretra firma* Stephenson.

**Diagnosis.**—Medium-sized fusiform shells with a high tuberculate spire of slightly less than half total shell height. Whorls posteriorly constricted to a strong nodose subsutural collar and constricted anteriorly to a very elongate pillar. Sculpture of strong collateral transverse ribs that are continuous with nodes on collar and close-spaced spiral cords. Aperture lanceolate, siphonal canal elongate, and narrow outer lip sharply notched by subsutural sinus. Columella smooth.

**Discussion.**—The combination of features exhibited by both *Beretra* and *Fusimillis* make them rather unusual turrids. Other genera, such as *Tuvis Roedel*, *Fusiturrus Thiele*, and *Pleurotira Gregorio*, may attain the size of *Beretra* and may have equally as long a siphonal canal, but none appear to have an analogous strong subsutural collar in combination with the other features.

Stephenson (1941, p. 375) proposed *Beretra* to include *B. firma*, *B. contracta*, *B. striata*, *B. ornata*, and *B. * elongata* all described by him from the Navarro Group of Texas. In addition he also included: *Tuvis ripleyana* Conrad, Ripley Formation of Mississippi; *Surocula amica* Gardner, Monmouth Formation of Maryland; *Tuvicula ripleyana* (Conrad) of Wade, *Tuvicula gracilis* Wade, and *Tuvicula amica* (Gardner) of Wade, all from the Ripley Formation of Tennessee. To the above list *Drillia georgiana* Gabb—here considered a junior subjective synonym of *B. ripleyana*—should also be added.

All of the previously listed 11 species occur in the *Exogyra costata* zone of the Atlantic and Gulf Coastal Plains from Maryland to Texas. So many named species occurring in such a restricted stratigraphic range give rise to the question of possible synonymy. For the most part species splits are based upon minor differences in ornament. The synonyms included with the following described species do, in part, reduce the number of accepted specific names. One undescribed species, related to *Beretra gracilis* Wade, occurs in the Coffee Sand of Mississippi. This occurrence lowers the range of *Beretra* into beds of the *Exogyra ponderosa* zone. *Beretra* is also represented
in the western interior by an undescribed species from below the Great Sandstone of the Pierre Shale of Montana.

**Beretra ripleyana** (Conrad)

Plate 46, figures 19-21


1941. *Beretra striata* Stephenson. Texas Univ. Bull. 4101, p. 376, pl. 72, figs. 15, 16.

**Diagnosis.**—A *Beretra* with 10–13 strong rather wide spaced transverse ribs; spiral ribbons suppressed on rib tops and spiral lirae suppressed on subsutural welt and excavation but nodings coarse and moderately strong.

**Description.**—Medium-sized fusiform shells with a turriculate spire somewhat less than half total shell height. Protoconch unknown. Suture impressed, bordered below by a strong subsutural welt. Below welt the body bears an excavated band about as broad as the welt; whorl sides rather flat constricting below to a narrow elongate pillar. Sculpture of strong rather wide-spaced transverse ribs that diminish in vigor and die out on the basal slope below and above are suddenly restricted and flexed on the excavated band but are accentuated to nodes on the subsutural welt. Spiral sculpture very faint and weak on welt and excavated band of body, but lirae somewhat more prominent, especially on the excavated band of the earlier whorls; whorl sides bear spiral ribbons of equal or greater width than interspaces that are suppressed or absent on rib tops; basal slope and pillar with many wider spaced spiral cords. Aperture lenticular in outline, posteriorly angulated, and anteriorly drawn out to a long, narrow, siphonal canal that is longer than aperture. Parietal lip callus extends out of aperture a short distance onto body; columellar lip callus thin. Columella smooth.

**Measurements.**—The largest topotype is missing both apical and anterior tips and measures 51.3 mm in height and 17.3 mm in diameter.

**Discussion.**—The holotype of *Turris ripleyana* Conrad, from the Owl Creek Formation of Mississippi (loc. 46), is evidently lost. Johnson (1906) did not mention it as being present in the collections of the Academy of Natural Sciences of Philadelphia, and recent searches of those collections by me have failed to discover it. The holotype as figured by Conrad is that of an immature specimen consisting of about four whorls. The description given above is based on specimens from the type locality that agree with the description given by Conrad but that are somewhat larger in size. The species is scarce and generally specimens are recovered in an incomplete condition.

The topotypes indicate that the number of transverse ribs ranges from about 10 to 13 per whorl and that the suppression of the spiral ribbons on the rib tops is greatest on the whorl sides of the body, but that they may be almost continuous across the ribs on the whorls of the spire (pl. 46, fig. 20).

*Drillia georgiana* Gabb is based upon an unfigured distorted specimen from the Providence Sand of Georgia. The holotype (pl. 46, fig. 21) is preserved in the collections of the Academy of Natural Sciences of Philadelphia. Gabb (1877, p. 281) noted the similarity to Conrad’s species and remarked “a pretty species, resembling *Turris Ripleyana*, Con * * * in ornament, but more slender, with a higher spire and shorter body whorl.” This species, as defined by Gabb, falls well within the range of variability of *Beretra ripleyana* (Conrad).

*Beretra striata* Stephenson occurs in the Kemp Clay of Texas at about the same level as the Owl Creek Formation. It is based upon a poorly preserved holotype that initially appears distinct from *B. ripleyana*. The lesser strength of the transverse ribs, however, is due to their crests being quite worn. It appears to fall within the range of Conrad’s species.

*Surcula amica* Gardner (1916, p. 420) is based upon incomplete specimens from the Monmouth Formation of Maryland. Both figures given by Gardner are highly retouched. One specimen is worn. The better preserved, but more incomplete, specimen is highly compressed. Both specimens come from an area of the Monmouth Formation that is probably a part of the Monmouth Formation equivalent to the Owl Creek Formation. In those characters of sculpture and form that are discernible they are very similar to Conrad’s species and are here tentatively placed in that species at least until better preserved material is available.

**Types.**—Holotype lost; holotype of *D. georgiana*, ANSP 14995; holotype *B. striata* USNM 17375; hypotypes USNM 130536, 130537.

**Occurrence.**—Mississippi: Owl Creek Formation at locs. 40? 46, Texas; Kemp Clay, Alabama and Georgia; Providence Sand, Maryland; Monmouth Formation.

**Beretra gracilis** (Wade)

Plate 46, figures 15–18


**Diagnosis.**—A *Beretra* with 16–21 strong slender and rather close spaced transverse ribs per whorl; spiral ribbons present but faint on rib tops.

**Measurements.**—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

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**Discussion.**—*Beretra gracilis* (Wade) is a highly variable species. Of the three species of *Beretra* occurring in the Ripley and Owl Creek Formations of Mississippi and Tennessee, this is the most common form.

At the type locality on Coon Creek, McNairy County, Tenn., the forms described by Wade as *Turrricula ripleynana* Wade and *Turrricula amica* (Gardner) appear to represent end members of an intergradation sequence. Taken separately, *Beretra gracilis* differs from *B. amica* (Gardner) of Wade by being more slender and by lacking spiral ornament on the collar of its later whorls. If one traces the ornament back onto the spire on all the specimens assignable to *B. gracilis*, a point is reached where either on the penultimate whorl or at a considerably earlier stage of development, spiral sculpture appears on the subsutural welt and on the excavated area below. Therefore differentiation into species on the basis of presence or absence of spiral sculpture over this area is untenable. Its absence on some specimens can be shown to be a function of the strength of nodding on the subsutural collar. It also is interesting to note that with only three exceptions the largest specimens lack spiral ornament on the collar. Thus the loss of sculpture on this area may also be, at least in part, a function of size. If this criteria were to be used, more than two subdivisions would be needed to house the variations in this one character alone.

In the character of slimness there again appears to be no clear-cut difference. Similarly, differences in pleural angle of about 10° are present between the two specimens figured by Wade. Other specimens fill the gap between the 20°–30° range. In other features there is a wide range in the strength of the subsutural nodes and with it a linked variation in the amount of excavation below. Spiral sculpture below the collar is strongest in the interrib spaces and may consist, on the whorls of the spire, of 6–10 spiral ribbons or cords. The transverse ribs are thin and closely spaced in comparison to other species and generally number 16 or 17 on the body whorl. The number and character of the ribs is perhaps the most distinctive character of the species.

The specimens from above the *Esoqyra cancellata* zone in the Ripley Formation in Mississippi show similar variations within collections from given localities.

Compared with *Beretra firma* Stephenson, the type species of the Nacatock Sand in Texas, *B. gracilis*, has more slender ribs and stronger spiral ornament. The two species are so close that one is tempted to consider *B. firma* as no more than a geographic subspecies. *Beretra contracta*, also from the Nacatock Sand, appears to be a synonymous name for *B. firma*. *Beretra speciosa* Sohl possesses wider spaced less numerous transverse ribs, finer spiral sculpture and stronger growth lines. *Beretra ripleynana* (Conrad) from the Owl Creek Formation has much wider spaced ribs, more subdued sculpture, and is never as slim in outline.

**Types:** Holotype USNM 32853; hypotype (T. amica (Gardner) of Wade) USNM 32848; hypotypes USNM 130638–130640.

**Occurrence:** Tennessee: Ripley Formation at loc. 1. Mississippi: Ripley Formation at locs. 47, 6, 7, 14–18, 22, 27, 29. Georgia and Alabama: Ripley Formation.

*Beretra speciosa* Sohl, n. sp.

Plate 46, figures 22, 23


**Diagnosis.**—A *Beretra* bearing 10–13 strong widely spaced transverse ribs per whorl; spiral elements fine, generally overriding ribs, and present on subsutural welt.

**Description.**—Shell of medium size, spire high, pleural angle 25°–35°. Suture impressed. Whorls strongly constricted posteriorly to a nodal subsutural welt that is followed below by an excavated band; whorl sides nearly flat, rounding gently below to a tapering pillar. Transverse ribs strong, wide spaced, and numbering 10–13 per whorl. Spiral sculpture consists of numerous close-spaced cords on the collar and of spiral ribbons that are wider spaced and broader on basal slope than on whorl sides. Growth lines sinuous on subsutural collar, arcately opisthoclone over whorl sides, becoming orthoclone on pillar. Aperture incompletely known, lenticular in outline, and drawn out anteriorly to a narrow elongate canal; columella smooth.

**Discussion.**—*Beretra speciosa* differs from *B. ripleynana* (Conrad), to which Wade (1926, p. 111) assigned it, by the strong spiral sculpture of the subsutural collar and by a greater tendency for the spiral elements to override the ribs. *B. gracilis* (Wade) is generally slimmer, has more numerous close spaced transverse ribs and different spiral sculpture.
This species is restricted to its type locality in the Ripley Formation on Coon Creek in McNairy County, Tenn., where it is scarce.

Types: Holotype USNM 32651; paratype 139641.

Occurrence: Tennessee: Ripley Formation at loc. 1.

Genus FUSIMILIS Stephenson, 1941

Type by original designation, Fusimilis robustus Stephenson.

Diagnosis.—Medium sized fusiform shells with a spire less than half total shell length. Whorls constricted posteriorly to a subsutural collar, may be shouldered and strongly constricted below to a very elongate slim and somewhat twisted pillar. Sculpture of strong collabral transverse ribs and spiral ribbons weakest on the periphery. Growth lines sinued on shoulder and at base of body. Aperture subovate, notched posteriorly and anteriorly drawn out to a narrow siphonal canal, longer than the aperture. Columella smooth.

Discussion.—Fusimilis occurs with and superficially resembles Beretra. It differs from Beretra by the proportional length of its siphonal canal and, most importantly, by possessing a growth-line sinus on the shoulder at a lower position than the posterior sinus of Beretra. The body is also more strongly constricted anteriorly which forms a shorter aperture. There appears to be no similar or morphologically closely related genus in the Tertiary. Some of the species such as Fusimilis novemcostatus (Conrad) are distinctive among the turrids for their extreme proportional length of the siphonal canal.

Stephenson (1941, p. 378) proposed this genus to include: Fusimilis robustus Stephenson, from the Navarro Group of Texas; Turris proxima Wade and Turris constricta Wade, from the Ripley Formation of Tennessee; and Dryllia novemcostata from the Owl Creek Formation of Mississippi. The two species from the Ripley Formation of Tennessee appear to be synonyms. Turris monnouthensis from the Monmouth Formation of Maryland belongs in Fusimilis along with an undescribed species from the Ripley Formation of Alabama. One additional species, Fusimilis kunneli from the Ripley Formation of Mississippi, is described herein.

Outside of North America the genus may also be present in west Africa in Fusimilis auritolaris Cox (1952, p. 28; Darteville and Brébian, 1956, p. 92).

Fusimilis proxima (Wade)

Plate 46, figures 26, 27, 34, 35


Diagnosis.—Shell large for genus, fusiform, elongate, spire less than half total shell height. Transverse sculpture strong, generally consisting of 13–14 transverse ribs, spiral elements variable. Shoulder of moderate strength.

Description.—Medium sized elongate fusiform shells, spire turreted and less than half total shell length, pleural angle 25°–40°. Protoconch unknown. Suture impressed. Whorls posteriorly constricted to a subsutural welt that bears elongate nodes and is separated from the shoulder by a narrow excavated band; shoulder moderately strong, formed by the truncate upper ends of the transverse ribs; whorl sides flat to slightly convex and abruptly constricted below to a slender elongate pillar. Sculpture dominated by strong collabral transverse ribs that are truncated at the shoulder above and die out high on the basal slope. Spiral cords are most prominent on the whorls of the spire and basal slope but are suppressed and faint or totally absent on the periphery of the body whorl. Finer spiral lirate may be present on the posterior constriction. Growth lines are strong on later whorls, arcuate prosocline over posterior constriction, sinued at the shoulder, gently opisthoclinal on periphery, swinging to prosocline on basal slope, and shallowly sinued at base of body but somewhat sinuous on pillar. Aperture narrowly subovate, narrowly notched posteriorly, and produced anteriorly to a very narrow and somewhat sinuous siphonal canal that is longer than the aperture. Outer lip incompletely known, inner lipcallused with callus heaviest on parietal lip. Columella smooth.

Measurements.—Explantion of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 172).

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<td>1 (topotype)</td>
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The two smaller specimens are nearly complete, but the larger one is missing a considerable part of its siphonal canal.

Discussion.—Fusimilis proxima Wade reaches the largest size attained in any species of the genus. The holotype (pl. 46, fig. 27) is the largest specimen available and is missing a part of the siphonal canal. If complete the specimen would probably exceed 100 mm in length. Within the suite of totopotypes available, one
notes that the pleural angle is lowest on the late whorls of the largest specimens and that between them all there is a spread of some 15°. At the same growth stage the number of transverse ribs is constant, but again the largest specimen displays more numerous ribs on the body. Generally spiral sculpture is rather strong on the spire. On the body whorl it is generally suppressed to some degree on the periphery (pl. 46, figs. 27, 34), and on one specimen it is almost absent (pl. 46, fig. 26).

Turris constrictus Wade is based on a specimen that appears to be an immature form of Fusimilis proxima (Wade) and that has a slightly greater inclination of the transverse ribs than the holotype.

Fusimilis novemcostatus (Conrad) has a stronger shoulder, fewer but broader ribs per whorl, and almost totally lacks an excavated band above the shoulder. F. robustus Stephenson lacks a strong shoulder and has weaker more numerous arcuate transverse ribs.

Types: Holotype USNM 22847; holotype (T. constrictus) USNM 32550; hypotypes USNM 130542, 130543.

Occurrence: Tennessee: Ripley Formation at loc. 1. Plate 46, figures 29, 30, 32, 33, 39, 40

Diagnosis.—A fusimilid with 10 or 11 strong transverse ribs that die out on periphery; subsutural welt narrow and low.

Description.—Medium-sized shells, spire turreted; pleural angle about 30°-40°. Protoconch unknown, sutures impressed. Whorls constricted posteriorly by a moderately narrow subsutural collar that bears transverse cords; truncated upper ends of transverse ribs form an abrupt shoulder; whorl sides broadly rounding down to the rapidly constricted base. Sculpture dominated by 10 or 11 coarse broad collateral transverse ribs that on the larger specimens die out on the whorl sides just above the basal slope, but on immature specimens they carry part way down onto the basal slope. Spiral sculpture strongest on base of body where relatively strong wide-spaced spiral cords appear; on whorls of the spire, subsutural collar bears fine close-spaced lirae and the whorl sides have four or five wide-spaced ribs that become suppressed on sides of body whorl. Growth lines prosocline on collar, sinused on shoulder, opisthocline over whorl sides, arcuately prosocline on basal slope. Aperture incompletely known, notched posteriorly and drawn out anteriorly to an elongate, narrow, siphonal canal. Inner lip callus moderately thick and rather well margined. Columella smooth.

Measurements.—All specimens are incomplete and even an estimate of total size would be difficult.

Discussion.—In Mississippi, Fusimilis kummeli is known only from the lower part of the Ripley Formation and in Alabama only by the holotype (USNM 21166) from the Ripley Formation as exposed high on the bluffs of the Chattoohoochee River at Enfauila. The available specimens from Mississippi are all smaller than the holotype. Some Mississippi specimens show spiral sculpture at a late stage of growth (pl. 46, fig. 33), and most are slightly more obese than the holotype. As exhibited by the holotype, the subsutural collar becomes more prominent with increased size and an excavated band develops below the sutureal welt.

This species appears to bridge the gap between Fusimilis proxima Wade from the Exogyra cancellata zone and F. novemcostatus (Conrad) from the Owl Creek Formation. Fusimilis kummeli differs from F. proxima by its smaller size, its finer spiral sculpture, its lack of—except in the late stages of development—a strongly excavated band below the sutureal welt, and by its lack of subsutural nodes. F. kummeli differs from F. novemcostatus by its closer spaced more continuous transverse ribs, by its finer spiral sculpture, and by its less prominent subsutural collar. Fusimilis robustus Stephenson from about the same stratigraphic level in the Nacatoch Sand of Texas has a stronger collar that bears nodes, has close-spaced arcuate transverse ribs, and has suppressed spirals even on the spire. Thus it appears to belong to a different facet of the Fusimilis plexus.

The species is named in honor of Dr. Bernhard Kummel who aided me immeasurably during the preparation of this work.

Types: Holotype USNM 21166; paratypes USNM 130544-130546.


Fusimilis novemcostatus (Conrad)

Plate 46, figures 28, 37, 38


Diagnosis.—An elongate slim fusimilid with a narrow but prominent subsutural welt and a strong shoulder. Transverse ribs restricted to elongate shoulderings nodes on body; siphonal canal about as long as spire.

Description.—Medium-sized elongate fusiform shells; spire turreted and about two-fifths of total shell length. Pleural angle about 30°. Protoconch unknown. Whorls constricted posteriorly to a strong and transversely nodded subsutural welt that is followed below on later whorls by a very narrow excavated area that in turn is bordered below by the sharp shoulder;
periphery rounding down to a rapidly constricted base; pillar very long, slim, and sinuous. Sculpture ornate, consisting of about 10 strong transverse ribs that are continuous from sutural welt to suture on whors of spire but restricted to the shoulder and upper periphery near the aperture; spiral elements consist of wide-spaced strong cords on base of body, but only the faintest broad spiral undulations on the periphery of the body; on spire the spiral sculpture is stronger and consists of three or four widely spaced narrow ribbons that become somewhat subdued as they override the ribs. Growth lines slightly adaperturally sinuous over sutural welt swinging back to a stronger and broader adapertural sinus over the shoulder, becoming prosocline on whorl sides, and shallowly sinuous on basal slope. Aperture strongly and narrowly notched posteriorly and anteriorly drawn out to a very long, narrow, sinuous siphonal canal; outer lip thin at edge, sinuous in harmony with growth lines. Inner lip lightly calloused over parietal surface, but callus thickens to a slight well at entrance to siphonal canal.

Measurements.—The only nearly complete available specimen (pl. 46, fig. 37) measures about 71.7 mm in height and 20 mm in diameter but is missing 6 or 7 mm of its apex.

Discussion.—The holotype of Fusimilis novemcostatus is evidently lost. It is not in the collections of the Academy of Natural Sciences of Philadelphia, nor is it listed by Johnson (1905).

The topotype here figured (pl. 46, fig. 38) gives an excellent idea of the body proportions and especially of the siphonal canal. Compared with Conrad’s illustration of the holotype, it appears to have somewhat narrower transverse ribs, but in dimensions of the whors it is almost an exact duplicate of the holotype.

The distinctive multiple sinuous growth line and the restriction of the ribs on later whors, as well as the very narrow excavated band, separates this species from other members of the genus.

Types: Holotype lost; hypotypes USNM 204520, 130547.
Occurrence: Mississippi: Owl Creek Formation at loc. 45, 46.

Fusimilis tippana (Conrad)†
Plate 46, figures 31, 36


Discussion.—Conrad’s illustration and description of Drilina? tippana are insufficient for confident placement of specimens, but they are suggestive of Fusimilis. Unfortunately, the type specimen has been lost and direct comparison is not possible. The two incomplete specimens figured here indicate the presence of a second species of Fusimilis in the Owl Creek Formation that approximate the characters of Conrad’s species. These specimens differ from F. novemcostatus (Conrad), the other Owl Creek species, by having flatter sided whors, a less sinuous growth line, lower transverse ribs, and a less prominent shoulder and subapertural welt. In these characters they are closer to Fusimilis monmouthensis (Gardner) from the Monmouth Formation of Maryland. The available specimens from both Mississippi and Maryland are too poorly preserved for close comparison, but the distinct possibility exists that the two are conspecific.

Types: Holotype lost; hypotypes USNM 130548, 130549.
Occurrence: Mississippi: Owl Creek Formation at loc. 45, Tennessee: Clayton Formation (unworked Cretaceous at base) at loc. 40. Maryland: Questionably present in the Monmouth Formation.

Fusimilis† sp.
Plate 46, figures 24, 25

Discussion.—One internal mold collected from the Prairie Bluff Chalk at locality 72 simulates a number of characters common to the genus Fusimilis. The body whorl of this specimen is constricted above to a well defined but narrow collar. A whorl shoulder is formed by the upper ends of the strong transverse ribs. These ribs appear to die out on a subperipheral angulation above the basal slope. These features have been preserved on molds of a sponge boring that now encrust the internal mold of the mollusk shell.

Type: Figured specimen USNM 130549.
Occurrence: Mississippi: Prairie Bluff Chalk at loc. 72.

Subfamily CRYPTOCONINAE
Genus CRYPTOCONUS Koenen, 1867

Type by subsequent designation (Cossman, 1889, Pleurotoma filosa Lamarck, 1804).

Diagnosis.—Shells small to moderately large, bi-conical. Spire almost half total shell height. Protoconch small, first whorl somewhat deviated. Whors slightly constricted posteriorly, periphery rounded, basal slope almost flat; body proportionately large. Sculpture dominated by spiral cords. Growth line strongly sinuous subsuturally. Aperture moderately narrow, sublenticular; siphonal canal poorly developed; inner lip slightly excavated medially and very lightly calloused.

Discussion.—Cryptoconus is primarily an Eocene and and Oligocene genus, but is also known from the Paleocene. The only Cretaceous species assigned is Conorbis macroiriris Wade. Although none of the specimens retain a well-preserved protoconch, there is no indication of resorption of whors interiorly, a feature common to Conorbis. Therefore, Cossmann (1925, p. 240)
seems to have been justified in removing Wade's species from *Conorbis* and placing it in *Cryptoconus*.

*Cryptoconus* \textit{macnairiensis} (Wade)

Plate 47, figures 6–9


*Diagnosis.*—Whorls somewhat constricted posteriorly and shouldered weakly. Sculpture of moderately strong broad spiral cords. Callus thick on columnellar lip.

*Measurements.*—This is a small species with none of the available specimens exceeding 5 mm in height nor 2½ mm in diameter.

*Discussion.*—The assignment of this species to *Cryptoconus* by Cossmann is more reasonable than Wade's assignment to *Conorbis*, but even here there are differences worthy of consideration. A comparison of protoconchs is impossible as *C* *\textit{macnairiensis}* is known only from specimens lacking the nuclear whorls. The tendency for the formation of a shoulder is unusual but admissible. More serious objections to such a placement are the lack of a well-defined subsutural sinus and the presence of a diagonal basal truncation of the columnella forming a siphonal canal that is not typical of the genus. On the other hand, although Wade's species probably does not belong in *Cryptoconus*, it does appear to lie closer to that genus than any other in the subfamily.

*Types:* Holotype USNM 32840; bytypes USNM 130550, 130551.

*Occurrence:* Tennessee: Ripley Formation at loc. 1.

*Subclass:* OPISTHOBRANCHIA

*Order:* CEPHALASPIDA

*Superfamily:* ACTEONACEA

*Family:* ACTEONIDAE

*Subfamily:* ACTEONINAE

*Genus:* ACTEON Montfort, 1810

Type by original designation, *Voluta tornata*is Gmelin, 1788.

*Diagnosis.*—Small ovate shells having a moderately high spire. Protoconch deviated, heterostrophic. Suture channeled. Sculpture of incised spiral grooves with thin raised transverse elements that render a punctate surface. Aperture elongate, narrowed posteriorly, and well-rounded anteriorly. Columella thick, bearing a strong oblique fold.

*Discussion.*—Acteon has a relatively long geologic range. The diversification of the genus reached its acme in the Eocene and since that time has had a decline. The modern representatives are few but have a wide range and may be abundant in the warmer seas. The Late Cretaceous representation of this genus is rather extensive, but the documentation of the species is not good. Many species appear to be based on incomplete material or on specimens in which the complete apertural features are not to be seen. In this sense, Acteon has become a receptacle for small ovoid Mezozoic shells of suggestive but actually unknown affinities. In the Upper Cretaceous of North and South America alone, more than 40 species have been named. If a critical study were made this number would be reduced owing to reassignment and synonymy. Of the 40 named species more than one-quarter come from the Upper Cretaceous of the coastal plains of the United States.

*Acteon pistilliformis* Sehl, n. sp.

Plate 47, figures 24–28


*Diagnosis.*—Small variable Acteon with incised spiral grooves that are narrower than the raised groove interspaces.

*Description.*—Small ovoid shells having a spire 1/3–2/5 total shell height. Pleural angle 40°–50°. Suture weakly channeled. Whorls well rounded. Sculpture of four to five incised spiral grooves on spires that are about one-twentieth of a millimeter broad and are separated by smooth shell surfaces about three times as broad as the grooves; grooves broader near aperture and on base of body. Transverse threads thin, visible where they cross the grooves and forming a punctate surface. Aperture elongate, posteriorly narrowed, and anteriorly rounded; outer lip thin, arcuate, and crenulated where intersected by the spiral grooves; inner lip callus thin over parietal wall, thickening on columnella. Columella bears one broad strong plication that merges at the aperture with the reflected lip.

*Measurements.*—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 172).

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Discussion.—Acteon pistilliformis Sohl is the most common species of this genus to occur in the Exogyra costata zone. It ranges through the E. cancellata zone and up into the upper part of the Ripley Formation where its range overlaps that of Acteon cicatricosus. The latter, however, continues up into the Owl Creek Formation.

The species is most common at locality 1 on Coon Creek, McNairy County, Tenn. It is here that the largest individuals are found and the greatest variability within a single population can be noted. As both the measurements and a comparison of plate 47, figures 24, 26-28, indicate, shell outline varies from rather round to rather slender. Similarly minor differences in the spacing of the incised grooves is also present. Care must be exercised in using the columnellar character as a criteria for differentiation, as on some specimens the loss or spalling off of some of the inner lip callus (pl. 47, fig. 25) gives an entirely different appearance to this area of the shell than that on specimens in which it is retained.

The Mississippi specimens referred to this species are less variable. In part this may be due to the fewer specimens available from a given locality, but it may also be a factor of size as none in these collections reach as large a size as attained by the Tennessee specimens. In addition, the Mississippi specimens have broader incised grooves.

Acteon modicellus Conrad (1860, p. 387) is based upon a three-line description with no accompanying illustration. The generalized description is sufficient only to indicate that Conrad was probably speaking of an Acteon. The holotype of his species is lost and the type locality is given only as Tippah County, Miss. Although the species probably came from the Ripley Formation, it is impossible to identify and the name should be treated as a nomen dubium.

Acteon cicatricosus, from the upper part of the Ripley Formation, can be distinguished by its wider incised grooves and the presence of secondary grooves. Acteon? throckmortoni Stephenson, from the Neylandville Marl of Texas, has a much lower spine, a longer body, a longer aperture, and is more suitably placed in Eoacteon.

Types: Holotype USNM 130655; paratypes 130656-130658.

Occurrence: Tennessee: Ripley Formation at loc. 1. Mississippi: Ripley Formation at locs. 6, 15-17, 24, 29.

Acteon cicatricosus Sohl, n. sp.

Plate 47, figures 17, 18, 22.

Diagnosis.—Small-sized Acteon with incised grooves of base wider than interspaces and with a few fine secondary grooves on interspace ribbons.

Description.—Small ovoid shells with a spire of about one-third total shell height. Suture weakly channeled. Whorls moderately to well rounded. Sculpture of numerous flat-bottomed spiral furrows that are equal to or less broad than their interspaces on the upper part of the body whorl but become considerably broader than the interspaces on the basal slopes; narrow secondary spiral grooves sometimes develop on the inter spiral surfaces. Fine transverse threads are visible as they cross the spiral furrows. Aperture elongate, narrow posteriorly, well rounded anteriorly; outer lip thin and crenulate at edge where intersected by spiral furrows. Columella bearing a strong, rounded fold.

Measurements.—The holotype measures about 4.4 mm in height and 2.2 mm in diameter.

Discussion.—Acteon cicatricosus is closely similar to A. pistilliformis from the Ripley Formation in Mississippi and Tennessee but differs by its wider spiral furrows, which lend a rectangular rather than punctate pattern of sculpture, and by its few secondary spiral grooves in the spiral interspaces. The range of the two species overlaps slightly in the upper part of the Ripley Formation.

Acteon cicatricosus Sohl n. sp. is scarce and is definitely known from only Mississippi.

Types: Holotype 130717; paratype 130718.

Occurrence: Mississippi: Ripley Formation at locs. 24, 29; Owl Creek Formation at loc. 46.

Acteon sp.

Discussion.—Incomplete specimens recovered from several localities in the Ripley Formation of Mississippi, although not sufficiently well preserved for specific identification, serve to indicate the presence of the genus.

Occurrence: Mississippi: Ripley Formation at locs. 4, 27.

Genus EOACTEON Stephenson, 1955

Type by original designation, Solidulus linteus Conrad, 1858.

Diagnosis.—Ovate to elongately subovate shells, spire 1/4-1/2 total shell height. Sculpture of fine to moderately broad incised grooves of regular to irregular spacing that is crossed by fine spiral threads. Aperture elongate, inner lip callus thin, columella bearing one plication that is not visible at the aperture.

Discussion.—Stephenson (1955, p. 132) proposed the genus Eoacteon to include shells differing from Acteon by lacking a visible plication at the aperture. He included Solidulus linteus Conrad, from the Owl Creek Formation; A. linteus (Conrad) of Gardner,
from the Monmouth Formation of Maryland; and *A. linteus* (Conrad) of Wade, from the Ripley Formation of Tennessee. In his diagnosis a second weaker fold situated lower on the columella is mentioned, but I have been unable to substantiate this statement.

_Eocaeteon_ appears to be represented in the Nacatoch Sand of Texas by two species that were assigned by Stephenson (1941, p. 381–382) to the genus _Trostella_ Wade.

_Eocaeteon_ is very close to _Acteon_ and an argument could be made for consideration of _Eocaeteon_ as no more than a subgenus of _Acteon_. It does form a convenient repository for a number of Cretaceous species characterized not only for their columellar characters but for a size larger than that of _Acteon_ and a spire that is proportionally lower. For these reasons, _Eocaeteon_ is here accepted as a full genus.

_Eocaeteon linteus_ (Conrad)

Plate 47, figures 5, 10–12


_Diagnosis._—Moderately slender shells ornamented by incised punctate spiral grooves that are much narrower than their interspaces except on the base.

_Measurements._—Stephenson's hypotype (USNM 128308) measures 18.3 mm in height and 7.8 mm in diameter.

_Discussion._—Specimens of _Eocaeteon linteus_ may attain a size considerably larger than the holotype. Generally only fragments of the larger specimens are found, but one large compressed specimen indicates a length in excess of 30 mm.

_Insufficient material is available to indicate the full range of individual variation. It can be seen that the larger specimens possess a greater development of secondary incised spirals on the interspaces (pl. 47, fig. 5) than the smaller specimens._

The specimen from the Monmouth Formation of Maryland, assigned to this species by Gardner, comes from about the same stratiographic level as the type locality. Gardner's specimen is retained in _Eocaeteon linteus_ unquestionably, as it is more slender and appears to have a more curved columella. The specimen Wade (1926, p. 101) assigned to this species is here redescribed as _Eocaeteon percultus_ differing from _E. linteus_ by its slimmer outline, broader spiral grooves, a distinctly channelled suture, and by having a proportionally higher spire. The suture of _E. linteus_ is channelled but only faintly so.

_Type._ Holotype lost; hypotypes USNM 130559–130561.

_Occurrence._ Mississippi: Owl Creek Formation at locs. 45, 46, Maryland: Questionably in the Monmouth Formation.

_Eocaeteon percultus_ Sohl, n. sp.

Plate 47, figure 15


_Diagnosis._—Spire proportionally high for genus, suture distinctly channelled.

_Description._—Medium-sized elongate subovate shells with a spire about two-fifths total shell height. Pleural angle 40°–45°. Protoconch unknown. Suture resting in a narrow and proportionally deep channel. Body proportionally large, sides almost flat, rounding to a steeply sloping base. Sculpture of flat-bottomed spiral furrows that are about as broad or slightly narrower than their interspaces on the whorl side but are proportionally broader on the base. Transverse sculpture restricted to growth lines that have an arcuate trace across the whorl sides and appear as raised threads over the interspiral spaces; threads divide the spiral furrows to a series of either squares or rectangles dependent upon the width of the furrows and spacing of the transverse lines. Aperture elongate, very narrow for the upper one-third of its length, broadening below to a rounded anterior; outer lip thin at edge and crenulate where intersected by spiral elements; inner lip calloused over the curving columellar lip. Columella short with a low rounded fold that is suppressed on the columellar lip.

_Measurements._—The holotype measures 18.4 mm in height and 7.3 mm in diameter.

_Discussion._—_Eocaeteon percultus_ Sohl is a rare species and known only from its type locality on Coon Creek, McNeary County, Tenn. It most closely resembles _E. linteus_ (Conrad) of the Owl Creek Formation, and Wade (1926, p. 101) assigned the holotype to that species. _E. percultus_ differs from Conrad's species significantly by having a well-developed channelled suture, a higher spire, by being slimmer, by possessing a more elongate narrow posterior part of the aperture, and by having a more strongly curved columellar lip.

These two species probably belong to the same direct lineage. In the Mississippi embayment region there is no known form present that would bridge the gap between the two species, but in Georgia there is a related form that occurs in the Ripley Formation. In Texas, _Trostella sublinearis_ Stephenson, of the Nacatoch Sand, here assigned to _Eocaeteon_, has finer
spirals and a more obese outline but in other respects appears closer to E. linteus.

**Type:** Holotype USNM 32823.

**Occurrence:** Tennessee: Ripley Formation at loc. 1.

**Eoacteon ellipticus** (Wade)

Plate 47, figures 13, 14


**Diagnosis.**—An *Eoacteon* having a very low spire, a very long body whorl, and a very narrow band of callus on the columellar lip.

**Measurements.**—The holotype measures 15.2 mm in height and 6.5 mm in diameter, and has a body whorl 12.5 mm long. The holotype of *Acteon? throckmortoni* Stephenson, measures 7.2 mm in height, 3.9 mm in diameter, and has a body whorl 6.1 mm in length.

**Discussion.**—This species is known from only two specimens, the holotype from the Ripley Formation on Coon Creek, McNairy County, Tenn., and the holotype of *Acteon? throckmortoni* Stephenson from the same stratigraphic level in the Neylandville Marl of Texas.

*Eoacteon ellipticus* is distinguished by its rapidly expanding early whorls and proportionally long body. These characters lead to the possession of the lowest spire of any species in the genus. The apertural view of the holotype (pl. 47, fig. 13) distorts the length of the body as the upper part of the body whorl has been lost, but the back view gives a true picture of the length of the body.

The holotype of *Acteon? throckmortoni* from Texas appears to be no more than an immature shell of *Eoacteon ellipticus*.

**Types:** Holotype USNM 32823; holotype of *A. throckmortoni* USNM 77124.

**Occurrence:** Tennessee: Ripley Formation at loc. 1. Texas: Navarro Group.

**Eoacteon sp.**

Plate 47, figures 3, 4.

**Discussion.**—The presence of *Eoacteon* in the Prairie Bluff Chalk is attested by the internal molds having the elongately subovate outline and single columellar fold typical of the genus. These molds are similar in size to the holotype of *Eoacteon linteus* Conrad, from the Owl Creek Formation but do not reach as large a size as some of the individuals of that species. The sculpture of incised spiral grooves is reflected faintly on the surface of the molds as are the growth lines, but the whorls of the molds must be broken back to expose the columellar fold. This is typical of *Eoacteon* as the fold on well-preserved shells does not reach the aperture.

**Type:** Figured specimen USNM 130562.

**Occurrence:** Mississippi: Prairie Bluff Chalk at locs. 87, 90, 91.

**Genus NOACTEONINA** Stephenson, 1941

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

**Diagnosis.**—Elongate slender sublenticular shells; spire high, a little more than one-third total shell length. Suture appressed. Sculpture of impressed spiral grooves and arcuately trending growth lines that appear as raised transverse threads in the spiral grooves. Aperture very narrow posteriorly and well rounded anteriorly, callus restricted to a narrow band on columellar lip. Columella lacks folds.

**Discussion.**—Of the five species named by Stephenson (1941, p. 382-388) from the Navarro Group of Texas none appear to be present in Mississippi. The only representative of the genus in the Mississippi embayment is *Acteonina orientalis* Wade.

*Nonacteonina* appears to be quite close to *Eoacteon*, but lacks a columellar plication and is commonly more slender.

**Nonacteonina orientalis** (Wade)


**Discussion.**—This species is based upon an incomplete specimen, the holotype, on which only parts of the body and penultimate whorls are preserved. No columellar plications are visible and in shape, trend of growth line, and character of the aperture it seems to be well placed in *Nonacteonina*. Comparison with the Texas species is very difficult not only because of the incomplete state of the holotype, but because the Navarro species have been very finely subdivided on the basis of size, shape, and proportional height of spire.

No illustration is included here as Wade's figures (1926, pl. 34, figs. 8, 9) serve adequately and no additional specimens are available.

**Type:** Holotype USNM 32834.

**Occurrence:** Tennessee: Ripley Formation at loc. 1.

**Genus TROOSTELLA** Wade, 1926

Type by original designation, *Troostella perimpressa* Wade, 1926.

**Diagnosis.**—Subovate sometimes thick shells of medium to moderately small size with spire about one-third total shell height. Suture in angular very narrow channel. Sculpture of irregularly spaced narrow incised grooves and a few secondary incised lines that
may sometimes be punctate where thin transverse lines cross. Aperture elongate; inner lip with thick callus on columellar lip, but lacking callus on parietal wall. Colunella bears one highly oblique fold; umbilical chink narrow.

**Discussion.**—As here interpreted, Troostella contains two species, both occurring only at Coon Creek, Tenn. The species assigned by Stephenson from the Nacatoc Sand of Texas, *T. sublinearis* and *T.? brevispira*, appear more readily assignable to *Eoacteon* and show many similarities to the type species *Eoacteon linteus* (Conrad).

*Troostella substriatus* (Wade)
Plate 47, figures 16, 21

**Diagnosis.**—Subglobe thin shells ornamented by very fine spiral grooves that are sometimes punctate and by faintly incised transverse furrows.

**Measurements.**—The holotype measure 23.7 mm in height and 11.3 mm in diameter.

**Discussion.**—Only Wade’s original specimens are available for study. No additional specimens are present in any subsequent collections from the type locality in the Ripley Formation on Coon Creek, McNairy County, Tenn.

Stephenson (1941, p. 381) stated no reasons for reassigning Wade’s species to *Troostella*. *Troostella substriatus* differs from the type species *T. permipressa* by having a thinner shell, finer spiral sculpture, lip callus, and stronger growth lines. It does possess a faint umbilical chink, and its spiral sculpture is rather variable. All these features make an assignment to *Troostella* questionable. Assignment to *Eoacteon* is not unreasonable, but the variability of the spiral sculpture and the appearance of the columellar plication at the aperture place is closer to *Troostella*.

**Types:** Holotype and paratype USNM 32825.

**Occurrence:** Tennessee: Ripley Formation at loc. 1.

*Troostella perimpressa* Wade
Plate 47, figures 19, 20.

**Diagnosis.**—Subovate thick shells with smoothly rounded whorls sculptured only by narrow variably spaced incised spiral lines.

**Measurement.**—The incomplete holotype measures 28 mm in height and 15 mm in diameter.

**Discussion.**—The only specimen available for study is the holotype whose shape and sculpture serves to distinguish it from the species of all the other globose opisthobranchs with which it occurs.

**Type:** Holotype USNM 32830.

**Occurrence:** Tennessee: Ripley Formation at loc. 1.

**Genus TORNATELLAEA Conrad, 1860**

Type by monotypy, *Tornatellaea belzebuth* Conrad, 1860.

**Diagnosis.**—Subovate shells, spire generally less than half total shell height. Suture impressed to channeled. Sculpture consists of occasionally punctate spiral furrows, that are narrower than their interspaces. Aperture posteriorly narrowed, rounded submarginate anteriorly. Outer lip thickened and crenulate or lirate within. Inner lip callused over a columellar surface that bears two oblique sharp folds.

**Discussion.**—*Tornatellaea* Conrad is one of the longer ranging tectibranch genera. Cossmann (1890, p. 50) listed species as occurring through the Jurassic up to the Miocene.

Stephenson (1941, p. 385) compared the Cretaceous species from the Navarro Group of Texas with the type species from the Eocene of Alabama. He pointed out differences in pleural angle and obliquity of columellar plaits and threw doubt upon the assignment of his species to *Tornatellaea*. In view of the range of variation that, in the past, has been accepted as within the limits of this long-ranging genus, it would be unwise to withdraw the Upper Cretaceous species from *Tornatellaea*. This is not to say that a thorough study of the genus would not indicate the possibility or even advisability of subdivision, but that a better understanding of the genus as a whole is necessary before dismembering it.

During the Late Cretaceous the genus possessed a wide geographic range with species reported on both coasts of North America, in India, and in Europe.

*Tornatellaea cretacea* Wade
Plate 47, figures 23, 29–33.

**Diagnosis.**—Spire less than one-third total shell length and width about half that of length.

**Measurements.**—Explanation of measurements and symbols used in the following table appears in the section “Measurement of specimens” (p. 172).

**Discussion.**—The distinction between the Late Cretaceous species of *Tornatellaea* dealt with here is very difficult because of the variability in ornament within a given species and the retention of a closely similar type of ornament between the species. With the excep-
tion of *T. grandi* Stephenson, the simplest solution would be to lump them all into one species, *T. cretacea*. On the other hand, specimens from the various levels represented do show moderately distinct differences primarily in dimensions and with names already available for most of them, they are retained as discrete taxa.

The holotype is the next to the largest nearly complete specimen available of *Tornatella cretacea*. Its dimensions as listed above indicate that it is slimmer than the smaller topotypes. This discrepancy, however, is only an indication that the whorls have a tendency to flatten on larger specimens, an interpretation supported by incomplete topotypes of larger specimens and the Mississippi (loc. 22) specimen figured on plate 47, figure 19. The holotype is a somewhat worn specimen with the upper edge of the whorls spared off. Topotypes indicate that the suture is not channeled but appressed. Specimens from the lower levels of the Ripley Formation immediately above the *Exogyra cancellata* zone in Mississippi (loc. 22) show wider spiral furrows and correspondingly stronger transverse threads.

*Tornatella scotesi* Stephenson, from the Nacatoch Sand of Texas, has lower columnar plications, is more obese, has a proportionally higher more evenly tapering spire, and has a closely appressed suture. *Tornatella cretacea appressed*, Stephenson's variety from the Nacatoch Sand, has a considerably higher spire and has distinctly flatter sides at a much earlier stage of growth. The latter appears to be distinct from *T. cretacea*, but *T. cretacea hebes* falls within the range of variability.

Types: Holotype USNM 32831; holotype *T. cretacea hebes* USNM 77190; hypotypes USNM 130563–130567.


**Tornatella globosa** Wade

Plate 47, figures 1, 2.


Diagnosis.—Small globose tornatellaeids with a low spire and a body whorl more than half as broad as the total length.

**Measurements.—** Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 173).

<table>
<thead>
<tr>
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<th>H</th>
<th>MD</th>
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</thead>
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<td>1 (topotype)</td>
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<tr>
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<td>3.6</td>
<td>1.7</td>
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<td>3.7</td>
<td>1.6</td>
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<tr>
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<td>10.3</td>
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<tr>
<td>22</td>
<td>8.7</td>
<td>5.0</td>
<td>1.7</td>
</tr>
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</table>

Discussion.—This scarce species is known only from its type locality on Coon Creek, McNairy County, Tenn. It is distinguished from *Tornatella cretacea* by its more obese and shorter body and lower spire. The fact that only the holotype and two immature topotypes of questionable affinities are all that represent the species leads one to question the advisability of separate distinction. Perhaps this species is but an end member in the range of variability of *T. cretacea*, but study of additional material would be necessary to prove such a suggestion.

Type: Holotype USNM 32831.

Occurrence: Tennessee: Ripley Formation at loc. 1.

**Genus PARIEPTICLICATUM** Sohl, 1963

Type species, *Acteon conicus* Wade, 1926.

Diagnosis.—Medium to moderately small sized shells have an evenly tapering spire of greater than one-third total shell height. Suture appressed weakly. Whorls few, flat sided above, rounding over the periphery to an evenly sloping base. Sculpture of rather prominent growth lines and deeply incised moderately narrow spiral furrows that are irregularly spaced. Aperture angular posteriorly, rounded anteriorly; outer lip dentate within. Inner lip with a strong columellar fold and a weaker fold on the parietal surface.

Discussion.—*Acteon conicus* Wade is the only known species of the genus *Parietiplicatum*. The shape, columnar plications, and growth-line trend of its shell make it a distinct form. Wade (1926, p. 102) evidently did not recognize the second or parietal fold. It differs from *Acteon* by having a weak fold on the parietal wall, by lacking punctate sculpture, by its high spire, by lack of a channeled suture, and by its direct prosocline growth line trend. The parietal plication is more like that of a ringiculid, but the genus lacks a thickened outer lip and has a higher spire than is normal for the Ringiculidae.

**Parietiplicatum conicum** (Wade)

Plate 48, figures 3–5.


Description.—Medium to moderately small shells with a spire about three-fifths the total shell length; pleural angle of about 40°. Telococtch whorls number four to five. Body whorl flat sided above, rounding over periphery to a rather straight basal slope. Sculpture of five to seven incised spiral furrows of variable spacing and width but generally narrower than interspaces; transverse elements restricted to moderately strong growth lines that have a straight prosoclinal trend over the upper two-thirds of the whorl. Aperture angular posteriorly, rounding internally; outer lip thickened and lirate within. Inner lip callus moderate, well marginated. One strong sharp and oblique fold appears high on the columella and a second lower fold is present about the midpoint of the parietal surface but does not extend to the callus margin.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

<table>
<thead>
<tr>
<th>Loc.</th>
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<tr>
<td>Do.</td>
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<td>5.6</td>
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</tbody>
</table>

Discussion.—Parietipliacter conicum (Wade) is restricted to its type locality on Coon Creek, McNairy County, Tenn., but is moderately abundant and occurs well preserved. In general, there is little overall variation in proportional shape, but the width of the incised spiral grooves varies from quite narrow to specimens in which the grooves approach the breadth of the intergroove spaces.

Types: Holotype USNM 32826; hypotypes USNM 130568, 130569.
Occurrence: Tennessee: Ripley Formation at loc. 1.

Family RINGICULIDAE
Genus RINGICULA Deshayes, 1838

Type by subsequent designation (Gray, 1847), Auricula ringens Lamarck, 1804.

Diagnosis.—Small low-spired globose to subglobose shells. Sculpture smooth or with incised spiral lines or furrows. Aperture narrow; outer lip thickened, smooth or denticulate within; inner lip heavily calcified. Columella with two strong folds and parietal wall with a single denticle or fold.

Discussion.—Most of the Cretaceous species discussed here appear to belong to RINGICULA in the strict sense, as they possess a denticle outer lip as opposed to the smooth inner surface of the outer lip of RINGICULA (RINGICULella). Most recent species seem to belong to the latter subgenus.

The genus is rather long lived, ranging from at least the Ceromanian through the Late Cretaceous and Tertiary to the Recent and it is well represented throughout most of its range. RINGICULA is known from the Cretaceous of Europe, Africa, Asia, North America, and South America.

The following is a list of the 11 species that have been assigned to RINGICULA in Upper Cretaceous of North America.

RINGICULA aequispira Shumard, Eagle Ford Formation, Texas
RINGICULA arlingtonensis Stephenson, Woodbine Formation, Texas
RINGICULA clarki Gardner, Monmouth Formation, Maryland
RINGICULA colbertoni Stephenson, Kemp Clay, Texas
RINGICULA cholera Shumard, Nacatoch Sand, Texas
RINGICULA subpellucida Shumard, Eagle Ford Formation, Texas
RINGICULA suffusa Stephenson, Kemp Clay, Texas
RINGICULA phụchithan Shih, Ripley Formation, Mississippi
RINGICULA varia (Gabb) Stewart, Upper Cretaceous, California
RINGICULA cedellana Kauffman and Pope, Carlile Formation, Colorado
RINGICULA angusta Kauffman and Pope, Carlile Formation, Colorado.

Of the preceding species, Stewart (1927, p. 435) only doubtfully placed the California species in RINGICULA. RINGICULA clarki Gardner lacks both the parietal fold and the crenulations of the inner surface of the outer lip as well as having a lip that is thin for the genus, and for these reasons should be placed in the subgenus RINGICULLA Monterosato (1884). The placement of RINGICULA aequispira Shumard is also in doubt, as Shumard’s description (1861, p. 7):

outer lip with a narrow reflected margin and terminating above in a narrow produced angle; columnar lip * * * bearing below two prominent sinuate lamellar folds,

leads one to believe the outer lip to be thin and that it lacks a parietal fold which puts it close to RINGICULLA.

Subgenus RINGICULLA Deshayes, 1838
RINGICULA (RINGICULA) pulchella Shumard

Plate 48, figures 1, 2, 6-17

1941. RINGICULA pulchella Shumard. Stephenson, Texas Univ. Bull. 4101, p. 387, pl. 73, figs. 3-5.

Diagnosis.—A RINGICULA of moderately variable shape sculptured by many incised grooves having a zigzag trace; thickened outer lip bears cancellate ornament. Medial or upper columnar fold bifurcated and parietal fold lengthened above to a ridge paralleling posterior channel.
Measurements.—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 172).

<table>
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<tr>
<th>Loc.</th>
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</tr>
<tr>
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<td>7</td>
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<td>3.0-5.9</td>
<td>5.0</td>
<td>1.5-1.5</td>
</tr>
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</table>

Discussion.—Stephenson (1941, p. 387) described and discussed this species in considerable detail and, as Shumard's types are lost, he selected a neotype from the Nacatoch Sand of the type area in the vicinity of Chatfield, Navarro County, Tex. In this area of Texas, Ringicula pulchella occurs in considerable abundance and the suites show a moderate amount of variation in shape, size, and sculpture.

In Mississippi and Tennessee the species is slightly longer ranging, as it is found in the Exogyra cancellata zone at locality 1 (Wade, 1926, p. 105) and ranges upward through the Ripley Formation. Locally the species is moderately abundant.

Variation is moderate, affecting size, shape, and apertural features, but sculpture appears to be a conservative character. The specimen from locality 18, figured on plate 48, figure 1, possesses a callus lined posterior siphonal channel that extends across the penultimate whorl and across the whorl preceding that. Most other specimens have an extension only part way across the penultimate whorl. The striations on the inner surface of the outer lip carry out into the thickened part where they may be faint and extend only part way across the lip (pl. 48, figs. 7, 10, 17), or completely across (pl. 48, figs. 1, 14), or may be medially interrupted (pl. 48, fig. 8). In some specimens these striations on the lip bifurcate (Wade, 1926, pl. 34, fig. 11). Variation in the width of the posterior channel is exhibited by the specimens figured on plate 48, figures 1, 7. The species from locality 16, figured on plate 48, figure 17, exhibits a secondary ridge of callus that extends almost completely around the aperture and in addition has a lower callus margin on the body away from the aperture. Proportional spire height also varies as a comparison of the specimens figured on plate 48, figures 2, 8, 10, 14 shows. Besides the above mentioned characters, some specimens may be distinguished by the strength of their columellar folds or by the obesity or globosity of their whorls. Although individual specimens may appear distinctive because of extreme development in one or more of these features there are always either intermediate forms that tie them all together or the accentuation of a character may be laid to geronticism.

Types: Neotype USNM 77196 (Texas); hypotype USNM 77197 (Texas); hypotype USNM 32885 (Tennessee); hypotypes 130570-130576 (Mississippi).


Ringicula (Ringicula) yochelisoni Shih, n. sp.

Plate 49, figures 20-26.

Diagnosis.—Small low spired subglobose ringiculids with an exceptionally prominent medial plication.

Description.—Shell small, subglobose; spire low and about one-quarter total shell height. Protoconch small, consisting of about 1½ smooth round-sided whorls; the first visible whorl is distinctly deviated; junction with conch gradual with first teloconch whorl less rounded and bearing about four fine impressed lines. Suture slightly impressed, body well rounded, rather globose. Sculpture of impressed zigzag spiral furrows that are narrower than the flat even-surfaced interspaces; furrows generally number 6 on the penultimate whorl and 15 to 17 on the body.

Aperture narrow, constricted by prominence of folds and thickness of outer lip, narrowed posteriorly to a posterior channel that is bordered by callus and that extends up out of the aperture and well up onto the spire; siphonal notch, short, strong, and twisted. Outer lip enlarged and reinforced by callus layers that are reflexed back over the body and that build in thickness by offlap; outer lip denticulate at inner edge, smooth behind on inner surface of lip, but teeth lengthen to ribs over reinforced area. Inner lip bears a well-marginated heavy callus; callus of inner and outer lip continuous posteriorly forming a posterior channel that rides up onto spire; parietal wall bears one L-shaped tooth with the vertical bar as a ridge paralleling the posterior channel and the horizontal bar extending into the aperture as a plication for about one-quarter of a whorl; medial or upper columnar plication very strong, extending well out into aperture and expanded at edge; lowermost plication very strong, extending well out into aperture and expanded at edge; lowermost plication less strong and more highly inclined bordering the siphonal canal.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 172).

Discussion.—Ringicula (R.) yochelisoni is moderately common at several localities all within the Ripley
Formation. In size, shape, and sculpture they all show a singular lack of variation. Only one specimen shows a startling difference and appears to be a pathologic specimen from locality 6 that lacks the lowermost columnar fold and the siphonal notch (pl. 48, fig. 24).

Although the species occurs with Ringioclus pulchella Shumard, it not only differs by its smaller size but by having a more globose outline and a proportionally lower spire. In addition, R. yochelesoni lacks striations behind the apertural denticulation of the outer lip, has a stronger medial inner lip plication, and in general the aperture is narrower than in Shumard's species.

The species is named for E. L. Yocheleson of the U.S. Geological Survey.

Types: Holotype USNM 130557; paratype USNM 130578, 130579, 130580.

Occurrence: Mississippi: Ripley Formation at locs. 5, 7, 18.

Subgenus RINGICULINA Monterosato, 1884

RINGICULINA (RINGICULINA) cf. R. clarki Gardner

Plate 48, figures 18, 19.

1916. RINGICULINA clarki Gardner, Maryland Geol. Survey, Upper cretaceous, p. 400, pl. 18, figs. 3, 4.

Discussion.—Collections from locality 9a in the upper part of the Ripley Formation of Mississippi have yielded incomplete specimens of a ringiculid having suppressed spiral sculpture. Spiral ornament consists of a few widely spaced fine incised lines that are restricted to the upper one-fifth and lower one-third of the body whorl; the rest of the body is smooth. Compared with the holotype of RINGICULINA clarki Gardner, from the Monmouth Formation of Maryland, these specimens are not so obese and have a proportionally higher spire. In view of the state of preservation it appears wise only to point out the affinities of the specimens and await better-preserved material before preparing fuller description and perhaps a new name.

Types: Figured specimens USNM 130581, 130582.

Occurrence: Mississippi: Ripley Formation at loc. 9a.

Type by original designation, Acteon concinnus Meek and Hayden, 1854.

Diagnosis.—Globose shells with a depressed spire. Sculpture of incised spirals consists of a series of chainlike links. Outer lip smooth to moderately denticate. Columella bears a strong anterior fold with no to two weaker parietal folds.

Discussion.—Meek originally proposed Oligopytha as a subgroup of Cinula Gray along with Avellana d'Orbigny. More recent authors, including Stewart (1927), Stephenson (1941), and Popenoe (1957), in dealing with these globose ringiculids have preferred to consider them all as distinct genera. Of the three, Oligopytha and Avellana appear to the most similar. Meek (1876, p. 283) diagnosed Oligopytha as follows.

Shell with spire much depressed and obtuse; outer lip smooth within, and very slightly sinuous at the base of the aperture; inner lip bearing a single, very prominent, nearly transverse plication, or tooth, at the base of the columella.

The holotype of Acteon concinnus Meek and Hayden is from the Pierre Shale, but Meek (1876, p. 284) also listed the species as occurring in the Fox Hills Formation of the western interior. The specimen figured by Popenoe (1957, pl. 50, figs. 3, 4) as the holotype of O. concinnus is not the holotype as claimed but only a hypotype. The Pierre shale specimen figured by Meek (1857, pl. 31, figs. 6a, b) is the holotype. Wade's species Eryptycha americana from the Ripley Formation of Tennessee was discussed and reassigned to Oligopytha by Stephenson (1941, p. 390). Another species Oligopytha corrugata from the Ripley Formation of Mississippi is described herein. Stephenson recognized that these gulf coast species did not agree with Meek's type species as they possessed a dentate inner surface on the outer lip and more than one columellar plication. Although these features differed, he thought they merited only specific distinction. The generic diagnosis given above is expanded to include these species.

Further evidence for the relationship of the gulf coast species to the type species can be gleaned from comparing their morphologic features and stratigraphic position. Oligopytha americana (Wade) occurs at the lowest position in the Eowyrax cancellata zone and is the smallest species. It possesses the typical single columnar plication, but it also has two parietal folds plus strong denticles on the outer lip (pl. 48, fig. 32). Stratigraphically as well as morphologically, O. corrugata appears to occupy a medial position. It occurs above the E. cancellata zone, is larger in size than Wade's species, possesses only one parietal fold, and weaker denticulations (pl. 48, fig. 37). O. con-
cinnus from the higher levels in the Fox Hill Formation of the Black Hills possesses only the columellar fold, lacks the parietal folds, and has, contrary to former belief, very faint denticles on the outer lip of some specimens. Sculpture is of the same type on all three species as is the character of the siphonal canal. A common lineage of these species is indicated and is viewed as a uniform change with time directed toward decreasing the number of plications, decreasing the thickness of the outer lip, and the strength of its denticles, but increasing the average size.

Once the Gulf coast species are included in Oligopych a, trouble arises. *Avellana* d'Orbigny is differentiated from *Oligopycha* on the basis of having one columellar and generally two parietal folds and in having a denticate outer lip. Although these are features not found in the type species of *Oligopycha*, they are found in *O. americana* (Wade). In fact, *Avellana subincrasata* d'Orbigny, as figured by Popoe (1957, pl. 50, fig. 2), is exceedingly close to the typical shape and sculpture of *Oligopycha*. The temptation exists to synonymize *Oligopycha* with *Avellana*. On the other hand, some consistent differences do appear to be present. The parietal folds of *Avellana* extend to the aperture, whereas in *Oligopycha* the parietal folds never extend out as far as the columellar folds and may be well within the aperture as in the upper parietal fold of *O. americana*. In *Oligopycha* the columellar fold is much stronger than any others present and it has a distinctive trend, being directed at an angle down toward the anterior margin as it extends out into the aperture. In *Avellana* this fold is virtually horizontal. For these reasons it appears feasible to distinguish the two genera.

Aside from the above mentioned species, two other North American Cretaceous species have been assigned to *Oligopycha*. Of these, *O. obliqua* (Gabb) Stewart (1927, p. 436) from the Sononian of California has been reassigned by Popoe (1957, p. 435) to his genus *Biplica*. The other species *O. popoeae* Allison (1955, p. 430) is very suggestive of *Oligopycha*, but unfortunately is not well enough known for confident placement in the genus and on the basis of the available information could equally well belong to *Biplica* or perhaps *Avellana*.

*Oligopycha americana* (Wade)

Plate 48, figures 27, 30-33.


**Diagnosis.**—A small oligoptychid possessing a strong posterior channel, a strongly denticate outer lip, and two parietal folds.

**Description.**—Small low-spired globose shells. Protoconch deviated, consisting of about 1 1/2 smooth round-topped whorls, the first of which is always depressed below plane of teleoconch volution. Suture impressed. Sculpture begins as a few thin faint incised lines on the first teleoconch whorl, but they rapidly develop to incised grooves that are constricted to a series of chainlike links by the crossing of the growth line threads. Spiral grooves of upper and lower parts of whorl closer spaced than those of periphery, and the grooves generally number 18 to 19 per whorl. Aperture narrow posteriorly, broadening anteriorly. Outer lip thickened by layers of callus that are reflexed out of the aperture back onto the body; outer surface of reinforced lip transversely ridged by successive layers of callus and internally bearing strong denticulations that extend outward variably as spiral ridges onto the reinforced area. Inner lip with a thick well-margined callus; parietal callus transversely ridged and extended apically beyond aperture into a broad posterior channel of variable strength. Parietal wall bears two folds interiorly; the first is placed high on the wall and begins about one-eighth of a turn behind callus margin, the second arises at about the base of the parietal callus ridge and strengthens behind the aperture. Columella bears one strong plait with an expanded edge that is inclined anteriorly and overhangs a moderately strong and broad groove that serves as a siphonal canal.

**Measurements.**—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 172).

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**Discussion.**—As is easily discernible from the measurements, *Oligopycha americana* shows a consistently small size. In many other features individual variation is moderate. On some specimens the protoconch is entirely submerged below the plane of volution, whereas in others only the initial half whorl is distinctly submerged. The denticulations of the outer lip, although always present, do vary from forms with low ridges to those with moderately high and sharp crests; this is also reflected in the thickness of the
callus. Variations in strength and development of the upper parietal fold and the siphonal canal also are rampant.

This species differs from *Oligopytha corrugata* by its stronger outer lip denticulations, by the presence of the upper parietal fold, by having a strong parietal ridge, and by its smaller size.

**Types:** Holotype USNM 32836; hypotypes USNM 130553–130565.

**Occurrence:** Tennessee: Ripley Formation at loc. 1.

**Oligopytha corrugata** Sohl, n. sp.

Plate 48, figures 28, 29, 36, 37.

**Diagnosis.**—Shell of normal size for genus and bears a single parietal fold.

**Description.**—Globose low-spired shells. Protoconch of a little more than 1½ smooth whors, the initial half whorl of which is depressed. Suture faintly impressed. Teleoconch whors well rounded and have 2-2½ whors. Sculpture of impressed spiral grooves that appear as spiral chains with links formed by crossing of transverse growth line threads; spiral grooves number 23–29 per whorl. Aperture narrow posteriorly, expanding and rounded anteriorly. Outer lip dentate at inner edge, with nodes frequently lengthening to ridges over outer face, reinforced lip faintly ridged transversely by edges of the reflected callus layers. Inner lip covered by a heavy well margined callus; parietal callus continuous with outer lip callus as it ascends spire, which forms an ill-defined posterior channel, and below it bears a low transverse swelling or ridge that borders channel. Columella bears one strong fold that borders a weak siphonal canal below and an additional lower less strong and less exerted plication occurs at the base of the parietal wall.

**Measurements.**—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

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<td>18 (holotype)</td>
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**Discussion.**—*Oligopytha corrugata* Sohl is restricted to the Ripley Formation of Mississippi and is scarce. The few specimens available for study show some range in shape. The holotype is a little narrower than average, whereas the paratype (pl. 48, fig. 29) from the same locality is as wide as it is high. Similarly, the paratype from locality 6 (pl. 48, fig. 28) shows more numerous spiral grooves. Similar variation in thickness and denticulation of the outer lip, as well as in strength of the plications of the inner lip, can be seen by comparing the illustrations of the species.

Compared with *Oligopytha americana* Wade from the *Exogyra cancellata* zone of Tennessee, this species lacks a second parietal fold, has a weaker transverse siphonal wall on the parietal surface, is larger, has more numerous spiral grooves, and has a weaker siphonal canal.

**Types:** Holotype: USNM 130566; paratypes USNM 130557, 130558.

**Occurrence:** Mississippi: Ripley Formation at locs. 6, 13, 16, 18, 29.

**Oligopytha sp.**

1941. *Oligopytha americana* (Wade)‡. Stephenson, Texas Univ. Bull. 4101 p. 390, pl. 73, figs. 10, 11.

**Discussion.**—One small shell from the Owl Creek Formation at locality 44 is an immature specimen of an *Oligopytha*. Because of its stage of development it is specifically indeterminable, but it does serve to indicate the presence of the genus in this formation. Stephenson (1941, p. 390) described a similar specimen from about the same level in Texas in the Kemp Clay and it is assumed the two represent the same species.

**Types:** Figured specimen USNM 77206 (Texas); mentioned specimen USNM 130559 (Mississippi).

**Occurrence:** Mississippi: Owl Creek Formation at locs. 44, Texas: Kemp Clay.

**Family SCAPHANDRIDAE**

The species described below under the name *Ellipsostropha* Stephenson as well as those here included in the family Bullidae are difficult to interpret. Most of the Cretaceous species are based upon internal molds. This is understandable as the species in these groups commonly possess thin shells; recovery of well-preserved material is fortuitous. With such a lack of shell material the nature of the inner lip callus is unknown, knowledge of sculpture is based only upon reflections on the molds and the presence or absence of an umbilical perforation can only be surmised. Therefore, many of these species cannot confidently be placed in a genus or are so placed upon the basis of comparison with better preserved material that occurs elsewhere at the same stratigraphic position.

In view of the multiplicity of names and shifting generic concepts shells of the *Cylichna* type are difficult to deal with under the best of conditions. On conchological grounds most authors accept many genera which on anatomical grounds are poorly founded. Among the Retusiidae Lemeche (1948, p. 57) has found much variability in well accepted characters such as surface sculpture, width of apical per-
foration, presence or absence of columellar folds and width of umbilicus. Similarly in *Cylichna* Loven he illustrates great variability in shape and apical characters. In some cephalaspids, *Diaphana* (p. 37), he has shown that even characters such as an open spire may develop in species thought to have an entirely hidden spire. Such evidence makes the application of the name *Cylichna* to bulliform shells tenuous.

**Genus ELLIPSOPOSCAPA** Stephenson, 1941

Type by original designation, *Cylichna striatella* Shumard, 1861.

**Diagnosis.**—Subelliptical involute tightly coiled shells with a submerged but perforate apex. Sculpture of punctate spiral grooves. Aperture rather narrow above, broadening below to a rounded anterior margin. Inner lip callused over columellar lip and bears a low weak fold.

**Discussion.**—Stephenson (1941, p. 391) proposed this genus to include a group of species from the Upper Cretaceous of the coastal plains and the western interior. *Scaphander* Montfort has an imperforate apex and is umbilicate. *Bulla* Linnaeus approaches *Ellipsoasca* in shape but lacks spiral sculpture over the median part of the shell and has a callus wash over the columellar lip and parietal wall. *Haminaea* Leach is closely similar and some of the internal molds assigned to *Ellipsoasca* herein might just as well be assigned to *Haminaea*. *Ellipsoasca* generally is less ovate than *Haminaea* and has, according to Stephenson, a weak columellar fold. Most of these differences, however, are indistinguishable on internal molds. *Haminaea* as used here is reserved for those forms that have a more ovate shape and that are more broadly punctate apically.

**Ellipsoasca mortoni** (Forbes?)

Plate 48, figures 34, 35, 38, 39; plate 49, figures 4, 5.


**Diagnosis.**—Medium-sized elongate subelliptical shells, apical perforation narrow; columella proportionally short.

**Discussion.**—The internal molds here tentatively assigned to *Ellipsoasca mortoni* all come from the Prairie Bluff Chalk of Mississippi. The type locality of the species is at the classic Atlantic Highlands of New Jersey and occurs with *Baculites ovatus* Morton of the Red Bank Sand, which may be slightly younger than the Prairie Bluff Chalk. The Mississippi specimens agree quite well with the specimens subsequently figured from the Atlantic Highlands locality, but that figured by Weller (1907, pl. 99, fig. 16) from the Navesink Formation appears to be more obese. Specimens similar to those from Mississippi have been noted by the author in the Prairie Bluff Chalk of Alabama.

The surface of these internal molds bear moderately strong impressions of an external sculpture consisting of incised spiral grooves that were punctate where crossed by fine transverse threads. One internal mold was found along with a part of an external mold to which a calcite replacement of a part of the shell adhered. This mold showed the shell material originally to have been thin (pl. 49, fig. 4). Both in sculpture and shape this species is close to the type species *Ellipsoasca striatella*, but it differs by being less slender, by having somewhat more round-sided whorls, slightly broader spiral grooves, and by more strongly constricted base to the parietal lip. *Haminaea subcylindrica* Meek and Hayden from the western interior is also exceedingly close, differing noticeably only in its finer sculpture. In addition to the internal molds assigned here, one specimen from the Owl Creek Formation sand facies equivalent of the Prairie Bluff Chalk and has yielded one moderately well preserved *Ellipsoasca* at locality 46 (pl. 48, figs. 34, 35). This specimen may be conspecific with the molds as it is similar in sculpture, but its body is slightly more obese and rounded.

**Types:** Figured specimens USNM 130090-130092.

**Occurrence:** Mississippi: Prairie Bluff Chalk at locs. 67, 67, 72, 82, 87, 94. Owl Creek Formation at loc. 46. Alabama: Prairie Bluff Chalk, New Jersey: Atlantic Highlands.

**Ellipsoasca** sp.

**Diagnosis.**—*Ellipsoasca* is represented in the collections from the Ripley Formation of Mississippi by one incomplete compressed specimen. This specimen is much like *E. striatella* in ornament and occurs close to the same stratigraphic position, but it is so compressed that any further comparison with that species is impossible. The thin-shelled nature of the species makes the finding of well-preserved specimens of this type exceedingly difficult.

**Occurrence:** Mississippi: Ripley Formation at loc. 29.

**Ellipsoasca?** sp.

Plate 49, figures 1-3.

**Discussion.**—A moderate number of internal molds having a rather ovate outline, an involute form, and
a narrowly punctate apex have been collected from the Prairie Bluff Chalk. The surfaces of these molds are covered by fine spiral lines similar to the sculpture of the other species of *Ellipsosopha*. The two specimens illustrated show the extremes of obesity, but other specimens are somewhat less so. Although in his definition of *Ellipsosopha*, Stephenson emphasized the character of slimness, he included in the genus *Haminacea minor* (Meek) a form having an outline not unlike the smaller Prairie Bluff specimens discussed here.

Types: Figured specimens 130303, 130304.

Occurrence: Mississippi: Prairie Bluff Chalk at localities 57, 66, 67, 72, 87, 88, 90, 91, 94.

Genus SCAPHANDER Montfort, 1810

Type by original designation, *Bulla lignaria* Linnaeus, 1758.

Diagnosis.—Medium to large size involute shells having the shallow apical perforation closed by callus. Whorls coiled around a hollow axis. Sculpture of incised spiral grooves. Aperture expanding anteriorly and proportionally large and broad. Inner lip callused.

Discussion.—Although well represented in the Tertiary, *Scaphander* is poorly if at all represented in the Cretaceous. Wade (1926, p. 107) described as *Scaphander rarus*, a small and immature shell from the Ripley Formation on Coon Creek, Tenn. This specimen possesses the apical plug of the genus, but it lacks the broad large aperture and open coiling of *Scaphander*. What genus this shell actually represents is difficult to determine and the holotype (USNM 32841) is now partly broken and one must depend on Wade's figures. At best the species should be listed as *Scaphander rarus* Wade.

Family ACTEOGENIDAE

Genus CYLICHNA Loven, 1846, sensu lato

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

Diagnosis.—Small slender cylindrical shells. Spire involute, apically truncate, and perforate in early growth stages. Surface smooth or with fine incised spiral grooves. Aperture posteriorly narrow but expanding to a rounded anterior end; columnar lip with a low fold.

Discussion.—*Cylichna* is the best represented opisthobranch genus in the Upper Cretaceous of the Gulf coast. If Stephenson's (1955, p. 196) questionably assigned specimens from the Woodbine Formation of Texas belong to *Cylichna*, the genus is present in this area from the Cenomanian through the Maastrichtian.

*Cylichna* is used here in the broadest sense. As noted in the discussion of the Scaphandridae identification of genera is unclear when based upon purely conchological grounds.

*Cylichna secalina* Shumard

Plate 49, figures 20, 27


Diagnosis.—Slender shells of moderately large size for genus with four to five strong raised spiral cords near apical end but widely separated fine and weakly incised grooves medially.

Measurements.—Judging by the sizes of specimens from the type area in the Nacatooch Sand of Texas, the shells of this species average between 9 and 10 mm in height and 4.5 mm in diameter.

Discussion.—The specimens from the Ripley Formation of Mississippi, here assigned to *Cylichna secalina* Shumard, compare well in size and shape with specimens from the type area in Texas. The Texas specimens display a rather wide variation in their sculpture. They range from forms that possess only very widely spaced narrow incised grooves over the posterior one-eighth of the shell to those in which the spiral grooves have widened and deepened to such an extent that the interspaces are left as four to five rather strong spiral cords. The Mississippi specimens have less widely spaced elements over this posterior area and have more strongly incised grooves over the medial part of the shell. Yet, these shells, like the Texas specimens, lack such strongly incised grooves and punctuations as those on *C. incisa* Stephenson.

Types: "Neotype" USNM 77214; hypotype USNM 77215; hypotype USNM 130305.

Occurrence: Mississippi: Ripley Formation at localities 7, 16, 17, 27, 29.

*Cylichna diversilirata* Sohl, n. sp.

Plate 49, figures 34–36.

Diagnosis.—Shell large and thick for genus; spiral grooves and furrows cover surface, are shallow and are irregularly spaced; interspiral spaces traversed by faint thin growth-line threads.

Description.—Medium-sized cylindrical thick apically truncate involute shells; apical perforation moderately broad and deep with a well-rounded margin. Whorls flat sided, tapering slightly above to the truncation and rounding off at the base. Spiral sculpture irregular, consisting of shallowly incised grooves and flat-bottomed furrows of variable width and spacing; spiral elements strongest anteriorly but covering whole surface including upper parts of walls of apical pit. Thin threadlike growth lines are visible on the interspiral spaces, but these vary in strength and diminish.
in vigor in the interspersal spaces. Aperture narrow above, expanding anteriorly; outer lip thin at edge, faintly crenulate at spiral terminations, thickening rapidly within and longer than shell axis. Parietal lip finely washed by callus; columellar lip reinforced, margined by a strong oblique ridge that is continuous with the low columellar fold.

**Measurements.**—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

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1 Anterior end missing.

**Discussion.**—The larger specimens of *Cylichna diversilirata* exhibit features that are unusual in *Cylichna*. Commonly the shells of *Cylichna* are much thinner. In those species in which the transverse elements are strong, they cross the spiral grooves as sharp lines forming a typical punctate sculpture as in *C. incisa* Stephenson. In *C. diversilirata* the transverse threads are strongest on the interspiral spaces, that is, between and not in the grooves. In addition, it differs from all other species of *Cylichna* in the Upper Cretaceous of the Gulf coast in the strength of its reinforced columellar lip. The most closely similar species appears to be *C. secalina* from the Nacatoch Sand of Texas, but in addition to the differences noted above, *C. secalina* is also proportionally slimmer and smaller.

*Cylichna diversilirata* is restricted to the Owl Creek Formation of Mississippi where it is moderately common. *Cylichna recta* Gabb of Gardner (1916, p. 411) may belong to this species as it comes from about the same stratigraphic position, but the surface sculpture of the holotype is too poorly preserved to be certain. In any event, Gardner’s specimen does not belong to Gabb’s species, which, according to Stephenson (1955, p. 134), is based upon an internal mold from the Eocene Hornerstown Formation of New Jersey.

**Types:** Holotype USNM 130596; figured paratype USNM 77217; paratypes USNM 77218; hypotypes USNM 130596, 0001.

**Occurrence:** Mississippi: Owl Creek Formation at locs. 41, 44–46.

*Cylichna incisa* Stephenson

Plate 40, figures 18–21, 28–31.

1941. *Cylichna incisa* Stephenson, Texas Univ. Bul. 1101, p. 350, pl. 74, figs. 7, 8.

**Diagnosis.**—A moderately small *Cylichna* that bears punctate spiral sculpture.

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**Discussion.**—*Cylichna incisa* appears to be a rather highly variable species. Although the specimens available from the type locality in Texas are few, they do serve to show that the strength of the punctations and the width of the spiral lines differ with individual specimens. A comparison of the holotype (Stephenson, 1941, pl. 74, figs. 7, 8) with the paratype (pl. 49, figs. 28, 29) indicates additional variation in the rounding of the body and in the sharpness of the margin of the apical pit. The Mississippi specimens conform, in general, more closely to the paratype than they do to the holotype in having a more rounded outline and all are smaller. These differences probably are a reflection of growth stages rather than that of specific difference, with slimness increasing with size. (See measurements.)

In Mississippi and Tennessee the species is represented throughout the *Exogyra costata* zone, a range considerably greater than that in Texas. In this area only one specimen is known to occur as low as the *Exogyra concallata* zone, which is the level at which the species occurs in Texas. In addition, one specimen has been noted reworked from the Owl Creek Formation into the basal unit of the Clayton Formation in Tennessee. Here it occurs with other species of *Cylichna* that are indigenous to the Paleocene.

The punctate sculpture serves to distinguish this species from the others in the fauna. In addition it has a somewhat narrower apical depression.

**Types:** Holotype USNM 77217; figured paratype USNM 77218; paratypes USNM 77219; hypotypes USNM 130596–606.

**Occurrence:** Tennessee: Ripley Formation at loc. 1. Clayton Formation (Cretaceous reworked at base) at loc. 40, Mississippi: Ripley Formation at locs. 4, 6, 7, 15, 18, 24, 29, 34. Owl Creek Formation at loc. 46. Alabama and Georgia (Chattahoochee River region): Ripley Formation.

*Cylichna intermissa* intermissa Sohl, n. sp.

Plate 40, figures 22, 23.

**Diagnosis.**—Subcylindrical cylichnids lacking sculpture on the medial part of the shell.

**Description.**—Moderately small subcylindrical apically truncate involute shells. Apical pit rather
narrow and deep with a well-rounded margin. Whorls gently convex medially. Sculpture of faintly incised grooves over upper one-quarter of whorl and lower one-third. Aperture elongate, rounded anteriorly; outer lip thin at edge, longer than shell axis; parietal wall thinly callused; columnellar lip reflexed, thin and only partly adnate, leaving a thin narrow umbilical slit; columella with a low faint highly obtuse narrow fold at base.

Measurements—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

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Discussion.—The lack of a pronounced columnellar plait, the presence of an umbilical slit, and the absence of sculpture upon the medial parts of the body distinguishes this species from all others in the fauna.

In the Ripley Formation of Mississippi and Tennessee shells of this species occur in some abundance at a number of localities. Variation is primarily restricted to the obesity of shell and to the height at which the basal sculpture occurs on the whorl. Generally the incised spirals are weak and restricted to the lower one-third of the shell length, but on some specimens faint spirals can be seen over almost all the lower half of the body. In general the smaller shells are the more obese and with increased size the shells become more slender and cylindrical.

Types: Holotype USNM 130602; paratype USNM 130603.

Occurrence: Tennessee: Ripley Formation at loc. 1, Mississippi: Ripley Formation at locs. 15, 19, 18, 29.

_Cylchna intermissa_ curta Sohl, n. subsp.

Plate 49, figure 25.

Description.—Resembling _C. intermissa_ proper, but smaller in size, whorls globose, umbilical slit broad for species.

Discussion.—This subspecies is represented by only one specimen from the Ripley Formation of Tennessee at locality 1. Although the sculpture and size of the apical pit and the columnellar features are like those of _Cylchna intermissa intermissa_, this form is proportionally shorter and has a much more rounded and more obese body.

Type: Holotype USNM 130604.

Occurrence: Tennessee: Ripley Formation at loc. 1.

_Cylchna pessumata_ Sohl, n. sp.

Plate 49, figure 24.

Diagnosis.—Subcylindrical small shells lacking spiral sculpture over the medial part of the shell and having the apical pit covered by a callus plug.

Description.—Small subcylindrical apically truncate involute shells. Whorl sides moderately convex. Sculpture restricted to a few widely spaced incised spiral grooves over the anterior 1/4–2/5 and on the posterior 1/4 of the shell. Growth lines arcuate. Aperture elongate, longer than shell axis; outer lip thin, rounded anteriorly and continuous posteriorly with the callus of the inner lip; callus plug forms at junction of lips and seals the apical pit. Inner lip callus thin over parietal surface, thickening over columnellar lip, callus here reflexed and well margined, no umbilical slit evident. Columella with a low very weak fold near base of body.

Measurements.—The holotype measures 3.6 mm in height and 2.1 mm in diameter.

Discussion.—Although similar in sculpture to _Cylchna intermissa_, this species differs by possessing an apical plug, a more curving columnellar lip, and more reflexed callus of the columnellar lip.

The species is very rare and is known only from its type locality in the Ripley Formation on Coon Creek, McNairy County, Tenn.

Types: Holotype USNM 130605.

Occurrence: Tennessee: Ripley Formation at loc. 1.

_Cylchna_ sp.

Specifically indeterminable specimens of _Cylchna_ also occur at other localities in the _Exogyra costata_ zone. On the basis of body proportions and visible characters they probably belong to several species but are suitable only to serve as occurrence records of the genus.

Occurrence: Mississippi: Ripley Formation at locs. 27, 32.

Genus CYLINDROTOCRUCATUM Sohl, 1968

Type species, _Cylindrotrocutatum demersum_ Sohl.

Etymology.—Composed from the Latin cylindrus (cylinder) and truncus (cut short).

Diagnosis.—Small slender apically truncate cylindrical shells with all the spire visible in the concave apical depression. Whorls terminating above in a sharply carinate edge that borders the apical depression. Sculpture faint, consisting of incised spiral grooves that are faintly pitted and fine collabral transverse elements restricted to the posterior part of the whorl. Aperture narrow, expanding anteriorly. Columella basally truncate.
Discussion.—This genus is proposed for the type species that occurs in the Ripley Formation of Tennessee and for Cylichnus carinata Stephenson, from the Snow Hill Marl Member of the Black Creek Formation of North Carolina.

The unusual depressed open spire and carinate upper whorl edge separate this genus from all others. Cylichnus and other similar genera, although occasionally exhibiting moderately open apical pits, do not possess a pit bordered by a sharp carina. In addition Cylindr truncatum lacks any col umellar plications, has a very narrow and deep posterior notch, and has distinctive ornament on the posterior part of the whorl.

*Cylindr truncatum demersum* Sohl

Plate 49, figures 8–12.


Description.—Shell moderately small, slender, and squarely truncate posteriorly; spire depressed in an open apical pit bordered and partly overhung by the sharply carinate upper edge of the body whorl. Protoconch partly submerged, heterostrophic; suture covered by a callus that covers channel between carinate whorl edges of body and penultimate whorl. Whorls carinate above, rather flat sided and rounded anteriorly. Sculpture dominated by punctate spiral grooves that are wider and closer spaced on the anterior part of the whorl. Fine close-spaced collateral transverse threads and fine spiral threads form a subcancellate sculptured band over the posterior one-twelfth of the whorl. Growth lines abaperturally arcuate on upper whorl surface reflecting posterior notch, somewhat opisthocl ine just below carinate whorl edge, orthocl ine over most of whorl surface below, becoming prosocl ine anteriorly. Aperture narrow and notched posteriorly, expanding anteriorly; outer lip thin at edge; inner lip thin above, thickening at posterior notch, callus of col umellar lip thicker and reflexed. Columellar smooth, truncate below.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

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<tr>
<td><em>Cylichnata</em> Stephenson (holotype)</td>
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Discussion.—*Cylindr truncatum demersum* is moderately common at its type locality in the Ripley Formation on Coon Creek, Tenn. The toptypes display uniformity in proportional size and shape and show only moderate variation in strength of sculpture. One specimen from locality 18 in the Ripley Formation of Union County, Miss., appears to belong to this species but is imperfectly preserved.

*Cylindr truncatum carinatum* (Stephenson) ([*Cylichnus*] from the Snow Hill Marl Member of the Black Creek Formation of North Carolina is closely related and exhibits the open apical pit and carinate upper whorl edge of the genus. Compared with the type species, it differs by being smaller, proportionately more obese, preserves an umbilical slit, and possesses faint transverse ribs over the upper surface of the whorl.

Wade (1926, p. 106) assigned Cretaceous specimens to *Cylichnus recta* Gabb. Gabb’s species is based upon a single internal mold from the Eocene, Hornerstown Marl of New Jersey. Stephenson (1955, p. 134) has pointed out that Weller (1907, p. 814) and Gardner (1916, p. 411) have also erroneously assigned Cretaceous shells to this species. Their specimens are not conspecific with the Coon Creek species but are involute shells probably belonging to *Cylichnus*.

Types: Holotype USNM 130906; paratypes USNM 130907, 130908; hypotype USNM 32888.


Genus GONIOCYLICHNA Wade, 1926

Type by original designation, *Gonioyclychna bispulcata* Wade, 1926.

Diagnosis.—Small to moderately small cylindrical shells have a low turreted spire. Protoconch small, heterostrophic. Whorls squarely truncate posteriorly, rounded anteriorly. Sculpture of short transverse ribs on posterior one-fifth and of incised spirals on anterior four-fifths of body. Aperture anteriorly expanded and rounded, posteriorly terminating in a shallow notch. Inner lip gently truncate below with col umellar bearing a distinct fold at top of col umellar lip that begins just behind aperture.

Discussion.—The above diagnosis of *Gonioyclychna* is emended to emphasize a feature overlooked by Wade (1926, p. 106) in his original diagnosis. That is the presence of a col umellar plication high on the col umellar lip. This feature was brought to light upon cleaning the aperture of the holotype, which had not been done by Wade.

Wade noted the genus as being similar to *Retusa* Brown and *Gonioyclychridites* Meek, and in fact it is
so similar to the former that if it were not for the lack of the distinctive columnar plication in *Retusa*, the two would be difficult to distinguish. *Gonio cylindrites* is based on *Cylindrites brevis* Morris and Lyceet (1854, p. 101) from the Jurassic, a form with a totally truncate spire. In addition, Wade stated (1926, p. 106) “The spire of *Gonio cylindrica* Wade is intermediate in form between *Gonio cylindrites Meek and Conac tomee Meek.*” With the additional knowledge of the presence of a columnar plication, the genus, *Gonio cylindrica* appears to be more closely related to the genus *Acetocina* especially those forms possessing subtruncate posterior whorls surfaces. *Gonio cylindrica* differs from *Acetocina* by the placement of the fold and by its extremely truncate posterior surfaces.

Of the two species that Wade included in *Gonio cylindrica*, *Cylindrica greisbachi* Etheridge and *Trochactecon seminocustos* Whiteaves, we must await further information as to the presence or absence of columnar plications before accepting them in this genus.

**Gonio cylindrica elongata** Sohl, n. sp.

Plate 40, figures 39, 40

**Diagnosis.**—Shell small, cylindrical; protoconch subemerged; transverse ribs flat topped.

**Description.**—Shell moderately small, cylindrical, and slender. Spire turreted and low. Protoconch subemerged. Teleconch whorls number about 3½. Upper whorl surface narrow and flat, bounded by a raised narrow rim that forms a sharp shoulder; body very gently inflated and very broadly rounded below, base rounded. Sculpture of broad rather sharp crested ribs that extend from the shoulder down onto body for about 1½ mm and are overridden at their upper extremity by 3 or 4 fine spiral threads. Body below ribs covered by wide-spaced incised spiral grooves. Aperture incompletely known, narrow above and expanding anteriorly. Columella bears one moderately strong highly oblique fold.

**Measurements.**—The holotype measures 11.6 mm in height and 4.3 mm in diameter.

**Discussion.**—The holotype is the only known specimen and was collected at locality 22 in the lower part of the Ripley Formation of Mississippi.

**Gonio cylindrica biscalpturnata** Wade, also present in the Ripley Formation, is less slender, smaller at the same growth stage, has flat-topped transverse ribs, a lower spire, a less subemerged protoconch, broader incised spirals, and a less oblique columnar plication.

**Type:** Holotype USNM 380699.

**Occurrence:** Mississippi: Ripley Formation at loc. 22.

**Gonio cylindrica biscalpturnata** Wade

Plate 49, figures 32, 33, 37, 38


**Diagnosis.**—Shell small and cylindrical; protoconch partly subemerged; spire very low.

**Description.**—Shell small, cylindrical; spire low and turreted. Protoconch smooth, heterostrophic, resting at an angle of about 90° to the teleconch axis and partly subemerged below the plane of the first teleconch volute. Whorls about three in number, rounded anteriorly, and posteriorly squarely shouldered, body widest medially. Shoulder formed by a carinate rim inside of which the upper whorl surface is flat and slightly depressed below rim. Sculpture of broad transverse ribs covers posterior three-quarters of a millimeter of body whorl; remainder of shell covered by wide-spaced incised spiral furrows. Growth lines rather faint, prosocline on flat upper whorl surface, slightly opisthocline immediately below shoulder, becoming orthocline below. Aperture narrow and squarely truncate posteriorly and expanding anteriorly. Outer lip thin at edge, but entire. Inner lip reflexed and faintly truncate below, callused over columnar lip. Columella bears one low fold high on the columnella that begins immediately inside the aperture.

**Measurements.**—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

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**Discussion.**—Only one specimen, the holotype (USNM 32837), has been discovered at the type locality on Coon Creek, McNairy County, Tenn. A number of additional specimens have been collected from higher levels in the Ripley Formation in Mississippi. Because of the distinct differences in proportional slimness between the type material and the Mississippi specimens, one is tempted to separate the forms. On the other hand although the Mississippi specimens differ by the slimness of shell, the sculpture is so similar and the total number of specimens so few that it appears to be foolhardy to differentiate them, at least until more specimens are available for study.

**Gonio cylindrica elongata** Sohl differs from *G. biscalpturnata* by its much greater size at the same growth.
stage, by its more slender outline, and by having a totally submerged protoconch.

**Type**: Holotype USNM 32837; hypotypes USNM 130610, 130611.


**ZIKKURATIA** Sohl, 1963

Type species, *Zikkuratia tabanneensis* Sohl.

**Etymology**.—Zikkurat, a Babylonian temple with a stair-stepped profile.

**Diagnosis**.—Small subcylindrical shells with a tur- reted spire of about one-quarter total length. Protoconch heterostrophic and erect. Whorls rounded anteriorly, very broadly rounded on the sides, and squarely shouldered above. Sculpture subdued, transverse elements restricted to posterior part of whorls, spiral furrows wide spaced. Aperture notched posteriorly, expanding anteriorly. Callus narrow and reflexed over the short columellar lip. Columella smooth.

**Discussion**.—It is difficult to determine the familial affinities of this genus. In some respects it is similar to *Aeuteolina* Grey, but the protoconch is entirely erect and visible, there is no columellar fold, and the spire is higher than normal for that genus. Similar differences pertain to such forms as *Rhusa* Brown. In the lack of columellar folds and the possession of an exposed spire, this genus may be closer to *Acteonina* d’Orbigny, *Oraeacteonina* Cossmann, and similar genera. Almost all these shells, however, have a tendency toward large size, and generally in the Acteonidae the spire is tapering, not turreted. Over all, the shells of this genus are more reminiscent of the small forms of *Acteonina* having an exposed protoconch and spire, and *Zikkuratia* is here provisionally placed in the family Acteoninidae.

**Zikkuratia tabanneensis** Sohl

Plate 49, figures 13-17

1963. *Zikkuratia tabanneensis* Sohl, Jour. Paleontology, v. 37, no. 4, p. 754, pl. 90, figs. 1-5.

**Description**.—Small subcylindrical shells with a tur- reted spire of less than one-quarter total length. Protoconch heterostrophic and erect, consisting of about 2½ smooth whorls. Suture impressed. Whorls very broadly rounded medially and with a flat upper whorl surface bounded by a slightly raised shoulder rim. Sculpture of fine collabral transverse threads that extend across the flat upper whorl surface, areaccentuated across the shoulder, and diminish on the body about a short distance below the shoulder. Wide-spaced incised spiral grooves cover the whorl surface. Aperture expands anteriorly, notched posteriorly. Outer lip thin at edge, entire. Columnellar lip thin, reflexed, and smooth.

**Measurements**.—The holotype from the Ripley Formation at the old site of Mercers Mill on Tabanee Creek, Quitman County, Ga., measures 2.8 mm in height and 1.3 mm in diameter.

**Discussion**.—The shells of this rare species are all very small, but the uniformity in size of the available specimens leads one to the conclusion that they represent mainly adult individuals.

Four specimens are known from the type locality in the Ripley Formation at the site of Mercers Mill on Tabanee Creek near Georgetown, Quitman County, Ga. (USGS 23923) and one incomplete specimen from about the same stratigraphic position in the Ripley Formation of Mississippi at locality 6. All the available specimens show a close agreement in character with minor differences in strength of sculpture.

**Type**: Holotype USNM 130612; paratypes USNM 130613-130615.

**Occurrence**: Mississippi: Ripley Formation at loc. 6. Georgia: Ripley Formation.

**Genus SCOBINDOLA** Sohl, 1963

Type species, *Scobindola guttata* Sohl.

**Etymology**.—Compound from the Latin, Scobina (rasp, file) and dolo (hew, cut).

**Diagnosis**.—Shells small, involute, subglobe, and moderately thick for size; spire narrowly perforate. Sculpture of intersecting transverse cords and spiral threads. Aperture as long as shell, expanded and slightly patulous anteriorly and posteriorly extended over penultimate whorl save for a small apical perforation. Outer lip thin at edge, rather straight mediially, and blending into inner lip. Inner lip lightly callused over parietal wall; columellar lip sharp-edged and partly reflexed over an umbilical perforation. Columella truncate below with a plait developing above truncation.

**Discussion**.—Though approximating a number of genera in certain characters, its glossole outline, plicate columella, narrow umbilical and apical perforations, as well as its very distinctive sculpture, have not allowed placement in any preexisting genus. Although one should be hesitant to erect new genera known from a single species, it is well known that among the opisthobranchs many forms of similar shell characters vary widely in soft part anatomy. I see no alternative for such distinctive shells as those represented by *Scobindola guttata* but to erect a new genus.
Scobinidola guttatus Sohl
Plate 50, figures 1-5

1963. Scobinidola guttatus Sohl, Jour. Paleontology, v. 37, no. 4, p. 763, pl. 90, figs. 6-10.

Diagnosis.—Small ovoid shells bear strong transverse cords that are intersected by slightly weaker spiral threads.

Description.—Shell involute, small, and globose; apical pit rather narrow. Sculpture of strong collabral raised round-topped transverse cords that are over-ridden by weaker but closer spaced spiral threads. Low nodes form at the intersection of the sculpture elements. Aperture as long as the shell, expanding anteriorly and posteriorly overlapping penultimate whorl. Outer lip thin at edge, slightly patulous anteriorly. Inner lip very lightly calloused over parietal surface, collumellar lip moderately thin and reflexed over a narrow umbilical slit. Columella smooth, with a highly oblique basal truncation that on the larger shells develops to a basal fold.

Measurements.—Explanation of measurements and units used in the following table appears in the section "Measurements of specimens" (p. 172).

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<td>Georgia (paratype)</td>
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<tr>
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</tr>
<tr>
<td>29 (paratype)</td>
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Discussion.—The strongly and beautifully sculptured little shells of Scobinidola guttatus are rare and restricted to the Ripley Formation of the East Gulf Coastal Plain. In Georgia, they are at present known only from their type locality at the old site of Mercers Mill on Tabanee Creek, southeast of Georgetown, Quitman County, Ga. (USGS 25923). The available specimens from this locality are all small and of uniform size and exhibit only the faintest collumellar fold above the highly oblique basal collumellar truncation. Another paratype (pl. 50, fig. 5) from the Ripley Formation of Mississippi represents a slightly larger individual and shows a rather strong plication developing anteriorly. This specimen also serves to show that the spiral threads become flat topped with increased shell size.

The distinctive sculpture serves to distinguish this species from any other known forms in the fauna, and to the author’s knowledge no closely related species occur elsewhere.

Types: Holotype USNM 130616; paratypes USNM 130617, 130618.


Genus SULCORUTUS Burch, 1945

(= Sulcicularia Dall, 1921, not Sulcicularia Rafinesque, 1831).

Type by original designation (Dall, 1921, p. 61, 202), Bulla sulcata d’Orbigny, 1841.


Discussion.—Sulcicularia was accepted as valid by Woodring (1928, p. 123), Gardner (1937, p. 264), and others, but, as pointed out by Myra Keen (in Burch, 1945, p. 16), the name has been preoccupied by Rafinesque (1831) for another mollusk. Burch substituted the name Sulcoretus, which has subsequently been used by Keen and Pearson (1952, p. 14).

The shells of this genus are closely similar to Coleophysis Fischer (1883) but lack any indication of the collumellar plait present in that genus and in addition it possesses a strong apical pit. Gardner (1938, p. 264) mentions a monoplicate columella as a generic character of Sulcicularia Dall but fails to mention it in the species she describes thereunder. If plications are present, her species may belong in Coleophysis.

The type species, Bulla sulcata d’Orbigny, is a Recent species from Florida and the Caribbean region. Other Recent species have been reported from both the American Atlantic and Pacific coasts. There are a number of representatives in the Tertiary of the same area in beds as old as the Miocene. The following described subgenus extends the range down into the Cretaceous.

Subgenus MONILIRETUS (Sohl, 1963)

Type species, Sulcoretus (Moniliretus) spinosa Sohl.

Diagnosis.—Shells have the shape and form of Sulcoretus but possess spiral threads in addition to the transverse threads and a posterior-lateral adaxial extension of the aperture.

Discussion.—The type species closely approximates the typical Sulcoretus in shape, lack of a collumellar plait, possession of transverse sculpture, and a thin collumellar lip reflexed over a narrow umbilical slit. The differences noticed in the above diagnosis, however, seem sufficient to warrant a subgeneric degree of separation.
Sulcorectus (Monilirectus) spinosa Sohl

Plate 49, figures 6, 7

1963. Sulcorectus (Monilirectus) spinosa Sohl, Jour. Paleontology v. 37, no. 4, p. 756, pl. 90, figs. 16, 17.

Description.—Very small involute subcylindrical shells. Apical perforation rather wide and deep. Shell expands somewhat anteriorly. Sculpture of intersecting transverse and spiral threads, with transverse threads wider spaced and a small spinose pustule forming at the intersection of the elements. Aperture as long as the shell, narrow, but expanding anteriorly, and posteriorly overlapping previous whorl to some extent. Inner lip thinly callused, parietal callus resting on the spinose sculpture of the penultimate whorl; columellar lip thin and reflexed over a narrow umbilical slit. Columella smooth.

Measurements.—The holotype, the largest specimen, measures 3.5 mm in height and has a maximum diameter of 1.6 mm.

Discussion.—These beautifully sculptured small shells are very scarce. Two specimens are known from the type locality in the Ripley Formation at the site of Mercers Old Mill on Tabanee Creek near Georgetown, Quitman County, Ga. (USGS 25923). Only one specimen has been discovered in the Ripley Formation of Mississippi at locality 29.

Because of the distinctive sculpture, I know of no other species likely to be confused with this one. Only the sculpture of Scobinidota guttata approaches this type, but that species possesses a columellar plication, a narrow apical pit, and has a squat obese outline.

Types: Holotype USNM 130619; paratypes USNM 130620, 130621.

Occurrence: Mississippi: Ripley Formation at loc. 29. Georgia: Ripley Formation.

Family BULLOPSIS

Genus BULLOPSIS Conrad, 1858

Type by monotypy, Bullopsis cretacea Conrad, 1858.

Diagnosis.—Apically truncate subglobose shells with a broad and open apical depression. Protoconch raised and heterostrophic. Sculpture of faint incised spiral grooves and, on some specimens, weak transverse riblets restricted to posterior part of whorl. Aperture flaring and slightly patulous anteriorly. Columella with two strong oblique plications.

Discussion.—The familial placement of Bullopsis has been an enigma to most authors who have dealt with it. Conrad (1858, p. 334) completely sidestepped the issue of familial placement. Stoliczka (1868, the apical surface to a short distance down on the whorl considered as a subfamily of the Acteocinidae. His placement was later followed by Tyron (1883, p. 361), who considered the genus near Hydratina Schumacher in the Aplustridiidae. Cossmann (1885, p. 111) continued this placement on the basis of the truncate spire. In 1896 (p. 168) he changed his mind and placed Bullopsis in the Bullidae, where it since has remained. The columellar plications and the protoconch are unlike those of a normal build, but there seems little necessity at present for setting Bullopsis aside in a new family.

Only two species of Bullopsis are known, one of which is herein described as new, and both are restricted to the late Upper Cretaceous of the Mississippi embayment area. One specimen related to B. cretacea is present in the Survey collections from the Pierre Shale of the Red Bird section of Niobrara County, Wyo. (D-1985).

Bullopsis cretacea Conrad

Plate 53, figures 9-16


Diagnosis.—Shells reaching medium size, surface sculpture subdubed with only scattered incised lines.

Description.—Medium-sized moderately thick apically truncate subovate shells. Spire depressed, apical depression broad with the smooth heterostrophic protoconch visible at the center. Suture lies in an impressed groove. Teleoconch of five to six whorls, upper surface rounded, descending with increased curvature into the apical depression; whorl sides rounded. Sculpture consists of faint impressed spiral grooves that are close spaced on upper part of whorl, absent to wide spaced medially, and closer spaced and more deeply incised on the base. Growth lines opisthoclone on upper third of body, becoming gently prosocline below. Aperture expands rapidly anteriorly, narrowly rounded posteriorly; outer lip thin at edge, almost straight above, but rounded and slightly patulous anteriorly. Inner lip lightly callused above; columellar lip thickened and well margined. Columella bears two parallel strong plications.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 172).
NEOGASTROPODA, OPISTHOBRANCHIA, AND BASOMMATOPHORA

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Discussion.—Bulopsis cretacea Conrad is one of the more common gastropods in the Owl Creek Formation, but it is restricted in distribution to the Mississippi embayment area. Variation in size within a given suite is rather large. On some specimens, sculpture appears to be almost entirely subdued (pl. 50, fig. 10). This is so with almost all the larger specimens and also a few of the smaller specimens. The specimen figured on plate 50, figure 15, is the largest known specimen and shows some unusual features. The apical pit is shallow and the growth lines of the earliest whorls show a strengthening to fine ribs. Breakage and subsequent repair of the shell is shown by the spiral groove that developed after the shell was repaired (pl. 50, fig. 16). This groove probably represents an injury to the mantle and may account in part for the shallow apical pit. A number of specimens possess three brownish spiral bands that may well represent original patterns of coloration.

Bulopsis demersus Sohl from the Ripley Formation is the only other known species. It differs by size and most pronouncedly by its development of transverse sculpture on the posterior whorl surface.

Types: Holotype ANSP 18924; hypotypes USNM 123221, 123241, 128209, 130622, 130623, 130624, 20438.

Occurrence: Mississippi: Owl Creek Formation at locs. 41, 45-47, Clayton Formation (Cretaceous reworked at base) at loc. 49. Tennessee: Clayton Formation (Cretaceous reworked at base) at loc. 49. Missouri: Owl Creek Formation.

Bulopsis demersus Sohl, n. sp.

Plate 50, figures 6-8

Diagnosis.—Small bullopsids with a narrow apical pit, short transverse ribs on the posterior whorl surface, and incised spirals that are restricted to the basal slope.

Description.—Shell small, subglobose, and apically truncate. Apical pit rather narrow with protoconch visible in its center. Teleoconch whorls strongly rounded above and into apical pit and broadly rounded over the whorl sides. Transverse ribs extend from the apical surface to a short distance down on the whorl sides. Spiral sculpture restricted to a few incised spiral grooves on the basal slopes. Aperture moderately narrow posteriorly, expanding greatly anteriorly. Outer lip thin at edge, rather straight medially, and rounded and slightly patulous anteriorly. Inner lip very thinly washed with callos over parietal lip but thickenes anteriorly to a well margined columellar lip. Columella bears two plications, the lower of which continues onto columellar lips as an arcuate ridge.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

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<tr>
<td>D0</td>
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<td>1.7</td>
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</table>

Discussion.—This small species is known from only two localities both of which are in the upper part of the Ripley Formation of Union County, Miss. At its type locality (29), it is moderately common. Some variation is present, as a comparison of the specimens figured on plate 50, figures 6, 8, indicates, but all preserve the normal Bulopsis columella. Compared with the type species, Bulopsis cretacea Conrad, from the Owl Creek Formation, this species is not only smaller but also lacks spiral sculpture on the medial parts of the whorl and has a narrower apical pit.

Types: Holotype USNM 130625; paratypes 130626, 130627.

Occurrence: Mississippi: Ripley Formation at locs. 27, 29.

Genus BULLA Linnaeus, 1758

Type by subsequent designation (Montfort, 1810), Bulla amplula Linnaeus, 1758.

Diagnosis.—Medium-size involute ovate to rather globose shells. Apical pit generally narrow. Surface smooth to spirally grooved. Aperture as long as shell, expanding anteriorly; outer lip thin at edge; inner lip calloused, columellar lip arcuate.

Discussion.—The nomenclatural difficulties involved in stabilizing the name Bulla in its historically accepted sense are set forth in Opinion 196 of the International Commission on Zoological Nomenclature (1984).

Although a moderately large number of Cretaceous species have been assigned to Bulla the preponderance are based upon internal molds of questionable affinities. Although many of these species have been reassigned to other genera by subsequent authors, Bulla still remains a receptacle for placement of involute internal molds of globose outline.
Discussion.—The two specimens figured on plate 50, figures 17, 20, from the Owl Creek Formation are of questionable affinities. Unfortunately both have been compressed and are missing parts of the shell. They are globose, involute, with a perforate apex and possess parietal and columellar callus. The shell surface is virtually smooth with only the faintest of spiral lines. In these respects they resemble bullds. On the other hand, the shell material is very thin and more on the order of Haminia Leach. Haminia differs significantly, however, by lacking parietal and columellar callus.

Types: Figured specimens USNM 20454a, b.
Occurrence: Mississippi: Owl Creek Formation at loc. 46.

Superfamily PYRAMIDELLACEA

Following Fretter and Graham (1949) the pyramidalids are removed from the Mesogastropoda and placed in the Opisthobranchiata. Such a placement had been anticipated by Thorson as early as 1946 (p. 199).

Family EULIMIDAE

Wenz and other authors included the Eulimidae (Melanellidae) in the Pyramidellacea along with the Styliferidae having an ectoparasitic habit in common. The two families Eulimidae and Pyramidellidae because of their similarity in habit have commonly been placed together in the superfamily Aglossa. Depending upon the author, others have used the Aglossa as a repository for some endoparasites also (Entoconchidae). Morton (1958, p. 177, 215–216), on the other hand, considered the Pyramidellacea as opisthobranchs but differentiates the Eulimidae and Stiliferidae, placing these in the Mesogastropoda on the basis of lack of sinistrality and differences in their feeding organs. Perhaps the strongest recent proponent of differentiating Eulimidae from the Pyramidellacea is Boettger (1954, p. 262), who raised a number of objections, on the basis of fundamental anatomy, to their inclusion in the same superfamily or for that matter in the same subclass. Although in the face of Boettger's statements the author leans toward exclusion of the Eulimidae from the Pyramidellacea, the point is controversial and a conservative view is adopted in this paper by tentatively considering the two together. (See Tikasingh and Pratt, 1961, and Taylor and Sohl, 1962.)

Genus EULIMA Risso, 1826

Type by subsequent designation (Herrmannsen, 1846), Turbo subulatus Donovon, 1804.

TENNESSEE AND MISSISSIPPI

Eulima persimplicae Wade
Plate 50, figures 35, 36


Diagnosis.—Moderately small shells of slim outline having a very acute spire. Suture faint, partly obscured by the glaze of the smooth surface. Basal slope well rounded. Aperture ovate with a somewhat patulous expanded outer lip.

Measurements.—The holotype is missing the apical tip and measures 5.4 mm in height and has a maximum diameter of 1.7 mm.

Discussion.—The holotype from the Ripley Formation on Coon Creek, McNairy County, Tenn., is the only specimen available for study. The characteristic rounded basal slope and slim outline readily distinguish this species from Eulima laevigata Wade, which has a subangular break between the whorl sides and basal slope. E.? cora on the other hand has more elongate whorls and a longer aperture and possesses faint fine spiral lines on the base.

Type: Holotype USNM 73090.
Occurrence: Tennessee: Ripley Formation at loc. 1.

Eulima laevigata Wade
Plate 50, figures 29, 30


NEOGASTROPODA, OPISTHOBRANCHIA, AND BASOMMATOPHORA


Measurements.—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 172).

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<tr>
<th>Loc.</th>
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<tr>
<td>F. ramesi Stephens (holotype)</td>
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Discussion.—Wade (1926, p. 174) based this species upon a single immature specimen and no topotypes have subsequently been discovered to extend knowledge of the species. Wade’s illustrations (1926, pl. 58, figs. 16, 17) give the erroneous impression that the aperture is acute posteriorly and not rounded and show no visible evidence of sutures.

Perhaps the most characteristic feature of the species is the proportionally greater width than any of the other known species. In addition, the basal whorl angulation is stronger than either E. gracillimyis or E. persimilica.

In the Ripley Formation of Mississippi a number of specimens have been discovered that possess smooth flat whorl sides and have the width proportional to that of the holotype. They differ from the holotype by their greater size and by having somewhat more distinct sutures. Even though topotypes of more mature individuals are not available for comparison, the Ripley specimens are judged to be conspecific.

The size, shape, possession of a subangular periphery, and the height-width ratio of *Pseudomelania runnelsi* Stephenson from the Kemp Clay of Texas so exactly match those of the Mississippi specimens here included in *E. laevigata* that there is no alternative but to consider it as a junior synonym of this species.

Types: Holotype USNM 73901; holotype (Pseudomelania runnelsi) Stephenson) USNM 76860; hypotype USNM 130065.


**Eulima gracilliis** Sohl, n. sp.

Plate 50, figures 31-34.

**Diagnosis.**—Shell moderately large for genus, whorls become broadly rounded in later development stages.

**Description.**—Shell moderately small, spire acute. Protoconch of 2 1/4 volutions, smooth, round sided with the initial whorl small, bulbous, and lying at a small angle to later whorls. As many as 10 whors glazed and flat sided on early whorls; later whors become slightly swollen medially. Body broadly rounded down to the basal slope. Sculpture absent save for growth lines that are gently flexed medially. Aperture acute posteriorly, widest opposite columellar lip, rounded anteriorly; outer lip thin; inner lip gently arched, columellar lip with callus reflexed and narrow.

Measurements.—Explanation of measurement and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

<table>
<thead>
<tr>
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<td>7.0</td>
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<tr>
<td>18</td>
<td>6.9</td>
<td>2.1</td>
<td>3.0</td>
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</tbody>
</table>

*Estimated to be 100.
*Estimated to be 3.0.

Discussion.—*Eulima gracillimyis* ranges through the Ripley Formation and possibly into the Owl Creek Formation. It reaches a size larger than any other species in the fauna except *E. clara*. The larger individuals are easily distinguished from *E. laevigata* by both the rounded periphery of the body and the slightly constricted upper whorl surface. Distinction of smaller specimens is less easy as the characteristic constriction does not develop until the later stages, but the smaller shells of this species are slimmer and have a less broad aperture as a comparison of the measurements of the two species shows.

Types: Holotype USNM 130066; paratype USNM 130067.


**Eulima of. E. monmouthensis** (Gardner)

Plate 50, figures 31-34.

Discussion.—One incomplete specimen in the collections from the Owl Creek Formation of Mississippi possesses the generic characters of *Eulima*. It differs distinctly from the other species of the genus in the fauna by its proportionally shorter whorls and by its very steep basal slope that in turn is reflected by the proportionally shorter aperture. In its short whors and other features it approaches *Pseudomelania monmouthensis* (Gardner) (1916, p. 480) a form that occurs at about the same level in the Monmouth Formation of Maryland. The only known specimen of that species, the holotype, is larger and has a less angular periphery.

Type: Figured specimen USNM 130068.

Occurrence: Mississippi: Owl Creek Formation at loc. 46.
**Eulima clara** Wade

Plate 50, figure 28


**Diagnosis.**—Shell large for genus, slim, suture distinct, whorls elongate, smooth except for fine spiral threads on base. Aperture lanceolate.

**Discussion.**—These thin shells do not lend themselves to fine preservation and most specimens consist of only a few whors. Wade’s species was erected on one incomplete and crushed specimen from Coon Creek, Tenn. Stephenson (1941, p. 263) recorded a smaller, but definitely related, specimen from about the same level in the Neylandville Marl of Texas. Similar fragmentary specimens of the same, or a very closely related, species possessing identical basal sculpture and an elongate aperture have been discovered in the Ripley and Owl Creek Formations.

Owing to the incomplete state of preservation of all known specimens, the character of the protoconch and early whors are unknown. Thus the generic affinities of the species is in some doubt, but the sutural and apertural characters are suggestive of the subgenus *Polygyrulina* Sacco.

**Types:** Holotype USNM 76068; hypotype USNM 76062.

**Occurrence:** Tennessee: Ripley Formation at loc. 1. Mississippi: Ripley Formation at loc. 10. Owl Creek Formation at loc. 46. Texas: Neylandville Marl.

**Family PYRAMIDELLIDAE**

**Genus CREONELLA** Wade, 1917

Type by original designation, **Creonella triplicata** Wade, 1917.

**Diagnosis.**—Small rather slender subulate shells. Protoconch raised, moderately large, consisting of several smooth whors coiled normal to teleoconch axis. Whors flat sided, glazed, and unornamented. Suture impressed. Aperture subovate, posteriorly angulate; outer lip medially excavated. Columella bears three strong plications.

**Discussion.**—Creonella is similar to *Pyramidella* (Pyramidella) Lamarck by having three columellar plications, but it is much more slender and lacks the rounded whorl sides of such forms as the type species *Pyramidella* (Pyramidella) dolabrata Linneaus. It also has no trace of an umbilicus. Some species of *Tiberia* Monterosato, especially in the subgenera *T.* (Cossmannia) and *T.* (Lozoptyzis), show a closer approach in shape, but all the members of this genus possess only two columellar plications.

**Creonella triplicata** Wade

Plate 51, figures 7, 8


1941. **Creonella triplicata** Wade, Stephenson, Texas Univ. Bull. 4101, p. 204, pl. 48, figs. 8, 9.

**Diagnosis.**—Shell small, outline slim, whors flat sided with a rounded basal periphery.

**Description.**—Shell small to moderately small, anomphalous. Protoconch erect and heterostrophic, consisting of about 2½ smooth whors. Telococh whors flat sided, glazed, and smooth, and may number as many as eleven. Suture impressed. Sculpture absent save for faint mainly ortholine growth lines. Body whorl with a well-rounded periphery and very steep basal slope. Aperture subovate, posteriorly angulate; outer lip marked interiorly by five raised sharp spiral ridges beginning about one-quarter of a turn inside the aperture and extending well back into the shell. Inner lip excavated medially, callused, and bearing three folds, one on the base of the parietal wall, followed anteriorly by a stronger fold on the upper part of the columella, with a third weaker fold slightly lower; a deep strong channel separates the two posterior folds.

**Measurements.**—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

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<td>16</td>
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<tr>
<td>17</td>
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</table>

The holotype is missing about four whors of the spire and the siphonal canal but measures 9 mm in height and has a maximum diameter of 1.75 mm.

**Discussion.**—Measurements of the available specimens are poor, as most specimens lack their apical tip. To circumvent this difficulty a plot was made of the height of the penultimate whorl against the width of the penultimate whorl. The spread for a given sample is so great that the only generality possible is that the
specimens from the Ripley Formation of Mississippi are slightly slimmer than those from the type locality in the *Eocygrya cancellata* zone of Tennessee.

*Creonella trilobicata* is a rather common element of fauna at the type locality on Coon Creek, McNairy County, Tenn., and becomes less abundant at higher levels in the same formation in Mississippi.

Wade's type specimens were both incomplete and his illustrations give an erroneous impression of a squat aperture. Better preserved topotypes indicate the aperture is rather elongate.

*Creonella subangulata* Sohl differs from this species primarily by the presence of a subangular periphery that lends the aperture a more subquadrate outline and, in addition, that species is proportionally wider. *C. deuressi* Stephenson (1941, p. 265), from the Kemp Clay of Texas, occurs at a higher stratigraphic level but is exceedingly close to *C. trilobicata*. Stephenson stated that *C. trilobicata* is more slender and has a less deeply impressed canal.

**Types:** Holotype and paratype USNM 73086; holotypes USNM 130628, 130629.


*Creonella subangulata* Sohl, n. sp.

Plate 51, figures 3–6, 9


**Diagnosis.**—A *Creonella* with smooth whorls and a subangular periphery that lends the aperture a subquadrate outline.

**Description.**—Moderately small anomphalous subulate shells. Protoconch heteromorphic, erect, consisting of about 2½ smooth whorls that reach a slightly greater diameter than the first teleconch whorl. Teleconch whorls number eight and nine and are flat sided, glazed, and smooth. Suture impressed to almost channeled. Sculpture absent except for generally faint growth lines. Body whorl with flat sides, bordered below by a subangular to sharply rounded periphery, below which the body slopes very steeply over the base. Aperture subquadrate in outline, acute posteriorly, siphonal canal short, round bottomed, and about as wide as deep. Outer lip bears a maximum of six sharp spiral ridges on inner surface that do not reach aperture. Inner lip sharply excavated medially and callused, bearing three approximately equally-spaced plications. First plication near base of parietal lip is sharp and may overhang the deep round-bottomed channel that separates it from the less sharp but stronger fold on the posterior part of the columella. Lower plication is the weakest one at aperture but frequently strengthens interiorly and borders the siphonal canal.

**Measurements.**—All the available specimens are incomplete. The holotype from locality 5 is missing a part of the apical end and its outer lip and measures 4.4 mm in height (estimated total length about 7 mm) and has a maximum diameter of 2.4 mm.

**Discussion.**—This species shows a moderate amount of variation in character of its suture, with the specimen figured on plate 51, figure 4, possessing almost staitstepped whorls, whereas the holotype (pl. 51, fig. 6) has an evenly tapering spire. One specimen (pl. 51 fig. 9) from locality 22 measures about 4.9 mm in diameter about twice that of the holotype a normalized specimen, and serves as an indication of the size attained by some members of this species. At this advanced growth stage, very faint and fine spiral threads develop.

Compared with *Creonella trilobicata* this species differs not only by its less rounded base and subangular periphery but also by seeming to have somewhat shorter whorls, a more excavated inner lip, and by being somewhat less slender.

The specimen figured by Wade (1926, pl. 58, figs. 6, 7) as *Liostraca cincta* (Conrad) bears the typical columnar features of *Creonella* inside the aperture and possesses the whorl profile of *C. subangulata*. Conrad's species is from the Woodbury Clay (lower part of the *Eocygrya ponderosa* zone) of New Jersey and published descriptions and illustrations indicate it does not belong in *Creonella* or even probably in *Liostraca*.

**Types:** Holotype USNM 130630; paratype USNM 130631.


*Creonella cf. C. subangulata* Sohl

Plate 51, figures 1, 2

**Discussion.**—One incomplete specimen from the Owl Creek Formation at locality 45 although similar to *Creonella subangulata* has a rather weak parietal fold and is proportionally broader than is typical of the species. These differences, if constant, would warrant the recognition of a new species, but because of the lack of sufficient material the placement of the specimen must remain in doubt.

**Type:** Figured specimen USNM 13064.

**Occurrence:** Mississippi: Owl Creek Formation at loc. 45.

*Creonella turretiformis* Sohl, n. sp.

Plate 51, figures 10–13

**Diagnosis.**—Shell small for genus. Suture very narrowly channeled, bounded below by a low welt on
the upper whorl surface that is delimited below by an impressed spiral groove.

**Description.**—Shell small, spire slightly turreted. Protoconch heterostrrophic, partly submerged. Suture in a very narrow channel. Whorls 4 or 5 in number, flat sided, glazed, and smooth with a low subsutural welt bounded below by a narrow impressed spiral groove. Body below welt, straight on sides and well-rounded over periphery and basal slope. Aperture subovate, angulated posteriorly, and developing a broad round-bottomed slightly reflexed siphonal canal. Outer lip spirally striated within by five raised ridges that begin behind aperture. Inner lip moderately excavated medially and bearing three plications; medial plica strongest on largest individuals; on shells of only about 2½ whorls only medial plica visible, at four whorls the parietal plica appears and at five whorls the anterior plica is apparent, but weak.

**Measurements.**—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

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<td>20</td>
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**Discussion.**—Creonella turretiforma is distinguished primarily on the basis of its subsutural welt. In sculpture, it is closest to *C. whitei* Stephenson, but that species is consistently large for the genus, whereas this species is quite small, more slender, and has more distinct sutures. *Creonella turretiforma* is rare, occurring at only two localities in Union County, Mississippi, both of which are in the upper part of the Ripley Formation.

**Types:** Holotype USNM 130662; paratype USNM 130663.

**Occurrence:** Mississippi: Ripley Formation at locs. 27, 29.

**Genus LACRIMIFORMA** Sohl, 1963

Type species, *Creonella secunda* Wade, 1926.

**Etymology.**—Compounded from the Latin *lacrimal* (tear drop). Gender, feminine.

**Diagnosis.**—Small fragile subulate shells having an evenly tapering spire of about three-fifths total shell length. Protoconch heterostrrophic. Whorl sides flat to gently convex and glazed, with body more rounded than preceding whors. Sculpture absent or restricted to faint microscopic spiral threads. Aperture auriform, acute posteriorly, rounded anteriorly. Outer lip thin, striate within; inner lip medially to submedially excavated. One low sharp fold appears low on columellar wall, followed closely by a stronger less sharp plication on upper part of columella and then a third small plication near base of columella that is more widely separated.

**Discussion.**—Creonella Wade, to which Wade (1926, p. 173) assigned the type species, differs by its more slender shape, proportionally higher spire, more sinuous growth line at maturity, by having an orthoclone rather than prosocline growth line in earlier stages, and by its more exposed and erect protoconch. *Pyramidella* Lamarck differs by lacking a parietal plait, by the posterior plait being the strongest, and by its slimmer higher spired form. *Tiberia* Monterosato s. l. is close in shape but possesses only two columellar plait and lacks striations on the interior of the outer lip.

**Lacrimiforma secunda** (Wade)

Plate 50, figures 21–27.


**Description.**—Shell small, teardrop shaped; spire rather evenly tapering but of variable height. Suture impressed. Whorls of spire with rather flat to convex sides. Body whorl generally well rounded. Surface generally smooth but with an impressed subsutural groove appearing on some specimens. Aperture auriform with the inner lip plications typical of the genus.

**Measurements.**—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

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**Discussion.**—Wade’s (1926, p. 173) description of *Creonella secunda* is not clear as to its columellar pliactions. The type specimen (pl. 50, fig. 24) shows parietal and upper columellar folds that are closer spaced and stronger than a third fold low on the columella. The medial or upper columellar fold is the strongest of all.

*Odostomia plicata* Wade is, first of all, a homonym of *Turbo plicata* Montagu, the type species of
Odostomia. Secondly, the holotype of Wade’s species was incompletely cleaned and matrix covered all but the strongest fold on the columnella. Although Wade (1926, p. 173) stated O. plicata Wade had only one plait and that O. impressa had only two, reexamination of the holotypes of both indicates that they have an inner lip arrangement of plaits identical with those of Creonella secunda Wade and that all belong in the same genus. In addition, these three forms proposed by Wade possess a striate inner surface of the outer lip.

Although the holotypes show differences in size, whorl shape, and sculpture, it is here proposed that they are in fact no more than members of one moderately variable species. The following evidence is given in support of that thesis. The impressed subsutural spiral used by Wade as the distinctive feature of O. impressa (pl. 50, fig. 22) is to be found also on the holotype of O. secunda (pl. 50, fig. 22), although it is fainter and Wade did not note it in his description. The holotype of the latter, however, has flatter whorl sides on the whorls of the spire. This can be explained in that whose convexity appears to increase proportional to size. Other specimens such as the holotype of O. plicata (pl. 50, fig. 27) show a squatter outline and lack the impressed spiral, but differentiation of this form as a separate species on the basis of shape is difficult, as other topotypes lack the spiral groove but in size and shape are much like O. impressa. Thus even though the holotypes may appear to be distinct, topotypes indicate them all to be intergradational.

Types: Holotype USNM 73088; holotype (O. plicata) USNM 73062; holotype (O. impressa) USNM 75087; hypotype USNM 130634.

Occurrence: Tennessee; Ripley Formation at loc. 1.

Superfamily EPITONIACEAE

The placement of the superfamily Epitoniacea within the Opisthobranchia is unconventional and must be considered tenuous. As stated in the introduction (Sohl, 1960, p. 46) the classification on the superfamily level follows that of Knight and others (1954). These authors placed the Epitoniacea near the Pyramidellacea in the Opisthobranchia. They, however, gave no reasons for so doing. More recent authors, Morton (1958), Abbott (1954), Taylor and Sohl (1962), and others, have not followed this lead but have retained the Epitoniacea in the Prosobranchia. Thorson (1946, p. 194), however, noted a similarity in the excretory organs of Scala clothera (Linneé) and Philine, an opisthobranch. How much weight should be given to such similarities is questionable, but these certainly should be investigated.

Family EPITONIIDAE
Subfamily ACIRSAE
Genus ACIRSA Mösch, 1857

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

Diagnosis.—Small to medium-sized moderately thick turriculate anomalous shells. Whorls rather flat to convex sided and lacking a distinct basal carina or disc. Sculpture of both transverse ribs and spiral cords. Aperture subrounded.

Discussion.—None of the species present in the Ripley and Owl Creek fauna belong in Acirsa (Acirsa), but several do appear assignable to other subgenera. Of the three species, Acirsa microstriatus, A. corrugata, and A. cerithiformis (Meek and Hayden), that Wade described from the Ripley Formation, the first and second belong in A. (Plesiencirsa) and the latter belongs in Bellascula. Although Acirsa in the strictest sense is probably represented only from the Tertiary to Recent, other subgenera have representatives that extend back as far as the Jurassic.

Subgenus HEMIACIRSA de Bouy, 1890

Type by original designation, Turbo lanceolata Brocchi, 1814.

Diagnosis.—Slim very elongate rather thick, turriculate shells with flat to moderately convex whorl sides. Body peripherally subangulate. Sculpture of strong collabral transverse ribs overridden by numerous fine spiral cords or threads. Aperture auriform.

Discussion.—Although Acirsa (Hemiacirsa) is well represented especially in the lower Tertiary there is only one Recent species known and only one species, A. (H.) cretacea Wade, that has heretofore been reported in the Cretaceous.

Acirsa (Hemiacirsa) cretacea (Wade)

Plate 51, figures 22, 23


Diagnosis.—Shell moderately large for genus. Transverse ribs straight on early whorls but developing a decided sinuosity on later whorls.

Measurements.—The holotype (USNM 32952) is the only known specimen and is missing a part of the outer lip and the apical tip. This specimen measures 39 mm (+) in height and 11.1 mm in diameter.

Discussion.—This species, especially in its earlier stages, agrees well with the characters of Acirsa (Hemiacirsa) but is especially distinguished by the
sinuosity of the low spiral ribbons on the posterior parts of the whorl. In addition to the loss of the apex, the spire of the holotype shows the affects of at least four catastrophes during life that forced repairs to be made to the shell. The second break affects about half a whorl and subsequent repair was made in such a manner that the spire now lies at a slight angle to the last 2½ whorls.

Wade's illustration (1926, pl. 55, fig. 9) is considerably retouched and over accentuates the strength of the spiral sculpture.

**Type**: Holotype USNM 32951.

**Occurrence**: Tennessee: Ripley Formation at loc. 1.

**Aciris (Hemiacrira) americana** (Wade)

Plate 51, figures 24–28


**Diagnosis**.—Medium-sized turriculate shells with 10–12 strong straight transverse ribs that die out at the basal periphery. Spiral sculpture of very fine and faint incised threads. Basal periphery marked by a spiral cord on early whorls, but cord not present on body of larger individuals.

**Measurements**.—The holotype is missing its apical tip, but as preserved it measures 29.9 mm in height and 9.2 mm in diameter.

**Discussion**.—Wade's description of this species was evidently based solely upon the holotype, as no mention is made of a cord at the basal periphery. Actually such a cord exists on several topotypes (pl. 51, fig. 28) that represent earlier stages of growth. Close examination of the holotype indicates that there is a swelling marking the carination immediately above and partly covered by the suture on several whorls of the spire. In addition, microscopically fine pittings of the incised spiral threads can be noted on some specimens.

**Proscala** Coissmann, to which Wade assigned this species, is based upon the type species *Sclaria albensis* d'Orbigny, from the Albian of France. This species has a well-rounded base that lacks a basal angulation, has a narrow posterior collar, and has an uninterrupted circular aperture with a well-curved inner lip. All these features are lacking in Wade's species. Other species similar to *P. americana* Wade, such as *Sclaria canaliculata* d'Orbigny and *S. elementina* d'Orbigny, have been placed in *Clavoscala* de Boury by de Boury, but they probably do not belong there. These species differ from *P. americana* by retaining their basal cord to maturity and are more properly placed in the Scalininae near *Amaea* H. and A. Adams.

Several other closely related species occur in the Ripley fauna of Mississippi. At the same level within the *Exogyra cancellata* zone, the strikingly similar *Aciris (Hemiacrira) cretacea* (Wade) is found. This species differs by attaining greater size, by having coarser spiral sculpture, and by developing numerous transverse ribs. *A. (Hemiacrira) flexicostata* Sohl from the Ripley Formation above the *E. cancellata* zone in Mississippi has more numerous transverse ribs, the ribs develop a sinuous trend in the mature stages of development, and spiral sculpture is almost lacking.

**Types**: Holotype USNM 32952; hypotypes 130635–130637.

**Occurrence**: Tennessee: Ripley Formation at loc. 1.

**Aciris (Hemiacrira) flexicostata** Sohl, n. sp.

Plate 51, figures 29–31


**Diagnosis**.—Medium-sized shells with 12–14 strong and flexed transverse ribs. Spiral sculpture exceedingly faint.

**Description**.—Shell small to medium sized, with a turriculate elongate spire. Pleural angle 18°–20°. Protoconch unknown. Suture bordered above by a spiral cord marking basal periphery of preceding whorl and bounded below by a narrow and low sub-sutural swelling. Whorls rather flat sided to convex. Whorls of early stages having a basal cord separating whorl sides from base; cord is lost on body of larger individuals, but basal periphery remains subangular. Transverse sculpture of 12–14 strong raised collateral costae that possess a rather straight trend on early part of spire, but increase in flexure with growth; costae extend from suture to basal angulation and are absent on base. Spiral sculpture of broad extremely faint close spaced spiral ribbons. Growth lines opisthocline subsuturally, orthocline over whorl sides, opisthocline over basal periphery, and arcuate on base. Aperture incompletely known, subovate, angulated posteriorly, and developing a faint siphonal angulation at the base of the columella. Columella smooth.

**Measurements**.—The holotype preserves about 9½ whorls but is missing the apical tip. As preserved, it measures 31.5 mm in height and 10 mm in diameter.

**Discussion**.—*Aciris (Hemiacrira) flexicostata* is rather rare in the Ripley Formation of Mississippi. It occurs only in the lower part of the formation but has been discovered at a number of localities.

This species differs from *Aciris (Hemiacrira) americana* by its stronger more numerous and more sinuous transverse ribs and in the extreme suppression of spiral
sculpture. In addition, the apical angle is somewhat higher and the base is less rounded. *A. (H.) cretacea* Wade has weaker and closer spaced transverse ribs and lacks the distinctive suprasutural spiral cord and subsutural welt of this species.

**Types:** Holotype USNM 130638; paratypes USNM 130639, 130640.

**Occurrence:** Mississippi: Ripley Formation at locs. 6, 17, 18, 22.

*Acisra* (Hemiacisra) clathrata Sohl, n. sp.

Plate 51, figures 32-36

**Diagnosis.**—Moderately small shells bearing moderately strong transverse ribs and numerous rather fine spiral liae with punctate interspaces.

**Description.**—Moderately small slender turriculate shells. Pleural angle 18°-22°. Protoconch unknown. Suture impressed. Whorls numerous, broadly rounded on sides; body sharply rounded over basal periphery to the steeply sloping base. Sculpture consisting of 12 or 14 round-topped collabral transverse ribs that are strong on the whorl sides but die out on the base. Spiral elements are finer, consisting of primary and spiral liae that cover the whorl sides and base and override the transverse ribs; the interspiral spaces are finely punctate. Aperture subquadrate, outer lip moderately thin, inner lip strongly arched, columellar lip narrow, reflected slightly. Columella smooth.

**Measurements.**—The holotype is missing its apex, but as preserved, measures 14.0 mm in height and has a maximum diameter of 6.2 mm.

**Discussion.**—*Acisra* (Hemiacisra) clathrata is a rare and moderately variable species. The holotype from the Ripley Formation of Mississippi at locality 18 is the largest available specimen. In some features it appears to be somewhat atypical. Some topotypes and one specimen from locality 6 show a low wehtlike cord developing on the basal periphery that does not appear on the holotype. This feature may, however, be lost on the larger specimens. Similarly, the holotype shows somewhat coarser spiral sculpture on the earlier whorls and a greater differentiation of the spiral elements into primaries and secondaries. On most other specimens there is considerably less differentiation and on some, the spiral elements are uniform.

The smaller size, punctate spiral sculpture, and more angular aperture all serve to distinguish this species from *A. (H.) cretacea* (Wade).

**Types:** Holotype USNM 130641; paratypes USNM 130642-130644.

**Occurrence:** Mississippi: Ripley Formation at locs. 6, 16, 18.

*Subgenus PLEOSIOACISRA* de Bouy, 1909

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

**Diagnosis.**—Small to medium-sized slender turriculate shells. Suture deeply impressed. Whorls broadly to strongly convex sided. Body angulate to rounded on basal periphery. Sculpture of spiral ribs or threads frequently punctate, with transverse ribs restricted to earlier whorls. Aperture subround with a moderately thick outer lip.

**Discussion.**—The forms assignable to this subgenus possess a wide variation in sculpture with the exception of consistently suppressed transverse elements. *Acisra* (Hemiacisra) possesses stronger transverse but weaker spiral elements and has an auriform aperture. *A. (Pleosioacisra)* is well represented in the Tertiary and is known in the Cretaceous by the three species discussed below from the Ripley Formation of Mississippi and Tennessee and by *Scalaria densetria* Kaunhoven from the Maestrichtian of Belgium.

*Acisra* (Pleosioacisra) microstriata Wade

Plate 51, figures 37, 38


**Diagnosis.**—Shell large for genus, transverse sculpture very suppressed except for the earliest whorls; spiral sculpture consisting of numerous narrowly incised to flat-bottomed spiral furrows that are much narrower than their interspaces.

**Measurements.**—The holotype is missing the apical tip and measures 31.4 mm in height and 9.9 mm in diameter.

**Discussion.**—*Acisra* (Pleosioacisra) microstriata Wade differs from *A. (P.) wadei* Cossmann by its much larger size, its loss of transverse sculpture at an earlier stage, and by its lack of interspiral punctuation.

The holotype from the Ripley Formation on Coon Creek in McNaury County, Tenn., is the only known specimen.

Cossmann (1925, p. 279) discussed and figured this species and paraphrased Wade's description but was in error in citing the measurements of the holotype of *A. (Pleosioacisra) wadei* as belonging to this species.

**Type:** Holotype USNM 32953.

**Occurrence:** Tennessee: Ripley Formation at loc. 1.
Acisra (Plesioceris) wadei Costmann

Plate 51, figures 14-16


**Diagnosis.**—Surface sculptured by thin collabral transverse ribs that become wider spaced and round topped on later whorls and punctate incised grooves that are about as wide as their interspaces.

**Measurements.**—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

<table>
<thead>
<tr>
<th>Loc.</th>
<th>H</th>
<th>MD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (holotype)</td>
<td>11.5+</td>
<td>4.3</td>
</tr>
<tr>
<td>18</td>
<td>14.0+</td>
<td>5.8</td>
</tr>
</tbody>
</table>

**Discussion.**—There is an indication, on the holotype, that with further growth the transverse sculpture of this species continues to diminish in strength. This is further substantiated by an incomplete toptype (USNM 130646) that is somewhat larger, on which the transverse ribs become almost entirely suppressed near the aperture. Thus it is reasonable to place this species in *Acisra* (Plesioceris) even though the transverse elements are retained for a considerable part of the life history. One larger and somewhat more completely preserved individual from the Ripley Formation of Union County, Miss., at locality 18 (pl. 51, fig. 14), appears to belong in this species. It differs from the holotype by having a slightly higher pleural angle and in having somewhat finer spiral elements of sculpture. Although missing the body whorl, this specimen does possess a more complete spire than the holotype and preserves a somewhat worn protoconch. The protoconch is smooth and consists of about 1½ whors with the initial stages somewhat deviated. Transverse sculpture begins abruptly, with the spiral elements beginning almost immediately thereafter. Later whors display well the suppression of the transverse elements typical of the subgenus.

Compared with *Acisra* (Plesioceris) microstriata Wade, this species is more slender, has somewhat more rounded whorl sides, a more deeply impressed suture, a less acute posterior apertural angulation, closer spaced spiral grooves that are punctate, and suppression of the transverse ribs beginning at a latter growth stage.

**Type:** Holotype USNM 32964; hypotype USNM 130645.

**Occurrence:** Tennessee: Ripley Formation at loc. 1. Mississippi: Ripley Formation at loc. 18.

Acisra (Plesioceris?) impexa Sohl, n. sp.

Plate 51, figures 17, 18

**Diagnosis.**—Shell slim and sculptured by low transverse ribs and spiral cords of about equal spacing and strength.

**Description.**—Shell of moderately small size, very slender, and elongate. Suture impressed. Whorls very gently rounded to almost flat; body with a well-rounded basal periphery and a broadly concave base. Spiral ribbons cover the surface and are almost equal in strength to the transverse cords they override, thinner secondary spirals may occur between the primaries but are less numerous; transverse cords are somewhat wider spaced than spiral elements on whorl sides, but diminish in vigor and die out on base. Growth lines proscline, inclined at about 20° to teleoconch axis. Aperture broadly subovate, broadly angulated posteriorly; outer lip rather thick, inner lip reflexed and medially excavated. Columella smooth.

**Measurements.**—The holotype, missing its apical tip, measures 9.3 mm in height and 3.2 mm in diameter.

**Discussion.**—This species fits well in *Acisra* because of its lack of a basal disk and in its apertural features and form. The retention of strong spiral sculpture makes placement in *A. (Plesioceris)* dubious, but it differs to an even greater extent from *A. (Hemiaceris).*

**Type:** Holotype USNM 130647.

**Occurrence:** Mississippi: Ripley Formation at loc. 16.

**Genus BELLISCALA** Stephenson, 1941

Type by original designation, *Bellisca rockensis* Stephenson, 1941.

**Diagnosis.**—Medium sized turreted high-spired shells. Whorls well rounded, plump, with deeply impressed sutures. Sculpture of rounded transverse ribs that are overridden by finer spiral lirae. Aperture posteriorly acute, columellar lip thin and reflexed.

**Discussion.**—The position of *Bellisca* in the family Scalaridae is unknown, but its lack of a distinct basal disc suggests placement close to *Acisra*.

Stephenson erected the genus for three very closely related species from the Nacatoh Sand of Texas. Whether these species should be so finely split on the basis of such minor and variable characters as strength of sculpture is debatable. *Acisra? cerithiformis* (Meek and Hayden) of Wade (1926, p. 169) belongs in *Bellisca* as does *Scalaria cerithiformis* Meek and Hayden from the western interior.

**Bellisca c*. B. rockensis* Stephenson


**Discussion.**—Wade was justifiably hesitant to assign this form a new specific name. The specimens figured
by him and now in the collection of the U. S. National Museum consist of two incomplete shells. One fragment preserves the body whorl of a medium-sized shell and the other consists of an incomplete spire. On the basis of shell sculpture the two shells appear to be conspecific. No additional specimens have been discovered in subsequent collections made in the Ripley Formation on Coon Creek, McNairy County, Tenn.

* Scalaria cerithiformis* Meek and Hayden has less obese and more rounded whorls, attains a larger size, and has wider spaced coarser spiral sculpture.

The fragment preserving the spire agrees quite well in sculpture with *B. rochenais* Stephenson, except that the elements are less coarse.

**Types:** Figured specimen USNM 32940.  
**Occurrence:** Tennessee: Ripley Formation at loc. 1.

**Genus STRIATICOSTA** Sohl

Type species, *Striaticostatum harbisoni* Sohl.

**Etymology.**—Compounded from the Latin striatus, (fluted) and costa, (rib). Gender, feminine.

**Diagnosis.**—Medium-sized high spired shells. Whorls numerous, sides well rounded, sutures deep, and generally obscured by transverse sculpture; body basally carinate, delimiting a flattened basal disk. Sculpture of strong transverse ribs composed of fluted lamellae that lend a honeycombed appearance; ribs strongly prosocline subsuturally, notched below at basal carination and diminishing decidedly in vigor on base. Spiral sculpture present, but faint in interspaces. Aperture subovate; outer lip thickened by a varix; inner lip usually thin and may or may not expose an umbilical fissure.

**Discussion.**—*Striaticostatum* is proposed for a group of Cretaceous species occurring on the Atlantic and Gulf Coastal Plains that historically have been assigned to *Epitonium* Bolten (in Roeding) or to one of its synonyms. The shells dealt with here never show as loose coiling as in *Epitonium*, but some variance in whorl embracement is noticeable. The most noticeable difference is in the fluted character of the varices. In this respect they more closely approximate *Cirrostrema* Möhrch, a well-known Recent and Tertiary genus, and are especially close to those forms called *Cirrostrema* (*Cirrostrenopsis*) Theile, an invalid subgenus according to Clench and Turner (1950, p. 226). This genus differs from *Cirrostrema* by its much more poorly defined spiral sculpture, by never developing a coalescence of the lamellar varices, and also by lacking the incipient siphonal canal. However, *Striaticostatum* should be placed with Cirrostrema in the Acisinae.

Outside of the Late Cretaceous of the coastal plain I know of no species definitely assignable to this genus.

* Scalaria ornata* Baily from Pondoland, South Africa, may belong here, but the character of the ribs is not well enough known (Woods, 1906, p. 315). Other species from North Africa and India are closely similar in form, but both the descriptions and illustrations are insufficient for confident placement.

**Striaticostatum bearensen* (Stephenson)**

Plate 52, figures 8, 14, 20


**Diagnosis.**—Shell of medium size, pleural angle 26°-29°, whorls well rounded; transverse ribs not strongly shouldered, but close spaced and numbering about 20-22 per whorl on large shells.

**Description.**—Shell moderately large for genus, thick, with a high turriculate spire; pleural angle 26°-29°. Protoconch unknown. Whorls plump and well rounded. Suture impressed. Sculpture dominated by close-spaced coarse collabral transverse ribs that are proportionally higher and thinner on early whorls and that become broader on the later whorls; ribs flexed subsuturally and again over the basal carinae that separate the rounded whorl sides from the flattened base; ribs formed by numerous lamellar layers that are crenulate at their outer edges by the spiral lirae; these crenulate overlapping lamellae lend the vesicular appearance of the ribs. Spiral elements visible in the rib interspaces as round-topped lirae of variable width that extend up to the edge of the lamellae of the transverse ribs. Aperture subcircular, outer lip thin and reflected anteriorly; inner lip slightly reflexed but not covering the umbilical fissure.

**Measurements.**—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

<table>
<thead>
<tr>
<th>Loc.</th>
<th>Number of whors</th>
<th>H of Specimen</th>
<th>H</th>
<th>MD</th>
<th>Pleural angle (degrees)</th>
<th>Number of ribs per whorl</th>
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<tbody>
<tr>
<td>Texas (holotype)</td>
<td>12</td>
<td>41.9</td>
<td>55</td>
<td>19.1</td>
<td>27</td>
<td>22</td>
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<tr>
<td>18 (fig. spec.)</td>
<td>11-12</td>
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<td>50</td>
<td>31.0</td>
<td>21</td>
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<td>9</td>
<td>33.8</td>
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<td>9.0</td>
<td>16</td>
<td>7</td>
</tr>
<tr>
<td>18</td>
<td>8</td>
<td>32.4</td>
<td>29</td>
<td>36.2</td>
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<td>14</td>
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<tr>
<td>15</td>
<td>6</td>
<td>13.3</td>
<td>17</td>
<td>5.3</td>
<td>16</td>
<td>17</td>
</tr>
</tbody>
</table>

**Discussion.**—The holotype of this species from the Corsicana Marl of Texas, is an incomplete and somewhat crushed specimen. The Mississippi specimens here assigned to *Striaticostatum bearensen* Stephenson are better preserved. They retain their original shell material and thus show features not to be seen on the holotype. In size, shape, pleural angle, and spacing of
the transverse ribs are close to the holotype, although a comparison of the finer details of sculpture is difficult.

Stephenson (1941, p. 266) stated:

Compared with E. sillimanii (Morton), as figured, this species is larger, has a rougher and more prominent development of the longitudinal ribs which, however, are narrower, is a little less tapering, and has a somewhat stronger and coarser development of fine revolving ridges.

Striaticostatum pondi (Stephenson), from the Ripley Formation on Coon Creek, Tenn., is smaller, slimmer, and has less numerous and less closely spaced transverse costae.

The species is relatively rare with few specimens being present at any given locality.

Types: Holotype USNM 78511; hypotype USNM 130648.

Occurrence: Mississippi: Ripley Formation at locs. 6, 15, 16, 18. Texas: Corsicana Marl.

Striaticostatum pondi (Stephenson)

Plate 52, figures 7, 9, 13, 19

1926. Scala sillimanii (Morton). Wade (in part) U.S. Geol. Survey Prof Paper 137, p. 168, pl. 54, figs. 13, 15, 16 [not fig. 12].


Diagnosis.—Moderate-sized slender shells; pleural angle 22°–24°; whorls bearing 12–13 rather thin but strong transverse costae.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

<table>
<thead>
<tr>
<th>Loc.</th>
<th>Number of specimens (estimated)</th>
<th>Specimen H</th>
<th>H (estimated)</th>
<th>MD</th>
<th>Pleural angle (degrees)</th>
<th>Number of costae</th>
</tr>
</thead>
<tbody>
<tr>
<td>Holotype</td>
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<td>28.0</td>
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<td>23</td>
<td>14</td>
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<td>Topotype</td>
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<td>30.0</td>
<td>12.4</td>
<td>22</td>
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<tr>
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<td>10</td>
<td>25.1</td>
<td>28.2</td>
<td>8.9</td>
<td>24</td>
<td>13</td>
</tr>
<tr>
<td>Do</td>
<td>11</td>
<td>25.3</td>
<td>28.0</td>
<td>12.1</td>
<td>23</td>
<td>14</td>
</tr>
</tbody>
</table>

Discussion.—Stephenson (1941, p. 267) based this species upon specimens from the Ripley Formation of Tennessee figured by Wade (1926, pl. 54) and assigned by him to Scala sillimanii Morton. He stated:

This species differs from E. sillimanii (Morton) as figured in that it is more slender, has more prominent more direct and rougher axial ribs, has the backward reflected notches at the lower ends of the ribs much more strongly developed, and has more sharply developed spiral sculpture.

The holotype (USNM 32942) is an incomplete specimen retaining only four whorls. Although the species is not abundant, sufficient topotype material is present to indicate a remarkable constancy in outline and sculpture. One specimen with a broken apex shows an abaperturely convex internal partition that evidently separated the early whorls. The specimen figured by Stephenson (1941, pl. 48, fig. 22) from the Nacatoch Sand of Texas is very incompletely preserved and can only be included in this species with grave doubt.

Wade (1926, pl. 56, fig. 19) figured a small specimen as an immature individual of Scala sillimanii and Stephenson later reassigned it to his new species as a paratype of Epitonum pondi. This specimen is here transferred to Opalia (Pleisocera).

Striaticostatum pondi differs from S. bezarensi by its slimmer outline, by its fewer wider spaced transverse ribs, and by its narrower basal disk.

Type: Holotype USNM 32942; hypotype 130649.


Striaticostatum harmisoni Sohl

Plate 52, figures 24–27

1963. Striaticostatum harmisoni Sohl, Jour. Paleontology, v. 37, no. 4, p. 748, pl. 60, figs. 16–19.

Diagnosis.—Medium-sized shells with an apical angle of 31°–33°; whorls with 12 or 13 strong high well separated transverse ribs that are strongly notched at the basal cord and reflexed and carinate above.

Description.—Medium sized moderately thin but strong high-spired shells. Suture deep, almost obscured by the costal flexures. Whorls plump with well-rounded sides; body with a raised basal spiral cord separating the rounded sides from the rather flat base. Sculpture dominated by strong highly raised lamellar transverse costae of moderate inclination; lamellae are crenulate, forming the honeycombed appearance of the expanded ends of the costae; costae are low reflexed ridges between suture and the abaperturally flexed carinate shoulder, gently proscline over rounded whorl sides, then becoming strongly flexed to an abapertural notch over the basal carination and appear as broad low ribs on the base. Interspaces much wider than costae; at base and on the adapertural side of the costae are broad transverse swellings that are separated from the concave interspaces by a fine impressed transverse groove and are sharply separated from the costae base by a strongly impressed transverse furrow. Spiral sculpture consists of numerous low broad cords that rise to the top, but do not overstep the costae. Aperture subcircular slightly flattened. Outer lip thickened by a varix, angulated at shoulder and base; inner lip thin and in contact with tops of basal ribs only over medial part of its extent.
Measurements.—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

<table>
<thead>
<tr>
<th>Loc.</th>
<th>Number of whors (estimated)</th>
<th>H of specimen</th>
<th>MD</th>
<th>Pleural angle (degrees)</th>
<th>Number of ribs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Holotype</td>
<td>11</td>
<td>25.9</td>
<td>18.4</td>
<td>33</td>
<td>12</td>
</tr>
<tr>
<td>Paratype</td>
<td>11</td>
<td>26.0</td>
<td>17.8</td>
<td>31</td>
<td>12</td>
</tr>
</tbody>
</table>

Discussion.—The type specimens are from locality 38 in the Chiwapa Member of the Ripley Formation of Pontotoc County, Miss. Both the holotype and paratype are exceptional in that they preserve color markings, a feature not only absent in the other specimens from the Gulf coast Cretaceous, but even uncommon in Recent forms of the family. Color bands of from one to several mm in width parallel the transverse costae. The first band is a milky gray and is restricted to the apertural side of the costations. In the intercostal space there is a narrower flesh-colored band that is followed by a darker pink band that ends at the incised groove at the base of the next costa.

This species is distinguished from the other members of this genus described herein by its especially high and carinate transverse ribs and also by possessing the distinct transverse swelling and incised groove at the base of the costae. In addition, the pleural angle is high as is the obliquity of the transverse ribs.

Types: Holotype USNM 130650; paratype USNM 130651.

Occurrence: Mississippi: Ripley Formation at loc. 38.

**Striaticostatum siliimanii (Morton)**

Plate 52, figures 11, 17, 22

1864. Scolaria siliimanii Morton, Synopsis of the organic remains of the Cretaceous group of the United States, p. 47, pl. 13, fig. 9.


**Discussion.**—Representatives of the genus Striaticosta are moderately common in the Prairie Bluff chalk. In contrast to other gastropods found in the chalk, they retain their shell material. The most common type is that which is here assigned to Striaticosta siliimanii.

Unfortunately, the only record remaining of the holotype is Morton’s original illustration and description, both of which leave much to be desired. Two specimens from Prairie Bluff, Ala., remain in the collections of the Academy of Natural Sciences of Philadelphia along with a label in Morton’s handwriting, but neither specimen conforms in size to the original illustration. Specimens of Striaticosta in the U.S. Geological Survey collections from the type locality and from nearby localities in the Prairie Bluff Chalk of Wilcox County, Ala., indicate that two species are represented. The specimen herein figured on plate 52, figure 11, from Shell Bluff on Shell Creek in Wilcox County near Prairie Bluff, conforms most closely to the holotype as illustrated. The other form represented in these collections is slimmer, higher spired, and has less numerous transverse ribs. *Striaticosta pondi* Stephenson has fewer wider spaced costae and is more slender. *Striaticosta beaveruse* likewise is less stout and has more rounded whorls, in addition to reaching a larger size. In other respects this seems to be the most closely related species.

Types: Holotype lost(?); hypotypes USNM 130652; hypotypes Walker Museum 10625.


**Striaticosta asperum Sohl, n. sp.**

Plate 52, figures 28, 29, 30

**Diagnosis.**—Medium-size slender *Striaticosta* with a pleural angle of 22°–24° and 14–15 rather thin transverse ribs that almost fuse with the ribs of the preceding whorl.

**Description.**—Medium-size turriculate shells; pleural angle 22°–24°. Suture deep and obscured by reflexions of the transverse ribs. Whorls rounded on sides, body carinate basally, basal disk steeply sloping. Sculpture of raised moderately narrow transverse ribs that are flexed above and notched at the basal carina, rib ends fluted by laminae. Intercostal areas broad, concave, and bearing fine close-spaced spiral ribbons and with a fine transverse incised line in each interspace. Aperture subovate; inner lip arched, moderately thin.

**Measurements.**—The holotype measures 54.3 mm in height and 15.4 mm in diameter but is missing several millimeters of the apical tip.

**Discussion.**—Compared with *Striaticosta siliimanii* (Morton), with which they occur, the shells of this species have a narrower base over which the rib traces are weaker. In addition, the ribs are less numerous and wider spaced and are almost fused with the
ribs of the preceding whorl. The whorls themselves are somewhat less plump and the shell more slender than in Morton’s species.

*Striaticostatum asperum* is rare in the Prairie Bluff Chalk.

**Types:** Holotype USNM 130653.

**Occurrence:** Mississippi: Prairie Bluff Chalk at locs. 71, 72, 83, 84, 87, 88. Alabama: Prairie Bluff Chalk.

*Striaticostatum congestum* Sohl, n. sp.

Plate 52, figures 18, 23

**Diagnosis.—** *Striaticostatum* of moderate size; pleural angle of about 20°. Whorls rather flat sided for genus and bearing 22–24 close-spaced transverse ribs; ribs almost absent on base.

**Description.—** Medium-sized slim turriculate shells; pleural angle about 20°. Whorls broadly convex on sides with a basal disk delimited by a basal carination. Sculpture of numerous close-spaced transverse ribs that are prosocline on whorl sides and strongly notched at the basal carination but almost lost on the base; rib tops expose crenulate lamellae of the varices; rib interspaces narrow, bearing close-spaced narrow ribbons and cords. Aperture subovate, inner lip moderately thin, leaving a narrow umbilical fissure.

**Discussion.—** The close-spaced numerous transverse ribs and the weakness of the basal sculpture serve to distinguish this from other species.

*Striaticostatum congestum* is rare and known from only two incomplete specimens, both of which occur at locality 87 in the Prairie Bluff Chalk of Mississippi.

**Types:** Holotype USNM 130654; paratype USNM 130655.

**Occurrence:** Mississippi: Prairie Bluff Chalk at loc. 87.

*Striaticostatum sparsum* Sohl, n. sp.

Plate 52, figures 10, 15, 16, 21

**Diagnosis.—** Medium-sized shells with 9–12 strong shouldered broad transverse ribs per whorl.

**Description.—** Medium-sized turriculate shells Pleural angle about 22°. Suture deep, obscured by the ends of the transverse ribs. Whorls well rounded on sides; body with base delimited by a strong basal carination. Transverse ribs strong, raised, rather broad or flaring at their crests; component lamellae fluted, forming honeycombed varices; ribs somewhat oblique, strongly shouldered above and notched at the basal carination. Spiral cords in the convex rib interspaces rather strong for genus. Aperture subovate, inner lip embracing body and lacking an umbilical fissure.

**Measurements.—** The holotype measures 30.5 mm in height and 13.8 mm in diameter but is missing about 2 mm of its apical tip.

**Discussion.—** *Striaticostatum sparsum* appears to be most closely related to *Striaticostatum barbisoni* from the Chiwapa Member of the Ripley Formation. It differs from the latter by its smaller size, slimmer profile, more distinct spiral sculpture, proportionally broader stronger but less raised transverse ribs, and by lack of a coronation on the upper rib face. *Striaticostatum sillimanii* (Morton), from the Prairie Bluff Chalk, is more obese and has more numerous and less broad ribs that are less deeply notched at the basal carination.

The species is restricted to the northern limits of the Prairie Bluff outcrop in Mississippi but ranges down into the uppermost part of the Chiwapa Member of the Ripley Formation.

**Types:** Holotype USNM 130656; paratype USNM 130657.

**Occurrence:** Mississippi: Ripley Formation at loc. 55, colln. 25504 (unit 1 of section), USGS colln. 25507. Prairie Bluff Chalk at loc. 54.

**Subfamily OPALINIDAE**

**Genus OPALIA H. and A. Adams, 1858**

Type by subsequent designation (de Bouy, 1886), *Scalari australis* Lamarck, 1822.

**Diagnosis.—** Small to medium-sized high-spired whorls generally well rounded, suture impressed; body whorl with or without a basal carination. Sculpture generally of strong transverse ribs, but in some groups these become weak or restricted to crenulations at the suture; spiral elements usually fine and punctate with exception of basal ridge, which may be coarse. Aperture holostomous, frequently thickened.

**Discussion.—** In this group as in the other subfamilies of the Scalidae there appears to be a considerable variety of opinions as to the limits and even the characters of the taxa involved. In part this is due to the many subdivisions proposed by de Bouy. Frequently they appear to be little more than categories representing arbitrary morphologic types rather than having any phylectic significance. When so viewed it is reasonable to expect that some of the groups may have very long ranges.

In placing the Cretaceous species described below in *Opalia*, the work of Clench and Turner (1950, 1951, 1952) on the Epitonidae has been of special help.

*Opalia* (Opalia?) *Estusosa* Sohl, n. sp.

Plate 52, figures 1, 2

**Diagnosis.—** Medium-sized shells, whorls well rounded with about 12 thin sharp-crested and wide-spaced costae.

**Description.—** Medium-sized high-spired shells; pleural angle about 29°. Whorls numerous with well-rounded sides; body basally carinate. Suture impressed. Sculpture dominated by thin collabral sharp-
crested widely spaced ribs that die out at the basal carination. Fine punctate incised spiral lines cover the whorl sides and base and override the transverse elements. Aperture subrounded, outer lip unknown; inner lip thin and somewhat reflexed anteriorly.

Measurements.—The incomplete holotype measures 22.3 mm in height and 10.8 mm in diameter.

Discussion.—The type species of Opalia as illustrated by Wenz (1940, fig. 2297) shows ribs on the base. Clench and Turner (1950, p. 231) as well as other authors have maintained that Opalia is distinctive for its lack of transverse sculpture on the base. On O. (Opalia?) fistulosa the ribs are mere wrinkles on the base and probably fall within the range of variability for the subgenus, but doubt still remains.

Only one specimen, the holotype, is available for study, but it is such a distinctive element of the fauna that it is not likely to be confused with any of the other epitoinds.

Type: Holotype USNM 130662.
Occurrence: Tennessee: Ripley Formation at loc. 1.

Subgenus Plicisca de Boury, 1887

Type by original designation, Scalaria gouldi de Boury, 1888.

Diagnosis.—Small slender shells with well-rounded whorls and a strong basal carination. Transverse ribs numerous with occasional strong varices that continue onto base. Spirals fine and punctate.

Discussion.—The species described below from the Ripley Formation of Tennessee is slightly atypical but appears to be placed better here than in the other subgenera of Opalia. The transverse ribs stop at the basal carination on O. (Opalia). On O. (Denticula) the ribs are suppressed and the basal ridge becomes obsolete or may even be lacking. O. (Nodisca) according to Clench and Turner (1950, p. 237) lacks a basal ridge but in other features is very close to the characters of the Ripley species. O. (Plicisca), where the species is here placed, generally has finer transverse elements but agrees in other characters.

Korobkov (1955, p. 151) followed Cosman and has raised Plicisca to generic rank and has placed Punctisca, Nodisca of de Boury, and Tunisca de Boury as subgenera thereunder. This arrangement has certain merits, but with such minor differences involved between the subgenus a grouping under Opalia appears to be more realistic.

Opalia (Plicisca) wadei Sohl, n. sp.

Plate 52, figures 5, 6.


Diagnosis.—Shell small, basal carination strong and flexed, transverse ribs wide spaced, coarse, and continuing onto base.

Description.—Shells small, with a high acute spire. Pleural angle about 25°. Protoconch unknown. Teleconch whors number six or seven, are round sided with a deeply impressed suture that is crenulated by the transverse ribs. Body well rounded over sides, angulated below by a strong carination that delimits basal disc. Sculpture dominated by widely spaced strong raised round-topped collabral transverse ribs and one or two varices per whorl that continue onto base with diminished vigor. Spiral sculpture consists of fine punctate spiral grooves and a strong basal carination that overrides the transverse ribs. Aperture, round, holostomous, inner and outer lips smooth; outer lip thin at edge and reflected onto the thickened and reinforcing varix of the outer lip.

Measurements.—The holotype measures 4.75 mm in height and 2.0 mm in diameter.

Discussion.—Wade (1926, pl. 54, figs. 12, 13, 15, 16) figured two epitoinds, which he assigned to Scala siliusani Morton. Stephenson (1941, p. 206) selected the larger specimen (figs. 13, 15, 16) to serve as the holotype of his new species Epithionum pondi and the smaller one (fig. 12) to serve as paratype. The large specimen has here been reassigned to the new genus Striaticostatum. The smaller specimen is not an Epithionum, is not conspecific with Striaticostatum pondi (Stephenson), and is here described as the holotype and only known specimen of Opalia (Plicisca) wadei Sohl.

The holotype comes from the Ripley Formation of Tennessee and is, to my knowledge, the first species of this subgenus to be reported in the Cretaceous.

Type: Holotype USNM 130662.
Occurrence: Tennessee: Ripley Formation at loc. 1.

Subfamily EPITONIINAE

Genus ACICULISCA Sohl, 1983

Type species, Aciculisca acuta Sohl.

Etymology.—Compounded from the Latin acus, (needle) and scala, a genus of the Gastropoda; gender, feminine.

Diagnosis.—Small very attenuate high-spired shells. Protoconch multispiral with carinate whors. Teleconch whors numerous, somewhat flattened medially, with a smooth basal disk bounded above by a subperipheral carination. Sculpture of strong transverse ribs interrupted above and at carination below. Aperture subovate, lips thin with outer lip sinuous in profile.

Discussion.—The needlelike outline, carinate protoconch whors, and sinuous outer lip profile set this
genus apart from the other genera of the Epitonidae. The lack of spiral sculpture and other features make placement in the Epitonidae not unreasonable although subfamilies of the Epitonidae have been erected on less distinctive characters.

Aside from the type species from the Ripley formation of the Gulf Coastal Plain, one additional species appears to be present in the Claiborne Eocene in the form of “Epitonium” jacobsi Palmer (1937, p. 94). Palmer placed this species in Epitonium very hesitantly and stated that generic assignment must await further study. The Claiborne species is exceedingly similar in character of sculpture, shape and protoconch.

Aciculiscala acuta Sohl
Plate 51, figures 19-21
1963. Aciculiscala acuta Sohl, Jour. Paleontology, v. 37, no. 4, p. 749, pl. 89, figs. 8-10.

Diagnosis.—Small thin shells lacking spiral sculpture, but bearing about 16 strong transverse ribs per whorl.

Description.—Small rather thin, very slim shells. Protoconch of 3–3 1/2 whorls; first whorl smooth globular; whorls becoming medially carinate after about the first 1 1/2; junction with teleoconch abrupt, marked by a transverse line beyond which normal teleoconch sculpture begins. Teleoconch whorls eight to nine in number broadly rounded on the sides; body with a basal carination separating the basal disk. Suture impressed, but faintly exposing the basal carination. Sculpture of about 16 strong raised round-topped transverse ribs that die out at the basal carination below and are interrupted above as they do not quite carry to the suture. Ribs are rounded to moderately abruptly shouldered and frequently very faint spines develop at the shoulder angulation; basal disk devoid of sculpture. Aperture subovate, faintly emarginate below columellar lip; outer lip thin, arcuate in profile; inner lip thin, sharpening somewhat low on the columellar lip.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section “Measurements of specimens” (p. 172).

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Discussion.—The very narrow, needlelike form alone is sufficient to distinguish Aciculiscala acutalis from the other species of the epitonds of the Upper Cretaceous. Only Aciculiscala jacobsi (Palmer) from the Claiborne appears to be similar. According to Palmer's (1937, p. 94) description, that species has a smaller protoconch, but like A. acutalis its protoconch whorls are angulate. The two are much alike in other respects even to development of the sculpture. The Claiborne form is, however, somewhat larger, and the transverse ribs although not reaching the suture do rise higher at the shoulder to spinose ends.

The Ripley species shows little variation in sculpture or form, but the specimens from Georgia (USGS 25557) do appear to have slightly broader ribs.

Types: Holotype USNM 130629; paratypes USNM 130069, 130061.

Occurrence: Mississippi; Ripley Formation at loc. 29. Tennessee: Ripley Formation at loc. 1. Georgia: Ripley Formation.

Order BASOMMATOPHORA
Superfamily SIPOHONARIACEA
Family SIPOHONARIIDAE
Genus SIPOHONARIA G. B. Sowerby, 1823

Type by monotypy, Siphonaria sipho Sowerby, 1823.

Diagnosis.—Moderately small, thin patelliform shells with a central to slightly subcircular outline. Outline round to ovate, surface smooth to ornamented by radial ribs that occasionally may frill the lip. Muscle scar band interrupted at upper right.

Discussion.—According to Cosman (1895, p. 136), the genus Siphonaria ranges from the Paleocene to the Recent where it is an inhabitant of the warmer seas. In general, few species have been recognized. Only three previously reported occurrences in the Cretaceous are known to the author. The first is that referred to by Stoliczka (1868, p. 326) from the Limbourg Kreide and described as Siphonaria antiqua Beetcher (1873, p. 60), a designation later accepted by Kaunby (1898, p. 118). Holzapfel (1888, p. 74) later described a highly ribbed form from the Aachener Kreide as Siphonaria variabilis. In neither of the above species can one be sure of the musculature, but one cannot deny that the musculature of the form described as Anisomyxon weissi Wade is not that of an Anisomyxon but is typical of Siphonaria. The third species is Siphonaria lessoni form pampa von Hering (1914) from Argentina. Hubendick (1943, p. 74) casts doubt upon the validity of placing the two European species mentioned above in Siphonaria but accepts the Argentine species as the oldest verified species assignable to the genus. Siphonaria weissi (Wade) discussed as follows may be somewhat older.

Siphonaria weissi (Wade)
Plate 52, figures 3, 4
1926. Anisomyxon weissi Wade, U.S. Geol. Survey Prof. Pa-

322 CRETACEOUS GASTROPODS IN TENNESSEE AND MISSISSIPPI
**Diagnosis.**—Shell ovate, low in profile, with a virtually smooth surface save for concentric growth lines that wrinkle the surface.

**Measurements.**—The holotype measures 17 mm in length; 14.5 mm in width, and about 5 mm in height (Wade, 1926).

**Discussion.**—Wade described this species entirely upon the basis of its external features. Careful cleaning of the interior of this fragile shell has brought to light a muscle scar band that is interrupted at the upper right (pl. 52, fig. 4) in the manner of *Siphonaria*. On the exterior of the shell the position of this interruption is marked by a very faint impressed radiating line.

**Types:** Holotype USNM 73100.

**Occurrence:** Tennessee: Ripley Formation at loc. 1.

**Genus ANISOMYON** Meek and Hayden, 1860a

Type by subsequent designation, (Meek and Hayden, 1860b) *Helcion patelliformis* Meek and Hayden, 1857.

**Diagnosis.**—Medium-sized thin asymetrically conical patelliform shells; surface generally smooth except for concentric growth lines and occasionally faint radiating ribs. Apex subcentral, curved backwards. Muscle scars horseshoe shaped, interrupted on the left anterior and occasionally broken to intermittent patches of attachment on the right posterior.

**Discussion.**—The taxonomic position of *Anisomyon* has puzzled most paleontologists, but generally it is placed in the Siphonaridae. It is distinguished from *Siphonaria* by the band of muscle attachment being interrupted on the left anterior instead of the right and by the occasional interruption of that band on the right posterior.

The genus is well represented in the Upper Cretaceous especially in the western interior. Stephenson (1941, p. 396) described two species from the Nacatoch Sand of Texas that appear, on the basis of apex character and shape, to belong to *Anisomyon*, but the musculature is unknown. Other species have been described from California and the western interior from as low in the Cretaceous as the Comanche, but one may question these assignments on the basis of inadequate information, as without muscle scar information, generic assignment is uncertain.

**Anisomyon** sp.

Plate 52, figure 12

**Discussion.**—Three specimens collected from the Owl Creek Formation on Owl Creek in Mississippi may be the only representatives of the genus in the eastern part of the Gulf Coastal Plain. The specimens are all incomplete or compressed and are difficult to compare with other described species, but they possess a rather smooth shell surface with only a faint suggestion of radiating ribs. In addition, one specimen exhibits several thin impressed lines similar to those to be found on *A. centrale* Meek or some specimens of *A. borealis* (Morton).

**Type:** Figured specimen USNM 130663.

**Occurrence:** Mississippi: Owl Creek Formation at loc. 46.

**LOCALITY REGISTER**

(See Sohl, 1961, p. 27-46, for a full description of localities)

**Locality:**

1. Coon Creek Tongue (*E. cancellata* zone). Bluffs and bed of Coon Creek on the former Dave Weeks' place, one third of a mile east of T-road intersection (bench mark N. 192), 1/4 mile south of Enville, 7/4 miles north of Adamsville, and 2 1/4 miles northeast of Leawood, McNairy County, Tenn. USGS 10198, Bruce Wade, 1917; USGS 10551, G. A. Cooper, H. D. Miser, and R. D. Medler, 1933; USGS 25406, N. F. Sohl, 1950-53.

2. Coon Creek Tongue (post *E. cancellata*). Cut of the Southern Railway, half a mile northwest of station at Wenassau, Atoka County, Miss. SW1/4, NW1/4 sec. 17; T. 1 S., R. 7 E. USGS 3577, L. W. Stephenson, 1910; USGS 17294, L. W. Stephenson and W. H. Monroe, 1916.


4. Coon Creek Tongue, Bluff of Cox (Davis') Branch of Big Hatchie Creek, Tippah County, Miss., SE1/4 sec. 10, T. 5 S., R. 5 E. USGS 543 and 606, L. C. Johnson, 1888.


6. Coon Creek Tongue. Roadcut on northeast-facing slope of Hall Creek, a tributary of Talahatchie River, 2.5 miles (airline) southwest of Dumas, Tippah County, Miss., center SW1/4, NW1/4 sec. 34, T. 5 S., R. 4 E. USGS 25407, N. F. Sohl, 1950-52.

7. Coon Creek Tongue. W. O. Kelly farm, probably in bluffs of Pickens Creek just south of house, 2.3 miles south of Dumas, Tippah County, Miss., NE1/4 sec. 35, T. 5 S. R. 4 E. USGS 700, T. W. Stanton, 1909.


9. 9a Chiwawa Member. Landers' millsite on Cane Creek, 5.75 miles east of Dumas, Tippah County, Miss., SE1/4 sec. 24, T. 5 S., R. 3 E. USGS 714, T. W. Stanton, 1889(9); USGS 23346, N. F. Sohl and H. L. Saunders, 1956; (9a).

10. Coon Creek (?) Tongue DeG's Bluff on Mooney's Branch of Big Hatchie Creek, Tippah County, Miss. USGS 548, L. C. Johnson, 1888.
Locality
11. Chiwawa Member. Head of ravine, underpass and roadcut 100 ft north of y-road fork, 0.75 mile south of Dumas, Tippah County, Miss., center of eastern ridges of SE\(^4\) sec. 24, T. 5 S., R. 4 E. USGS 25416, N. F. Sohl, 1950-51.
13. Coon Creek Tongue Bluff on North Branch of Wittie Creek, 3 miles south of Molino and 0.8 mile south of Mount Olivet School, Union County, Miss., NW\(^4\) sec. 21, T. 6 S., R. 4 E. USGS 712, T. W. Stanton, 1890.
15. Coon Tongue Tongue. Lee’s old millsite, roadcut on northwest-facing slope of Tallahatchie River valley, 2 miles north-northeast of Keoweeville, Union County, Miss. NW\(^4\)NE\(^4\) sec. 17, T. 6 S., R. 4 E. USGS 25408, N. F. Sohl, 1950-52.
16. Coon Tongue Tongue. Locality as above, but from a higher level. USGS 25409, N. F. Sohl, 1950-52.
17. Coon Tongue Tongue. Roadcut on east-facing slope of Hall Branch, 0.9 mile west of Molino, Union County, Miss., SW\(^4\)NE\(^4\) sec. 8, T. 6 S., R. 4 E. USGS 25410, N. F. Sohl, 1950-52.
19. Coon Tongue Tongue. Ravine east of Union County Lake, about one-third of a mile east of loc. 18, Union County, Miss. NW\(^4\)NW\(^4\)NE\(^4\) sec. 12, T. 6 S., R. 4 E. USGS 25412, N. F. Sohl, 1950.
20. Coon Tongue Tongue. Roadcut on Mississippi State Route 30, 3 miles east of Pleasant Ridge School on east-facing slope of Sweden Hill at Graham, Union County, Miss. NE\(^4\) sec. 21, T. 6 S., R. 5 E. USGS 25413, N. F. Sohl, 1950.
21. Coon Tongue Tongue. Roadcut on old Mississippi State Route 30, 4 miles east of Pleasant Ridge School on east-facing slope of Little Camp Creek, Union County, Miss. NW\(^4\)SW\(^4\)NE\(^4\) sec. 21, T. 6 S., R. 5 E. USGS 25414, N. F. Sohl, 1950.
22. Coon Tongue Tongue. Roadcut on new Mississippi State Route 30 on east-facing slope of Little Camp Creek. 0.8 mile east of Graham Road intersection, Union County, Miss. SW\(^4\)SW\(^4\)NE\(^4\) sec. 21, T. 6 S., R. 5 E. USGS 25587, L. W. Stephenson and N. F. Sohl, 1955.
23. Coon Tongue Tongue. Roadcut on new Mississippi State Route 30, east slope of Sweden Hill, 0.45 mile northeast of Graham, Union County, Miss. NW\(^4\)NE\(^4\)NW\(^4\) sec. 29, T. 6 S., R. 5 E. USGS 25494, L. W. Stephenson and N. F. Sohl, 1955.
Locality
27. Sands of the upper part of the Ripley Formation. Small bluff below bridge of St. Louis-San Francisco Railway over East Branch of Okannahatchie Creek, 2.5 miles east-northeast of Blue Springs, Union County, Miss., center E\(^3\) sec. 5, T. 8 S., R. 3 E. USGS 8506, L. W. Stephenson, 1915; USGS 25415, N. F. Sohl, 1951.
28. Sands of the upper part of the Ripley Formation. Roadcut on Mississippi State Route 30, on the north-facing slope of Willow Creek valley about 0.7 mile south of Keoweeville, Union County, Miss. (about 130 ft below the base of the Prairie Bluff). SE\(^4\)SW\(^4\)NE\(^4\) sec. 30, T. 8 S., R. 4 E. USGS 25491, L. W. Stephenson and N. F. Sohl, 1955.
29. Sands of the upper part of the Ripley Formation. Locality as above but about 117 ft below the base of the Prairie Bluff Chalk. USGS 25485, L. W. Stephenson and N. F. Sohl, 1955.
30. Chiwawa Member. Locality as above but about 45 ft below the base of the Prairie Bluff Chalk. USGS 25492, L. W. Stephenson and N. F. Sohl, 1955.
33. Limestone of the lower part of the Ripley Formation. Roadcut on the west wall of Tallabulana Creek, 0.25 mile east of Troy, Pontotoc County, Miss., NE\(^4\)NE\(^4\) sec. 21, T. 11 S., R. 4 E. USGS 6471, L. W. Stephenson, 1909; USGS 18028, W. H. Monroe, 1941; USGS 25417, N. F. Sohl, 1951.
35. Chiwawa Member. Pit of the Mississippi Minerals Co., 3.4 miles northeast of Pontotoc, Pontotoc County, Miss., NE\(^4\)NW\(^4\) sec. 23, T. 9 S., R. 3 E. USGS 18881, L. W. Stephenson, 1942.
36. Limestone of the lower part of the Ripley Formation. Roadcut overlooking Bob Miller Creek on the old Tupelo Road, 5 miles east of Pontotoc, Pontotoc County, Miss. NE\(^4\) sec. 6, T. 10 S., R. 4 E. USGS 19096, W. H. Monroe, 1940.
Locality

37. Chilwapa (?) Member Pontotoc-Aberdeen road, 6 miles southeast of Pontotoc County, Miss. USGS 6359, L. W. Stephenson, 1908.

38. Chilwapa Member. Roadcuts on an east-facing slope of new Mississippi State Route 6, 3.5 miles, east of Pontotoc. Pontotoc County, Miss. NE½ SW¼ sec. 33, T. 9 S., R. 3 E. USGS 25418 N. F. Sohl, 1951-53.

39. Chilwapa Member. Roadcuts on old Mississippi State Route 3, about 4.7 miles west of Buena Vista, on west-facing slope of a tributary of Houka Creek, Chickasaw County, Miss. SE¼ sec. 6, T. 14 S., R. 4 E. USGS 25419, N. F. Sohl, 1952.

LOCALITIES IN THE OWL CREEK FORMATION

40. Clayton Formation, basal beds containing reworked Cretaceous fossils. Roadcut on Tennessee State Route 57, on west-facing slope of Muddy Creek valley, near Triman's old mill site, 3.3 miles east of the road junction that is 1.5 miles south of Middleton, Hardeman County, Tenn. USGS 25420, N. F. Sohl, 1951-53.


42. Roadcuts on Bradock's farm on south-facing slopes of Walnut Creek valley, 3.75 miles east-southeast of Faulkner, Tippah County, Miss. NE¼ SE¼ SE¼ sec. 16, T. 3 S., R. 4 E. USGS 713, T. W. Stanton, 1889; USGS 25421, N. F. Sohl, 1950-51.


44. Place of Charles Alexander on White Oak Creek, 5¼ miles northeast of Tippah, Tippah County, Miss., center sec. 33, T. 3 S., R. 4 E. USGS 6975, L. W. Stephenson, 1916.

45. Roadcuts on north-facing slope of a tributary of Fourth Creek, 0.9 mile north of Providence School, Tippah County, Miss., NE¼ NW¼ sec. 27, T. 2 S., R. 4 E. USGS 25422, N. F. Sohl, 1950-51.


47. Roadcut and excavation for underpass at head of southeast-facing ravine on Dumas-Pleasant Ridge Road, 0.8 mile south of Dumas, Tippah County, Miss. Center of eastern edge of SE¼ sec. 24, T. 5 S., R. 4 E. USGS 25424, N. F. Sohl, 1950-51.

48. Owl Creek Formation or Prairie Bluff Chalk. Bed of small stream 100 yd above the crossing of the old Pontotoc road just north of the corporate limits of New Albany, Union County, Miss., probably SW¼ SW¼ sec. 8, R. 3 E., T. 7 S. USGS 8308, E. N. Lowe and C. W. Cooke, 1912.

49. Clayton Formation and basal beds with reworked Cretaceous fossils. Roadcut on Mississippi State Route 15 on north-facing slope of King's Creek Valley, Union County, Miss., NW¼ NW¼ sec. 29, T. 7 S., R. 3 E. USGS 29068, N. F. Sohl, 1949-53.

50. Owl Creek Formation or Prairie Bluff Chalk. Roadcut on new Albany-Ecura road, 3 miles south of New Albany on the north-facing slope of Kings Creek valley, Union County, Miss. USGS 6752, L. W. Stephenson, 1910.

51. Gullies north and south of the St. Louis-San Francisco Railway, just northwest of the station at Wallerville, Union County, Miss. NE¼ SE¼ sec. 29, T. 8 S., R. 3 E. USGS 0560, L. W. Stephenson, 1910.

52. Owl Creek Formation or Prairie Bluff Chalk. Roadcut on old Pontotoc-Houston Road, ¼-⅔ of a mile south of Pontotoc, Pontotoc County, Miss. USGS 6470, L. W. Stephenson, 1909.

LOCALITIES IN THE OWL CREEK FORMATION

53. Same locality as 47 and overlies that unit. Tippah County, Miss. USGS 25488, L. W. Stephenson and N. F. Sohl, 1935.

54. Roadcut on Mississippi State Route 30, 3.3 miles east-northeast of the junction of State Route 15, 0.3 mile east of Baker crossings, Union County, Miss. SE¼ NE¼ NW¼ sec. 1, T. 7 S., R. 3 E. USGS 25516, L. W. Stephenson and N. F. Sohl, 1935.

55. Roadcut on Mississippi State Route 30, 4.9 miles east-northeast of the junction with State Route 15, 2.8 miles (airline) south of Keoweeville crossings, Union County, Miss. SE¼ SW¼ SE¼ sec. 31, T. 7 S., R. 4 E. USGS 25488, L. W. Stephenson and N. F. Sohl, 1935.

56. Roadcuts on the new Mississippi State Route 6, 3.5 miles east of Pontotoc, Pontotoc County, Miss. NE¼ SW¼ sec. 33, T. 9 S., R. 3 E. Collector: USGS 25425, N. F. Sohl, 1951-53.

57. Roadcuts 5 miles east of Pontotoc on the old Tupelo road, 50-60 ft above Bob Miller Creek, Pontotoc County, Miss. USGS 19083, W. H. Monroe, 1938.

58. Exposure along the right bank of a small creek ¼-¼ mile south of the Mobile, Jackson, and Kansas City Railroad (now Gulf, Mobile, and Ohio Railroad) station at Pontotoc, Pontotoc County, Miss. USGS 6852, L. W. Stephenson, 1910.

59. Cut on the Gulf, Mobile, and Ohio Railroad half a mile south of Pontotoc, Pontotoc County, Miss. USGS 6854, L. W. Stephenson, 1910.

60. Roadcuts on Mississippi State Route 15, 2 miles south of Pontotoc on the north-facing slope of Chilwapa Creek valley, Pontotoc County, Miss. NW¼ NW¼ sec. 16, and NE¼ NE¼ sec. 17, T. 10 S., R. 3 E. USGS 25436, N. F. Sohl, 1951.

61. Roadcut 0.4 mile east of Mississippi Route 15, 2 miles north of old Houka, Chickasaw County, Miss., NW¼ sec. 4, T. 12 S., R. 3 E. USGS 19064, L. W. Stephenson and W. H. Monroe, 1938.

62. Roadcut 2.25 miles (airline) northeast of Houka, Chickasaw County, Miss., NW¼ sec. 4, T. 12 S., R. 3 E. USGS 25427, N. F. Sohl, 1951.

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Locality

65. Washes in a field just northwest of the abandoned Gulf, Mobile, and Ohio Railroad track, 1.25 miles northeast of Houston, Chickasaw County, Miss. USGS 6489, L. W. Stephenson, 1910.

66. Bluffs of Houka Creek, 0.5 mile (? east of Houston, Chickasaw County, Miss. USGS 612, T. W. Stanton, 1889.

67. East-facing slope of Houka Creek about 1.25 miles east of the Court House at Houston, Chickasaw County, Miss. USGS 8206, E. N. Lowe and C. W. Cooke, 1912.

68. Roadcut on east-facing slope of Sockatoumah Creek (Houka Creek?) on the Houston-Bruena Vista (old Mississippi Route 8), 2 miles east of Houston, Chickasaw County, Miss. 8 3/4 sec. 2, T. 14 S., R. 3 E. USGS 6473, L. W. Stephenson, 1909.

69. Clayton Formation, basal beds containing reworked Cretaceous fossils. Cut on the Gulf, Mobile, and Ohio Railroad, 1 mile south of Houston, Chickasaw County, Miss. USGS 4039, A. F. Crider, 1907.

70. Roadcut on Mississippi State Route 15, 1.5 miles south of Houston, Chickasaw County, Miss. USGS 6474, L. W. Stephenson, 1910.

71. Roadcuts and bold spots on north-facing slopes of Cane Creek valley, just 100-250 yd east of Mississippi State Route 389 and 1.4 miles north of Sparta, Chickasaw County, Miss. SW 1/4 NW 1/4 sec. 10, T. 15 S., R. 3 E. USGS 25429, N. F. Sohl, 1951-52.

72. Roadcut 5.9 miles (airline) north-northeast of Montpelier, Clay County, Miss., NW 1/4 sec. 8, T. 15 S., R. 4 E. USGS 25429, N. F. Sohl, 1951.

73. Roadcut on north-facing slope of a tributary of Standing Reed Creek, 2.5 miles east-northeast of Montpelier, Clay County, Miss., NE 1/4 SW 1/4 sec. 32, T. 15 S., R. 4 E. USGS 25430, N. F. Sohl, 1951.

74. Roadcut and gullies on a hillside slope east of a tributary of Standing Reed Creek, 1.5 miles northeast of Montpelier, Clay County, Miss., sec. 5, T. 16 S., R. 4 E. USGS 25431, N. F. Sohl, 1951.

75. Roadcut east and bed of Buck creek, 2.6 miles (airline) east of Montpelier, Clay County, Miss., N 3/4 sec. 5, T. 16 S., R. 4 E. USGS 25432, N. F. Sohl, 1951.

76. Roadcuts 2.7 miles (airline) west of Caradine store, Clay County, Miss., SW 1/4 sec. 8, T. 15 S., R. 4 E. USGS 17229, L. W. Stephenson and W. H. Monroe, 1936.

77. Roadcut 2.7 miles south-southwest of Montpelier, Clay County, Miss., NW 1/4 SW 1/4 sec. 14, T. 16 S., R. 3 E. USGS 25433, N. F. Sohl, 1951.

78. Roadcut on Montpelier road, 4.5 miles northeast of Cedar Bluff, Clay County, Miss. USGS 6861, L. W. Stephenson, 1910.


80. Gullies and bold spots on north-west facing slope of Trim Cane Creek valley, south of county routes E and UN, 4.3 miles (airline) northwest of Starkville, Oktibbeha County, Miss. NW 1/4 NW 1/4 sec. 16, T. 19 N., R. 14 E. USGS 25434, N. F. Sohl, 1951.

81. Gullies on the Aikin farm about 2.3 miles north of Starkville, Oktibbeha County, Miss. USGS 6845, L. W. Stephenson, 1910.

Locality

82. Bald spots in fields adjacent to but west of road, 2.5 miles north of Starkville, Oktibbeha County, Miss., NW 1/4 sec. 23, T. 19 N., R. 14 E. USGS 25435, N. F. Sohl, 1951.

83. Roadcut at crossroads 2.7 miles (airline) north of Starkville, Oktibbeha County, Miss. NW 1/4 SW 1/4 NW 1/4 sec. 14, T. 14 N., R. 14 E. USGS 25436, N. F. Sohl, 1951.

84. Gullies near Starkville-Osborn road about 3 miles north-east of Starkville, Oktibbeha County, Miss. USGS 6846, L. W. Stephenson, 1910.

85. Roadcut half of a mile north of Rocky Hill Church, about 5 miles (airline) north of Starkville, Oktibbeha County, Miss., NW 1/4 NE 1/4 sec. 11, T. 19 N., R. 14 E. USGS 25437, N. F. Sohl, 1951.

86. Roadcut 1.5 miles east of Mississippi State College at Starkville, Oktibbeha County, Miss. USGS 405, L. C. Johnson, 1889.

87. Gullies on grounds of Mississippi State College at Starkville, Oktibbeha County, Miss. USGS 3188, A. F. Crider, 1903; USGS 6843, W. N. Logan, 1910; USGS 6844, L. W. Stephenson, 1910.

88. Bald spots at rural road intersection just north of Salen Church, 6.7 miles (airline) south-east of Starkville, Oktibbeha County, Miss., SE 1/4 NE 1/4 sec. 32, T. 15 N., R. 15 E. USGS 25438, N. F. Sohl, 1951.

89. Bluff on Nuxee River 1 mile (airline) west of Horse Creek bridge. Nuxee County, Miss. SW 1/4 SW 1/4 NW 1/4 sec. 16, T. 15 N., R. 16 E. USGS 17241, W. H. Monroe, 1930.


91. Cuts on U.S. Highway 45, 0.6 mile south of Running Water Creek, 5 miles due south of the Nuxee River bridge in Macon, Nuxee County, Miss. USGS 6479, L. W. Stephenson, 1909; USGS 17210, L. W. Stephenson and W. H. Monroe, 1930.


95. Lacy-For Rd, 3,000 ft south of State road to Gainesville and 2.5 miles east of Scooba, Kemper County, Miss. USGS 6825, C. W. Cooke, 1912.

96. Scooba-Giles Road 3 miles east of Scooba, Kemper County, Miss. USGS 6825, L. W. Stephenson, 1910.

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PLATES 19–52
**PLATE 19**

**Figures 1, 5.** *Echophora proquadricostata* Wade (p. 173).
Front and back views of a specimen (× 5) from the Ripley Formation at loc. 6. USGS 25407, USNM 130195.

2–4, 6, 8, 10. *Paramorella latata* Wade (p. 179).
2, 4. Front and back views of a toptype (× 4) from the Ripley Formation at loc. 1. USGS 25406; USNM 130209.
3, 8. Front and back views of a toptype (× 4) from the same locality. USGS 25406, USNM 130210.
6, 10. Back and front views of a toptype (× 4) from the same locality that preserves the features of the outer lip. USGS 25406, USNM 130208.

7, 9. Top and back views of a specimen (× 3) from the Ripley at loc. 18 showing the shell at an immature stage of development. USGS 25411, USNM 130190.
11, 12. Back and front views of a specimen (× 2) from the Ripley Formation at loc. 1. USGS 25407, USNM 130194.
13, 18, 22. Apical, back, and front views of a specimen (× 3) from the Ripley Formation at loc. 18. USGS 25411, USNM 130187.
14–16. Back, apical, and front views of a specimen (× 1) from the same locality showing an exceptional number of spiral cords. USGS 25411, USNM 130186.
17, 21, 25. Apical, back, and front views of a specimen (× 3) from the same locality. USGS 25411, USNM 130188.
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23, 24. Back and apical views of a specimen (× 3) from the Ripley Formation at loc. 18 showing early stages of sculpture development. USGS 25411, USNM 130189.
ECPHORA, PARAMOREA, SARGANA
FIGURES 1, 8. *Morea cosicanensis cosicanensis* Stephenson (p. 176).
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2, 3. *Morea reticulata* (Stephenson) (p. 175).
Front and back views of the holotype (× 3) from the Kemp Clay of Texas. USGS 7721, USNM 77020. (Type species of *Pinello* Stephenson).

4. Front view of an immature specimen (× 5) from the Ripley Formation at loc. 18. USGS 25411, USNM 130201.
5, 6. Back and front view of a specimen (× 3) from the Ripley Formation at loc. 16. USGS 25409, USNM 130200.
10. Back view of a specimen (× 2) from the Ripley Formation at loc. 5. USGS 708, USNM 20549.
19, 20. Front and back views of a specimen (× 2) from the Ripley Formation at loc. 18. USGS 25411, USNM 130202.
21, 22. Back and front views of a specimen (× 2) from the Ripley Formation at loc. 6 showing outer lip characters. USGS 25407, USNM 130204.
25, 26. Back and front views of a specimen (× 2) from the Ripley Formation at loc. 18. USGS 25411, USNM 130203.

Front and back views of a topotype (× 1) from the Ripley Formation in bluffs of the Chattahoochee River at Ensalla, Ala. USGS 279, USNM 21169.

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11, 12. *Morea rotunda* Sohl, n. sp. (p. 177).
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16, 18. *Morea* sp. (p. 179).
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17. *Moredia* sp. (p. 179).
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27, 28, 33, 34. Front, side, basal, and back views of a topotype (× 1½) from the Ripley Formation at loc. 1. USGS 10198, USNM 130213.
29, 30. Back and front views of an immature topotype (× 1½) from the same locality. USGS 16951, USNM 130212.

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11–13. Apical, back, and front views of a topotype (× 3) from the same locality. USGS 25406, USNM 130214.

Top, back, and front views of a specimen (× 1) from Dept. Molluscs, USNM 344199.

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15, 18. Front and apical views of a specimen (× 2) from the Ripley Formation at loc. 18. USGS 18616, USNM 130220.
20, 22, 25. Back, front, and apical views of a specimen (× 1½) from the Ripley Formation at loc. 18. USGS 25411, USNM 130218.

16, 17. Apical and front views of an internal mold (× 1) from the Prairie Bluff Chalk at loc. 82. USGS 25485, USNM 130222.
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24, 27. Lovenstania cucullata Sohl, n. sp. (p. 180).
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4, 5. *Buccinopsis solida solida* (Wade) (p. 189).
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6, 7. *Buccinopsis solida vulgata* Sohl, n. subsp. (p. 190).
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14, 15. *Stantonella subnodosa* Wade (p. 185).
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16, 17. Front and profile views of a toptype ($\times 1$) from the Owl Creek Formation at loc. 46. USGS 707, USNM 130228.

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14, 15. *Rhombopina malinoensis* Sohl (p. 199).
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4. Back view of a holotype (× 1) from the Owl Creek Formation at loc. 45. USGS 25422, USNM 130264.

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Back view of a specimen (× 1) from the Owl Creek Formation at loc. 46. USGS 707, USNM 130772.

14, 16. *Devesenia* sp. (p. 201).
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15, 18–20, 25, 26. *Bellifius angulicostatus* Sohl (p. 204).
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   6. Front view of an internal mold (× 2) from the Prairie Bluff Chalk at loc. 83, broken back to show the columnar features. USGS 6843, USNM 130285.
   7. Front view of an internal mold (× 1) from the Prairie Bluff Chalk at loc. 71. USGS 25428, USNM 130286.

   8. Back view of an internal mold (× 1) from the Prairie Bluff Chalk at loc. 57 with molds of *Clione* borings preserving surface sculpture. USGS 25425, USNM 130308.
   14. Back view of an internal mold (× 1) from the same locality. USGS 25455, USNM 130307.

9, 10, 16, 17. *Doliolatirus torquatus* Sohl, n. sp. (p. 209).

9, 10. Back and front views of a paratype (× 1½) from the Owl Creek Formation at loc. 46. USGS 707, USNM 130312.

11, 12, 13. *Bellifusus curvicostatus brevisculus* Sohl, n. subsp. (p. 203)
   11. Back view of a paratype (× 1) from the Owl Creek Formation at loc. 43. USGS 6463, USNM 130278.
   12. Back view of a paratype (× 1) from the Owl Creek Formation at loc. 46. USGS 707, USNM 130277.
   13. Back view of the holotype (× 1) from the same locality. USGS 707, USNM 130276.

   18. Back view of a hypotype (× 1½) from the Ripley Formation at loc. 6. USGS 25407, USNM 130271.
   23, 24. Back and front views of a hypotype (× 1½) from the Ripley Formation at loc. 6. USGS 25407, USNM 130272.

   20, 21. Front and back views of a topotype (× 1) from the Ripley Formation at loc. 1. USGS 25406, USNM 130306.
   22. Back view of a topotype (× 1) from the same locality. USGS 25406, USNM 130305.
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1. Back view of the holotype (× 1) from the Ripley Formation at Eufaula, Ala. AMNH 6060.
2. Back view of a specimen (× 1) from the Ripley Formation at loc. 6. USGS 25407, USNM 130294.
3. Back view of a specimen (× 1) from the same locality. USGS 25407, USNM 130297.
4. Back view of a specimen (× 1½) from the Ripley Formation at loc. 18. USGS 25411, USNM 130298.
5. Back view of a topotype (× 1) from the Ripley Formation at Eufaula, Ala. USGS 279, USNM 130299.
6. Front view of the holotype (× 1) of Turrilina (Chemnitzia) laqueata (Conrad) from the Ripley Formation of Tippah County, Miss. AMNH 9051.
7. Front view of a topotype (× 1) from the Ripley Formation at Eufaula, Ala. USGS 279, USNM 130203.
8–11, 25, 26. Drillata buboannus Sohl, n. sp. (p. 207).
8. Back and front views of a paratype (× 1) from the Owl Creek Formation at loc. 45. USGS 25422, USNM 130304.
9. Back view of a paratype (× 1) from the Owl Creek Formation at loc. 46. USGS 707, USNM 130302.
10. Front view of a paratype (× 1) from the same locality. USGS 25423, USNM 130303.
11. Back and front views of a specimen (× 1½) from the same locality. USGS 25407, USNM 130296.
12. Back and front views of a topotype (× 1) from the Ripley Formation at loc. 1. USGS 25406, USNM 130291.
13. Back view of a topotype (× 1) from the same locality. USGS 16951, USNM 130288.
14. Front view of a topotype (× 1) from the same locality. USGS 16951, USNM 130289.
15. Back view of a topotype (× 1) from the same locality. USGS 25406, USNM 130290.
16–19. Drillata lenniscata Sohl, n. sp. (p. 207).
16, 17. Back and front views of a paratype (× 1½) from the Owl Creek Formation at loc. 46. USGS 707, USNM 130300.
18, 19. Back and front views of the holotype (× 1) from the same locality. USGS 707, USNM 20428.
1, 2. Front and back views of a topotype (× 1½) from the Ripley Formation at loc. 1. USGS 25406, USNM 130314.
3, 4. Front and back views of a specimen (× 1½) from the Ripley Formation at loc. 18. USGS 25411, USNM 130315.
5. Back view of a topotype (× 1½) from the Ripley Formation at loc. 1. USGS 25406, USNM 130313.
6. Front view of a specimen (× 1½) from the Ripley Formation at loc. 18. USGS 25411, USNM 130316.

7, 8. Back and front view of the holotype (× 1½) from the Ripley Formation at loc. 18. USGS 25411, USNM 130317.
15. Front view of a paratype (× 3) from the same locality. USGS 25411, USNM 130318.
16. Back view of a paratype (× 3) from the same locality. USGS 25411, USNM 130319.

9. View of the holotype (× 3) from the Ripley Formation at loc. 1. USNM 32866.
17. Front view of the paratype (× 1) from the same locality. USNM 32866.

Back view of a specimen (× 1) from the Owl Creek Formation at loc. 45. USGS 25422, USNM 130347.

11, 12. Front and back views of a topotype (× 2) from the Ripley Formation at loc. 1. USGS 25406, USNM 130367.
13. Front view of a topotype (× 1½) from the same locality. USGS 16951, USNM 130366.
14. Back view of a topotype (× 2) from the same locality with the spire sectioned to show placement of columellar plications. USGS 25406, USNM 130368.

18. Back view of a specimen (× 1) from the Ripley Formation at loc. 6. USGS 25407, USNM 130346.
23. Front view of a specimen (× 3) from the Ripley Formation at loc. 18. USGS 25411, USNM 130344.
27. Front view of the holotype (× 1) from the Ripley Formation of Tippah County, Miss. AMNH 9050.
32, 33. Back and front views of a specimen (× 1) from the Ripley Formation at loc. 18. USGS 16629, USNM 130345.
34, 35. Back and front views of a specimen (× 1) from the same locality. USGS 25411, USNM 130343.

21. View of part of the spire of a topotype (× 2) from the same locality showing the placement of the columellar plait. USGS 25406, USNM 130139.
22, 30, 31. Enlarged segment of shell (× 3) showing sculpture and back and front views of a topotype (× 1) from the same locality. USGS 10198, USNM 130340.

24, 25. Back and front views of a specimen (× 3) from the Ripley Formation at loc. 18. USGS 25411, USNM 130341.
26. Front view of a specimen (× 3) from the Ripley Formation at the same locality. USGS 25411, USNM 130342.

Back and front views of the holotype (× 2) from the Ripley Formation at loc. 1. USNM 32891.
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1. Front view of an internal mold (× 1) from the Prairie Bluff Chalk at loc. 87. USGS 3186, USNM 130350.
2. Back view of an internal mold (× 1) from the Prairie Bluff Chalk at loc. 71. USGS 25428, USNM 130348.
3. Back view of an internal mold (× 1) from the Prairie Bluff Chalk at the same locality. USGS 25428, USNM 130349.

4–7. Ornopsis (Parnoidea) modesta Sohl, n. sp. (p. 218).
4, 5. Back and front views of the holotype (× 1½) from the Ripley Formation at loc. 6. USGS 25407, USNM 130362.
6, 7. Front and back views of a paratype (× 1½) from the Ripley Formation at loc. 5. USGS 708, USNM 20545.

8–10, 15, 16. Ornopsis (Ornopsis) glenni Wade (p. 215).
8–10. Back, side, and front views of a topotype (× 1) from the Ripley Formation at loc. 1. USGS 10158, USNM 130355.
15, 16. Front and back views of a topotype (× 1) from the Ripley Formation at loc. 1. USGS 16954, USNM 130354.

11, 17. Ornopsis (Parnoidea) sp. (p. 219).
Front and back views of an internal mold (× 1½) from the Prairie Bluff Chalk at loc. 11. USGS 25428, USNM 130364.

12. Front view of a specimen (× 1½) from the Ripley Formation at loc. 18. USGS 25411, USNM 130359.
14. Front view of a topotype (× 1½) from the Ripley Formation at loc. 1. USGS 25411, USNM 130361.

Back view of an internal mold (× 1½) from the Prairie Bluff Chalk at loc. 11. USGS 25428, USNM 130353.

19. Ornopsis (Parnoidea) modesta lacus Sohl, n, subsp. (p. 219).
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20–21, 26, 27. Pectechilus curviflatus (Conrad) (p. 216).
20, 21. Front and back views of a topotype (× 2) from the Owl Creek Formation at loc. 46. USGS 707, USNM 130352.
26, 27. Back and front views of a specimen (× 2) from the Providence Sand at the mouth of Patsaua Creek, Clay County, Ga. USGS 855, USNM 130351.

22–25. Ornopsis (Ripleyella) elevata Wade (p. 216).
22, 25. Front and back views of a specimen (× 2) from the Ripley Formation at loc. 16. USGS 25409, USNM 130356.
24. View of the apex of the same specimen (× 10).
23. Back view of a specimen (× 1) from the Ripley Formation at loc. 6. USGS 25407, USNM 130357.
1. Front view of the holotype (× 1 1/2) from the Owl Creek Formation at loc. 46. USGS 25423, USNM 130373.
2, 3. Front and back views of a paratype (× 1) from the same locality. USGS 25423, USNM 130374.
4, 5. Back and back front of a paratype from the Clayton Formation at loc. 40. USGS 25420, USNM 130375.

6, 7. *Latusus keoveniillensis* Sohl, n. sp. (p. 220).
Front and back views of the holotype (× 2) from the Ripley Formation of Union County, Miss. USGS 25507, USNM 130365.

8, 9. Front and back views of a specimen (× 1 1/2) from the Ripley Formation at loc. 16. USGS 25409, USNM 130372.
10. Back view of a specimen (× 2 1/2) from the Ripley Formation at loc. 17. USGS 25410, USNM 130371.
13, 14. Front and back views of a specimen (× 1) from the Ripley Formation at loc. 18. USGS 25411, USNM 130370.
15, 16. Front and back views of a specimen (× 1) from the same locality. USGS 25411, USNM 130369.

Back and front views of a topotype (× 1 1/2) from the Ripley Formation at loc. 1. USGS 25406, USNM 130376.

17, 18. Back and front views of a paratype (× 1 1/2) from the Ripley Formation at loc. 18. USGS 25411, USNM 130380.
19, 20. Back and front views of the holotype (× 1 1/2) from the Ripley Formation at loc. 5. USGS 705, USNM 130379.
23, 24. Front and back views of a paratype (× 1 1/2) from the Ripley Formation at loc. 18. USGS 25411, USNM 130381.

21. Back view of a topotype (× 1 1/2) from the Ripley Formation at loc. 1. USGS 25406, USNM 130377.
25, 26. Front and back views of a topotype (× 1 1/2) from the same locality. USGS 10198, USNM 130378.

22. *Hercorhyncus (Haplooolata) quadriliratus* Sohl, n. sp. (p. 224).
Back view of the holotype (× 1 1/2) from the Owl Creek Formation at loc. 46. USGS 707, USNM 130384.
1. Back view of a toptype (× 2) from the Ripley Formation at loc. 1. USGS 25406, USNM 130397.
2. Back view of a toptype (× 2) from the Ripley Formation same locality. USGS 25406, USNM 130398.
3. Front view of a toptype (× 1) from the same locality. USGS 10198, USNM 130400.
4. Back view of a toptype (× 1) from the same locality USNM 130399.

5, 6. Front and back views of the holotype (× 2) from the Ripley Formation at loc. 6. USGS 25407, USNM 130405.

7. Back view of the holotype (× 2) from the Owl Creek Formation at loc. 46. USGS 25423, USNM 130407.
8. Back view of a paratype (× 4) from the same locality. USGS 25423, USNM 130408.
11, 12. Front and back views of a paratype (× 2) from the same locality. USGS 707, USNM 130725.
13. Back view of a paratype (× 2) from the same locality. USGS 707, USNM 130724.

9, 10, 14, 15. *Anomalofusus* sp. (p. 231).
9, 10. Front and back views of a specimen (× 1½) from the Prairie Bluff Chalk at loc. 87. USGS 6843, USNM 130409.
14, 15. Front and back views of a specimen (× 1½) from the Prairie Bluff Chalk at loc. 66. USGS 612, USNM 130410.

16. View of a specimen (× 2) from the Ripley Formation at loc. 18. USGS 25411, USNM 130395.

17, 18. Back and front views of a toptype (× 2) from the Ripley Formation at loc. 18. USGS 25411, USNM 130391.
22, 23. Front and back views (× 2) from the Ripley Formation at loc. 6. USGS 25407, USNM 130390.

20. Back view of the holotype (× 2) from the Owl Creek Formation at loc. 46. USGS 707, USNM 130392.
21. Back view of a paratype (× 2) from the same locality. USGS 707, USNM 130393.

24, 25. Back and front views of a specimen (× 4) from the Ripley Formation at loc. 6. USGS 25407, USNM 130396.
26. View of the holotype (× 2½) from the Ripley Formation at loc. 1. USNM 32880.

27, 28. Views of the holotype (× 2) from the Ripley Formation at loc. 1. USNM 32886.

29, 30. Back and front views of the holotype (× 1) from the Ripley Formation at loc. 1. USNM 32892.

31, 32. Back and front views of a toptype (× 2) from the Ripley Formation at loc. 1. USGS 25406, USNM 130386.

33. Back view of a toptype (× 2½) from the Ripley Formation at loc. 1. USGS 10198, USNM 130387.
34. Back view of a toptype (× 2½) from the same locality. USGS 10198, USNM 130388.
35, 36. Back and front views of the holotype (× 2½) from the same locality. USNM 32889.
ANOMALOFUSUS, REMERA, FUSINUS, EUTHROFUSUS, WOODSELLA, BOLTENELLA
Figure 1. *Pyropis* sp. D (p. 231).
   Back view of an internal mold (×1) from the Prairie Bluff Chalk at loc. 71. USGS 25428, USNM 130438.
2, 3. *Cryptorhysis* nobilis Wade (p. 231).
   2. Front view of a topotype (× 1½) from the Ripley Formation at loc. 1. USGS 10198, USNM 130411.
   3. Back view of a topotype (× 1½) from the same locality. USNM 130412.
4, 5. *Anomalofusus* sp. (p. 231).
   Front and back views of an internal mold (× 1½) from the Prairie Bluff Chalk of Noxubee County, Miss. USGS 10063.
   6. Back view of an internal mold (× 1) from the Prairie Bluff Chalk at loc. 71. USGS 25428, USNM 130439.
   12. Back view of an internal mold (× 1) from the Prairie Bluff Chalk at loc. 87, USGS 6843, USNM 130440.
   Back, front, top views of an internal mold (× 1) from the Prairie Bluff formation at loc. 82. USGS 25435, USNM 130439.
10, 11, 18, 19, 20. *Lupira pyriformis* Stephenason (p. 233).
   10. Back view (× 1) of a specimen from the Ripley Formation at loc. 7. USGS 709, USNM 130418.
   11. Front view of a specimen (× 1) from the Ripley Formation at loc. 18, sectioned to show the columellar plications. USGS 25411, USNM 130416.
   13, 19, 20. Back, side, and front views (× 1½) of a specimen from the Ripley Formation at loc. 18. USGS 25411, USNM 130417.
   14. Back view of a topotype (× 1) from the Ripley Formation at loc. 1. USGS 25406, USNM 130415.
   15, 16. Front and back views of a topotype (× 1) from the same locality. USGS 10198, USNM 130414.
24, 25. Front and back views of the holotype of *Xancus major* Wade- *Lupira variabilis* (Wade) from the same locality. USNM 32874a.
   17. Front view of an internal mold (× 1½) from the Prairie Bluff Chalk at loc. 71, broken to show the columellar pliciation. USGS 25428 USNM 130420.
   18. Back view of a paratype (× 1) from the Ripley Formation at loc. 1. USGS 16951, USNM 130419.
   22, 23. Back and front views of the holotype (× 1) from the same locality. USNM 32874B.
PYROPSIS, CRYPTORHYTIS, ANOMALOFUSUS, LUPIRA
PLATE 33

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1, 8, 11. Front, top, and back views of a specimen (× 1) from the Ripley Formation at loc. 16. USGS 25409, USNM 130421.
18. Back view of a specimen (× 1) from the Ripley Formation, 2.6 miles south of Pleasant Ridge Union County, Miss. USGS 26340, USNM 130423.
20. Enlargement (× 3) of the spire of a specimen from the Ripley Formation at loc. 15. USGS 25408, USNM 130422.

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3-5. *Pyropis interstriatus* (Wade) (p. 239).
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7, 10, 14. Front, top, and back views of the holotype (× 1) from the Ripley Formation at loc. 1.
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16, 22. Top view (× 3) and back view (× 1) of a paratype from the same locality. USGS 25406, USNM 130424.

Front view of the holotype (× 1) from the Fox Hills Formation of South Dakota. USNM 252.

12, 13, 17. *Pyropis proliva* Sohl, n. s. (p. 240).
12, 13. Back and front views (× 1) of the holotype from the Owl Creek Formation at loc. 46. USGS 707, USNM 130431.
17. Front view of a paratype (× 1) from the same locality. USGS 707, USNM 130433.


Back and front views of a topotype (× 1) from the Ripley Formation at loc. 1. USGS 25406, USNM 130428.
Back, front, and top views of a topotype (× 1) from the Ripley Formation at loc. 1. USGS 10198, USNM 130429.

2–4. Front, top, and back views of a topotype (× 1) from the Ripley Formation at loc. 1. USGS 16951, USNM 130430.
11, 13. Back and front views of a paratype (× 1) from the same locality. USNM 32962.

7, 9, 10. *Pyropis cornutus* Sohl, n. sp. (p. 237).
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3, 4. Views of the holotype (× 1) from the Providence Sand on Patula Creek, Ga. ANSP 15155.

5, 6. Front and back views of a specimen (× 1) from the Ripley Formation at loc. 6. USGS 25407, USNM 130455.


7. Back view of a topotype (× 1½) from the Owl Creek Formation at loc. 46. USGS 707, USNM 20413.

14. Back view of a specimen (× 1½) from the Owl Creek Formation at loc. 45. USNM 25422, USNM 130450.

8–11, 13, 15. *Napulus* sp. (p. 244).

8, 9. Front and back views of an internal mold (× 1½) from the Prairie Bluff Chalk at loc. 94. USGS 6489, USNM 130449.

10, 11. Back and front views of an internal mold (× 1½) from the Prairie Bluff Chalk at loc. 53. USNM 25488, USGS 130451.

13. Back view of an internal mold (× 3) the Prairie Bluff Chalk at loc. 57. USGS 25425, USNM 130453.

15. Back view of an internal mold (× 3) from the Prairie Bluff Chalk at loc. 71. USGS 25428, USNM 130452.


12. Back view of a paratype (× 1½) from the Ripley Formation at loc. 5. USGS 708, USNM 130447.

21–23. Front, back, and side view of the holotype (× 3) from the Ripley Formation at loc. 18. USGS 25411, USNM 130444.


16. Back view of a paratype (× 3) from the Ripley Formation at loc. 1. USGS 25406, USNM 130443.

17–19. Front, back, and side views of the holotype (× 1½) from the same locality. USNM 32966.

20. Back view of a paratype (× 3) from the same locality. USGS 10198, USNM 130441.

24. Front view of a paratype (× 3) from the same locality. USGS 10198, USNM 130442.
PLATE 36

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3, 10. Back and front views of a specimen (× 4) from the Owl Creek Formation at loc. 45. USGS 25422, USNM 130465.
4, 5. Front and back views of the holotype (× 4) from the Kemp Clay of Texas. USNM 77127.
6, 7. Back and front views of a specimen (× 3) from the Owl Creek Formation at loc. 46. USGS 707, USNM 130467.

8, 12. Fulgera attenuata Wade (p. 247).
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11. Front view of a specimen (× 5) from the Ripley Formation at loc. 6. USGS 25407, USNM 130464.
13–16. Front and back views of the holotype (× 1½) from the Ripley Formation at loc. 18. USGS 25411, USNM 130458.
15. Front view of a paratype (× 1½) from the Ripley Formation at loc. 18. USGS 25411, USNM 130459.
17, 21. Longicornea tennesseensis (Wade) (p. 251).
17. Front and back views of a topotype (× 1) from the Ripley Formation at loc. 1. USGS 10198, USNM 130473.
19, 20. Hydrotribulus nodosus Wade (p. 245).
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1, 2. Front and back views of the holotype (× 3) from the Ripley Formation at loc. 6. USGS 25407, USNM 130468.
3. Back view of a paratype (× 2) from the Ripley Formation at loc. 12. USGS 711, USNM 130470.
6, 7. Back and front views of a paratype (× 2) from the same locality. USGS 711, USNM 130469.
4. *Volutamorpha* sp. (p. 257).
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8, 9, 16. *Longocochea quadririrata* Sohl, n. sp. (p. 251).
8, 9. Front and back views of the holotype (× 1) from the Ripley Formation at loc. 18. USGS 25411, USNM 130475.
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10. Back view of an internal mold (× 1) from the Prairie Bluff Chalk at loc. 83. USGS 25436, USNM 130671.
11, 12. Back and front views of an internal mold (× 1) from the Prairie Bluff Chalk at loc. 94. USGS 6480, USNM 130672.
14. Front view of an internal mold (× 1) from the Prairie Bluff Chalk at loc. 87. USGS 6843, USNM 130670.
18. Back view of an internal mold (× 1) from the Prairie Bluff Chalk at loc. 82. USGS 25435, USNM 130669.
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21, 22. *Longocochea tennesseensis* (Wade) (p. 251).
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PALEOFUSIMITRA, MITRIDOMUS, LONGOCONCHA, VOLUTOMORPHA
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2–5, 8. *Volustomorpha valida* Sohl, n. sp. (p. 253).
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3, 5. Back and front views of a specimen (× 1) from the Ripley Formation on the Chattahoochee River at Eufaula, Ala. USNM 21127B.
9. Front view of the holotype (× 1) of *Volutomorpha liaica* Dall from the same locality. USNM 21127.

4. *Volutomorpha cf. V. retifera* Dall (p. 257).
View of an incomplete specimen (× 1) from the Owl Creek Formation at loc. 46. USGS 541, USNM 130689.

7, 11. *Volutomorpha valida* Sohl, n. sp. (p. 233).
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8, 10. *Volutomorpha gigantea* Wade (p. 256).
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1. Front view of an incomplete specimen (× 1) from the Ripley Formation at loc. 6. USGS 25407, USNM 130678.
2, 5. Back and front views of a specimen (× 1) from the Ripley Formation on the Chattahoochee River, 2 miles below Eufaula, Ala. USNM 130677.
3. *Volutomorpha retifera* Dall (p. 256).

Back view of a specimen (× 1) from the Ripley Formation at loc. 6. USGS 25407, USNM 130688.

Back view of the holotype (× 1) from the Ripley Formation at loc. 1. USNM 32856.

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5, 7. Front view of a rubber cast of an external mold and a front view of the corresponding internal model (× 1) from the Ripley Formation at loc. 29. USGS 25494, USNM 130687.
3, 4, 6. "Volutamorpha" aspera Dall (p. 257).
3, 4. Back and front views of the holotype (× 1) from the Owl Creek Formation at loc. 46. USNM 20404.
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13, 15. Back and front views of the holotype (× 1) from the same locality. USGS 25407, USNM 130691.

2-8, 12. Liopeplum leiodermum Conrad (p. 258).

2. Back view of a specimen (× 1) from the Ripley Formation at loc. 16. USGS 25409, USNM 130700.

3, 4. Back and front views of an immature specimen (× 2) from the Ripley Formation at loc. 17. USGS 25410, USNM 130699.

5, 6. Back and front views of a specimen (× 2) from the Ripley Formation at loc. 6. USGS 25407, USNM 130701.

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11, 14. "Volutomorpha" aspersa Dall (p. 257).

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6, 7. Back and front views of a specimen (× 1) from the Ripley Formation at loc. 17. USGS 25410, USNM 130698.

3. Back view of a specimen (× 1) from the Clayton Formation at loc. 40. USGS 25420, USNM 130707.
21, 22. Back and front views of a specimen (× 1) from the same locality. USGS 25420, USNM 130706.
24, 25. Front and back views of a topotype (× 1) from the Owl Creek Formation at loc. 46. USGS 25423, USNM 130705.

4, 5. Back and front views of a topotype (× 1) from the Owl Creek Formation at loc. 46. USGS 707, USNM 130704.
17, 18. Front and back views of a topotype (× 1) from the same locality. USGS 707, USNM 20437.
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9. Front view of a paratype (× 1) from the Ripley Formation at loc. 16. USGS 25409, USNM 130714.
10. Front view of a paratype (× 1) from the Ripley Formation, 2 miles below Eufaula, Ala. USNM 130713.
11, 12. Back and front views of a paratype (× 1) from the Ripley Formation at loc. 12. USGS 711, USNM 20437.
15. Back view of the holotype (× 1) from the Ripley Formation, 2 miles below Eufaula, Ala. USNM 130712.
16. Back view of a paratype (× 1) from the same locality. USNM 130711.

13, 14, 19, 20. *Liopeplum coronatum* Sohl, n. sp. (p. 262).
13. Back view of a topotype (× 1) from the Ripley Formation at loc. 1. USGS 25406, USNM 130709.
14. Front view of a topotype (× 1) from the same locality. USGS 10198, USNM 130710.
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3, 4. *Caveola* sp. (p. 270).
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5. Back view of a toptype (× 4) from the Ripley Formation at loc. 1. USGS 10198, USNM 130554.
6–8. Front, side, and back views of a toptype (× 2) from the same locality. USGS 10198, USNM 130494.
9, 10. Front and back views of a specimen (× 4) from the Ripley Formation at loc. 6. USGS 25407, USNM 130496.
11, 12. Front and back views of a paratype (× 4) from the Ripley Formation at loc. 18. USGS 25411, USNM 130726.
13, 14. Front and back views of the holotype (× 4) from the same locality. USGS 25411, USNM 130495.
15, 16. Front and back views of the holotype (× 2) from the Owl Creek Formation at loc. 46. USGS 6464, USNM 130482.
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Front view of the holotype (× 1) from the Ripley Formation at loc. 1. USNM 32877.
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25, 27. *Trigonostoma ripleyana* Sohl, n. sp. (p. 268).
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CANCELLARIA, CAVEOLA, MYOBARBUM, PARAFUSUS, TECTAPLICA, TRIGONOSTOMA
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4, 5. Front and back views of a toptype (× 5) from the same locality. USGS 10198, USNM 130515.
6, 7. Back and front views of the holotype (× 3) from the Ripley Formation at loc. 6. USGS 25407, USNM 130516.
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9. Back view of a paratype (× 5) from the same locality. USGS 25411, USNM 130518.
10. View of an incomplete paratype (× 4) from the Ripley Formation at loc. 18. USGS 25411, USNM 130523.
11. Back view of a paratype (× 4) from the Ripley Formation at loc. 18. USGS 25407, USNM 130520.
12, 13. Front and back views of the holotype (× 4) from the same locality. USGS 25407, USNM 130519.
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16–19. Amuleatum (Amuleatum) wadei Harbison (p. 277).
16, 17. Front and back views of the holotype (× 3) from the Ripley Formation at loc. 18. USNM 103750.
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19. Front view of a specimen (× 5) from the Ripley Formation at loc. 6. USGS 25406, USNM 130525.
20, 21. Front and back views of a toptype (× 1½) from the Ripley Formation at loc. 1. USGS 25406, USNM 130487.
22, 23. Front and back views of a toptype (× 2) from the same locality. USGS 25406, USNM 130488.
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29. Back view of a specimen (× 2) from the Ripley Formation at loc. 18. USGS 25411, USNM 130501.
30. Back view of a specimen (× 2) from the same locality. USGS 25411, USNM 130500.
31, 32. Back and front views of a specimen (× 2) from the same locality. USGS 25411, USNM 130503.
33. Back view of a specimen (× 2) from the same locality. USGS 25411, USNM 130504.
34. Back view of a specimen (× 2) from the same locality. USGS 25411, USNM 130502.
35. Front view of a toptype (× 5) from the Ripley Formation at loc. 7. USGS 706, USNM 130513.
36. Front view of a paratype (× 3) from the same locality. USGS 709, USNM 130511.
37. Front view of a paratype (× 3) from the same locality. USGS 709, USNM 130512.
38, 39. Back and front views of the holotype (× 4) from the same locality. USGS 25411, USNM 130506.
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AMULETUM, MATAXA, PALADMETE
PLATE 46

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3. Back view of a toptype (× 3) from the same locality. USGS 10198, USNM 130536.
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   7. Back view of a toptype (× 5) from the Ripley Formation at loc. 5. USGS 25406, USNM 130531.
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12. Back view of the holotype (× 4) from the Owl Creek Formation at loc. 46. USGS 25423, USNM 130533.
13. Back view of a paratype (× 4) from the Owl Creek Formation at loc. 45. USGS 25422, USNM 130534.
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15. 16. Front and back views of a specimen (× 1) from the Ripley Formation at loc. 6. USGS 25407, USNM 130538.
17. Back view of a specimen (× 2) from the same locality. USGS 25407, USNM 130539.
18. Back view of a specimen (× 1) from the Ripley Formation at loc. 6. USGS 25407, USNM 130540.
19. Front view of a toptype (× 1) from the Owl Creek Formation at loc. 46. USGS 707, USNM 130536.
20. View of a part of the spine of a toptype (× 1½) from the same locality. USGS 25423, USNM 130537.
22, 23. *Berreta speciosa* Sohl, n. sp. (p. 283).
22. Back and front views of the holotype (× 1½) from the Ripley Formation at loc. 1. USGS 10198, USNM 130541.
24, 25. *Fusimilis* sp. (p. 286).
24. Back and front views of an internal mold (× 1) from the Prairie Bluff Chalk at loc. 72. USGS 25429, USNM 132153.
26, 27, 34, 35. *Fusimilis proxima* (Wade) (p. 284).
27. Front view of the holotype (× 1) from the same locality. USNM 32847.
34, 35. Front and back views of a toptype (× 1) from the same locality. USGS 10198, USNM 130542.
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37, 38. Front and side views of a toptype (× 1) from the Owl Creek Formation at loc. 46. USGS 25423, USNM 20420.
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32, 33. Front and back view of a paratype (× 2) from the same locality. USGS 25411, USNM 130544.
39, 40. Front and back view of the holotype (× 1) from the Ripley Formation in bluffs of the Chattahoochee River at Eufaula, Ala. USNM 21166.
31, 36. *Fusimilis tippanus* (Conrad) (p. 286).
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PLATE 47

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Back and front views of the holotype (× 4) from the Ripley Formation at loc. 1. USNM 32832.

3, 4. *Eoacteon* sp. (p. 290).
Back and front views of an internal mold (× 2) from the Prairie Bluff Chalk at loc. 91. USGS 17210, USNM 130562.

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5. Section of a toptype (× 5) from the Owl Creek Formation at loc. 46, enlarged to show sculpture.
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12. Front view of a toptype (× 3) from the same locality. USGS 707, USNM 130559.

6, 7. Front and back views of a toptype (× 6) from the Ripley Formation at loc. 1. USGS 25406, USNM 130550.
8, 9. Front and back views of a toptype (× 6) from the same locality. USGS 25406, USNM 130551.

Front and back views of the holotype (× 3) from the Ripley Formation at loc. 1. USGS 32828.

Front view of the holotype from the Ripley Formation at loc. 1. USNM 32823.

16. Back view of the holotype (× 1½) from the same locality. USNM 32825.
21. Front view of a paratype (× 1) from the Ripley Formation at loc. 1. USNM 32825.

17, 18, 22. *Acteon cincticeps* Sohl, n. sp. (p. 285).
17, 18. Front and back views of the holotype (× 10) from the Ripley Formation at loc. 29. USGS 25485, USNM 130717.
22. Back view of a paratype (× 8) from the Owl Creek Formation at loc. 46. USGS 25423. USNM 130718.

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23. Front view of a toptype (× 6) from the same locality. USGS 25406, USNM 130565.
29. Back view of a specimen (× 6) from the Ripley Formation at loc. 22. USGS 26352, USNM 130567.
30. Front view of a specimen (× 6) from the same locality. USGS 26352, USNM 130566.
31, 32. Front and back views of a toptype (× 8) from the Ripley Formation at loc. 1. USGS 25406, USNM 130564.
33. Back view of a toptype (× 8) from the Ripley Formation at loc. 1. USGS 25406, USNM 130563.

24, 25. Front and back views of the holotype (× 10) from the Ripley Formation at loc. 1. USGS 10198, USNM 130555.
26. Back view of a paratype (× 10) from the Ripley Formation at loc. 6. USGS 25407, USNM 130558.
27. Back view of a paratype (× 10) from the Ripley Formation at loc. 1. USGS 25406, USNM 130556.
TORNATELLAEA, EOACTEON, CRYPTOCONUS, ACTEON, TROOSTELLA
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6, 7. Back and front views of a specimen (× 4) from the Ripley Formation at loc. 6. USGS 25407, USNM 130574.
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10, 11. Front and back views of a specimen (× 4) from the same locality. USGS 25409, USNM 130576.
12, 13. Front and back views of a specimen (× 4) from the Ripley Formation at loc. 5. USGS 542, USNM 130575.
14, 15. Front and back views of a specimen (× 4) from the Ripley Formation at loc. 6. USGS 25407, USNM 130573.
16, 17. Back and front views of a specimen (× 4) from the Ripley Formation at loc. 16. USGS 25409, USNM 130572.
3-5. *Parietipsiculatum cenicum* (Wade) (p. 299).
3, 4. Back and front views of a toptype (× 3) from the Ripley Formation at loc. 1. USGS 25406, USNM 130568.
5. Front view of a toptype (× 3) from the Ripley Formation at loc. 1. USGS 10198, USNM 130569.
18. Rubber impression of an external mold from the Ripley Formation at loc. 9a. USGS 26846, USNM 130581.
20, 21. Back and front views of the holotype (× 10) from the Ripley Formation at loc. 6. USGS 25407, USNM 130577.
22, 23. Back and front views of a paratype (× 10) from the same locality. USGS 25407, USNM 130579.
24. Front view of an aberrant specimen (× 10) from the same locality. USGS 25407, USNM 130580.
25, 26. Front and back view of a paratype (× 10) from the same locality. USGS 25407, USNM 130578.
27, 30-33. *Oligopttica americana* (Wade) (p. 296).
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30, 31. Front and back views of a toptype (× 8) from the same locality. USGS 25406, USNM 130583.
32, 33. Front and back views of a toptype (× 8) from the same locality. USGS 25406, USNM 130585.
28, 29, 36, 37. *Oligopttica corrugata* Sohl, n. sp. (p. 297).
28. Front view of a paratype (× 5) from the Ripley Formation at loc. 6. USGS 25407, USNM 130588.
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36, 37. Back and front views (× 5) of the holotype from the same locality. USGS 25411, USNM 130586.
34, 35. *Ellipsoscoapha mortoni* (Forbes)? (p. 295).
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8–12. Cylindrorthorax demersum Sohl (p. 302).
8, 9. Front and back views of the holotype (× 6) from the Ripley Formation at loc. 1. USGS 25406, USNM 130606.
10, 11. Front and back views of a paratype (× 6) from the same locality. USGS 25406, USNM 130607.
12. Apical view of a paratype (× 8) from the same locality. USGS 10198, USNM 130608.
13. Back view of a paratype (× 10) from the Ripley Formation at loc. 6. USGS 25407, USNM 130605.
14, 15. Front and back views of a paratype (× 10) from the Ripley Formation at the former site of Mercer’s Mill on Tabanzzee Creek, 0.2 miles above the crossing of the Central of Georgia R. R., south of Georgetown, Quitman County, Ga. USGS 25623, USNM 130614.
16, 17. Front and back views of the holotype (× 10) from the same locality. USGS 25623, USNM 130612.
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19. Front view of a specimen (× 7/5) from the Ripley Formation at loc. 6. USGS 25407, USNM 130599.
20, 21. Front and back views of a specimen (× 7/5) from the Ripley Formation at loc. 16. USGS 25409, USNM 130598.
28, 29. Front and back views of a paratype (× 7/5) from the Navarro Formation of Texas. USNM 16170a.
30, 31. Back and front views of a specimen (× 7/5) from the Ripley Formation at locality 29. USGS 25485, USNM 130600.
22, 23. Cyliclina intermedius Sohl, n. sp. (p. 300).
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25. Cyliclina intermedius curtus Sohl, n. subsp. (p. 301).
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26, 27. Cyliclina secundua Shumard (p. 299).
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32, 33, 37, 38. Gonocyliclina biaescutata Wade (p. 303).
32. Front view of the holotype (× 7) from the Ripley Formation at loc. 1. USNM 32837.
33. Front view of an immature specimen (× 10) from the Ripley Formation at loc. 29. USGS 25485, USNM 130611.
37, 38. Front and back views of a specimen from the Ripley Formation at loc. 16. USGS 25409, USNM 130610.
34–36. Cyliclina diversirrata Sohl, n. sp. (p. 299).
34, 35. Back and front views (× 4) of the holotype from the Ripley Formation at loc. 45. USGS 25422, USNM 130696.
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1, 2. Front and back views of a paratype (× 10) from the Ripley Formation at the site of Mercer's Mill on Tabanee Creek, 0.2 mile above the crossing of the Central Georgia R.R., south of Georgetown, Quitman County, Ga. USGS 25923, USNM 130617.

3. Front and back views of the holotype (× 10) from the same locality. USGS 25623, USNM 130616.

4. Front view of a paratype (× 10) from the Ripley Formation of Mississippi at loc. 29. USGS 25485, USNM 130618.


6, 7. Front and back views of the holotype (× 10) from the Ripley Formation at loc. 29. USGS 25485, USNM 130625.

8. Front view of a paratype (× 10) from the Ripley Formation at loc. 29. USGS 25485, USNM 130626.


9, 10. Front and back views of a topotype (× 2) from the Owl Creek Formation at loc. 46. USGS 707, USNM 130622.

11, 12. Front and apical views of a specimen (× 4) from the Owl Creek Formation at loc. 45. USGS 25422, USNM 130624.

13, 14. Back and front views of a topotype (× 2) from the Owl Creek Formation at loc. 46. USGS 594, USNM 20438.

15, 16. Front and apical view of a topotype (× 2) from the same locality. USGS 594, USNM 130623.


17. Back view of a specimen (× 1) from the Owl Creek Formation at loc. 46. USGS 707, USNM 20454a.

18–20. Apical, front, and back views of a specimen (× 1) from the same locality. USGS 707, USNM 20454B.


21, 22. Back and front view of the holotype (× 8) of *Odostomia impressa* Wade, from the Ripley Formation at loc. 1. USNM 73687.

23, 24. Back and front views of the holotype (× 8) from the same locality. USNM 73688.

25, 26. Back and front views of a topotype (× 8) from the same locality. USGS 10198, USNM 130634.

27. Front view of the holotype (× 10) of *Odostomia plicata* Wade, from the same locality. USNM 73692.


Back view of an incomplete specimen (× 5) from the Ripley Formation at loc. 16. USGS 25409, USNM 130728.


Front and back views of a specimen (× 8) from the Ripley Formation at loc. 18. USGS 18616, USNM 130655.


31, 32. Front and back view of the holotype (× 5) from the Ripley Formation at loc. 16. USGS 25409, USNM 130666.

33, 34. Front and back views of a paratype (× 5) from the Ripley Formation at loc. 17. USGS 25410, USNM 130667.


Front and back views of the holotype (× 8) from the Ripley Formation at loc. 1. USNM 73690.


Front and back views of a specimen (× 8) from the Owl Creek Formation at loc. 46. USGS 25423, USNM 130668.
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Figures 1–2. Crenella cf. C. subangulata Sohl (p. 311).
   Front and back views of a specimen (× 4) from the Owl Creek Formation at loc. 45. USGS 25422, USNM 130664.

3–6, 9. Crenella subangulata Sohl, n. sp. (p. 311).
   3, 4. Front and back views of a paratype (× 4) from the Ripley Formation at loc. 1. USGS 25406, USNM 130728.
   5, 6. Back and front views of the holotype (× 5) from the Ripley Formation at loc. 5. USGS 25406, USNM 130306.
   9. Front view of a paratype (× 3) from the Ripley Formation at loc. 22. USGS 26352, USNM 130631.

7, 8. Crenella trispirata Wade (p. 310).
   7. Back view of a specimen (× 5) from the Ripley Formation at loc. 6. USGS 25407, USNM 130628.

10–13. Crenella turreiforma Sohl, n. sp. (p. 311).
   10, 11. Back and front views of a paratype (× 10) from the Ripley Formation at loc. 29. USGS 25485, USNM 130632.
   12, 13. Front and back views of the holotype (× 10) from the Ripley Formation at loc. 27. USGS 25415, USNM 130633.

   14. View of a specimen (× 3) from the Ripley Formation at loc. 18. USGS 25411, USNM 130645.
   15, 16. Front and back views of the holotype (× 3) from the Ripley Formation at loc. 1. USNM 32954.

17, 18. Acicra (Plesiocircus) impleza Sohl, n. sp. (p. 316).
   Front and back views of the holotype (× 5) from the Ripley Formation at loc. 16. USGS 25409, USNM 130647.

19–21. Acicra (Plesiocirca) acuta Sohl (p. 322).
   19. Front view of a paratype (× 10) from the Ripley Formation at loc. 29. USGS 25485, USNM 130660.
   20, 21. Back and front views of the holotype (× 10) from the Ripley Formation at same locality. USGS 25485, USNM 130660.

22, 23. Acicra (Hemiacicra) crenacea (Wade) (p. 313).
   Back and front views of the holotype (× 1½) from the Ripley Formation at loc. 1. USNM 32951.

   24. Front view of a topotype (× 2) from the Ripley Formation at loc. 1. USGS 10198, USNM 130635.
   25. Back view of a topotype from the same locality. USGS 25406, USNM 130637.
   26, 27. Front and back views of the holotype from the same locality. USNM 32962.
   28. Back view of a topotype (× 2) from the same locality. USGS 25406, USNM 130636.

   29. Back view of a paratype (× 6) from the Ripley Formation at loc. 6. USGS 25407, USNM 130639.
   30, 31. Back and front views of the holotype (× 1½) from the same locality. USGS 25407, USNM 130638.

32–36. Acicra (Hemiacicra) clathrata Sohl, n. sp. (p. 315).
   32, 33. Back and front views of a paratype (× 4) from the Ripley Formation at loc. 18. USGS 25411, USNM 130641.
   34, 35. Back and front views of a paratype (× 5) from the Ripley Formation at loc. 6. USGS 25406, USNM 130643.
   36. Back view of a paratype (× 5) from the same locality. USGS 25406, USNM 130644.

37, 38. Acicra (Plesiocircus) microtria Sohl, n. sp. (p. 315).
   Back and front views of the holotype (× 2) from the Ripley Formation at loc. 1. USNM 32953.
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Figures 1, 2. Opalia (Opalia?) fatulosa Sohl, n. sp. (p. 320).
   Front and back views of the holotype (x 2) from the Ripley Formation at loc. 1. USGS 25406, USNM 130658.
3, 4. Siphonaria wieseri (Wade) (p. 322).
   Apical and basal views of the holotype (x 2) from the Ripley Formation at loc. 1. USNM 73109.
5, 6. Opalia (Plicescale) wadei Sohl. n. sp. (p. 321).
   Back and front views of the holotype (x 10) from the Ripley Formation at loc. 1. USNM 130662.
7, 9, 13, 19. Striaticostatum pondi (Stephenson) (p. 318).
   7, 9, 13, 19. Front, back, and basal views of a topotype (x 2) from the Ripley Formation at loc. 1. USGS 25406, USNM 130649.
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   8, 14, 20. Front, back, and basal views of a specimen (x 1) from the Ripley Formation at loc. 18. USGS 25411, USNM 130648.
10, 15, 16, 21. Striaticostatum sparsum Sohl. n. sp. (p. 320).
   10, 15, 16, 21. Front, back, and basal views of the holotype (x 13/4) from the Ripley Formation in cuts of Mississippi State Route 30 about 5.5 miles east-northeast of New Albany, Union County, Miss. USGS 26394, USNM 130656.
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18, 23. Striaticostatum congestum Sohl, n. sp. (p. 320).
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28-30. Striaticostatum asperus Sohl, n. sp. (p. 319).
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OPALIA, SIPHONARIA, STRIATICOSTATUM, ANISOMYON