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

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1964

UNITED STATES DEPARTMENT OF THE INTERIOR

STEWART L. UDALL, *Secretary*

GEOLOGICAL SURVEY

Thomas B. Nolan, *Director*

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402

CONTENTS

	Page
Abstract	153
Introduction	153
Acknowledgments	153
Résumé of the stratigraphy	154
Evolution of the gastropod faunal balance	156
Development of the gulf coast late Upper Cretaceous gastropod faunas	158
Stratigraphic value of the gastropods	159
Comparison with marine Upper Cretaceous gastropod faunas of other areas	160
Gulf Coastal Plain	161
Atlantic Coastal Plain	162
Western interior	162
Mexico and Central America	163
Caribbean and West Indies	163
West coast	164
South America	164
Europe	165
Africa	167
North Africa	167
West Coast of Africa	167
South Africa	168
Near East	168
Persia	168
Transcaucasian Russia	169
India	169
Japan	169
New Zealand	170
Proposed new genera and subgenera	170
Proposed new species and subspecies	170
Changes in generic or specific assignments	170
Definitions of morphologic terms	171
Measurements of specimens	172
Systematic descriptions	173
Order Neogastropoda	173
Superfamily Muricacea	173
Family Muricidae	173
Subfamily Rapaninae	173
Subfamily Moreinae	175
Family Magilidae	181
Superfamily Buccinacea	184
Family Buccinidae	184
Family Melongenidae	193
Family Fasciolaridae	202
Subfamily Fasciolarinae	202
Subfamily Fusininae	220
Systematic descriptions—Continued	
Order Neogastropoda—Continued	
Superfamily Buccinacea—Continued	Page
Family Xancidae	232
Subfamily Xancininae	232
Subfamily Vasinae	234
Superfamily Volutacea	244
Family Olividae	244
Subfamily Pseudolivinae	244
Subfamily Olivinae	247
Family Mitridae	248
Subfamily Vexillinae	248
Family Harpidae	249
Subfamily Harpinae	249
Subfamily Mitrinae	249
Family Volutidae	250
Subfamily Volutoderminae	250
Subfamily Athletinae	258
Subfamily Scaphellinae?	264
Family Cancellariidae	267
Family Paladmetidae	270
Family Turridae	274
Subclass Opisthobranchia	287
Order Cephalaspidea	287
Superfamily Acteonacea	287
Family Acteonidae	287
Subfamily Acteoninae	287
Family Ringiculidae	293
Family Scaphandridae	294
Family Acteocinidae	299
Family Bullidae	306
Superfamily Pyramidellacea	308
Family Eulimidae	308
Family Pyramidellidae	310
Superfamily Epitoniacea	313
Family Epitoniidae	313
Subfamily Acirsinae	313
Subfamily Opaliinae	320
Subfamily Epitoniinae	321
Order Basommatophora	322
Superfamily Siphonariacea	322
Family Siphonariidae	322
Locality register	323
References	326
Index	335

ILLUSTRATIONS

[Plates 19–52 follow index]

PLATE 19. *Ecphora, Paramorea,* and *Sargana.*
20. *Morea* and *Schizobasis.*
21. *Schizobasis, Latiaxis,* and *Lowenstamia.*
22. *Buccinopsis, Stantonella,* and *Aliofusus.*
23. *Odontobasis, Buccinopsis,* and *Protobusycon.*
24. *Pyrifusus, Rhombopsis, Deussenia, Lomirosa,* and *Protobusycon.*
25. *Deussenia* and *Bellifusus.*
26. *Drilluta, Dolicholatirus,* and *Bellifusus.*
27. *Drilluta.*
28. *Paleopsephaea* and *Graphidula.*
29. *Graphidula, Ornopsis,* and *Piestochilus.*
30. *Hercorhyncus* and *Latirus.*
31. *Anomalofusus, Remera, Fusinus, Euthriofusus, Woodsella,* and *Boltenella.*
32. *Pyropsis, Cryptorhytis, Anomalofusus,* and *Lupira.*
33, 34. *Pyropsis.*
35. *Ptychosyca* and *Napulus.*
36. *Ancilla, Fulgerca, Hydrotribulus,* and *Longoconcha.*
37. *Paleofusimitra, Mitridomus, Longoconcha,* and *Volutomorpha.*
38–41. *Volutomorpha.*
42. *Volutomorpha* and *Liopeplum.*
43. *Liopeplum.*
44. *Cancellaria, Caveola, Myobarbum, Parafusus, Tectaplica,* and *Trigonostoma.*
45. *Amuletum, Mataxa,* and *Paladmete.*
46. *Amuletum, Gemmula, Remnita, Beretra,* and *Fusimilis.*
47. *Tornatellaea, Eoacteon, Cryptoconus, Acteon,* and *Troostella.*
48. *Ringicula, Parietiplicatum, Oligoptycha,* and *Ellipsoscapha.*
49. *Ellipsoscapha, Sulcoretusa, Cylindrotruncatum, Zikkuratia, Cylichna,* and *Goniocylichna.*
50. *Scobinidola, Bullopsis, Bulla?, Lacrimiforma,* and *Eulima.*
51. *Creonella, Acirsa,* and *Aciculiscala.*
52. *Opalia, Siphonaria, Striaticostum,* and *Anisomyon.*

Page

FIGURE 12. Correlation of the Upper Cretaceous rocks of the *Exogyra costata* zones of the Atlantic and Gulf Coastal Plains 154
13. Comparison of selected fossil gastropod faunas 157
14. Development of the species of *Lowenstamia* in the Upper Cretaceous of the Mississippi embayment region 182
15. Comparison of growth lines between *Busycon* (*Busycon*) and *Protobusycon* 194
16. Comparison of growth lines of the three subgenera of *Ornopsis* 215
17. Development of the species of the subgenus *Ornopsis* (*Pornosis*) 219
18. Suggested phylogeny of the species of *Liopeplum* 259

TABLES

[Tables in pocket]

TABLE 1. Geographic and stratigraphic distribution and abundance of the gastropod species of the Ripley, Owl Creek, and Prairie Bluff Formations of southern Tennessee and northeastern Mississippi.
2. Geologic range and geographic distribution of the gastropod genera represented in the fauna of the *Exogyra costata* zone of Mississippi and Tennessee.

LATE CRETACEOUS GASTROPODS IN TENNESSEE AND MISSISSIPPI

NEOGASTROPODA, OPISTHOBRANCHIA, AND BASOMMATOPHORA FROM THE RIPLEY, OWL CREEK, AND PRAIRIE BLUFF FORMATIONS

By NORMAN F. SOHL

ABSTRACT

Description of the gastropods found in the Upper Cretaceous (Late Campanian-Maestrichtian) 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 Eutaw 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 Coniacian 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 (Aachen and Limburger Kreide), and those of southern India all show a gross similarity, especially when compared to those of the Caribbean, Gosau, 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 Bassomatophora. 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 *Lowenstamia* and *Ornopsis* (*Pornosis*) 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

Geology of the University of Illinois for making available both research facilities and Research Board Funds to aid in the collection and the study of the material. Since 1954 the study has continued under the auspices of the U.S. Geological Survey.

Drs. H. A. Rehder and J. P. E. Morrison, Division of Mollusks, U.S. National Museum, have given freely of their advice on taxonomic problems and have allowed free access to collections of Recent mollusks in the museum. Dr. H. G. Richards of the Academy of Natural Sciences of Philadelphia made available both Conrad's and Gabb's Cretaceous type specimens from Mississippi, Alabama, and Georgia in the collections of the academy. I am also indebted to Dr. N. D. Newell, Department of Geology, American Museum of Natural History, for the loan of other Cretaceous Conrad type specimens housed at that institution.

Geological Survey colleagues who deserve special thanks for their advice and council during preparation of the manuscript are the late L. W. Stephenson and J. B. Reeside, Jr., and special thanks to R. W. Imlay and E. L. Yochelson of the Survey and W. P. Popenoe of the University of California at Los Angeles for critically reading the manuscript.

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 *Exogyra 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 Maestrichtian 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 *Exogyra 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

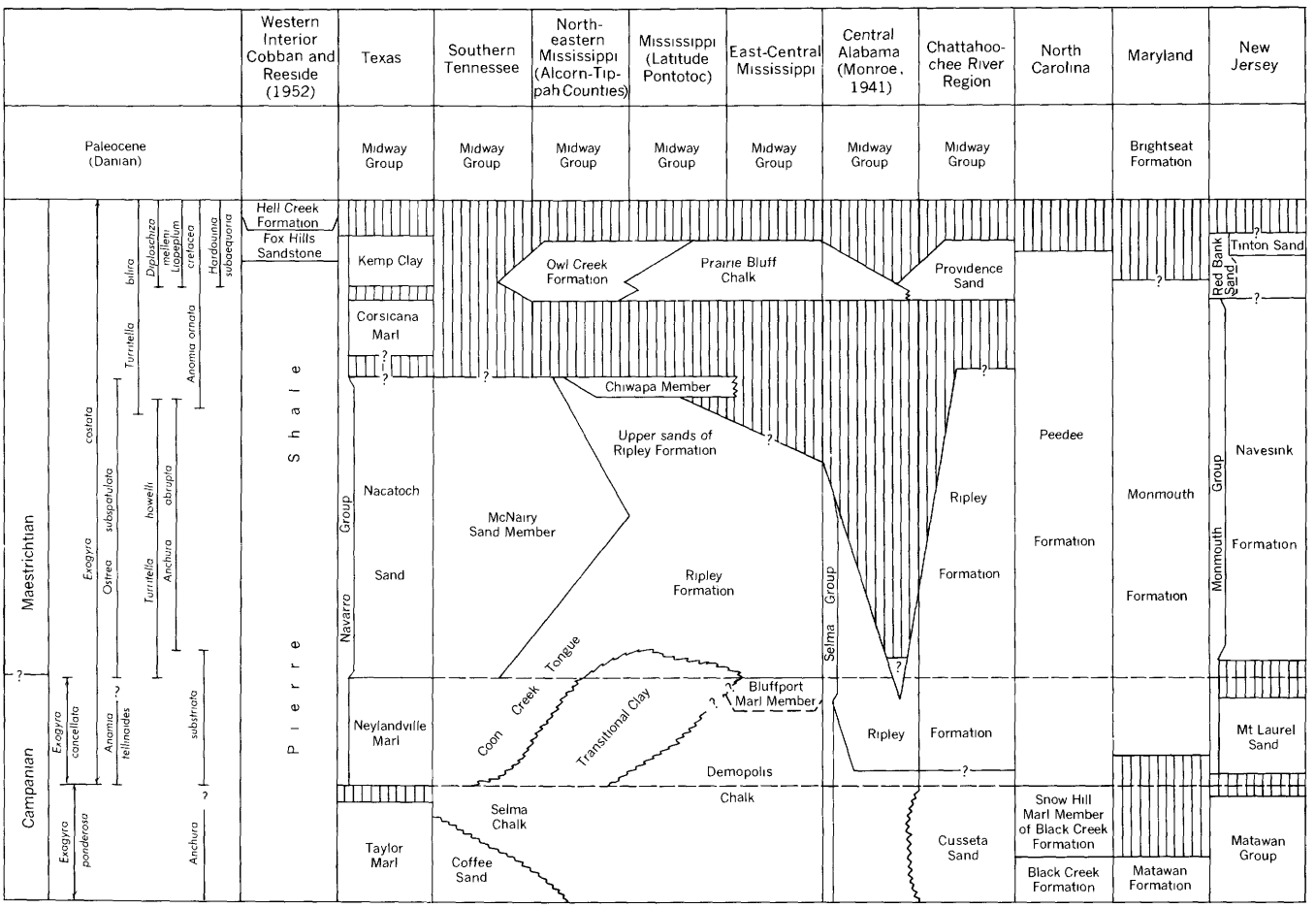


FIGURE 12.—Correlation of the Upper Cretaceous rocks of the *Exogyra costata* zones of the Atlantic and Gulf Coastal Plains (modified from Stephenson and others, 1942).

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, 15).

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 *Exogyra 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 intraformational 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 into 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 Maestrichtian 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 Maestrichtian 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 Chavàn 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.

EVOLUTION 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 cerithids, 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 ecologic 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

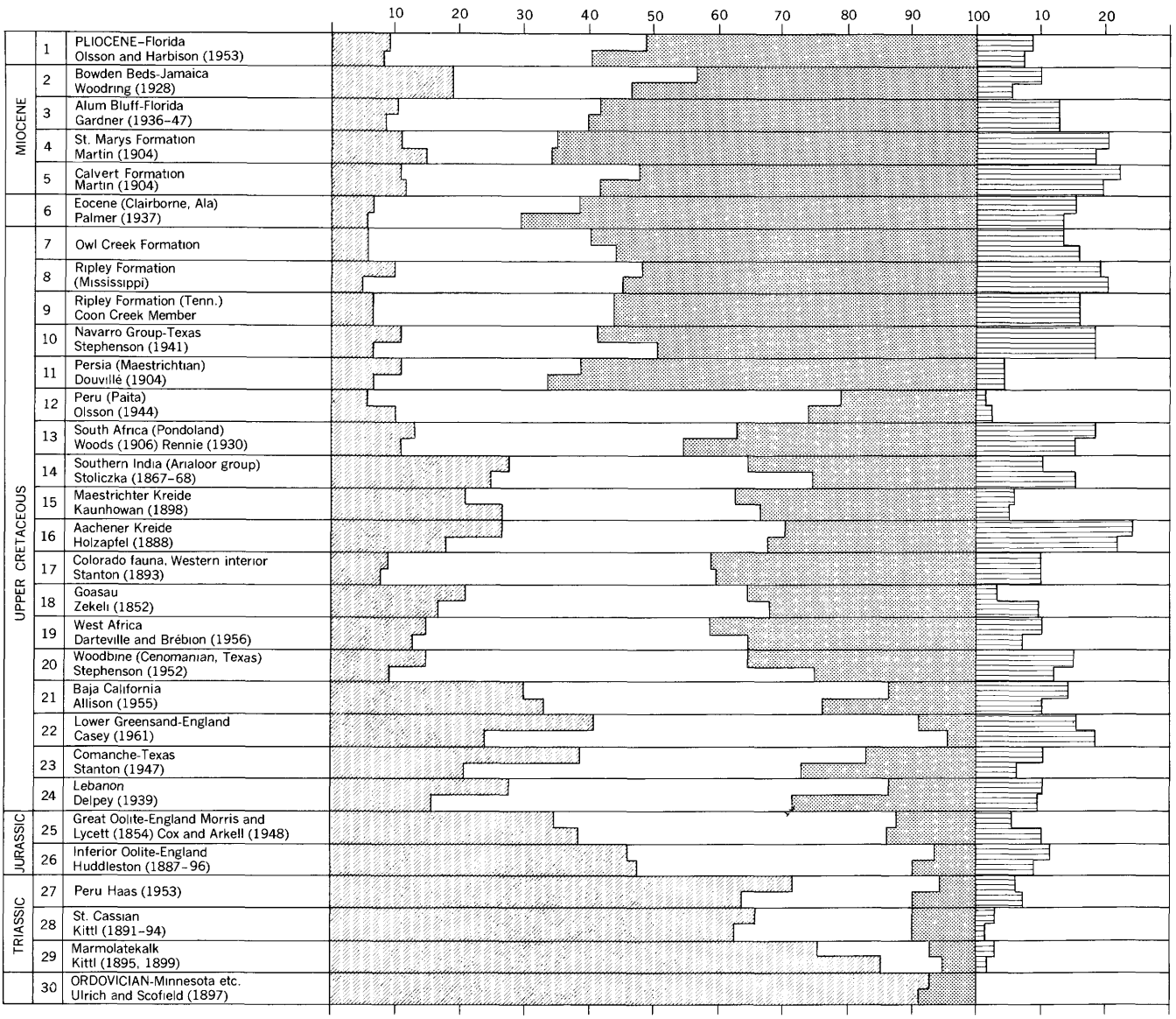


FIGURE 13.—Comparison of selected fossil gastropod faunas. Diagonal area, Archaeogastropoda; blank area, Mesogastropoda; stippled area, Neogastropoda; straight lines, percentage of Opisthobranchia relative to total fauna.

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 ascendancy 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 *Exogyra 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), Aachen (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 Epitoniacea were not included in the Opisthobranchia. Some of the Cretaceous highs, 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 *Ecphora*, *Pleisiotriton*, *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 aporrhaids and in its typically Cretaceous strombids, such as *Pugnellus*. 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, Cusseta, 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 (*Gyrodes*, *Turritella*, *Euspira*, *Acmaea*, *Ringicula*, *Anchura*, *Neritina*) 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 25567, 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*, *Acirsa* (*Hemiacirsa*), *Longoconcha*, *Stantonella*, *Buccinopsis*, *Fulgerca*, *Paladmete*, and *Fusimilis* are present.

Whereas the Woodbine species of *Turritella*, such as *T. schuleri* Stephenson, possessed nodose spiral sculpture in the fashion of *T. seriatimgranulata* Roemer and others from the Albian 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 turritellas (*T. quadrilia* Johnson, *T. trilira* Conrad, *T. bilira* 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 bilira* 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 ostreids, 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), Lemche (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 forgemolli* Coquand (= *Nerinea quettensis* Noelting, *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 Escondido 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 bilira* 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 *Urceolabrum*, *Calliomphalus*, and *Lowenstamia*, and the *Turritella quadrilira* Johnson line, have demonstrated that the gastropods can be used in zoning 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 *Zikkuratia*, *Cylichna*, *Melanella*, *Ringicula*, and *Creonella* 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 CRETACEOUS 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 coextensive 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 circumequatorial 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 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 (Nacatoch 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 Mississippi, Ripley, and Owl Creek ammonite species occur in Texas, with perhaps the exception of the narrowly limited carinate 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 *Sphenodiscus* type are abundant, and *Coahuilites*, a sphenodiscid that is more typically a Mexican element, appears. Among the gastropods, genera such as *Stantonella*, *Buccinopsis*, and *Liopeplum*, as well as certain species of the ubiquitous *Turritella* 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 are 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 (Applin and Applin, 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 *Remera*, *Pterocerella*, *Longoconcha*, *Drilluta*, 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 Escondido 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 Tinton 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 spangleri* 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*, *Acirsa* (*Hemiacirsa*), *Morea*, *Ptychosyca*, *Astandes*, *Bellifusus*, *Remera*, *Liopeplum*, *Amuletum*, *Beretra*, *Ringicula*, and *Bullopsis* 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*, *Pugnellus*, and others we find such forms as *Idonearca wadei* 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 Cardenas in the State of San Luis Potosi (Böse, 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 *Hercorhyncus*, *Liopeplum*, *Pugnellus*, *Morea*, *Beretra*, *Longoconcha*, *Sargana*, *Bellifusus*, *Drilluta*, and others are represented in collections (USGS Mesozoic colln. 27175, 28172, 28178) from beds that were evidently not considered by Böse (1906). About 300 miles farther south in Guerrero the gastropods *Nerinea* and *Acteonella* were present during the Coniacian and Santonian (Böse, 1923, p. 191–208, pls. 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 *Titanosarcolites* fauna of the Caribbean in southern Mexico was noted by Mülleried (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, 1927), 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. *Anchura* 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 trilira* Conrad, *Turritella bilira* Stephenson, *Cerithium* cf. *C. nodoliratum* 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—*Paladmete*, *Dircella*, *Margaritella*, and *Anisomyn*—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. *Tessarolax*, *Biplica*, *Liocium*, *Lysis*, *Sycodes*, *Haydenia*, and others all show the strong endemic nature of the gastropod fauna. Recent studies by Popenoe (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* Weller. *Sargana* is known only from the Gulf and Atlantic Coastal Plains; from Coahuila, Mexico; and from the Senonian of Pondoland, 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 verfication 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 (Matsumoto, 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 Quinquirina-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 pelecypod 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 *Pseudocucullaea* 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, *Pseudocucullaea* 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. *Turritella bilira* Stephenson finds an analog in *Mesalia janja* Olsson. *T. trilira* 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 pelecypod 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, inoceramids, 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; Kaunhowen, 1898).

The Aachen sands have yielded a varied fauna of gastropods and pelecypods (126 genera according to Chavan, 1946, p. 196). Although of considerably

older age (lower Senonian, *Scaphites hippocrepis* and *Actinocamax* 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 addtion, volutes with *Volutoderma*-like species are present, as well as similar fasciolariids, cancelariids, aporrhaids, cerithiids, 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 *Turritellas* that possess sculpture lirae of a type more typical of the earlier turritellids than those of the Campanian and the Maestrichtian.

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.

Urceolabrum (*Liotia* of Holzapfel)
Damesia
Astandes (*Tritonium cretaceum* Müller)
Turritella
Laxispira
Capulus
Cerithium
Xenophora
Trichotropis
Pseudomalaxis? (*Discohelix simplex* Holzapfel)
Arrhoges (*Latiala*) (*Lispodesthes schlotheimi* Roemer)
Helicaulax
Euspira (*Lunatia* and *Amauropsis* of Holzapfel)
Gyrodes
Pyrifusus (*Strombus fenestratus* Müller)
Drilluta? (*Volutilithes subsimplicata* Holzapfel not d'Orbigny)
Hercorhyncus (*Rapa monheimi* Müller)
Boltenella? (*Hemifusus cornatus* Roemer)
Pyropsis (*Tudicla quadricarinata*)
Palcopsephaea (*Volutilithes nana* Müller)
Cancellaria?
Cylichna
Tornatellaea (*Acteon mülleri* Bosquet)
Nonacteonina (*Acteonella lineolata* Reuss)
Ringicula
Eulima

Some of the species assigned by Holzapfel to *Eutrochus* may well belong in *Calliomphalus*, 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 Turonian Gosau fauna (Zekeli, 1852, Stoliczka, 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 Kaunhowen (1898) on the Limberg-Maestrichter 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 *Belemnitella mucronata* (Schlotheim) (Bohm, 1898) and thus are considered of Maestrichtian age. In general Kaunhowen'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 fissurellid element, indicating somewhat different bottom conditions that afforded these rock clingers 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 *Laxispira*, a possible *Astandes*, an *Ornopsis*, and some cerithids similar to Ripley types. Several closely related species also occur, among which the following show striking similarities:

Trochus rimosus granulata Kaunhowen--*Calliomphalus* (*Calliomphalus*) *americana* Wade
Turritella plana Binckhorst (1873, pl. 3, figs. 12–14)--*Turritella chalybeatensis*, Sohl
Aporrhais (*Cultigera*) *propinqua* Kaunhowen--*Pterocerella poinsettiformis* Stephenson
Aporrhais (*Arrhoges*) *pelecyphora* Kaunhowen--*Arrohoges* (*Latiala*) *lobata* (Wade)

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

Germany and Bohemia and have been well illustrated by Weinzittle (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; Stoliczka, 1865). 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-Maestrichtian) but because of environmental differences. The Gosau beds according to Vaughan and Wells (1943, 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, acteonellas, or rudistids, although such elements are present.

A large number of species in the Tunisian faunas (Thomas and Peron, 1889; Pervinquière, 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 Maestrichtian 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. *Scalaria desortorum* Wanner and *Scalaria calamistrata* Wanner described from the Libyan faunas, but also present in Tunisia, appear to belong to *Striaticostatum;* 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 *Exogyra overwegi* and *Libycoceras.* 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 quadricinta* Goldfuss of Quass is similar to *T. vertebroides* Morton and *T. (Zaria) figarii* Quass is very close to *T. trilira* Conrad. In addition *Laxispira* appears to be represented by *Vermetus libycus* 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 (1932), Rennie (1929), Cox (1952), Darteville and Brébion (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 aurilitaralis* Cox appears to be a true *Fusimilis*, but the application of such generic names as *Nudivagus*, *Ornopsis*, and *Paleopsephaea* to species of west Africa appears to be highly questionable. The presence of some genera, of which the pelecypod *Pseudocucullaea* Solger is a good example, shows that there was direct

access to northern South America and the Caribbean. Darteville and Freneix (1957, p. 223–228) 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. Stephenson (1941, p. 45) listed a series of molluscan species he considered analogous or closely related. The following gastropods are all closely similar: *Paleopsephaea scalaris* Rennie is close to *P. mutabilis* Wade; *Cryptorhytis rigida* Baily may well be an *Aliofusus; Arcotia vanhoepeni* Rennie is similar to *Gegania parabella* (Wade); *Dicroloma* (*Perissoptera*) *baylyi* (R. Etheridge, Jr.) is close to *Arrhoges* (*Latiala*) *lobata* Wade; *Gyrodes tenellus* Stoliczka of Rennie is similar to *Gyrodes spillmani* Gabb; *Solarium baylyi* Gabb may be a *Margaritella*, and *Turritella* (*Zaria*) *bonei* Baily is like *T. trilira* 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 *Pyropsis geversi* Rennie a form remarkably close to *Sargana stantoni* Weller. This genus is known from only the Gulf and Atlantic Coastal Plains, northern Mexico, and South Africa. Likewise, *Woodsella* Wade is known only from these two regions in the form of *Woodsella 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* Douvillé of Collignon, 1949), which ranges from Algeria to Baluchistan in beds of Maestrichtian age. *Turritella* (*Zaria*) *besairie* Collignon (1949a) and *T. breantiana* d'Orbigny of Boule and Thevenin (1906) represent the ubiquitous trilirate turritellid common to the Campanian and Maestrichtian. The other common elements such as *Gyrodes*, *Pugnellus*, *Pyropsis*, and *euspira* 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 *Scalaria desortorum* 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. turgidula* Deshayes of Douvillé has a considerable similarity to *Tectaplica simplica* Wade and *Procerithium morgani* Douvillé is reminiscent of *Cerithium weeksi* 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* Douvillé is an analog of *T. forgemoli* Coquand of north Africa and Madagascar.

Overall the gastropod fauna of Iran is dominated by the littorinid, cerithiid, and melanopsid elements (*Pyrazus*, *Potamides*, *Procerithium*, *Campanile*, *Cerithium*, *Pirena*, *Faunus*, *Melanopsis*, 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 *Drilluta*, *Pyropsis*, 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 Noetling 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 *Pugnellus crassicostatus* 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 quettensis* 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* Douvillé, 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 aporrhaids and volutes and the presence of a number of pyropsids 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, littorinids, 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 *Volutoderma*, *Tessarolax*, and *Biplica* show a very strong affinity to the gastropod fauna of California.

NEW ZEALAND

Wilckens (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. *Procancellaria parkiana* Wilckens may belong in the genus *Morea*. The genus *Conchothyris*, a strombid related to *Pugnellus*, is close to some South American species from Chile. Wilckens (1922, p. 30) pointed out other similarities to Chile, southern India, and Antarctic faunas.

PROPOSED NEW GENERA AND SUBGENERA

Lowenstamia
Ornopsis (*Pornosis*)

PROPOSED NEW SPECIES AND SUBSPECIES

Morea corsicanensis coonensis
rotunda
marylandica halli
Lowenstamia funicula
cuculata
Aliofusus stamineus
Buccinopsis solida sulcata
dorothiella
Odontobasis sulcata
Protobysycon binodosum
Pyrifusus crassus
ejundicus
Rhombopsis molinoensis
Deussenia bellalirata costata
Bellifusus spinosus
curvicostatus crenulatus
angulicostatus
Drilluta lemniscata
buboanus
Paleopsephaea tenuilirata
Dolicholatirus torquatus
Ornopsis (*Pornosis*) *modica*
(*Pornosis*) *modica laevis*
Latirus keownvillensis
Hercorhyncus (*Hercorhyncus*) *pagodiformis*
(*Haplovoluta*) *triliratus*
quadriliratus
Remera flexicostata
Anomalofusus subnodosus
lemniscatus
Lupira turbinea
Pyropsis cornutus
prolixa
Napulus reesidei
fragilis
Hydrotribulus elegans
Longoconcha quadrilirata
Volutomorpha valida
producta
Liopeplum coronatum
nodosum
Parafusus saffordi
Trigonostoma ripleyana
Cancellaria macnaryensis
Caveola acuta speciosa
Paladmete gardnerae pygmaea
laevis
Amuletum macnairyensis torquatum
dumasensis
wadei
(*Lutema*) *limbatum*
Remnita hastata
Gemmula cretacea
Beretra speciosa
Fusimilis kummeli
Acteon pistiliformis
cicatricosus
Eoacteon percultus
Ringicula yochelsoni
Oligoptycha corrugata
Cylichna diversilirata
intermissia
intermissia curta
pessumata
Goniocylichna elongata
Bullopsis demersus
Eulima gracilostylis
Creonella subangulata
turretiforma
Acirsa (*Hemiacirsa*) *flexicostata*
(*Hemiacirsa*) *clathrata*
(*Pleisoacirsa*?) *implexa*
Striaticostatum aspera
congesta
sparsa
Opalia (*Opalia*?) *fistulosa*
(*Pliciscala*) *wadei*

CHANGES IN GENERIC OR SPECIFIC ASSIGNMENTS

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

Old assignment	*New assignment*
Pyropsis geversi Rennie	*Sargana*
Pinella Stephenson	*Morea*
Pseudomorea Cossmann	*Morea*
Pinella reticulata Stephenson	*Morea*
Morea cancellaria corsicanensis	*Morea corsicanensis*
Morea marylandica languida Stephenson	*Morea cancellaria languida*
Hippocampoides Wade	*Latiaxis*
Hippocampoides serratus Wade	*Latiaxis*
Hippocampoides liratus Wade	*Lowenstamia*
Straparolus supblanus Gabb	*Loiwenstamia*
Fasciolaria? rugosa Stephenson	*Stantonella*
Strepsidura ripleyana Conrad	*Stantonella*
Strepsidura interrupta Conrad	*Stantonella*
Pyrifusus monmouthensis Gardner	*Stantonella*
Fasciolaria? lyelli Stephenson	*Stantonella?*

Old assignment	*New assignment*
Seminola Wade	*Buccinopsis* Conrad
Seminola crassa Wade	*Buccinopsis*
Seminola solida Wade	*Buccinopsis*
Nassa globosa Gabb (in part)	*Buccinopsis crassicostatus* (Gabb)
Fasicolaria (*Cryptorhytis*) *crassicosta* Gabb	*Buccinopsis*
Bellifusus tenuistriatus Stephenson	*Bellifusus curvicostata* Wade
Fusus (*Afer*) *bellaliratus* Conrad	*Deussenia*
Rhombopsis microstriatus Wade	*Deussenia*?
Voluta rigida Baily	*Deussenia*?
Cryptorhytis pseudorigida Rennie	*Deussenia*?
Fusus culbertsoni Meek and Hayden	*Graphidula*
Turbonilla (*Chemnitzia*) *melanopsis* Conrad	*Graphidula*
Graphidula tippahensis Harbison	*Graphidula melanopsis* (Conrad)
Fasciolaria cretacea Meek and Hayden	*Graphidula*
Rimella curvilirata Conrad	*Piestochilus*
Ripleyella Harbison	*Ornopsis* (*Ripleyella*)
Hercorhyncus mundum Stephenson	*Pyrifusus*
Hercorhyncus coronale Stephenson	*Hercorhyncus* (*H.*) *tippanus* (Conrad)
Hercorhyncus vadosum Stephenson	*Hercorhyncus* (*H.*) *tippanus* (Conrad)
Hercorhyncus gracilis Harbison	*Hercorhyncus* (*H.*) *tippanus* (Conrad)
Haplovoluta Wade	*Hercohyncus* (*Haplovoluta*)
Falsifusus convexus Wade	*Euthriofusus*?
Anchura pergracilis Johnson of Wade	*Remera*
Fusus? *macnairyensis* Wade	*Fusinus*?
Xancus variabilis Wade	*Lupira*
Lupira polycyma Harbison	*Lupira pyriformis* Stephenson
Cryptorhytis torta Wade	*Cryptorhytis*? *nobilis* Wade
Pyropsis lenolensis Weller	*Napulus*
Medionapus Stephenson	*Pyropsis*
Trochifusus spinosus Wade	*Pyropsis*
Trochifusus interstriatus Wade	*Pyropsis*
Trochifusus perornatus Wade	*Pyropsis*
Eoancilla Stephenson	*Ancilla* (*Ancillus*)
Fasciolaria ripleyana Wade	*Mitridomus*
Volutoderma (*Longoconcha*)	*Longoconcha*
Rostellites angulatus Whitfield	*Longoconcha*
Volutoderma appressa Wade	*Longoconcha*
Voluta elongata Sowerby of d'Orbigny	*Longoconcha*
Mitra murchisoni Müller	*Longoconcha*
Rostellites nasutus Gabb	*Longoconcha*
Volutoderma protracta Dall	*Longoconcha*
Rostellites texturatus Whitfield	*Longoconcha*
Volutoderma tennesseensis Wade	*Longoconcha*
Volutomorpha tarensis Stephenson	*Liopeplum*
Volutomorpha lioca Dall	*Volutomorpha dumasensis* Dall
Liopeplum monmouthensis Gardner	*Liopeplum cretaceum* (Conrad)
Mataxa valida (Stephenson)	*Mataxa elegans* Wade
Cancellaria eufaulensis Gabb	*Paladmete cancellaria* (Conrad)
Paladmete densata Wade	*Paladmete cancellaria* (Conrad)
Paladmete poecilma Harbison	*Paladmete cancellaria* (Conrad)
Exilia ripleyana Wade	*Amuletum macnairyensis* (Wade)
Amuletum curvocostatum Stephenson	*Amuletum macnairyensis* (Wade)
Turricula fasceolata Wade	*Amuletum*
Drillia georgiana Gabb	*Beretra ripleyana* (Conrad)
Surcula amica Gardner	*Beretra ripleyana* (Conrad)
Beretra striata Stephenson	*Beretra ripleyana* (Conrad)
Turricula amica Gardner of Wade	*Beretra gracilis* (Wade)
Beretra contracta Stephenson	*Beretra firma* (Stephenson)
Turricula ripleyana (Conrad) of Wade	*Beretra speciosa* Sohl
Turris constricta Wade	*Fusimilis proxima* (Wade)
Drillia tippana Conrad	*Fusimilis*
Turris monmouthensis Gardner	*Fusimilis*
Acteon solidulus (Conrad) of Wade	*Eoacteon percultus* Sohl
Acteon ellipticus Wade	*Eoacteon*
Acteon? *throckmortoni* Stephenson	*Eoacteon ellipticus* Wade
Troostella sublinearis Stephenson	*Eoacteon*
Troostella? *brevispira* Stephenson	*Eoacteon*
Acteonina orientalis Wade	*Nonacteonina*
Acteon conicus Wade	*Parietiplicatum*
Cylichna carinata Stephenson	*Cylindrotruncatum*
Cylichna recta Gabb of Wade	*Cylindrotruncatum demersum* Sohl
Pseudomelania runnelsi Stephenson	*Eulima laevigata* Wade
Liostraca cretacea (Conrad) of Wade	*Creonella subangulata* Sohl
Creonella secunda Wade	*Lacrimiforma*
Odostomia plicata Wade	*Lacrimiforma secunda* (Wade)
Odostomia impressa Wade	*Lacrimiforma secunda* (Wade)
Proscala americana Wade	*Acirsa* (*Hemiacirsa*)
Scalaria cerithiformis Meek and Hayden	*Belliscala*
Acirsa? *cerithiformis* (Meek and Hayden) of Wade	*Belliscala*
Epitonium bexarense Stephenson	*Striaticostatum*
Scala sillimani Morton of Wade (in part)	*Aciculiscala acuta* Sohl
Epitonium pondi Stephenson	*Striaticostatum*
Scala sillimani Morton	*Striaticostatum*
Anisomyon wieseri Wade	*Siphonaria*

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.
Anomphalous—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.
Columellar 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 teloconch forming an angle of less than 180°.
Funicle—Strong spiral cord extending from edge of inner lip into umbilicus.
Hemiomphalous—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 consisting of the parietal and columellar lips.
Opisthocline—Growth lines which slope forward (adapertural) from upper suture to lower suture.
Orthocline—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.
Phaneromphalous—With open umbilicus.
Pleural angle—Angle formed by two lines tangent to last two whorls.
Prosocline—Growth lines that slope backward (abapertural) from upper suture to lower suture.
Protoconch—Earliest formed whorls, generally clearly demarcated from the teloconch 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 similarly and limited by the shoulder carina.
Sinus—Parasigmoidal 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 fasciole—Band of variable width formed by arched flexed growth lines marking previous position of anterior siphonal notch.
Teloconch—Shell exclusive of protoconch.
Thread—Very fine elements of ornament, finer than costae or cords.
Turreted—Shell with whorls rising in steps as on *Napulus*.
Turriculate—(Turrited)—acute spire of shell commonly flat sided. 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.

D—Diameter, measured normal to teloconch axis of coiling.
DU—Diameter of umbilicus, measured parallel to base of shell.
DA—Diameter of aperture, measured normal to axis of coiling.
D4W—Diameter of fourth whorl, measured normal to axis of coiling.
MD—Maximum diameter, measured normal to the teloconch axis of coiling.
MD + Wi—Maximum diameter plus the length of an expanded outer lip or wing.
MinD—Minimum diameter, used in cap-shaped shells for shorter diameter.
H—Total height of shell, measured parallel to axis of coiling.
HA—Height of aperture, measured parallel to axis of coiling.
HPW—Height of penultimate whorl, measured parallel to axis of coiling.
H4W—Height of fourth whorl, measured parallel to axis of coiling.
HB—Height of body whorl, measured parallel to axis of coiling.
HS—Height of spire, measured parallel to axis of coiling.
H:D—Ratio of height to maximum diameter.
Estimated H—Total height of incomplete specimen estimated by projection of pleural angle.
L—Length or long diameter of capuliform shells.
No. W—Number of whorls, generally exclusive of nuclear whorls.
PA—Pleural angle.

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 ECPHORA Conrad, 1843

Type by monotypy, *Fusus quadricostatus* Say, 1824.

Diagnosis.—Small to moderately large subfusiform 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 serrate strong carina.

Discussion.—With the exception of the Cretaceous species, *E. proquadricostata* Wade, all the known species of *Ecphora* are from the Oligocene and Miocene. With such a restricted range the propriety of placing Wade's species from the Ripley Formation in the genus *Ecphora* 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. *Ecphora proquadricostata* does possess nuclear whorls, ornament, apertural 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 *Ecphora* 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 *Ecphora* 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.

Ecphora proquadricostata Wade

Plate 19, figures 1, 5

1917. *Ecphora proquadricostata* Wade, Philadelphia Acad. Nat. Sci. Proc., v. 69, p. 293, pl. 18, fig. 7.
1925. *Ecphora proquadricostata* Cossmann, Essais Paléoconchologie Comparée, v. 13, p. 263, pl. 8, fig. 26.
1926. *Ecphora proquadricostata* Wade, U.S. Geol. Survey Prof. Paper 137, p. 135, pl. 52, fig. 3.

Diagnosis.—Small, phaneromphalous 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).

Loc.	No. *W*	*H*	*MD*
1 (holotype)		11.4	9.5
1 (topotype)	5	9	8.7
Do	4.25	8.25	7.4
Do	4.75	8.4	7.9
Do	5	9.25	8.8
Do	4.75	7.6	6.9
6	4.5	8.3	7.6

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 topotype 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 Tabannee Creek, Quitman County, Ga., (USGS colln. 25923).

Types: Holotype USNM 32920; hypotype USNM 130195.
Occurrences: Tennessee: Ripley Formation, loc. 1. Mississippi: Ripley Formation, locs. 6, 15–17, 22, 29. Georgia: Ripley Formation. Mexico: Cardenas Formation of San Luis Potosi.

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 serrate 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

690-081 O - 64 - 2

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 a 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, *Ecphora* 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 Rapaninae. The relocation of the type genus makes the retention of the name Sarganidae superfluous.

In North America, *Sargana* ranges through the *Exogyra 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 stantoni (Weller)

Plate 19, figures 7, 9, 11–25

1907. *Rapana stantoni* Weller, New Jersey Geol. Survey, Paleontology, v. 4, p. 754, pl. 89, figs. 1–3.

1923. *Sargana stantoni* (Weller). Stephenson, North Carolina Geol. and Econ. Survey Bull., v. 5, p. 377, pl. 93, figs. 1–5.

1926. *Sargana stantoni* (Weller). Wade, U.S. Geol. Survey, Prof. Paper 137, p. 136, pl. 46, figs. 7, 8.

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

1941. *Sargana stantoni* (Weller). Stephenson, Texas Univ. Bull. 4101, p. 325, pl. 60, figs. 15–17.

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).

Loc.	*H*	*MD*
Texas (holotype)	24.2+	25
1 (hypotype)	32.5	31.5
1	37.3	36.9
1	14.5	15.5
1	18.0	19.0
1	15.5	17.4
1	19.6	17.9
18 hypotypes	30.0	32.1
18	16.5	15.9
18	12.5	14.8
18	14.0	14.0
18	10.0	10.8
6 hypotypes	14.0	14.0
6	16.9	15.5
6	16.0	16.5
6	14.4	14.7
6	16.6	16.5

Discussion.—Most specimens of *Sargana stantoni* 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 subsutural 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 flutings.

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.

Pyropsis geversi Rennie (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); 32895, 130191–130194 (Tennessee); and USNM 20548, 130186–130190 (Mississippi).

Occurrences: Tennessee: Ripley Formation, loc. 1. Mississippi: Ripley Formation, locs. 4–6, 11, 18, 22, 23, 29, 39, Coffee (?)Sand. Texas: Neylandville (?)Marl, Nacatoch Sand. Alabama and Georgia: Ripley Formation. North Carolina: Peedee Formation. Delaware: Crosswicks Clay of Carter, 1937 = Merchantville Formation of Groot and others, 1954. New Jersey: Merchantville Formation.

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 pseudoumbilicus, and a surface marked by intersecting strong spiral ribbons 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 Cancellaridae. 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. marylandica* 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 columella. These differences caused Cossmann (1925, p. 265) to hesitatingly propose the name *Pseudomorea* for the later species as follows:

> Il est donc probable qu'il foundra séporer une nouvelle Section de *Morea*, dont le génotype serait *M. marylandica*: on pourrait lui donner le nom *Pseudomorea* "nobis," si les différences signalees ci-dessus sont constantes, ce que je ne puis affirmer, d'après d'uniques specimens.

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 columella 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. marylandica*, 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 *Exogyra 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. marylandica*. (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

1860. *Morea cancellaria* Conrad, Philadelphia Acad. Nat. Sci. Jour., 2d ser., v. 4, p. 290, pl. 40, fig. 30.

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

Diagnosis.—Slim ovate low-spired moreids with 7–8 spiral ribbons 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).

Loc.	*H*	*MD*	*HB*	Rows of nodes	*H:D*	*HB:H*
Eufaula, Ala. USGS 279 (topotype)	29.5	17.6	22.7	8	1.6	0.8
Topotype	25.9	16.0	19.7	8	1.6	.8
Do	20.9	12.9	16.4	7	1.6	.8
Do	22.0			7		
USGS 5417 (Alabama)	22.7	14.7	18.2	8	1.6	.8

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 (1899, 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 coonensis* 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 pseudoumbilicus, 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 languida* 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.

Types: Holotype lost; hypotype USNM 21169; hypotype, see Cossmann, 1899.

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

Morea corsicanensis corsicanensis Stephenson

Plate 20, figures 1, 8

1941. Morea *cancellaria corsicanensis Stephenson*, Texas Univ. Bull. 4101, p. 326, pl. 61, figs. 7–9.

Diagnosis.—Medium-sized low-spired obese shells with 8–9 noded 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).

Loc.	*H*	*MD*	*HB*	Rows of nodes	*H:D*	*HB:H*
Texas (holotype)	35.5	27.8	28±	8	1.3	0.8
Texas (paratype)	25.7	20±	20.8	8	1.3	.8
6 (Mississippi)	24.7	16.4	19.6	8	1.5	.8
6	22+	16.9	18.5	9	1.3	.9
6	25.7	18.1	20.8	8	1.4	.8
16	16.0	12.0	13.0	8	1.3	.8
16	20.8	15.4	16.5	8	1.3	.8

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 hopotype (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.

Morea corsicanensis coonensis Sohl, n. subsp.

Plate 20, figure 9

1926. *Morea cancellaria* Conrad. Wade, U.S. Geol. Survey Prof. Paper 137, p. 134, pl. 51, figs. 11, 12.

Discussion.—This subspecies differs from *M. corsicanensis corsicanensis* Stephenson by its more constricted base and in its raised, weltlike fasciolar 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.

Morea 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 ribbons, and a broad fasciolar 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 ribbons 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 ribbon at the suture; they are slightly flexed over each spiral ribbon 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 ribbons; inner lip broadly rounded; parietal lip with a callus that extends out onto body a short distance; columellar lip reflexed somewhat over the umbilical area; columella 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).

Loc.	*H*	*MD*	*HB*	Number of species	*H:D*	*HB:H*
16 (holotype)	35.5	27.8	30.4	11	1.3	0.9
18 (paratype)	28.7	21.8	25.2	10	1.3–	.9
Arkansas (paratype)	28.5	24.4	27.5	10	1.2	1.0

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 22622 (Arkansas).

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

Morea marylandica marylandica Gardner

Plate 20, figures 4–6, 10, 19–22, 25, 26

1916. *Morea marylandica* Gardner, Maryland Geol. Survey, Upper Cretaceous, p. 466, pl. 18, fig. 13.

1925. *Morea (Pseudomorea) marylandica* Gardner. Cossmann, Essais Paléoconchologie Comparée, v. 13, p. 264, pl. 8, figs. 37, 38.

1926. *Morea marylandica* Gardner. Wade, U.S. Geol. Survey Prof. Paper 137, p. 133, pl. 51, figs. 3, 8.

1941. *Morea (Pseudomorea) marylandica* Gardner. Wenz, Handbuch der Paläozoologie; Gastropoda, v. 6, pt. 5, p. 1115.

1945. *Morea marylandica* Gardner. Harbison, Philadelphia Acad. Nat. Sci. Proc., v. 97, p. 83, pl. 4, figs. 21, 22.

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).

Loc.	18	6	1
Number of specimens measured	8	5	4
Range of shell height	14.7–21.8	13.8–18.2	13.8–28.8
Average	18.7	16.3	19.9
Range of maximum diameter	9.3–12.5	8.5–12.0	8.4–18.7
Average	11.8	10.4	12.2
Range of height of body	10.3–15.0	10.4–12.8	10.5–20.2
Average	13.1	11.5	15.0
Range *H:D*	1.4–1.7	1.5–1.6	1.5–1.8
Average	1.5	1.6	1.5
Range of *HB:H*	.7–.8	.7–.8	.7–.8
Average	.7	.7	.7

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 slimmer outline, higher spire, weltlike 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. 20). The number of spiral ribbons 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 languida* 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 Mississippi specimens that I am hesitant to make any distinction.

Types: Holotype Gardner collection USNM (Maryland); hypotypes USNM 32913 (Tennessee), USNM 20549, 130200–130204 (Mississippi).

Occurrence: Tennessee: Ripley Formation, loc. 1. Mississippi: Ripley Formation, locs. 4–7, 12, 14–16, 18, 22. Texas: Nacatoch Sand (variety). Georgia and Alabama (Chattahoochee River region): Ripley Formation. Maryland: Monmouth Formation.

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 130205.

Occurrence: Mississippi: Ripley Formation, loc. 11.

Morea transenna Stephenson

Plate 20, figures 23, 24

1955. *Morea transenna* Stephenson, U.S. Geol. Survey Prof. Paper 274–E, p. 129, pl. 22, figs. 6–9.

Diagnosis.—Medium-sized finely ornamented moreids 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. 466) than it is to any available species of *Morea*. Compared with the Maryland species *M. transenna* has more numerous and closely spaced axials thus producing a finer sculpture pattern at the same growth stages, and its shoulder droops at a much steeper angle.

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. transenna*. This sloping leads to a more broadly rounded outline. In other respects, for example ornament, there appears little basis for differentiation. *M. transenna* 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 20433; paratype USNM 128193 (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. rotunda*, but the height of spire is more compatible with that of *M. marylandica* type.

Type: Figured specimen USNM 130206.

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, *Panamorea 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 liratus*, 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, fasciolar 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

1917. *Paramorea lirata* Wade, Philadelphia Acad. Nat. Sci. Proc., v. 69, p. 296, pl. 17, figs. 9, 10.
1925. *Paramorea lirata* Wade. Cossmann, Essais Paléoconchologie Comparée, v. 13, p. 260, pl. 11, fig. 11, 12.
1926. *Paramorea lirata* Wade, U.S. Geol. Survey Prof. Paper 137, p. 134, pl. 52, figs. 1, 2.
1941. *Cantharus (Paramorea) liratus* (Wade). Wenz, Handbuch der Paläozoologie, Gastropoda, v. 6, pt. 5, p. 1199, fig. 3412.

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).

Loc.	*H*	*MD*
Holotype	7.3	4.7
Topotype	7.7	5.0
Do	10.1	6.4

Discussion.—The holotype of *Paramorea lirata* from Coon Creek, Tenn., is not perfectly preserved and some of the ornament has been spalled 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 teloconch 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 32919; 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 columella and immediately above the siphonal canal.

Discussion.—Wade (1916, p. 468) 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. immersa*, 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 *Hillites* Stephenson.

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

Schizobasis depressa Wade

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

1916. *Schizobasis depressa* Wade, Philadelphia Acad. Nat. Sci. Proc., v. 68, p. 469, pt. 24, figs. 8, 9, 10.
1925. *Schizobasis depressa* Wade. Cossmann, Essais Paléoconchologie Comparée, v. 13, p. 274, pl. 8, figs. 27, 30.
1926. *Schizobasis depressa* Wade, U.S. Geol. Survey Prof. Paper 137, p. 177, pl. 59, figs. 17–19.
1940. *Schizobasis depressa* Wade. Wenz, Handbuch der Paläozoologie; Gastropoda, v. 6, pt. 4, p. 722, fig. 2092.

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).

Loc.	*H*	*MD*	*H:D*
1 (holotype)	18.3	22.2	0.8
1 (topotype)	20.0	22.8	.9
Do	25.0	26.2	.9
Do	21.5	25.7	.8

Discussion.—*Schizobasis depressa* is known only from its type locality on Coon Creek, McNairy County, Tenn. Although it is not a common element of the fauna, a number of well-preserved specimens are available for study. These show only minor variability in ornament and body proportions. One specimen, an incomplete and immature topotype (pl. 20, figs. 29, 30), shows that the deeply impressed sulcus at the base of the body does not develop until the later stages of growth and that there is an umbilical opening in the early stages. In addition, fine secondary spiral lirae are present in the spiral interspaces, but are lost near the aperture on the larger specimens.

Schizobasis immersa Wade differs by having less broad spiral elements that are more numerous, more closely spaced, and less coarsely noded. In addition its spire is lower.

Types: Holotype USNM 73102; hypotypes USNM 130211–130213.

Occurrence: Tennessee: Ripley Formation, loc. 1.

Schizobasis immersa Wade

Plate 20, figures 31, 32, 35, 36

1926. *Schizobasis immersa* Wade, U.S. Geol. Survey Prof. Paper 137, p. 177, pl. 59, figs. 22, 23.

Diagnosis.—A *Schizobasis* with a low spire and a body whorl bearing eight close-spaced noded spiral cords.

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

Loc.	*H*	*MD*	*H:D*
1 (holotype)	23.3	24.5	0.9
Eufaula, Ala	19.0	23.0	.8
Do	11.5	22.0	.8

Discussion.—Only one specimen of *Schizobasis immersa*, 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 species at a higher stratigraphic position within the Ripley Formation in Alabama.

Schizobasis immersa 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 73103.

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

Family MAGILIDAE

Genus LATIAXIS Swainson, 1840

Type by monotypy, *Pyrula mawae* 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. liratus* to *Hippocampoides*. The later species is here designated the type of the new genus *Lowenstamia*, 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. pilsbryi* Hirsae (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

1916. *Hippocampoides serratus* Wade, Philadelphia Acad. Nat. Sci. Proc., v. 68, p. 467.

1925. *Nummocalcar* (*Hippocampoides*) *serratus* (Wade), Cossmann, Essais Paléoconchologie Comparée, v. 13, p. 284, pl. 11, figs. 3–5.

1926. *Hippocampoides serratus* Wade, U.S. Geol. Survey Prof. Paper 137, p. 176, pl. 59, figs. 9–11.

1938. *Hippocampoides serratum* Wade. Wenz, Handbuch der Paläozoologie; Gastropoda, v. 6, p. 200, fig. 355.

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 teloconch 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 teloconch whorl generally depressed, occasionally lying at a slight angle to teloconch 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 gerontic development and specimens of earlier developmental stages show thin lips (pl. 21, fig. 5).

There are no other known related Cretaceous species, but the recent species *L. pilsbryi* (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 73099; 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 liratus* 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 Corsicana 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 *Latiaxis* Swainson 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 *Latiaxis*, such as *L. serratus* (Wade) and *L. pilsbryi* 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.

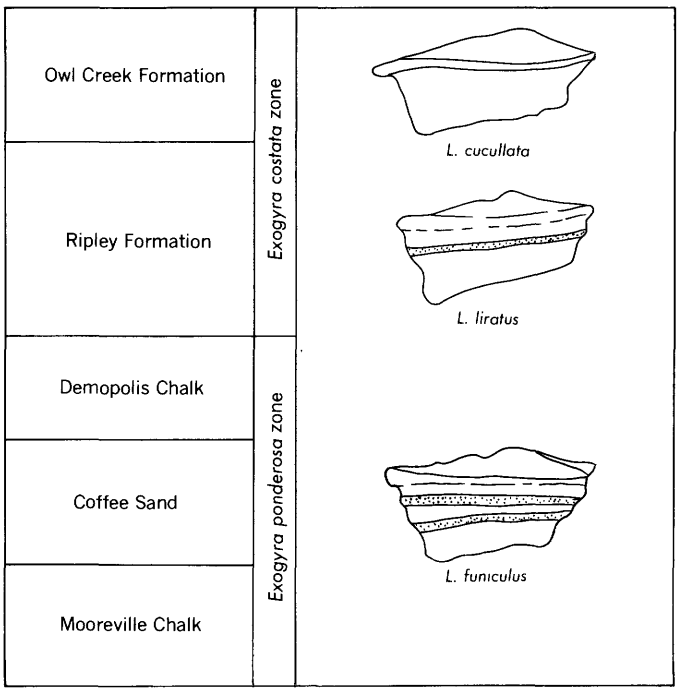


FIGURE 14.—Development of the species of *Lowenstamia* in the Upper Cretaceous of the Mississippi embayment region.

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. liratus*, 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 nodose to subspinose spiral cords upon the whorl sides between the peripheral and umbilical carinations.

Description.—Medium-sized very low spired phaneromphalus shells. Protoconch unknown. Suture impressed with an irregular trace. Whorls with flattened upper surface that may develop welts and bumps and a coarse surface in later developmental stages; whorls peripherally angulated by a strong nodose to subspinose carina; whorl sides slope adaxially but are broadly concave. Sculpture coarse; spiral ornament 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 carinations 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 serrate to subspinose carinate margin.

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

Discussion.—The holotype of *Lowenstamia 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).

Lowenstamia liratus (Wade)

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

1926. *Hippocampoides liratus* Wade, U.S. Geol. Survey Prof. Paper 137, p. 176, pl. 59, figs. 13–15.

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

Description.—Medium-sized very low spired phaneromphalus shells. Protoconch of about two erect well-rounded smooth whorls that stand up above the plane of teloconch volution; junction with teloconch 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).

Loc.	*H*	*MD*
1 (holotype)	10.8	17.2
18 (hypotype)	16.0	22.5
5 (hypotype)	19.0	26.0
1 (topotype)	10.5	19.0

Discussion.—*Lowenstamia 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.

Lowenstamia cucullata Sohl, n. sp.

Plate 21, figures 24, 27

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

Description.—Moderately small low-spired broadly phaneromphalus shells. Protoconch erect with smooth round-sided whorls. 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 *Lowenstamia 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.

Lowenstamia cf. L. subplanus (Gabb)

Plate 21, figures 16, 17, 21

cf. 1860. *Straparolus subplanus* Gabb, Philadelphia Acad. Nat. Sci. Jour., 2d ser., v. 4, p. 300, pl. 48, figs. 4a, b.
cf. 1941. *Weeksia subplanus* (Gabb). Stephenson, Texas Univ. Bull. 4101, p. 258.

Discussion.—The holotype of Gabb's species *Straparolus subplanus* is an internal mold from the Prairie Bluff Chalk of Alabama and is preserved in the collections of the Academy of Natural Sciences of Philadelphia (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 angulation. 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 together indicate a close affinity to *Lowenstamia*. *Weeksia*, 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, 66, 67, 71, 74, 82, 88. Alabama: Prairie Bluff Chalk.

Superfamily BUCCINACEA
Family BUCCINIDAE

Genus STANTONELLA Wade, 1926

Type by original designation, *Stantonella subnodosa* Wade.

Synonymy.—*Aliofusus* 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 canal that is bordered above by a distinct oblique swelling at the base of the columellar lip.

Discussion.—Wade (1926, p. 127) proposed this genus for two species, *Stantonella subnodosa* Wade from the Ripley Formation of Coon Creek, Tenn., and *Chemnitzia interrupta* Conrad from the Owl Creek Formation. Both these species are based upon incomplete 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 misunderstanding led to the introduction by Stephenson (1941, p. 336) of the name *Aliofusus*. He stated

> Specimens in the collections of the U.S. National Museum from the Ripley formation, Eufaula, Alabama, and from Union County, Mississippi, labelled *Strepsidura interrupta* Conrad and *Fusus* sp. probably belong to this genus (*Aliofusus*).

These specimens (USNM 21161, 20550, 20525, 20500) all belong to *Strepsidura ripleyana* Conrad a species here included in *Stantonella*. Stephenson (1941, p. 336) also included *Pyrifusus monmouthensis* Gardner (1916, p. 459) in *Aliofusus*, but this form appears to be a *Stantonella* also. *Aliofusus* Stephenson is probably a related form of which not all the features of the anterior extremities are known. *Aliofusus* lacks the distinctive posterior noded collar of *Stantonella*, has a sloping rather than an excavated shoulder area, and is more truly fusiform in outline. In the character of the protoconch, general trend of the growth lines, and in possessing a twisted siphonal canal the two genera are similar. *Aliofusus reagani subtilis* Stephenson even shows a few faint rudimentary nodes at the suture, which support a close relationship. It is entirely possible that *Aliofusus* 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 undescribed species the oldest occurrence lowers the range of *Stantonella* to the late Coniacian or Santonian 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
Strepsidura ripleyana Conrad, Ripley Formation, Mississippi
interrupta Conrad, Owl Creek Formation, Mississippi
Pyrifusus monmouthensis Gardner, Monmouth Formation, Maryland

Stantonella sp., Providence Sand, Georgia
cf. *S. rugosa* Stephenson, Coffee Sand, Mississippi
sp., Escondido Formation, Texas
Fasciolaria? *lyelli* Stephenson, Black Creek Formation, North Carolina (assignment questionable)

Wade (1926, p. 127) assigned *Stantonella* to the Fusidae. Stephenson (1941, p. 332) questionably assigned it to the Buccinidae. Wenz (1941, p. 1190) was also of the opinion that *Stantonella* should be placed in the Buccinidae. It is here placed in the Buccinidae close to *Tryonella* Stephenson and *Aliofusus* 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

1926. *Stantonella subnodosa* Wade, U.S. Geol. Survey Prof. 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 occurring below this zone than those above. Like *Fasciolaria*? *rugosa* Stephenson, from the *E. ponderosa* 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 noded 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 equivalents 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

1860. *Strepsidura ripleyana* Conrad, Philadelphia Acad. Nat. Sci. Jour., 2d ser., v. 4, p. 286, pl. 46, 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 teloconch whorls; initiation of ornament gradual; close-spaced broad transverse ribs with spiral ribbons in the rib interspaces present on the first teloconch whorl. Suture impressed. Typical shouldered whorls do not develop until the second teloconch whorl. Teloconch whorls number 6–7 and are posteriorly constricted to a strong subsutural collar 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 coarse ribs that are direct and continuous suture to suture on the round sides of the first teloconch 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 teloconch 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 ornament 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 shoulder and collar and strongest on the shoulder angulation 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, callused 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).

Loc.	*H*	*MD*	*H* spire	*MD:H* spire
6 (pl. 22, figs. 18, 19)	47.5	22.8	14.5	1.6
6	31.3+	16.0	9.8	1.6
16	36.8+	20.0	10.6	1.9
18	31.0+	15.6	10.4	1.5
18	40.5+	25.5	16.5	1.5
18	42.0+	24.8	----	----
7	20.1	9.4	----	----
7	22.4	11.9	----	----
17	41.5	21.5	13.3	1.6
12	31.8	18.2	10.3	1.8

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 columellar welt, and has more continuous transverse ribs, which are bowed over the periphery rather than directly opisthocline.

Types: 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

1858. *Chemnitzia interrupta* Conrad, Philadelphia Acad. Nat. Sci. Jour. 2d ser., v. 3, p. 333, pl. 35, fig. 15.

Diagnosis.—Shell large for genus; subsutural collar noded, transverse ribs arcuately 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 whorls 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 whorls, but on body whorls 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.

Loc.	*H*	*MD*	*H* spire	*MD:H* spire
Hypotype	65+	38.0	21.0	1.8
Do	58+	33.0	19.2	1.7
Topotype	41.4+	24.4	13.0	1.8
Do	37.2	21.0	12.0	1.7

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 ripleyana* (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). *Pyrifusus monmouthensis* 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, locs. 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 do 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 130229–130231.
Occurrence: Mississippi: Prairie Bluff Chalk, locs. 71, 82, 87, 90, 91, 92, 94.

Genus ALIOFUSUS Stephenson, 1941

Type by original designation, *Aliofusus reagani* Stephenson.

Diagnosis.—Subfusiform 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 lirae of variable strength. Aperture subrhomboidal 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 *Pyrifusus monmouthensis* and specimens labeled *Strepsidura 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 reagani* Stephenson belong in *Stantonella*. It should be pointed out that *Aliofusus reagani* Stephenson and the two varieties *A. reagani subtilis* and *A. reagani 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 *Cryptorhytis* possess a similar outline, shoulder, ornament, and growth line but possess plications on the columella. *Woodsella* 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, subfusiform; 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 whorls; junction of conch abrupt with addition of transverse ribs. Whorls 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 prosocline above shoulder, form a moderately strong sinus over the shoulder and become opisthocline over the periphery. Aperture angularly subovate, angulated posteriorly, and anteriorly produced to a narrow elongate slightly twisted siphonal canal; outer lip thin at edge, indented at shoulder; inner lip excavated, thinly callused. Columella smooth.

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 *Aliofusus reagani* 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, 1865, not Buccinopsis Jeffreys 1867, not Buccinopsis (Bayle) Mayer, 1876)

1857. *Buccinopsis* Conrad, 1857, Rept. U.S. and Mexican Boundary Survey, v. 1, pt. 2, p. 158.
1917. *Seminola* Wade, Philadelphia Acad. Nat. Sci. Proc., v. 69, p. 290.
1918. *Seminole* Wade, (misprint for *Seminola*) Am. Jour. Sci., 4th ser., v. 45, p. 334.
1920. *Ripleyia* Cossmann, Rev. Critique Paléozoologie et Paleophytologie, v. 24, no. 3, p. 137.
1926. *Seminola* Wade, U.S. Geol. Survey Prof. Paper 137, p. 144.

Type by monotypy, *Buccinopsis perryi* Conrad, 1857.

Diagnosis.—Globose low-spired shells with well-rounded to well-shouldered whorls 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. 23, fig. 25) show this species possesses the typical shape and fasciolar characters of the better known genus *Seminola* Wade. 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 Owl 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, 1923, 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 *Exogyra 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, *Fascioloria crassicostata* Gabb (1877, p. 282), an undescribed species from Pataula Creek, Ga., and *Buccinopsis perryi* Conrad all occur within the *Exogyra costata* zone. As known, *Buccinopsis* is restricted to the Gulf and Atlantic Coastal Plains and ranges through the *Exogyra ponderosa* and *Exogyra 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

1917. *Seminola crassa* Wade, Philadelphia Acad. Nat. Sci. Proc., v. 69, p. 291, pl. 19, figs. 6, 7.
1918. *Seminola crassa* Wade. Cossmann, Rev. Critique Paléozoologie, v. 22, no. 1–2, p. 21.
1925. *Ripleyia crassa* (Wade). Cossmann, Essais Paléoconchologie Comparée, v. 13, p. 259, pl. 11, figs. 1, 2.
1926. *Seminola crassa* Wade, U.S. Geol. Survey Prof. Paper 137, p. 145, pl. 50, figs. 9–12.
1941. *Seminola crassa* Wenz. Handbuch der Paläozoologie; Gastropoda, v. 6, pt. 5, p. 1184, fig. 3369.
1941. *Seminola crassa* Wade. Stephenson, Texas Univ. Bull. 4101, p. 329, pl. 63, figs. 1–4.

Diagnosis.—Large buccinopsids 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).

Loc.	*H*	*MD*	*HB*	*H:D*	*HB:H*	*HB:MD*
1 (holotype)	71.3	48.5	48.6	1.5	0.68	1.0
1 (paratype)	52.7	37.5	37.7	1.4	.73	1.0
1 (topotype)	40.6	31.4	31.7	1.3	.78	1.0
Do	79.4		65.4		.82	
Texas (hypotype)	89.0	61.0	54.2	1.40		1.1
Do	77+	55.2	53.4	1.4	.68	1.0
Do	22.6	20.7	20.4	1.1	.90	1.0

Discussion.—With the exception of *Buccinopsis perryi* Conrad this is the largest of the buccinopsids. 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 Nacatoch 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 subdued and the siphonal fasciole more coarsely ridged. On the largest Nacatoch 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 dorothiella* 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 crassicostata* of the Owl Creek shows poorly developed ornament at a very early stage and a complex fasciolar area.

Types: Holotype and paratype USNM 3291; hypotypes USNM 77029 and USNM 130234.

Occurrence: Tennessee: Ripley Formation, loc. 1. Texas: Nacatoch Sand.

Buccinopsis solida solida (Wade)

Plate 22, figures 4, 5

1917. *Seminola solida* Wade, Philadelphia Acad. Nat. Sci. Proc., v. 69, p. 292, pl. 19, figs. 1, 2.
1920. *Ripleyia solida* (Wade), Cossmann, Rev. Critique Paléozoologie et Paleophytologie, v. 24, no. 3, p. 137.
1926. *Seminola solida* Wade, U.S. Geol. Survey Prof. Paper 137, p. 145, pl. 51, figs. 1, 2.

Diagnosis.—Medium-sized globose low-spired buccinopsids 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 subsutural 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 ribbons 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 callus extending out over parietal lip onto body and down over columellar lip. Columella bears a heavy oblique fold bordering anterior canal.

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

Loc.	*H*	*MD*	*HB*	*H:D*
1 (holotype)	23.5	20	18.7	1.2
1 (paratype)	20+	17	16.2	1.2
1 (topotype)	27.8	19.8	21.0	1.3
Do [1]	31	21.6+	22.5	1.4
Do	28	21	19.9	1.3
18	40.5	32.2	30	1.2
18	23.4	19.4	17.8	1.2
7	31.2	24.5	25.0	1.3
29	25.5	22.0	17.9	1.2

[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 *Exogyra cancellata* zone.

Buccinopsis solida is distinguished from *B. crassa* 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. crassicostata* (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. 5, 6, 18, 29, 32.

Buccinopsis solida sulcata Sohl, n. subsp.

Plate 22, figures 6, 7

Diagnosis.—Medium-sized buccinopsids 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 40, 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 buccinopsid 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, trochoid 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 collabral 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 S-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

Loc.	H	MD	HB	H:D
Alabama (holotype)	26.5	19.6	19.5	1.3
Alabama (paratype)	29.6	21.8	21.9	1.3
Mississippi (paratype)	25.2	17.5	17.7	1.4

of Mercers Mill on Tabannee 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 paratype (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 dorothiella is distinguished from all other species of the genus by the general lack of spirals on the periphery and in its less obese body.

Types: Holotype USNM 130237; paratypes USNM 130238, 130239.

Occurrence: Mississippi: Ripley Formation, locs. 6?, 15, 16, 18. Alabama and Georgia (Chattahoochee River region): Ripley Formation.

Buccinopsis crassicostata (Gabb)

Plate 23, figures 14, 15, 16, 17

1876. *Nassa globosa* Gabb (in part), Philadelphia Acad. Nat. Sci. Proc., v. 28, p. 282.

1876. *Fasciolaria (Cryptorhytis) crassicostata* Gabb, Philadelphia Acad. Nat. Sci. Proc., v. 28, p. 282.

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 anteriorly to a spiral sulcus that borders the siphonal canal. Suture impressed. Ornament on early whorls consists of thick very broad but rather low transverse ribs that are strongest on the shoulder and die out on base; numerous spiral ribbons, broader than their interspaces, override the ribs. On larger shells the transverse ribs decrease in strength until only irregular 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 ribbon remains strong. Aperture incomplete, subovate, posteriorly 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. 172).

Loc.	H	MD	HB
46 (holotype)	29.3	23.2	22.4
46 (paratype)	29.5	24.7	22.9
Do	[1] 50+	37.7	----
40	36.9	26.1+	25+
42	28	18	21.5

[1] Estimated.

Discussion.—Gabb (1877, p. 282) proposed and described *Fasciolaria (Cryptorhytis) 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 compressed specimen. Better preserved specimens from the type locality in the collections of the U.S. Geological Survey indicate the nature of the mature stage to be that of the specimens from Mississippi described and discussed here. The holotype of *Nassa globosa* Gabb has been figured by Stephenson (1923, pl. 93, 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 under 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 specimens indicate that the earliest whorls of this species are completely filled with shell material.

This species is differentiated from other buccinopsids 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. dorothiella*, but it loses its subsutural 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, 46. 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 columellar 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-volution ventricose, 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; columella 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 columellar 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. 353 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. 23, 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

1926. *Odontobasis australis* Wade, U.S. Geol. Survey Prof. Paper 136, p. 146, pl. 51, figs. 13, 14; pl. 52, figs. 13, 14.

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

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

Loc.	*HS*	*MD*	*HB*
1 (topotype)	7.2	3.0	3.2
Do	7.0	3.1	3.4
Topotype (1) (pl. 23, fig. 5)	9.0	3.5	4.3

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 columellar plications. If the genus is accepted in this broad sense *Odontobasis australis* Wade can validly be retained in *Odontobasis*.

Types: Holotype USNM 32918; paratype USNM 32918; hypotype USNM 130244.

Occurrence: Tennessee: Ripley Formation, loc. 1.

Odontobasis sulcata Sohl, 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 siphonal 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 welts. Whorls three to four in number; suture impressed. Body well rounded peripherally, constricted both anteriorly and posteriorly; base of body delimited from siphonal 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 ribbons as wide or wider than their interspaces that override the ribs; there are 6 spiral ribbons on the penultimate whorl and 12 on the body above the sulcus. Surface of body covered by growth lines of moderate strength that are reflexed in the interspiral spaces, over the sulcus, and on the siphonal fasciole. Aperture slightly angulated posteriorly, anteriorly produced to a short oblique slightly twisted siphonal 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 siphonal 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).

Loc.	*H*	*MD*
18 (holotype) (pl. 23, fig. 1)	8.9	4.7
18 (paratype) (pl. 23, fig. 3)	7.8	4.1

Discussion.—*Odontobasis sulcata* Sohl compares well in shape and ornament with the western interior species described by Meek but possesses more numerous columellar 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. ventriocosa* 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

Protobusycon Wade, 1917

Type by original designation, *Busycon* (*Protobusycon*) *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 siphonal canal and a posterior notch; outer lip notched at intersection with the noded rows and toothed where the spiral sulcus intersects outer lip.

Discussion.—The relationship of the species here placed in *Protobusycon* Wade to *Busycon* Bolten is much clouded. Wade believed *Protobusycon* to be a forerunner of the present day *Busycon*. However, we know little or nothing of the character of the nuclear whorls of *Protobusycon* 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 *Busycon*. *Busycon* (*Busy-*

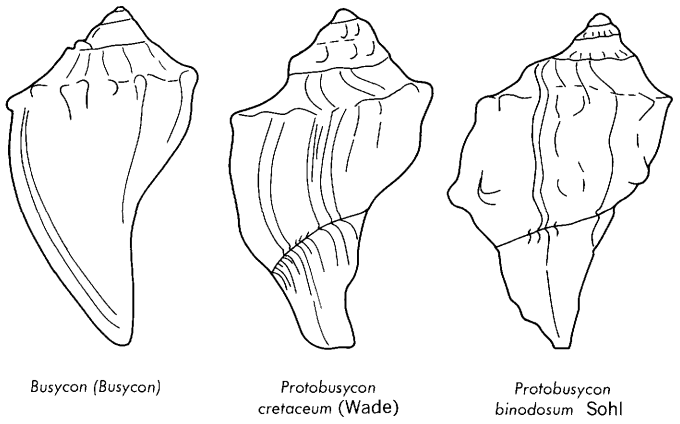


FIGURE 15.—Comparison of growth lines between *Busycon* (*Busycon*) and *Protobusycon*.

con) is generally conceded to range from the Oligocene to the Recent, but, on the basis of comparison of nuclear whorls, some doubt has been cast on the validity of inclusion of the Oligocene forms in *Busycon* (S. C. Hollister, oral communication.)

What scant evidence there is points to *Protobusycon* being distinct, even though possibly related to *Busycon*. One would expect that if *Protobusycon* were a forerunner of *Busycon* (*Busycon*) younger species of the genus would begin to become more *Busycon*-like in character. This does not appear to hold true. *Protobusycon cretaceum* Wade from the *Exogyra cancellata* zone has, like *Busycon* (*Busycon*), a single row of nodes at the shoulder but also has a lesser developed second row on the inflated part of the body just above the basal sulcus. These nodes die out near the aperture. In *Protobusycon binodosum* Sohl, from a higher level in the Ripley Formation, the lower row of nodes becomes as strong or stronger than the upper row. In addition, the spire becomes evenly tapering instead of stairstepped. The changes in these features are both in a direction leading away from typical *Busycon* features, not toward them.

Aside from these species from the Ripley Formation, the only tentative record of *Busycon* in the Cretaceous is that of a specimen from the Nacatoch Sand of Texas that Stephenson (1941, p. 324) identified as *Busycon*? sp. This specimen retains only the incomplete external impression of almost half a body whorl of a shell possessing a strongly noded shoulder. However, the specimen is so incomplete that even a guess as to the generic affinities is fruitless.

Protobusycon cretaceum (Wade)

Plate 23, figures 23, 24

1917. *Busycon* (*Protobusycon*) *cretaceum* Wade, Am. Jour. Sci., 4th ser., v. 43, p. 296, figs. 1, 2.

1917. *Fulgur* (*Protobusycon*) *cretaceum* (Wade). Cossmann, Rev. Critique Paléozoologie, v. 20, no. 3, p. 100.

1925. *Protobusycon cretaceum* (Wade). Cossmann, Essais Paléoconchologie Comparée, v. 13, p. 247, pl. 8, fig. 4.

1926. *Busycon* (*Protobusycon*) *cretaceum* Wade, U.S. Geol. Survey Prof. Paper 137, p. 136, pl. 47, figs. 1, 4.

1943. *Busycon* (*Protobusycon*) *cretaceum* Wade. Wenz, Handbuch der Paläozoologie; Gastropoda, v. 6, pt. 6, p. 1218, fig. 3464.

1954. *Busycon*? (*Protobusycon*) *cretaceum* Wade. Puffer and Emerson, Washington Biol. Soc. Proc., v. 67, p. 116–117, 120, 129.

Diagnosis.—A *Protobusycon* 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.

Protobusycon binodosum 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 32897.

Occurrence: Tennessee: Ripley Formation, loc. 1.

Protobusycon binodosum Sohl, n. sp.

Plate 24, figures 23, 24, 26, 27

Diagnosis.—A *Protobusycon* 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 toothlike 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).

Loc.	*H*	*MD*
18 (holotype)	63	37
17 (paratype)	52+	37

Discussion.—*Protobusycon binodosum* 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 spire. 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.

Protobusycon 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 *Protobusycon 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. binodosum* Sohl.

Genus LOMIROSA Stephenson, 1941

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

Diagnosis.—Medium-sized subfusiform 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 *Lirosoma* Conrad, of the Miocene, 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

1917. *Lirosoma cretacea* Wade, Philadelphia Acad. Nat. Sci. Proc., v. 69, p. 588, pl. 18, figs. 5, 6.
1926. *Lirosoma cretacea* Wade, U.S. Geol. Survey Prof. Paper 137, p. 139, pl. 47, figs. 2, 11.
1941. *Lomirosa cretacea* (Wade). Stephenson, Texas Univ. Bull. 4101, p. 348, pl. 67, figs. 18, 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 32898; hypotype USNM 77088 (Texas).
Occurrence: Tennessee: Ripley Formation, loc. 1. Texas: Nacatoch Sand.

Genus PYRIFUSUS Conrad, 1958

Type by monotypy, *Pyrifuses subdensatus* Conrad.

Diagnosis.—Low-spired pyriform shells with subshouldered 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, 1935). 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. vittatus* 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 *Hercorhyncus 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-Maestrichtian). 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

1858. *Pyrifusus subdensatus* Conrad, Philadelphia Acad. Nat. Sci. Jour., 2d ser., v. 3, p. 332, pl. 35, fig. 12.

Diagnosis.—Shell slimmer and smaller than average for the genus with strongly shouldered whorls and with the transverse ribs continuing to the sutural 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 lirae 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 callused with callus 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).

Loc.	*H*	*MD*	*H:MD*
Topotype	30	17	1.7
Do	23	13	1.7
45	29	18	1.6

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 subliratus* Wade serves to dis-

tinguish 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. 26353.

Pyrifusus crassus Sohl, n. sp.

Plate 24, figures 12, 16, 17

1860. *Pyrifusus subdensatus* Conrad, Philadelphia Acad. Nat. Sci. Jour., 2d ser., v. 4, pl. 47, fig. 2.

1892. *Pyrifusus subdensatus* Conrad, Whitfield, U.S. Geol. Survey Mon. 18, pl. 4, figs. 1, 2.

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 the total shell height; pleural angle 87°–99°. Suture impressed, irregular in trace where it overrides the transverse ribs of the preceding whorl and bordered below by a subsutural welt. Teloconch 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 collabral 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).

Loc.	*H*	*MD*	*H:MD*
6 (holotype)	32.7	22.0	1.5
18 (paratype)	33.0	22.0	1.5
18	27.0	17.0	1.6
18	34.0	22.5	1.5
18	25.5	15.0	1.7

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 1/6 and 1/7 of the total shell height and is reflected in the spread of 12° (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. sudensatus* 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 130253–130255.

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

Pyrifusus subliratus Wade

Plate 24, figures 11, 21

1926. *Pyrifusus subliratus* Wade, U.S. Geol. Survey Prof. Paper 137, p. 143, pl. 50, figs. 6, 7.

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).

Loc.	*H*	*MD*	*H:D*
Holotype	37.0	26.0	1.4
Topotype	36.0	25.5	1.4
Do	31.0	22.0	1.4
Do	37.0	24.0	1.5
Do	31.0	23.0	1.3

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.)

690-081 O - 64 - 3

In comparison with the other species of *Pyrifusus* dealt with here, *P. subliratus* has more sinuous 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. subliratus*, but this chink, although present on the holotype, is sealed by the callus of the columellar lip on several topotypes. In addition to the above characters the transverse ribs are lower and not continuous to the suture, as in *P. subdensatus* Conrad; the posterior notch is not so narrow as in *P. crassus* or *P. ejuncidus*, nor do the primary spiral cords begin as high on the whorl as on *P. subdensatus*.

Types: Holotype USNM 32910; hypotypes USNM 130256 and 130257.

Occurrence: Tennessee: Ripley Formation, loc. 1.

Pyrifusus ejundicus Sohl, n. sp.

Plate 24, figures 22, 25

1926. *Pyrifusus subdensatus* Conrad. Wade, U.S. Geol. Survey Prof. Paper 137, p. 143, pl. 50, figs. 5, 6.

Diagnosis.—A *Pyrifusus* 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. Teloconch 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 round-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 siphonal canal; outer lip thin and crenulated where intersected by the spiral cords; inner lip callused. Columella smooth.

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

Loc.	*H*	*MD*	*H:D*
Holotype	39	29	1.3
Hypotype	30	18	1.6
Topotype	36	24	1.5
Do	29	18	1.6

Discussion.—Wade (1926, p. 143) placed specimens of this species in *Pyrifusus 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. subliratus* Wade has fewer spiral cords, a more obese and basally constricted body whorl, and very sinuous growth lines. *P. ejundicus* also is more obese, has more sinus growth lines and transverse ornament, and a lower spire.

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

Occurrence: Tennessee: Ripley Formation, loc. 1.

Pyrifusus sp.

Plate 24, figures 8–10, 18, 20

Discussion.—Internal molds that have the outline of *Pyrifusus* 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 *Pyrifusus*. The molds are rare but are found at many localities.

Types: Figured specimens USNM 28334, 130260–130262.

Occurrence: Mississippi: Prairie Bluff Chalk, locs. 57, 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, siphonal 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 *Pyrifusus* to include three species from the Cretaceous of the western interior: *Fusus newberryi* Meek and Hayden, *Fusus subturritus* Meek and Hayden, and *Fusus intertextus* Meek and Hayden. As *Neptunella* Meek is preoccupied by *Neptunella* Gray, Gardner (1916, p. 456) substituted the name *Rhombopsis*. Meek's concept of the genus was broad. The type species *F. new-*

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 *Deussenia* 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. *Pyrifusus* 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 *Deussenia* 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 noded 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 interspaces, 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 opisthocline trend on the subsutural collar, slightly flexed at the shoulder, and gently opisthocline 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 coarse 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

1926. *Rhombopsis orientalis* Wade, U.S. Geol. Survey Prof. Paper 137, p. 142, pl. 49, figs. 4, 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 32904; hypotype USNM 130263.
Occurrence: Tennessee: Ripley Formation, loc. 1.

Genus DEUSSENIA Stephenson, 1941

Type by original designation, *Deussenia 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 sinused 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 *Deussenia* 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 here. The following is a list of known species assignable to *Deussenia*.

Deussenia cibolensis Stephenson, Kemp Clay of Texas
corbis Stephenson, Kemp Clay of Texas
travisana Stephenson, Kemp Clay of Texas
multilirae Stephenson, Kemp Clay of Texas
Fusus (Afer) bellaliratus Conrad, Owl Creek Formation
Deussenia ripleyana Harbison, Ripley Formation of Mississippi
Rhombopsis microstriatus Wade, Ripley Formation of Tennessee
Voluta rigida Bailey, Senonian, Pondoland, South Africa (questionable)
Cryptorhytis pseudorigida Rennie, Senonian, Pondoland, South Africa (questionable)

Deussenia bellalirata bellalirata (Conrad)

Plate 25, figures 8, 9

1858. *Fusus (Afer) bellaliratus* Conrad, Philadelphia Acad. Nat. Sci. Jour., 2d ser., v. 3, p. 332, pl. 35, fig. 17.

Diagnosis.—A *Deussenia* 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 prosocline over collar, sinused at junction with the shoulder, becoming slightly opisthocline 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 callused.

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

Discussion.—*Deussenia billalirata* (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 supplanted by *Rhombopsis* Gardner. However, the type of *Rhombopsis* lacks the distinctive subsutural collar. Stephenson (1914, faunal list) assigned it to *Pyrifusus* 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.

Deussenia bellalirata costata Sohl, n. subsp.

Plate 25, figures 3, 4

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

Discussion.—A number of specimens from the Owl Creek Formation, although similar to *Deussenia 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 numerous 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.

Deussenia ripleyana Harbison

Plate 25, figures 1, 2, 5–7, 11–13

1945. *Deussenia ripleyana* Harbison, Philadelphia Acad. Nat. Sci. Proc., v. 47, pl. 4, figs. 25, 26.

Diagnosis.—A *Deussenia* 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 teloconch 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 teloconch whorl.

Suture impressed. Teloconch 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 collar, sinused at shoulder, arcuate 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 callused. Columella smooth.

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

Loc.	*H*	*MD*
18 (hypotype)	47.8	22.7
18 (topotype)	45.5	21.4
Do	44.5	21.0
Do	36.7	18.0
7	47	22.2

Discussion.—*Deussenia ripleyana* is abundant at its type locality at Union County Lake, Union County, Miss. (loc. 18). It occurs less abundantly at a number of other Ripley 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 plate 25 shows that slimness 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 *Deussenia bellalirata* (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: Ripley Formation, locs. 5, 6, 9a(?), 18, 29. Alabama and Georgia: Ripley Formation.

Deussenia sp.

Plate 25, figures 14, 16

Discussion.—Several specimens from the Ripley Formation at Union County Lake, Union County, Miss. (loc. 18), although only fragmentary, indicate that one or more large species of *Deussenia* may be present. These specimens differ from *D. ripleyana* 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 collabral ribs.

Types: Figured specimens USNM 130270, 130721.
Occurrence: Mississippi: Ripley Formation, loc. 18.

Deussenia cf. D. travisana 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 *Deussenia 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.

Deussenia? microstriata (Wade)

Plate 24, figures 6, 7

1926. *Rhombopsis microstriatus* 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 Ripley Formation on Coon Creek, McNairy County, Tenn. The strong posterior constriction of the whorls to a collar is more typical of *Deussenia* than *Rhombopsis* to which Wade assigned the species. Its fine spiral ornament distinguishes *D.? microstriata* from the other known species of *Deussenia*, and the callus of the inner lip is somewhat stronger than is typical of the genus. In shape it is not unlike the Ripley species assigned to *Cryptorhytis*,

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 subsutural collar, 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. 5, figs. 18–21; Weller, 1907, pl. 90, figs. 1–4) could conceivably belong to *Bellifusus* but is specifically indeterminable, and Weller's assignment (1907, pl. 90, fig. 6) of well-preserved shells from the Ripley Formation of Mississippi to *O. medians* is implausible. Richards and Ramdell (1962, p. 63, 64) have assigned molds of *O. slacki* and *O. medians* to *Bellifusus*.

Drilluta Wade is similar to *Bellifusus* in the nature of the collar and columellar plications, but it has much straighter transverse ribs, a distinctly higher spire, and less rounded whorls.

Based on well-preserved material, the genus as known is restricted to the *Exogyra costata* zone of the Gulf and possibly the Atlantic Coastal Plains. Stephenson (1955, p. 183) has questionably assigned a species from the Cenomanian, Woodbine Formation of Texas, but the specimens do not closely resemble those from the higher parts of the Cretaceous.

The following is a list of described species and their known occurrences.

Bellifusus robustus Stephenson, Nacatoch Sand of Texas
Odontofusus curvicostata Wade, Ripley Formation of Tennessee
Bellifusus? coronatus Stephenson, Neylandville Marl of Texas
deatsvillensis Stephenson, Kemp Clay of Texas
multicostatus Stephenson, Kemp Clay of Texas
Bellifusus sp., Ripley Formation of Alabama
Providence Sand of Georgia
spinosus Sohl, Owl Creek Formation of Mississippi
angulicostatus Sohl, Ripley Formation of Tennessee, Mississippi, and Alabama
crenulatus Sohl, Ripley Formation of Mississippi
Odontofusus medians Weller (in part), Navesink Formation of New Jersey (questionable)
Bellifusus? crassicostatus Stephenson, Kemp Clay of Texas (questionable)
Bellifusus buffaloensis Stephenson, Kemp Clay of Texas = *Drilluta tenuistriatus* Stephenson, Kemp Clay of Texas = *B. curvicostatus* (Wade)
Bellifusus? parvilirae Stephenson, Woodbine Formation of Texas (questionable)

Bellifusus curvicostatus curvicostatus (Wade)

Plate 25 figures 23, 24; plate 26, figures 18, 19, 23, 24

1907. *Odontofusus medians* Weller (part), New Jersey Geol. Survey, Paleontology, v. 4, p. 761, pl. 90, fig. 6.
1926. *Odontofusus curvicostata* Wade, U.S. Geol. Survey Prof. Paper 137, p. 130, pl. 42, figs. 7–9.
1941. *Bellifusus curvicostatus Stephenson*, Texas Univ. Bull. 4101, p. 338.
1941. *Bellifusus tenuistriatus* Stephenson, Texas Univ. Bull. 4101, p. 339, pl. 65, figs. 7–9.

Diagnosis.—A *Bellifusus* having whorls with a rounded shoulder, only the faintest of spiral ornament over the periphery, but bearing numerous strong transverse ribs that generally become strongly sinuous on the body and die out both on the collar and below on the basal slope.

Description.—Fusiform shells with a spire about two-fifths the total shell height. Pleural angle 35°–90°. Suture impressed, irregular in trend as it conforms to transverse ornament. Protoconch consisting

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 teloconch, whorl spiral ornament appears. Whorls number six or seven, constricted posteriorly to a collar that develops on the fourth or fifth teloconch 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 collabral 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 orthocline on collar, sinused over shoulder and periphery, and swing back to prosocline 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.

Loc.	*H*	*MD*
1 (holotype)	50.0	21.0
1 (topotype)	41.0+	20.0
Do.	40.0+	18.0
12 (hypotype)	37.0	16.0
6 (hypotype)	50.0+	22.0
6	40.0+	16.0
6	27.0	12.0
6	28.0	12.0
6	27.0	11.0
18	25.0	10.0
18	32.0	14.0
18	30.0	14.0
18	28.0	12.0

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 in the amount of sinuosity of the transverse ribs is well illustrated by contrasting figure 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 topotype 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 tenuistriatus* 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. spinosus* from the Owl Creek Formation also has a spinose shoulder and more continuous ribs. Available specimens of *B. deatsvillensis* Stephenson from the Kemp Clay have a similar trend to the transverse ribs but are too poorly preserved for close comparison.

Types: Holotype USNM 32873; hypotypes USNM 20490, USNM 130271, 130272, 130274, 130275.

Occurrence: Tennessee: Ripley Formation, loc. 1. Mississippi: Ripley Formation, locs. 5, 6, 12, 14, 15–18, 24, 29. Texas Nacatoch Sand. Georgia and Alabama: Ripley Formation.

Bellifusus curvicostatus crenulatus Sohl, n. subsp.

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 nonwrinkled 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 collabral 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 ribbons and cords are present over the anterior part. Growth lines with flexure at shoulder that periodically develops to 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 curvicostatus* 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 130279; paratype USNM 130280.

Occurrence: Mississippi: Owl Creek Formation, locs. 45, 46?, 43?. 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 collabral 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 nontruncate on body; crest of ribs angulated by a thin raised extra strong growth lira. 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 callused and bearing a strong plication anterior to a much weaker fold.

Measurements.—The holotype is the only nearly complete specimen but is somewhat compressed dorsoventrally. 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.

Occurrence: Tennessee: Ripley Formation, loc. 1. Mississippi: Ripley Formation, locs. 16, 18. Georgia and Alabama: Ripley Formation.

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 columellar 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 130284–130287.

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; columella 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. Pilsbry and Olsson (1954, p. 15) placed it within their new subfamily Athletinae of the Volutidae, 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
Drilla? distans Conrad, Ripley Formation of Texas to Georgia
Drilluta major Wade, Ripley Formation of Tennessee
Rostellites marylandicus Gardner, Brightseat Formation of Maryland
Fusus novemliratus 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:*

Fasciolaria? sp. Gardner, Monmouth Formation of Maryland
Anchura? monmouthensis Gardner, Monmouth Formation of Maryland

Described species of *Drilluta* that are here reassigned:

Turbonilla (Chemnitzia) laqueata Conrad = *Drilluta distans* (Conrad)
Drilluta brevispira Stephenson = *Drilluta distans* (Conrad)
crassicostata Stephenson = *Drilluta communis* Wade
dimurorum Wade = *Drilluta major* Wade

Several species from Africa may also belong in *Drilluta.* Wade (1926, p. 116) believed that *Cerithium traffrarium* 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 Cameroons is probably not a *Drilluta.* Collignon (1949a) assigned an internal mold from the Senonian of Madagascar 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 columellar plication. Better preserved material is necessary before this species can be accepted in the genus.

The specimens Gardner (1916, p. 424, 438, pl. 15, fig. 1; pl. 14, fig. 11) assigned to *Rostellites marylandica* and *Fasciolaria?* sp. perhaps belong to the same species and have a columellar plication and ornament like that of *Drilluta.* They are most similar to *Drilluta major* Wade. *Anchura? monmouthensis* Gardner (1916, p. 476) the second questionably assigned form, is based on an internal mold that bears the impression of a columellar 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 *Fasciolaria?* sp. by Gardner.

Drilluta communis Wade

Plate 27, figures 12, 13, 20–22

1916. *Drilluta communis* Wade, Philadelphia Acad. Nat. Sci. Proc., v. 68, p. 459, pl. 23, figs. 5, 6.
1925. *Drilluta communis* Wade. Cossmann, Essais Paléoconchologie Comparée, v. 13, p. 244, pl. 10, figs. 25, 26.
1926. *Drilluta communis* Wade, U.S. Geol. Survey Prof. Paper 137, p. 116, pl. 38, figs. 4, 5.
1941. *Drilluta crassicostata* Stephenson, Texas Univ. Bull. 4101, p. 352, pl. 67, figs. 3, 4.

1941. *Drilluta crassicostata longa* Stephenson, Texas Univ. Bull. 4101, p. 353, pl. 67, figs. 5, 6.
1943. *Drilluta communis* Wade. Wenz, Handbuch der Paläozoologie; Gastropoda, v. 6, p. 1418, fig. 4006.

Diagnosis.—A high-spired moderately slender *Drilluta* 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, *Drilluta communis* Wade is one of the more common gastropod species. The same holds true where it is found in the Nacatoch Sand of Texas. *Drilluta 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.

Drilluta distans (Conrad) has a shorter spire 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: Nacatoch Sand.

Drilluta distans (Conrad)

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

1860. *Drillia? distans* Conrad, Philadelphia Acad. Nat. Sci. Jour., 2d ser., v. 4, p. 286, pl. 46, fig. 40.
1860. *Turbonilla (Chemnitzia) laqueata* Conrad, Philadelphia Acad. Nat. Sci. Jour., 2d ser., v. 4, p. 288, pl. 46, fig. 36.
?1926. *Drilluta distans* (Conrad). Wade, U.S. Geol. Survey Prof. Paper 137, p. 117, pl. 38, figs. 6, 7.
1941. *Drilluta paucicostata* Stephenson, Texas Univ. Bull. 4101, p. 353, pl. 67, figs. 1, 2.
1941. *Drilluta brevispira* Stephenson, Texas Univ. Bull. 4101, p. 354, pl. 67, fig. 7.

Diagnosis.—A *Drilluta* 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).

Loc.	*H*	*MD*
6	40.0	14.8
6	57.2	21.1
6	41.5	16.7
6	45.5	16.0
16	45.4	16.0
16	48.3	16.4
18	51.0	16.6
18	52.8	16.9
18	39.5	15.1
18	37.2	13.2

Discussion.—*Drilluta 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 *Drillia? 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 *Turbonilla (Chemnitzia) laqueata*, as a glance at the figure given herein (pl. 27, fig. 6) shows, belongs in *Drilluta distans*. *D. brevispira* Stephenson is typical of *D. distans* as defined here.

The specimens from Mississippi here assigned to *Drilluta 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 9060; hypotype (= holotype *Turbonilla laqueata* Conrad) AMNH 9051; hypotype (= holotype *D. brevispira*) USNM 77107; hypotype (= holotype *D. paucicostata*) USNM 77105; hypotypes USNM 130292, 130293 (Ala-

bama); hypotypes USNM 130723, USNM 130294–130299 (Mississippi).

Occurrence: Mississippi: Ripley Formation, at locs. 4–6, 12, 14, 15–18. Tennessee: Ripley Formation, at loc. 1(?). Alabama and Georgia: Ripley Formation.

Drilluta lemniscata Sohl, n. sp.

Plate 27, figures 16–19

Diagnosis.—Outline slim for genus; subsutural collar narrow and bears strong incrementals; 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 incrementals 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 ribbons and cords cover the entire shell surface and override the transverse elements; ribbons number 22–25 on the body whorl. Growth lines flexed on collar, orthocline to slightly opisthocline 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 ribbons. Inner lip lightly callused. 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).

Loc.	*H*	*MD*
46 (holotype)	72.2	26–
46 (paratype)	43.2	15.4

Discussion.—*Drilluta lemniscata* occurs in the Owl Creek Formation and is one of the more highly ornate species of *Drilluta*. The strong spiral ornament and sharp incrementals 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 incrementals.

Conrad (1858, p. 332) described and figured *Fusus novemliratus* 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 *Drilluta*. 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 *Drilluta* 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. novemliratus* a nomen dubium.

Types: Holotype USNM 20428; paratype USNM 130300.
Occurrence: Mississippi: Ripley Formation at locs. 42, 46.

Drilluta 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 arcuately opisthocline on periphery. Aperture incompletely known, notched arcuately posteriorly and anteriorly, developing a somewhat twisted siphonal canal of moderate length. Outer lip thin at edge, inner lip lightly callused. 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).

Loc.	H	MD
46 (holotype)	69+	14.4
46 (paratype)	45.5+	18.5
Do	48.2+	18.8
45 (paratype)	47.3	16.9

Discussion.—*Drilluta buboanus* 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. 25) 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 45 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.

Drilluta buboanus 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 subsutural collar.

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

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

Drilluta major Wade

Plate 26, figures 20–22

1916. *Drilluta major* Wade, Philadelphia Acad. Nat. Sci. Proc., v. 68, p. 460, pl. 23, figs. 7, 8.

1926. *Drilluta major* Wade, U.S. Geol. Survey Prof. Paper 137, p. 117, pl. 38, figs. 2, 3.

1926. *Drilluta dimurorum* Wade, U.S. Geol. Survey Prof. Paper 137, p. 118, pl. 39, figs. 5, 7.

Diagnosis.—Shell large for genus, transverse ribs strongly opisthocline over periphery of body; subsutural collar with raised strong imbricate incrementals; 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).

Loc.	H	Estimated H	MD
1 (holotype)	87	125	35
1 (hypotype)	90	100	29+
Do	85	125	40

Discussion.—Wade (1926, p. 118) stated *Drilluta dimurorum* differed from *D. major* "in the character of the posterior fasciole and in having a less ornate sculpture and a more prominent single columellar plait." The holotype of *D. dimurorum* is a very imperfect specimen with a worn exterior that led Wade to believe the sculpture of the body and subsutural 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 plaits being present posterior to the strong columellar 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. dimurorum* in the synonymy of *D. major*.

Types: Holotype USNM 32859; hypotype (= holotype of *D. dimurorum*) USNM 32864; hypotypes USNM 130305, 130306.

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

Drilluta cf. D. buboanus 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 *Drilluta buboanus* Sohl from the Owl Creek Formation.

Types: Figured specimens, USNM 130307, 130308.

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

Drilluta sp.

Discussion.—Fragments of large specimens that possess a subsutural collar, a plicate columella, and ornament typical of a *Drilluta* 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.

Drilluta? 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 columellar plication and occasionally the reflection of external ribbing. In addition, their size, shape, and outline agree with *Drilluta*.

Types: Figured specimens, USNM 130309, 130310.
Occurrence: Mississippi: Prairie Bluff Chalk at locs. 66, 71, 72, 78, 79, 81–84, 87, 90–92, 94.

Genus DOLICHOLATIRUS Bellardi, 1884

Type by subsequent designation (Cossmann, 1901, p. 23), *Turbinella bronni* 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 narrow and longer than aperture; inner lip weakly concave, callused, 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, *Dolicholatirus 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 *Dolicholatirus perexilis* (Conrad) (= *Latirus harrisi* Johnson) from the lower part of the Claiborne of Texas and Mississippi (Palmer, 1937, p. 345).

Dolicholatirus torquatus Sohl, n. sp.

Plate 26, figures 9, 10, 16, 17

Diagnosis.—A *Dolicholatirus* 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 slim pillar. 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 raised narrow cords over the periphery and base. Growth lines prominent but fine in trend prosocline 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, callused, 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 *Dolicholatirus 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 locs. 41, 46. Tennessee: Questionably present as a reworked element in the base of the Clayton Formation at loc. 40.

Genus PALEOPSEPHAEA Wade, 1926

Type by original designation, *Paleopsephaea mutabilis* Wade.

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, acutely angular posteriorly, siphonal canal slightly curved and inclined to the left. Columella generally bearing three oblique plications.

Discussion.—*Paleopsephaea* resembles *Drilluta* Wade 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 subdued 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 *Volutoderma 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 *Paleopsephaea scalaris* and *Paleopsephaea o'donelli* were described by Rennie (1930, p. 228; 1945, p. 55) from the Upper Cretaceous of Pondoland, South Africa, and Angola. *Voluta* (*Paleopsephaea*) *sulcata* Riedel (1932, p. 109) described from Mungofluss of the Cameroons should be assigned elsewhere as it appears to possess no posterior whorl constriction.

Paleopsephaea mutabilis Wade

Plate 28, figures 1–6

1926. *Paleopsephaea mutabilis* Wade, U.S. Geol. Survey Prof. Paper 137, p. 123, pl. 40, figs. 4, 5, 8.

1943. *Volutilithes* (*Paleopsephaea*) *mutabilis* (Wade). Wenz, Handbuch der Paläozoologie, Gastropoda, v. 6, pt. 6, p. 1328, fig. 3772.

1945. *Paleopsephaea mutabilis* Harbison, Philadelphia Acad. Nat. Sci. Proc., v. 97, pl. 4, figs. 29, 30.

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).

Loc.	*H*	*MD*	*H:D*	Number of ribs on body
1 (holotype)	45.5+	17.5	2.6	10–11
1 (paratype)	34.0+	11.8	2.8	9
1 (topotype)	35.2	11.9	2.9	10
Do.	35.5+	13.5	2.6	10
Do.	36.5+	12.5	2.9	10
Do.	34.2+	12.0	2.8	10
6	30.0	10.6	2.8	10
18	30.4+	12.0	2.6	9
18	30.8	11.2	2.7	10
18	25.0+	9.9	2.5	9
18	29	10.0	2.9	11
18	28.7	10.5	2.6	9

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 sinuous 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 32867; hypotype ANSP; hypotypes USNM 130313–130316.

Occurrence: Tennessee: Ripley Formation at loc. 1. Mississippi: Ripley Formation at locs. 5–7, 16, 18.

Paleopsephaea pergracilis Wade

Plate 28, figures 9, 17

1926. *Paleopsephaea pergracilis* Wade, U.S. Geol. Survey Prof. Paper 137, p. 124, pl. 40, figs. 3, 7.

Diagnosis.—A *Paleopsephaea* of rather slender outline; sculpture consisting of about six transverse ribs per whorl and close-spaced spiral lirae that cover 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 32866.

Occurrence: Tennessee: Ripley Formation at loc. 1.

Paleopsephaea tenuilirata 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 lirae 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 teloconch accompanied by flattening of the whorl sides plus addition of opisthocline transverse ribs that, after one-quarter of a turn, become orthocline; spiral ornament appears on the last part of the first teloconch 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 lirae 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 callused. 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 tenuilirata* 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 lirae. *P. mutabilis* Wade has more numerous and less coarse transverse ribs, extremely subdued spiral lirae, and stronger columellar plications.

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

Types: Holotype USNM 130317; paratype USNM 130318, 130319.

Occurrence: Mississippi: Ripley Formation at loc. 18.

Genus GRAPHIDULA Stephenson, 1941

Type by original designation, *Graphidula terebreformis* 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, posteriorly 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? multicostata* Stephenson and *G.? gabriellensis* 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 *Lomirosa*. 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 columellar 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*:
- *Piestochilus cancellatus* Wade, Ripley Formation of Tennessee
- *Graphidula terebriformis* Stephenson, Nacatoch Sand of Texas
- *Graphidula? multicostata* Stephenson, Kemp Clay of Texas
- *gabriellensis* Stephenson, Kemp Clay of Texas
- *Piestochilus pergracilis* Wade, Ripley Formation of Tennessee
- *Mesorhytis 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)
- *Fasciolaria cretacea* Meek and Hayden, Fox Hills (questionably assigned)
- *Turbonilla (Chemnitzia) 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 curvilirata* Conrad, Owl Creek Formation of Mississippi

Graphidula cancellata (Wade)

Plate 28, figures 28, 29

1926. *Piestochilus cancellatus* Wade, U.S. Geol. Survey Prof. Paper 137, p. 131, pl. 45, figs. 15, 16.
1941. *Graphidula cancellata* (Wade). Stephenson, Texas Univ. Bull. 4101, p. 346.

Diagnosis.—A *Graphidula* of medium size, bearing subcancellate surface ornament; spiral ribbons 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 columellar 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 ribbons. *G. terebriformis* Stephenson, from the Nacatoch Sand of Texas, is closely related but appears to have more subdued ornament with the spiral ribbons 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

1926. *Piestochilus pergracilis* Wade, U.S. Geol. Survey Prof. Paper 137, p. 131, pl. 45, figs. 9, 10.

Diagnosis.—Shell of medium to moderately large size for genus. Spiral sculpture dominant on spire; penultimate whorl bearing eight to nine spiral ribbons with interspaces wider than ribbons; 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).

Loc.	*H*	*MD*	*HB*
1 (holotype)	57.5	12.8	27.8
1 (topotype) (pl. 28, fig. 31)		18.8	42.8

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 ribbons 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 columellar plaits is restricted to a moderately strong to weak anterior plait and, occasionally, a very faint second plait 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. pergracilis* (Wade), but that species has stronger transverse ribs as well as a less slim spire.

Types: Holotype USNM 32888; hypotypes USNM 130338–130340.

Occurrence: Tennessee: Ripley Formation at loc. 1.

Graphidula obscura (Wade)

Plate 28, figures 11–14

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

1941. *Graphidula obscura* (Wade). Stephenson, Texas Univ. Bull. 4101, p. 346.

Diagnosis.—Shells medium sized for genus, ornament subcancellate, with spiral ribbons clustered in double-rowed bands and with secondary cords intervening occasionally; columellar plications weak.

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

Loc.	*H*	*MD*
Holotype	35.5	9.8
Topotype	24.8	7.1
Do	23.0	6.4
Do	14.6	4.7
Do	18.5	5.0

Discussion.—The shells of this attractive species are distinguished from those of *Graphidula cancellatus* by their greater number of spiral ribbons on the penultimate whorl. In addition, the ribbons of *G. cancellatus* are discrete whereas those of *G. obscura* are grouped into bands of two ribbons each that are raised over the interspiral spaces (pl. 28, figs. 12, 14). On a few specimens, secondary spiral cords are interpolated between the bands of paired ribbons. On the smallest paratype of the type species, *G. terebriformis* 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 subdued ornament with the transverse elements being proportionally stronger. The columellar 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. Actually the folds are seen only in highly inclined light and are highly oblique rather than low spirals as shown by him.

Types: Holotype USNM 32893; hypotypes USNM 130366–130368.

Occurrence: Tennessee: Ripley Formation at loc. 1.

Graphidula terebriformis Stephenson

Plate 28, figures 24–26

1941. *Graphidula terebriformis* Stephenson, Texas Univ. Bull. 4101, p. 346, pl. 66, figs. 13, 14.

Diagnosis.—Shell slim and small to medium sized for genus; ornament subcancellate, spiral ribbons close spaced, low, subdued, broad, and generally bearing a fine incised line medially that divides the ribbon, columellar 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 ribbons 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 cancellata* zone of Tennessee is similar but has more strongly developed ornament, is more robust, has rounder sided whorls, and has secondary lirae between the double-rowed primary ribbons.

Types: Holotype USNM 77085 (Texas); paratype USNM 21076 (Texas); hypotypes USNM 130341, 130342 (Mississippi).

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

Graphidula melanopsis (Conrad)

Plate 28, figures 18, 23, 27, 32–35

1860. *Turbonilla (Chemnitzia) melanopsis* Conrad, Philadelphia Acad. Nat. Sci. Jour., 2d ser., v. 4, p. 287, pl. 46, fig. 35.

1945. *Graphidula tippahensis* Harbison, Philadelphia Acad. Nat. Sci. Proc., v. 97, p. 85, pl. 5, figs. 33, 34.

Diagnosis.—Shells moderately large for genus; sculpture strong on spire, consisting of numerous strong transverse ribs with seven or eight spiral ribbons 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 2¾ smooth whorls, 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. Teloconch whorls number about 12 and are almost flat sided on spire; 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 callused, callus thickest 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. 172).

Loc.	*H*	Estimated *H*	*MD*
18 (hypotype) (pl. 28, fig. 34)	78.5	82.0	21.5
18 (hypotype) (pl. 28, fig. 33)	78.5	87.0	20.4

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.? gabrielensis* Stephenson, also from the Kemp Clay, has more numerous thinner and closer spaced transverse ribs.

Types: Holotype AMNH 9050; holotype of *G. tippahensis*, ANSP 16235; hypotypes USNM 130343–130345.

Occurrence: Mississippi: Ripley Formation at locs. 5, 6, 13–18, 23, 29. Georgia and Alabama: Ripley Formation.

Graphidula cf. G.? multicostata Stephenson

Plate 28, figure 10

1941. *Graphidula? multicostata* Stephenson, Texas Univ. Bull. 4101, p. 347, pl. 66, figs. 11, 12.

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 130347.

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

Graphidula sp.

Plate 29, figures 1–3

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.? gabrielensis* Stephenson.

Type: Figured specimens USNM 130348–130350.

Occurrence: Mississippi: Prairie Bluff Chalk at locs. 66, 71, 72, 82, 83, 85, 87, 88, 90, 91.

Genus PIESTOCHILUS Meek, 1864

Type by original designation, *Fusus* (*Pleurotoma?*) *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 curviliratus (Conrad)

Plate 29, figures 20, 21, 26, 27

1858. ***Rimella curvilirata*** Conrad, Philadelphia Acad. Nat. Sci. Jour., 2d ser., v. 3, p. 331, pl. 35, fig. 9.

Diagnosis.—A *Piestochilus* bearing numerous strong rather close spaced, collabral transverse ribs and strong spiral lirae or ribbons 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 flatsided; 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 ribbons 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 curvilirata* 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 volution; 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. curviliratus* by its smooth shell surface, but a part of the surface of the paratype (USNM 77093) shows close-spaced collabral 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 scarboroughi* (Meek and Hayden), from the sand of the Fox Hills of the western interior, lacks the strong transverse ribs of *P. curviliratus* and in this sense is closer to *P. levis* Stephenson.

Types: Holotype, lost; hypotypes USNM 130351, 130352.
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 curviliratus* and, in addition, the remnants of external ribs that are not interrupted by a posterior collar as in *Drilluta* are preserved.

Type: Figured specimen USNM 130353.
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; columella 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 1926 (p. 127) he added *O. digressa* Wade from the same locality. Stephenson (1941, p. 342–344) described *O. solistrella*, *O. pulchra*, and *O. maxeyi* 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 *Ripleyella* 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 s. s. Subfusiform; whorls strongly collared posteriorly; growth lines prosocline on collar, almost orthocline on periphery and base. *Ornopsis* (*O.*) *glenni* Wade. (See fig. 16.)

Ripleyella. 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).

Pornosis. Fusiform, body inflated, constricted posteriorly to a weak collar or subsutural 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).

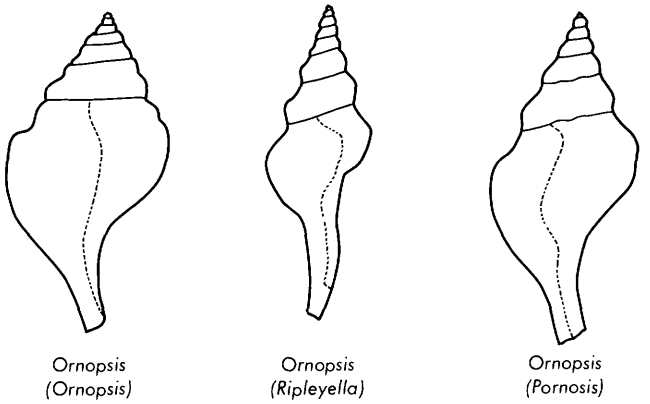


FIGURE 16.—Comparison of growth lines of the three subgenera of *Ornopsis*.

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. *Pyrifusus 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 Darteville 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 *Bellifusus* by its twisted siphonal canal and the position of its columellar plait. The latter feature also serves to distinguish it from *Woodsella* Wade and *Cryptorhytis* Meek of Wade.

Subgenus ORNOPSIS Wade

Ornopsis (Ornopsis) glenni Wade

Plate 29, figures 8–10, 15, 16

1916. *Ornopsis glenni* Wade. Philadelphia Acad. Nat. Sci. Proc., p. 463, pl. 24, fig. 1.

1925. *Ornopsis glenni* Wade. Cossmann, Essais Paléoconchologie Comparée, v. 13, p. 251, pl. 10, fig. 33.

1926. *Ornopsis glenni* Wade, U.S. Geol. Survey Prof. Paper 137, p. 126, pl. 44, figs. 8, 9, 12, 13.

Diagnosis.—Shells subfusiform in outline; whorls inflated peripherally, but constricted posteriorly to a strong subsutural collar; transverse ornament of strong ribs on the shoulder dying out above and below; spiral ornament covers entire surface and consists of strong ribbons 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).

Loc.	*H*	*HB*	*MD*	*H:H*	*H:D*
USNM 32883 (holotype)	[1] 53	37	28	1.4	1.9
USNM 32883 (hypotype)	48	35	26	1.4	1.8
Hypotype (pl. 29, fig. 15)	[1] 73	[1] 53	37	1.4	2.0
Topotype	42	31	23	1.4	1.8
Do	50	34	23	1.5	2.2
Do	38	26	19	1.4	2.0
Do	31	22	15	1.4	2.1
Do	37	26	19.5	1.4	1.9
Do	41	30	20	1.4	2.1
Do	44	31	23	1.4	1.9
Do	59	39	29	1.5	2.0
Do	55	38	30	1.4	1.8

[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 35 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 slimness of the spire and obesity of the body is exhibited by variation in the pleural angle from 59° 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 ribbons proportionally broader. The number of transverse ribs per body whorl ranges between 11 and 14 and the number of spiral ribbons 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, 130355.

Occurrence: Tennessee: Ripley Formation at loc. 1. Arkansas: Saratoga Chalk (USGS 13513).

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.

Diagnosis.—Very elongate fusiform shells with whorls posteriorly constricted to a subsutural collar and anteriorly constricted to a very elongate narrow siphonal canal immediately above which, on the columella, is a narrow strong oblique plication. 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 opisthocline over periphery and almost orthocline 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 oval orifice. These striking characters are not found in *Ornopsis elevata* which has a more slender spire and the anterior canal is larger than the oval 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

1916. *Ornopsis elevata* Wade, Philadelphia Acad. Nat. Sci. Proc., v. 68, p. 464, pl. 24, figs. 2, 3.
1926. *Ornopsis elevata* Wade, U.S. Geol. Survey Prof. Paper 137, p. 127, pl. 44, figs. 10, 11, pl. 45, figs. 1, 2.
1945. *Ripleyella* sp. Harbison, Philadelphia Acad. Nat. Sci. Proc., v. 97, p. 84, 85, pl. 6, figs. 39, 40.

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).

Loc.	*H*	*MD*	*HB*
Holotype	43.7	16.5	28
Topotype	28.5+	12.4	17.4+
6 (pl. 29, fig. 22)	42.3	13.5	26.8
6	36+	15.2	
18	37.8+	15.4	
18	37.8	12.9	

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 slimmer 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 130356, 130357.

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

Subgenus PORNOSIS Sohl, n. subgen.

Type species, *Ornopsis digressa* Wade, 1926.

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

1926. *Ornopsis digressa*, Wade, U.S. Geol. Survey Prof. Paper 137, p. 127, pl. 45, figs. 3, 4.

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 orthocline but develops an increasingly arcuate opisthocline 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. Aperture subovate, somewhat angulated posteriorly, and anteriorly drawn out to a narrow moderately long and twisted siphonal canal; inner lip lightly callused. 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.

Loc.	*H*	*MD*
1 (holotype)	39.0	18.2
18 (hypotype)	30.5	13.8
Do	30.5	14.5
18	24.4	12.8
18	24.0	9.9
6	30.0	13.3

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 whorl 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.

Loc.	*H*	*MD*
6 (holotype)	33.0	16.1
6 (paratype)	20.5	11.0
5 (paratype)	29.0	14.5

Discussion.—Variability in ornament within given populations of *O.* (*Pornosis*) *modica modica* is relatively great. The point at which the transverse ornament is lost or becomes subdued 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 subdued transverse ornament that is more widely spaced, more obscure, and by its subdued 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 130362; paratypes USNM 130363, 20545.

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 130364.

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, *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.*

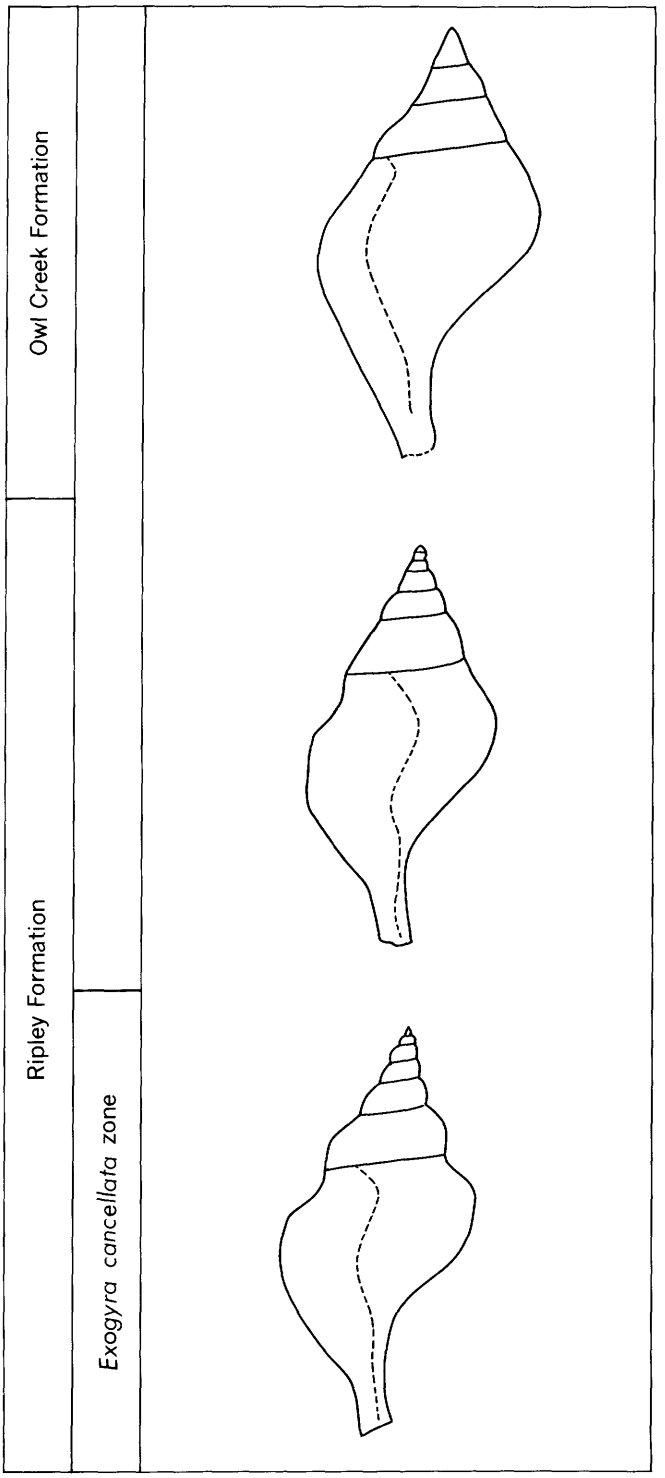


FIGURE 17.—Development of the species of the subgenus *Ornopsis* (*Pornosis*).

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 subshouldered 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 welt. Growth lines very faint and very gently prosocline between suture and siphonal welt, but strongly sinused over welt. 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 Paita region of Peru, this species is smaller, is less obese, and has stronger transverse ribs.

Type: Holotype USNM 130365.

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

Subfamily FUSININAE

Boltenella, *Hercorhyncus* (*Hercorhyncus*), and *Hercorhyncus* (*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, *Euthriofusus* Cossmann may also belong with the above. Cossmann (1925, p. 249) assigned *Haplovoluta* as a subgenus of *Euthriofusus*, 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 *Hercorhyncus*, which then would also include *Euthriofusus* 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 HERCORHYNCUS 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 Cossmann (1901, p. 73) as a synonym of *Streptosiphon* 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 *Hercorhyncus* (*Haplovoluta*) by its less well developed transverse ornament and by its unornamented basal sulcus.

Hercorhyncus (*Hercorhyncus*) 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 monheimi* Müller (Holzapfel, 1888, p. 106; Cossmann, 1901, p. 73). Cossmann (1901, p. 74) also assigned several species from the Upper Cretaceous of India to *Hercorhyncus*, 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 *Pyrifusus* 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) tippanus Conrad

Plate 30, figures 8–10, 13–16

1860. *Fusus tippana* Conrad, Philadelphia Acad. Nat. Sci. Jour., 2d ser., v. 4, p. 286, pl. 46, fig. 41 (*F. tippanus* on plate description).

1869. *Hercorhyncus tippanus* Conrad, Am. Jour. Conchology, v. 4, p. 247.

1901. *Streptosiphon* (*Hercorhyncus*) *tippanus* (Conrad). Cossmann, Essais Paléoconchologie Comparée, v. 4, p. 73, fig. 22.

1941. *Hercorhyncus coronale* Stephenson, Texas Univ. Bull. 4101, p. 323, pl. 61, figs. 12, 13.

1941. *Hercorhyncus vadosum* Stephenson, Texas Univ. Bull. 4101, p. 322, pl. 61, figs. 18, 19, 20.

1943. *Afer* (*Hercorhyncus*) *tippanus* (Conrad). Wenz, Handbuch der Paläozoologie; Gastropoda, v. 6, p. 1306, fig. 3723.

1945. *Hercorhyncus gracilis* Harbison, Philadelphia Acad. Nat. Sci. Proc., v. 97, p. 83, pl. 6, figs. 37, 38.

Diagnosis.—A robust proportionally broad *Hercorhyncus* 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 65° in normal-sized forms to 80° on larger individuals. Protoconch of about three smooth round-sided 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).

Loc.	*H*	Estimated *H*	*MD*
16 (hypotype)	38.9		21.
18	38.0	50	26.
6	36.0	44	23.
17	28.6		14.
ANSP 13828 (holotype)	26.8	32	16.

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 13828); 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 *Hercorhyncus* 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 lirae or 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 *Hercorhyncus 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 *Hercorhyncus* 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.*) *vadosum* Stephenson, from the Nacatoch Sand of Texas, compares well with the larger specimens of *H.* (*H.*) *tippanus* from Mississippi. *Hercorhyncus coronale*, also from the Nacatoch Sand of Texas, is likewise a synonym of *H.* (*H.*) *tippanus* Conrad, being merely an immature individual.

Hercorhyncus (*Hercorhyncus*) *pagodiformis* Sohl, from the Owl Creek Formation, differs by having

690-081 O - 64 - 4

fewer ribs per whorl and by being proportionally slimmer and higher spired.

Types: Holotype (*H. tippanus*) ANSP 13828; hypotype (holotype *H. coronale*) USNM 17368; hypotype (holotype *H. vadosum*) USNM 77009; hypotype (paratype *H. vadosum*) USNM 77010; hypotypes USNM 130369–130372.

Occurrence: Mississippi: Ripley Formation at locs. 5, 6, 12, 14–19, 24, 39. Texas: Nacatoch Sand. Georgia and Alabama: Ripley Formation.

Hercorhyncus (Hercorhyncus) pagodiformis Sohl, n. sp.

Plate 30, figures 1–5

Diagnosis.—A *Hercorhyncus* 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 subsutural collar; shoulder strong, formed by the truncate upper ends of the transverse ribs; whorls below shoulder flat sided, sloping rather steeply adaxially to a weltlike 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 opisthocline over shoulder and flat whorl sides, but adaperturally flexed over the weltlike band at the base of the body. Aperture incompletely known; notched posteriorly in harmony with the subsutural 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 callused 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 *Hercorhyncus* (*Hercorhyncus*) *tippanus* Conrad from the Ripley Formation and *H.* (*Hercorhyncus*) *malleiforme* Stephenson, from the Kemp Clay of Texas, by having a slimmer 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.

Types: Holotype USNM 130373; paratypes USNM 130374, 130375.

Occurrence: Mississippi: Owl Creek Formation at locs. 45–47. Tennessee: Clayton Formation (reworked Cretaceous at base) at loc. 40.

Hercorhyncus (Hercorhyncus) tennesseensis (Wade)

Plate 30, figures 11, 12

1926. *Serrifusus tennesseensis* Wade, U.S. Geol. Survey Prof. Paper 137, p. 143, pl. 50, figs. 3, 4.

1941. *Hercorhyncus tennesseensis* (Wade), Stephenson, Texas Univ. Bull. 4101, p. 321.

Discussion.—Only two specimens are available for study. Considering the range of variability of *H.* (*Hercorhyncus*) *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.* (*Hercorhyncus*) *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

1917. *Scobina* Wade, (not Lepeletier, 1825) Philadelphia Acad. Nat. Sci. Proc., v. 69, p. 287.

1918. *Haplovoluta* Wade, Am. Jour. Sci., 4th ser., v. 45, p. 334.

1920. *Brucia* Cossmann, Rev. Critique Paléozoologie et Paléophytologie, v. 21, p. 137.

1925. *Parafusus* Cossmann. (not Wade, 1918) Essais Paléoconchologie Comparée, v. 13, p. 249.

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 *Euthriofusus* but that genus lacks peripheral carinations. As discussed before, this subgenus appears to belong closer to *Hercorhyncus* from which it differs primarily in its more continuous transverse ornament and subdued shoulder nodes.

The subgenus ranges through the upper part of the *Exogyra ponderosa* zone and through the *E. costata* zone.

Hercorhyncus (Haplovoluta) bicarinatus (Wade)

Plate 30, figures 21, 25, 26

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

Diagnosis.—A *Haplovoluta* having two strong spiral cords that form a bicarinate 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).

Loc.	*H*	*MD*
1 (holotype)	35.1	25.4
1 (topotype)	35.8	23.7
Do	33.5	24.4
Do	32.0	24.5
Do	33.7	25.5

Discussion.—*Hercorhyncus* (*Haplovoluta*) *bicarinatus* 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. *Hercorhyncus* (*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).

Hercorhyncus (Haplovoluta) triliratus Sohl. n. sp.

Plate 30, figures 17–20, 23, 24

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 bicarinate; upper whorl area constricted to a poorly defined subsutural collar, below which the whorl is concavely excavated to the shoulder. Below the lower carination the body restricts rapidly to the tapering pillar. Sculpture ornate; transverse collabral ribs arise on the body just above the shoulder and are either noded or incrementally spinose at the shoulder and are noded 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 opisthoclinely to the lower carination where they swing back to prosocline over the basal slope. Aperture broadly ovate; notched 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 spinal cords.

Inner lip with callus adnate above, but loosening opposite entrance to siphonal 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).

Loc.	*H*	*MD*
5 (holotype)	30.7+	20.0
18 (paratype)	27.0	16.8
Do	33.3+	20.7

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

(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 prosocline 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. *Hercorhyncus* (*Haplovoluta*) *quadriliratus* 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 130380–130383.

Occurrence: Mississippi: Ripley Formation at locs. 5, 13, 16–18. Alabama and Georgia (Chattahoochee River region): Ripley Formation.

Hercorhyncus (Haplovoluta) quadriliratus Sohl, n. sp.

Plate 30, figure 22

Diagnosis.—A haplovolutid 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 carination. 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 callused, 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).

Loc.	*H*	*MD*
46 (holotype)	36.2+	21.9
46 (paratype)	36.3	16.9+

Discussion.—In its early growth stages *Hercorhyncus* (*Haplovoluta*) *quadriliratus* is scarcely distinguishable from *H.* (*Haplovoluta*) *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.* (*Haplovoluta*) *bicarinatus* but not to be seen in *H.* (*Haplovoluta*) *triliratus*.

Hercorhyncus (*Haplovoluta*) *quadriliratus* is the end product of the line of descent beginning with the bicarinate form in the upper part of the *Exogyra ponderosa* through *E. cancellata* zones, and which was followed by the trilirate species of the Ripley. *H.* (*Haplovoluta*) *quadriliratus* 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 BOLTENELLA 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 columellar 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 subsutural collar of *Boltenella*. Accordingly *Boltenella* is given full generic rank.

Boltenella excellens Wade

Plate 31, figures 31, 32

1917. *Boltenella excellens* Wade, Philadelphia Acad. Nat. Sci. Proc., v. 69, p. 286, pl. 18, figs. 3, 4.
1925. *Euthriofusus (Boltenella) excellens* (Wade). Cossmann, Essais Paléoconchologie Comparée, v. 13, p. 247, pl. 10, fig. 32.
1926. *Boltenella excellens* Wade, U.S. Geol. Survey Prof. Paper 137, p. 137, pl. 47, figs. 5, 6.
1943. *Euthriofusus (Boltenella) excellens* (Wade). Wenz, Handbuch der Paläozoologie; 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).

Loc.	*H*	*MD*
1 (holotype)	35.2	18.1
1 (hypotype)	28.3+	15.7
1 (topotype)	21.5	11.8

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

Types: Holotype USNM 32900; hypotype 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 *Fulsifusus mesozoicus* Wade from the Ripley Formation of Tennessee as belonging to *Euthriofusus*. *Euthriofusus* appears to be related in growth line character and form to *Hercorhyncus* Conrad and *Boltenella* Wade. The two Ripley species included here are done so with reservation as their nuclear characters are unknown.

Euthriofusus? mesozoicus (Wade)

Plate 31, figures 27, 28

1917. *Falsifusus mesozoicus* Wade, Philadelphia Acad. Nat. Sci. Proc., v. 69, p. 284, pl. 17, figs. 11, 12.
1925. *Euthriofusus mesozoicus* (Wade). Cossmann, Essais Paléoconchologie Comparée, v. 13, p. 246, pl. 8, fig. 3.
1926. *Falsifusus mesozoicus* Wade, U.S. Geol. Survey Prof. Paper 137, p. 128, pl. 45, figs. 5, 6.

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. *Falsifusus 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

1926. *Falsifusus convexus* Wade, U.S. Geol. Survey Prof. Paper 137, p. 129, pl. 45, figs. 11, 12.

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.

Euthriofusus? mesozoicus differs by having growth lines that lack the strong flexure present on the basal slope of *E.? convexus* 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 subdued overriding spiral ribbons. Aperture lenticular, angulated posteriorly; siphonal canal moderately long and straight; columella 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 columellar plications. *Beretra* has a noded subsutural collar and a typical turrid sinused 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 *Exilia cretacea*. Both species belong to *Remera* and are synonyms. As first reviser I select *Remera juncea* as valid by the criteria of pagination.

Remera stephensoni Harbison

Plate 31, figures 17–19, 22, 23

1926. *Anchura? pergracilis* Johnson. Wade, U.S. Geol. Survey Prof. Paper 137, p. 151, pl. 53, figs. 1, 2.

1945. *Remera stephensoni* Harbison, Philadelphia Acad. Nat. Sci. Proc., v. 47, p. 85, pl. 5, figs. 35, 36.

Diagnosis.—*A Remera* with tranverse 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 20°. 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, rounding 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 ribbons 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 opisthocline over the whorl sides and swing back to prosocline low on the basal slope. Aperture lenticular, posteriorly angulated, siphonal canal straight and of moderate length. Outer lip incompletely known, apparently broadly sinused above, inner lip lightly callused with callus of upper columellar lip extending out of aperture and onto whorl surface a short way; columella smooth.

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

Loc.	*H*	*MD*	*H:D*
18 (holotype)	17.8+	6.0	
18 (topotype)	24.5	6.8	3.6
Do	21.4	5.8	3.7
Do	[1] 30.0	8.2	3.6
Topotype	14.9	4.4	3.4
1	23.0	6.2	3.7
1	31.5+	10.7	
1 (hypotype)	28.8+	8.8	
1	24.8	7.1	3.5
16	25.3	6.7	3.9
R. microstriata (USNM 77082)	[1] 28.0	6.4	4.3

[1] Estimated.

Discussion.—*Remera stephensoni* Harbison is a moderately common species in the Ripley Formation of both Mississippi and Tennessee. Wade originally referred the Tennessee specimens to *Anchura? pergracilis* 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. stephensoni*, but which differs in having more convex whorl sides and less opisthocline ribs that carry down farther on the whorl. Richards and Ramdell (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 ribbons vary much in either numbers, strength, or positioning. *R. flexicostata* Sohl 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 130389–130391.

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 flexicostata Sohl, 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 collabral 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 arcuately 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 callus 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 flexicostata* 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. stephensoni* 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 130392; paratypes USNM 130393, 130394.

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

Remera microstriata Stephenson?

Plate 31, figure 16

1941. *Remera microstriata* Stephenson, Texas Univ. Bull. 4101, p. 344, pl. 65, figs. 3, 4.

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. stephensoni* 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 130395.

Occurrence: Mississippi: Ripley Formation at loc. 18.

Genus FUSINUS Rafinesque, 1815
(=Fusus Lamarck, 1799, not Fusus Helbling, 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 *Fusinus* 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? macnairyensis (Wade)

Plate 31, figures 24–26

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

Diagnosis.—Fusiform shells with a knife-edged columellar lip bordering a curved elongate siphonal canal.

Description.—Medium to moderately small fusiform shells possessing a spire of a little more than half the total shell height. Protoconch poorly known, consisting of about two to three trochoid round-sided whorls. Suture impressed. Whorls of spire round sided; body abruptly constricted below. Sculpture ornate; 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 subsuturally by two weak lirae which may, on the body, broaden and coalesce to form a subsutural welt; the ribbons of the whorl sides give way to spiral cords on the base; growth lines prominent in interspiral spaces 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 whorls are preserved, is 19.2 mm in height and 7.4 mm in diameter.

Discussion.—The holotype of *Fusinus? macnairyensis* (Wade) from the Ripley Formation on Coon Creek, McNairy County, Tenn., is incomplete, and only the penultimate and body whorls 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 cancellata* zone from those of younger beds has been noted.

Types: Holotype USNM 32880; hypotype USNM 130396.

Occurrence: Tennessee: Ripley Formation at loc. 1. Mississippi: Ripley Formation at locs. 7, 14, 16 and Coffee Sand.

Genus WOODSELLA Wade, 1926

Type by original designation, *Woodsella typica* Wade.

Diagnosis.—Medium-sized fusiform shells that have rather strongly shouldered and subsuturally constricted whorls; 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; *Cryptorhytis pseudorigida* Rennie (1930, p. 226–227) is thought to be a junior synonym.

Wade placed the genus in the family Fusidae, 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 *Aliofusus*, 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. *Woodsella typica* Wade, U.S. Geol. Survey Prof. Paper 137, p. 130, pl. 46, figs. 1, 5.

1943. *Fusinus (Woodsella) typicus* (Wade). Wenz, Handbuch der Paläozoologie; Gastropoda, 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. *Cryptorhytis rigida* (Bailey) of Woods from Pondoland, South Africa, as figured by Woods (1906, pl. 39, 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 blunted by a proportionally large regularly coiled protoconch; sculpture ornate, varices range from absent to two per whorl, growth lines slightly opisthocline, 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 *Exogyra costata* zone of the gulf coast.

Wade (1926, p. 125) placed this genus in the Fusidae. Wenz (1941, p. 1173) assigned it to the Buccinidae, and Stephenson (1941, p. 335) questioned its assignment to the Fusidae. 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 fasciole 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 columellar plications distinguishes *Anomalofusus* from the Fasciolarinae and places it much closer to the Fusininae.

Anomalofusus substriatus Wade

Plate 31, figures 1–4

1916. *Fusus (Anomalofusus) substriatus* Wade, Philadelphia Acad. Nat. Sci. Proc., v. 68, p. 461, pl. 23, figs. 9–11.
1917. *Anomalofusus substriatus* Wade, Cossmann, Rev. Critique Paléozoologie, v. 21, no. 3, p. 99.
1925. *Anomalofusus substriatus* Wade. Cossmann, Essais Paléoconchologie Comparée, v. 13, p. 262, pl. 8, fig. 34.
1926. *Anomalofusus substriatus* Wade, U.S. Geol. Survey Prof. Paper 137, p. 126, pl. 44, figs. 5–7.
1941. *Anomalofusus substriatus* Wade. Wenz, Handbuch der Paläozoologie; Gastropda, v. 6, pt. 5, p. 1173.

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 collabral 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 lanceolate, 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).

Loc.	*H*	*MD*	*HS*
1 (holotype)	17.5	7.5	7.4
1 (topotype)	34.6+	13.7	14.4
Do	37+	15.4	20.8
Do	33	14.2	14.0
Do	25	10.0	11.5
Do	22+	10.5	11.2
Do	12.2	17.1	7.4
Do	12.8	5.8	5.8
Do	14.5	5.7	7.0
29	26.0	10	11.0

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 topotype studied, although missing most of the spire, measures 42+ 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 here 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 130397–130400.

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).

Loc.	*H*	*MD*	*HS*
6 (holotype)	18.8	7.0	8.0
6 (paratype)	15.4	6.9	6.8
Do	13.7	6.2	5.2
Do	12.3	5.5	6.0
16	13.2	6.3	6.7

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 130405; paratypes USNM 130406a–c.

Occurrence: Mississippi: Ripley Formation at locs. 5, 6, 15, 16, 18, 29.

Anomalofusus lemniscatus 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 teloconch whorl. Suture impressed. Teloconch 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 lemniscatus* is restricted to the Owl Creek Formation and is known from several localities.

In outline, *A. lemniscatus* 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 teloconch whorl before the transverse ribs. On *A. lemniscatus* both elements develop at the same time.

Types: Holotype USNM 130407; paratypes USNM 130408, 130724, 130725.

Occurrence: Mississippi: Owl Creek Formation at locs. 43, 45, 46. Tennessee: Clayton Formation (reworked Owl Creek) at loc. 40.

Anomalofusus sp.

Plate 31, figures 9, 10, 14, 15; plate 32, figures 4, 5

Discussion.—The presence of *Anomalofusus* in the Prairie Bluff Chalk is well substantiated by a number of internal molds. These molds not only retain the shape of the genus but lack any trace of a columellar plication. In addition, the surface of the molds preserves reflections of strong transverse ribs, flexed at their upper ends (pl. 31, figs. 9, 15), as well as moderately strong spiral sculpture. The mold figured on plate 31, figure 14, also shows the remnants of several strong varices typical of *Anomalofusus*.

Types: Figured specimens USNM 130409, 130410.

Occurrence: Mississippi: Prairie Bluff Chalk at locs. 66, 87, 88.

Genus CRYPTORHYTIS Meek, 1876

Type by original designation, *Gladius? cheyennensis* Meek and Hayden, 1860. (*Rostellaria fusiformis* Hall and Meek, 1854, not *R. fusiformis* Pictet and Roux, 1848.)

Diagnosis.—Medium-sized fusiform shells with posteriorly constricted whorls, a relatively long siphonal canal, and several oblique plaits that occur relatively high on the columella but are not visible at the aperture.

Discussion.—The familial placement of this genus has been open to considerable doubt. Meek (1876, p. 355) placed it in the Fasciolaridae as a subgenus of *Fasciolaria* Lamarck; Wade (1926, p. 131) later followed Meek. Wenz (1943, p. 1308) noted *Cryptorhytis* as subgenus of *Peistochilus* Meek and placed it in the Vascidae of the Volutacea. This latter placement was probably proposed in deference to Meek's statement that the columellar plications occur high on the columella. When Meek's type material in the U.S. National Museum is viewed, one is struck by the poor quality of the material upon which the genus and species are based. No complete specimens exist and columellar plications are present on only one specimen. What can be seen of the specimens suggests that they may actually be more closely related to forms like *Ornopsis* (*Pornosis*). The ornament, shape, posteriorly constricted whorls, and trend of the growth lines is similar to *Ornopsis* (*Pornosis*), but the columellar plication is not so sharp or oblique and our lack of knowledge of *Cryptorhytis* limits further comparison.

With such questionable comparative material it is hazardous to assign species to the genus. Nonetheless, a number of species have been placed here, but most of them erroneously. Gabb (1877, p. 282, 283) described and assigned three species of *Cryptorhytis: Fasciolaria* (*Cryptorhytis*) *crassicosta*, from the Providence Sand of Georgia, and *Fasciolaria* (*C.*) *kerri* and *F.* (*C.*) *obliquicostata* 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. *Fasciolaria* (*C.*) *kerri* lacks the shape, growth-line trend, ornament, and columellar 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 *Lomirosa* Stephenson. Gabb never illustrated the first named species, *F.* (*C.*) *crassicostata*, but his holotype is retained at the Academy of Natural Sciences of Philadelphia and it has been assigned elsewhere herein to *Buccinopsis* 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 Brebrion, 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 nobilis* Wade, U.S. Geol. Survey Prof. Paper 137, p. 131, pl. 46, figs. 3, 4.

1926. *Cryptorhytis torta* Wade, U.S. Geol. Survey Prof. Paper 137, p. 132, pl. 46, figs. 9, 10.

Diagnosis.—Medium-sized fusiform shells with ornament of numerous thin spiral lirae 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).

Loc.	*H*	*MD*	*H:D*
C. torta (holotype)	36	18	2.0
C. nobilis (holotype)	28	14	2.0
1 (topotype)	31	14	2.2
Do	30	15	2.0
Do	23	11	2.0
Do	9	19	2.1

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 *Cryp-*

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 twisted pillar, and further the axial sculpture is more curved along the 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 callused 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 polycyma* Harbison, from the Ripley Formation of Mississippi, and *L. turbinea* Sohl (includes *Xancus major* Wade, in part), from the Ripley Formation of Tennessee.

As known, the genus is restricted to the *Exogyra costata* zone of the Gulf Coastal Plain. *Lupira polycyma* Harbison appears to be a direct descendant of *L. variabilis.* Virtually the only change is the stabilization of the number of columellar plaits to two in *L. polycyma* in the post *E. cancellata* of the beds Ripley of Mississippi. *Lupira turbinea* 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 genus.

Pyrifusus Conrad is similar to *Lupira* in ornament and shape but lacks columellar plications or any trace of a fasciolar 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).

Loc.	*H*	*MD*	*PA* (degrees)
1 (holotype)	39.0	24.3	86
1 (holotype)	89.1	54	85
1	40.8	24.6	90
1	32.3	20.2	89
1	34.4	19.4	90
1	35.9	23.8	91

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, variability 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 fasciolar 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 15 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 columellar plications. *Lupira turbinea* Sohl has wider spaced spiral cords and lacks the fasciolar band of *L. pyriformis*.

Types: Holotype USNM 32881; Holotype of *Xancus major* Wade USNM 32874a; 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

1941. *Lupira pyriformis* Stephenson, Texas Univ. Bull. 4101, p. 360, pl. 69, figs. 1, 2.

1945. *Lupira polycyma* Harbison, Philadelphia Acad. Nat. Sci. Proc., v. 97, p. 87, pl. 5, figs. 31, 32.

Diagnosis.—Medium-sized lupirids with a fasciolelike band on the anterior slope, a proportionately low spire for the genus, and only two columellar 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 volution of first teloconch 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 subsutural 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 fasciolelike band; growth lines adaperturally sinused 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 callused with edge of callus well defined over parietal lip and upper columellar 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 columellar 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).

Loc.	*H*	*MD*	*PA* (degrees)
Texas (holotype)	16.4	11.4	96
18	27.0+	20.2	97
18	32.0+	21.0	95
18	30.8+	22.7	95
7	33.5	19.0	85
5	32.8+	24.3	94
5	28.1	20.1	95
16	30.0+	18.7	97

Discussion.—Variation within the species is much like that described for *Lupira variabilis*, with the exception that *L. pyriformis* possesses at most three columellar 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 20895 (Texas); hypotype (holotype of L. polycyma) ANSP 16603; (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 turbinae 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 opisthocline 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 turbinea* 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 sinused 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 32874b; paratypes USNM 130419.
Occurrence: Tennessee: Ripley Formation at loc. 1. Mississippi: Ripley Formation at locs. 6, 18.

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 PYROPSIS Conrad, 1860

Type by monotypy, *Tudicla* (*Pyropsis*) *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 *Pyropsis* has had a troubled history. Superficially it resembles *Tudicla*, and Conrad (1860, p. 288) originally assigned it as a subgenus of *Tudicla* Bolten. However, in 1869 he separated it and raised it to generic rank, because it differed from *Tudicla* 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 *Pyropsis* as a distinct genus. On the other hand, most foreign authors have continued to treat *Pyropsis* as a subgenus of *Tudicla* (Wenz, 1941, p. 1304) or as a synonym of *Tudicla* (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, *Pyropsis perlata*, negates placement in *Tudicla*. Family placement has varied with almost every author and *Pyropsis* has been placed at one time or another in: Volutacea, Vasidae, Buccinidae, Turbinellidae, Tudiclidae, and Fulguridae. Stephenson (1941, p. 315) proposed

a new family name Pyropsidae but neglected to diagnose it. In it he included *Pyropsis* and *Hercorhyncus* Conrad plus two new genera he proposed, *Medionapus* and *Napulus*. Distinguishing *Pyropsis* from *Tudicla* on a familial level appears to be much too drastic a step, especially when one notes the many similarities. Even though *Pyropsis* 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, *Pyropsis*, though generically distinct from *Tudicla*, 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 *Pyropsis*, Stephenson stated

> *Medionapus* differs from *Pyropsis* in having a markedly higher spire, 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 volution.

Although the type species of *Pyropsis* and *Medionapus* appear to be widely separated when compared, the other included species, variously assigned to *Pyropsis*, *Medionapus*, or *Trochifusus*, seem to fill in the gap between the two end members. Therefore *Pyropsis* 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 teloconch. 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 *Pyropsis*, 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 *Pyropsis*. 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 *Pyropsis*, but which are based upon specifically indeterminable internal molds. (Plus marks preceding the name indicate molds have the form of *Pyropsis*.)

+*Pyropsis* (*Rapa*?) *corrina* Whitfield
  +*elevata* Gabb
  naticoides Whitfield
  alabamaensis Gabb
Pyropsis? *obesa* Whitfield
+*Pyropsis planimarginata* (Whitfield) Weller
  pyruloidea (Gabb) Weller
  +*reileyi* Whitfield
    retifer Gabb
  +*Richardsonii* (Tuomey) Gabb
  +*septemlirata* Gabb
    trochiformis (Tuomey) Weller

Species assigned to *Pyropsis* but in need of reassignment or herein reassigned:

Pyropsis hancocki Stanton
  lenolensis Weller = *Napulus*
  octolirata (Conrad) Whitfield = *Napulus*
  whitfieldi Weller = *Napulus*
  retifer (Gabb) Gardner
  geversi Rennie = *Sargana*

In addition, Pchelintsef (1953, p. 220–222) described two species, *Pyropsis quinquecostata* and *Pyropsis typica*, from the Upper Cretaceous of Russia. Both species are based on internal molds of dubious generic affinities and cannot be accepted in *Pyropsis* with any surety.

Species belonging in *Pyropsis*:

Pyropsis bairdi Meek and Hayden
  coloradoensis Stanton
  lanhanii Stephenson
  perlata Conrad
  proxima Wade
Trochifusus perornatus (Wade)
Pyropsis trochiformis (Tuomey) Gardner
  cornutus Sohl
  africana Woods
Trochifusus spinosus Wade
  interstriatus Wade

In addition four species from the Upper Cretaceous of southern India may belong here: *Rapa andoorensis* Stoliczka, *Rapa nodifera* Stoliczka, *Tudicla exima* Stoliczka, and *Rapa cancellata* Stoliczka. Several internal molds from the Aachen Cretaceous of Germany may belong in the genus as well as *Pyropsis patagonicus* Wilckens (= *P. gracilis* Wilckens and *Tudicla gracilis* (Wilckens) of Collignon) from Patagonia and Seymour Island.

Pyropsis perlata Conrad

Plate 33, figures 1, 8, 11, 18, 20

1860. *Tudicla* (*Pyropsis*) *perlata* Conrad, Philadelphia Acad. Nat. Sci. Jour., 2d ser., v. 4, p. 288, pl. 46, fig. 39.
1869. *Pyropsis perlata* Conrad, Am. Jour. Conchology, v. 4, no. 4, p. 248.
1901. *Tudicla perlata* Conrad. Cossmann, Essais Paléoconchologie Comparée, v. 4, p. 70.

1941. *Tudicla* (*Pyropsis*) *perlata* Conrad. Wenz, Handbuch der Paläozoologie; Gastropoda, v. 6, pt. 5, p. 1304, fig. 3717.

Diagnosis.—A low- to flat-spired *Pyropsis* with a distinctly carinate and spinose shoulder below which the body is roundly constricted to the siphonal canal. Spiral ornament of wide-spaced strong cords of almost equal strength below the carination.

Description.—Medium-sized low-spired pyriform shells. Protoconch raised above plane of teloconch volution 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 spinose; 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 opisthocline trend over the rounded body, swing back to a prosocline trend on the body constriction, becoming almost orthocline 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).

Loc.	*H*	*MD*
Conrad, 1860 (holotype)	42.3	39.0
15 (hypotype)	45.5+	44.5
USGS 26340 (hypotype)	40.0	42.0

Discussion.—In spite of its stout shell, without exception specimens of *Pyropsis perlata* 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 noding 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 *Pyropsis proxima* 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 *Pyropsis* but are specifically indeterminable. One specimen from near Brightseat, Prince Georges County, retains some shell material on the apex and is definitely a *Pyropsis*, 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 *Pyropsis perlata*, three such upper whorl face cords develop on the body whorl, but no tendency is shown for noding, 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 *Pyropsis* bearing spines on the whorl angulation and appears close to this species, but the specimen is too incomplete for positive identification. *Pyropsis lanhamii* Stephenson, from the Kemp Clay of Texas, is very close to *P. perlata*, 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 *Pyropsis* 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

1926. *Pyropsis proxima* Wade, U.S. Geol. Survey Prof. Paper 137, p. 139, pl. 47, figs. 8–10.

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).

Loc.	*H*	*MD*
1 (holotype)	48.5	39.8
1 (hypotype)	37.2+	32.3

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 prolixa* 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 have 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 teloconch whorls by flattening of the upper whorl surface and by addition of a single spiral cord on the first teloconch whorl. Suture impressed, becoming lowered to a troughlike depression on later whorls where the bordering subsutural row of nodes becomes spinose. Teloconch whorls expand moderately rapidly and number four to five. Whorls peripherally inflated and angulated 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 whorls 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, arcuately prosocline over upper whorl face, bearing an adaperturely directed sinus on the shoulder subcarination, and gently opisthocline to orthocline 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.

Loc.	*H*	*MD*
18 (holotype)	63	44.7
18 (paratype)	90.3	(1)
7 (paratype)	(1)	66.8
5	95.0+	73.0

[1] Incomplete.

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 *Pyropsis bairdi* (pl. 33, fig. 9), is one which would rest at an intermediate position between *Pyropsis* and *Medionapus* if the latter were to be accepted as a distinct genus. In general form and in ornament it approaches *Pyropsis*, but its stepped spire and more rounded body is like that of *Medionapus*, as defined by Stephenson. Some other species of *Pyropsis* have the sharp spinose 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, 17?, 18.

Pyropsis spinosus (Wade)

Plate 33, figures 19, 21; plate 34, figures 1, 5, 6

1926. *Trochifusus spinosus* Wade, U.S. Geol. Survey Prof. Paper 137, p. 140, pl. 48, fig. 7, pl. 49, figs. 1–3.

1941. *Medionapus spinosus* (Wade). Stephenson, Texas Univ. Bull. 4101, p. 317.

Diagnosis.—Subpyriform shells having an extremely long, thin, straight, siphonal canal. Below the subsutural row of spines and above the shoulder is a broad unornamented concave excavated area that becomes deeply excavated in later growth stages.

Description.—Medium to moderately large elongate subpyriform shells with rather low spire and an extremely long siphonal canal. Protoconch consists of about two round topped volutions that are raised above the plane of teloconch whorls, junction with conch is accompanied by whorls becoming angulated; nodes develop on this angulation on the first teloconch 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. Teloconch 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 spinose 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 ornate, dominated by strong spinose to noded spiral cords; subsutural cord and the cord at the shoulder form the strongest and most distinctly spinose 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 opisthocline over the periphery, and becoming almost orthocline over the pillar. Shape of aperture varies with developmental state, 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 callus thickened to a pad near the posterior channel and extending out of the aperture over the parietal wall; columellar lip thin at edge, curving the adnate 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).

Loc.	Estimated *H*	*H*	*MD*
1 (holotype)	91.9	91.9	29.5
1 (paratype)	177.0	76.8	59.0
1 (hypotype)	105.0	92.5	35.8
Do	144.0	71.0	48.0

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 proportionately

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 subsutural unornamented 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 columellar 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 columellar lips. In addition the depth of the excavated band between the posterior channel and the notch at the shoulder is accentuated by compression.

Pyropsis spinosus (Wade) compares most closely with *P. elongatus* Stephenson from the Nacatoch 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 unornamented subsutural 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 lirae 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 32903; hypotypes USNM 130428, 130429.

Occurrence: Tennessee: Ripley Formation at loc. 1.

Pyropsis interstriatus (Wade)

Plate 33, figures 3–5

1926. *Trochifusus interstriatus* Wade, U.S. Geol. Survey Prof. Paper 137, p. 141, pl. 49, figs. 7, 8.

1941. *Medionapus interstriatus* (Wade) Stephenson, Texas Univ. Bull. 4101, p. 317.

Diagnosis.—Subpyriform shells with an elongate and curving siphonal canal; numerous thin secondary spirals cover the surface of the body from the subsutural 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 lirae present in the interspaces of the primary lirae.

Type: Holotype USNM 32906.

Occurrence: Tennessee: Ripley Formation at loc. 1.

Pyropsis peronatus (Wade)

Plate 34, figures 2–4, 11, 13

1926. *Trochifusus perornatus* Wade, U.S. Geol. Survey Prof. Paper 137, p. 140, pl. 48, figs. 1–6.

Diagnosis.—A pyropsid 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 teloconch and has rounded whorls that grade to the flat-sided but round-topped first teloconch whorl. Suture impressed on early whorls, lying in a slight trough on later whorls where it is bordered by a subsutural row of nodes. Teloconch 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 noded, 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

subsutural 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.

Loc.	*H*	*MD*
1 (holotype)	58.5	46
1 (paratype)	95	74
1 (hypotype)	53	34

Discussion.—All the available specimens of *Pyropsis 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 spirals on the upper whorl face (pl. 34, fig. 3), but others (Wade, 1926, pl. 48, figs. 2, 6) bear close-spaced spirals.

Among other differences, *P. perornatus* is lower spired 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. prolixa* has a longer siphonal canal, higher spire, and a stronger shoulder.

Types: Holotype and paratype USNM 32902; hypotype USNM 130430.

Occurrence: Tennessee: Ripley Formation at loc. 1.

Pyropsis prolixa Sohl, n. sp.

Plate 33, figures 12, 13, 17; plate 34, figures 8, 12

Diagnosis.—A pyropsid 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 teloconch 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 subsutural row of spines. Teloconch 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. 172).

Loc.	*H*	*MD*
96 (holotype)	61.5	31.0
46 (paratype)		55.0
Do	42.8	24.1

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 prolixa 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. prolixa* 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 130432–130435.

Occurrence: Mississippi: Owl Creek Formation at loc. 46. Clayton Formation (Cretaceous reworked at base) at USGS loc. 6468.

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 carinate shoulder, below which the body is constricted to a narrow pillar. The whorl sides characteristically possess the impression of two additional strong spiral cords immediately below the carination and several specimens (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 noded. 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, 79, 80, 82–84, 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 septemlirata* Gabb. The spire is moderately low and lacks the angulated shoulder of *Pyropsis* spp. 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.

Types: Figured specimens 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 teloconch whorl is not shouldered. In addition, the columella 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. trivolva* 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, Mississippi
n. sp., Ripley Formation, Alabama
tuberculatus Stephenson, Nacatoch Sand, Texas
Fusus retifer Gabb, Wenonah Formation, New Jersey
Pyropsis lenolensis Weller, Merchantville Formation, New Jersey
whitfieldi Weller, Navesink Formation, New Jersey

Napulus reesidei Sohl, n.sp.

Plate 35, figures 16–20, 24

1926. *Perissolax whitfieldi* (Weller). Wade, U.S. Geol. Survey Prof. Paper 137, p. 141, pl. 49, figs. 6, 9.
1941. *Napulus whitfieldi* (Weller), Wade. Stephenson, Texas Univ. Bull. 4101, p. 318.

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 ribbons 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 1½ smooth well-rounded whorls that grade into the teloconch gradually. Suture deeply impressed and sometimes weakly channeled. 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 teloconch whorl with two spiral cords, a shoulder angulation forms after about three-quarters of a volution; body bears six or seven wide-spaced strong raised noded spiral ribbons 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 subcancellate pattern. Growth lines strongest near aperture and may form incremental imbrications; growth lines are gently prosocline in trend over the upper whorl face, gently opisthocline over the rounded outer whorl face but swing back strongly over the whorl constriction becoming orthocline 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; columellar 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).

Loc.	*H*	*MD*	*H:D*
1 (holotype)	32.0	18.8	1.7
1 (topotype)	26.9	16.1	1.7
Do	27.0	16.2	1.7
Do	23.0	14.0	1.6

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 ribbons that become less flat topped and usually round off to cords. Although no specimens have secondary spiral lirae between the uppermost three ribbons, their presence between the lower primaries is not rare. Although always remaining strong, there is variance in the width of the spiral ribbons. 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 ribbons than *N. tuberculatus* Stephenson. It has a more constricted body, stronger transverse ornament, and stronger nodings of the spiral ribbons than *N. fragilis* Sohl. In addition the profile of the outer lip of *N. reesidei* shows a more pronounced sinuosity, with the opisthocline trend over the lower periphery being stronger than on the other species of the genus (pl. 35, 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 *Napulus*, 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.

Napulus fragilis Sohl, n. sp.

Plate 35, figures 12, 21–23

Diagnosis.—A *Napulus* 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 ribbons 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 teloconch which is demarked by the presence of two spiral cords the upper of which forms a shoulder angulation after about one complete teloconch volution. 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 ribbons and cords; upper whorl face smooth save for faint microscopic spiral lirae; rounded whorl sides bear six or seven primary spiral ribbons 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 opisthocline 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 ribbons 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).

Loc.	*H*	*MD*	*H:D*
18 (holotype)	20.6	14.4	1.5
5 (paratype)	24.5	14.9	1.6
18 (paratype)	17.9	12.9	1.4
17 (paratype)	15.8	12.0	1.3

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 noding of the spiral ribbons 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 *Napulus reesidei*, from a lower stratigraphic position, *N. fragilis* is thinner shelled, has more numerous and less coarsely noded spiral ribbons, less well developed transverse ornament, a less constricted body, and a less curving growth line. *Napulus octoliratus* (Conrad) from the Owl Creek Formation has more subdued ornament and virtually lacks nodings of the spirals except on the earliest whorls. *Napulus 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(?), 38(?), 39.

Napulus octoliratus Conrad

Plate 35, figures 7, 14

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

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

1955. *Napulus octoliratus* (Conrad). Stephenson, U.S. Geol. Survey Prof. Paper 274–E, pl. 21, figs. 2–5.

Diagnosis.—A *Napulus* 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 override weak collabral transverse swellings. Growth lines rather strongly prosocline over the upper whorl face, arcuately opisthocline over the periphery and orthocline 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); hypotype USNM 128190 (Mississippi); hypotype USNM 76999 (Texas); hypotypes USNM 130448, 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 PTYCHOSYCA Gabb, 1877

Type by monotypy, *Ptychosyca 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 *Ptychosyca* 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). *Ptychosyca 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 Pseudolivinae, but even here no closely related genera are to be found and it stands alone. The genus is restricted to the *Exogyra costata* zone of the east gulf coast except for an undescribed species occurring in the Hygiene Sand of Colorado.

Ptychosyca inornata Gabb

Plate 35, figures 1–6

1876. *Ptychosyca inornata* Gabb, Philadelphia Acad. Nat. Sci. Proc., v. 29, p. 295, pl. 17, figs. 2–4.

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 opisthocline in trend near the suture, swinging to gently prosocline over the inflated part of the whorl, abaperturally sinused over the upper sulcus, adaperturally sinused over the platform, and again abaperturally sinused 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).

Loc.	*H*	*MD*
Holotype	31.0	24.0
7	36.8+	22.5
7	40.0+	24.0

Discussion.—The holotype *Ptychosyca inornate* 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 medially 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 canal· inner lip with a parietal tooth, heavily callused, with a siphonal canal bounded above by a strong ridge on the collumellar 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 *Rapa monheimi* Müller, which elsewhere herein has been assigned to *Hercorhyncus.* 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 *Hercorhyncus*, Wade may have had in mind specimens of that genus from Owl Creek.

Morphologically, *Hydrotribulus* appears to be closest to *Strepsidura* as typified by *S. turgida* (Solander) 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 teloconch whorl, of spiral ornament before the transverse.

Hydrotribulus nodosus Wade

Plate 36, figures 19, 20

1916. *Hydrotribulus nodosus* Wade, Philadelphia Acad. Nat. Sci. Proc., v. 68, p. 465, pl. 24, figs. 4, 5.
1925. *Hydrotribulus nodosus* Wade. Cossmann, Essais paléoconcholgie Comparée, v. 13, p. 253, pl. 10, fig. 29.
1926. *Hydrotribulus nodosus* Wade, U.S. Geol. Survey Prof. Paper 137, p. 147, pl. 51, figs. 6, 7.
1943. *Hydrotribulus nodosus* Wade. Wenz, Handbuch der Paläozoologie; Gastropoda, 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).

Loc.	*H*	*MD*
1 (holotype)	44.1	31.6
1 Topotype	39.5	23.4
Do	28.6	18.5

Discussion.—*Hydrotribulus nodosus* Wade is not common at its type locality in the Ripley Formation on Coon Creek McNairy County, Tenn. The suites 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 (USNM130457) 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

690-081 O - 64 - 5

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 subsutural 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).

Loc.	*H*	*MD*
18 (holotype)	26.0	17.0
18 (paratype)	29.7	18.2
Do	30.0	19.0
5 (paratype)	27.9+	22.0
Do	28.4	19.8

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 subsutural collar.

Compared with *Hydrotribulus nodosus* Wade, from Coon Creek, Tenn., this species lacks nodes on the subsutural 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.

Diagnosis.—Small subfusiform 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 sinused high on whorl and more strongly adaperturally sinused 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 *Fulgerca* to include the type species from the Neylandville Marl and *Pseudoliva? 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 Buccinidae; 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.

Fulgerca attenuata (Wade)

Plate 36, figures 8, 12

1926. *Pseudoliva? attenuata* Wade, U.S. Geol. Survey Prof. Paper 137, p. 146, pl. 51, figs. 4, 5.

1941. *Fulgerca attenuata* Stephenson, Texas Univ. Bull. 4101, p. 372.

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 *Exogyra 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 130463.
Occurrence: Tennessee: Ripley Formation at loc. 1.

Fulgerca 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 *Fulgerca* 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 candicla* 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 acutula* Stephenson, from the Kemp Clay of Texas, is the only substantiated member of the genus in pre-Tertiary strata.

Subgenus ANCILLUS Montfort, 1810

1941. *Eoancilla* Stephenson, Texas Univ. Bull. 4101, p. 361.

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* (*Ancillus*) 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 callus on the whorls 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 acutula*, its blunted apex, as well as the apertural features, and the character of the parietal callus warrants assigning the species to *Ancilla* (*Ancillus*) and synonymising *Eoancilla*.

Ancilla (Ancillus) acutula (Stephenson)

Plate 36, figures 1–7, 10

1941. *Eoancilla acutula* Stephenson, Texas Univ. Bull. 4101, p. 361, pl. 69, figs. 8, 9.

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).

Loc.	*H*	*MD*	*HB*	Percentage of total *H*	*H:D*
Texas (holotype)	9.6	4.1	5.4	0.56	2.3
Texas (paratype)	8.7	3.6	5.0	.57	2.4
46 (hypotype)	13.6	4.4	7.0	.51	3.0
Do	9.1	3.3	5.1	.56	2.3
45 (hypotype)	7.4	3.0	3.7	.50	2.5
46	9.3	3.5	4.7	.51	2.7

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 callus above the siphonal fasciole 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 callus band, a boundary formed by an incised groove that is normally covered by callus on the other specimens. This specimen (USNM 130-465) 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? ripleyana* Wade, 1926.

Etymology.—Compounded from the Latin *mitra*—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 lirae. Aperture elongate, posteriorly angulate; siphonal canal broad, slightly twisted back, and relatively short. Inner lip callus thin and poorly defined, columella 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 *Latiromitra* 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 callus and lack of any trace of a callus ridge on the parietal lip. The lack of these same features would necessitate the distinction of *Mesorhytis* Meek, also from the Upper Cretaceous, from *Vexillum* where Wenz (1943, p. 1287) placed it. *Mesorhytis* 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, *Mesorhytis obscura*, tentatively placed in *Mesorhytis* by Wade, has here been reassigned to *Graphidula*.

Mitridomus ripleyana (Wade)

Plate 37, figures 5, 13

1926. *Fasciolaria? ripleyana* Wade, U.S. Geol. Survey Prof. Paper 137, p. 133, pl. 40, figs. 1, 2.

1963. *Mitridomus ripleyana* Sohl, Jour. Paleontology, v. 37, p. 749, pl. 90, figs. 21, 22.

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 whorls. Teloconch whorls slightly constricted posteriorly, with a rounded periphery; anterior slope moderate. Sculpture of 20–25 low broad sharp-crested collabral ribs that are overridden 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 32865.
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. Whorls 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 Mississippi and one incomplete external mold from Missouri. The holotype appears to be a true harpid, but whether it represents a distinct genus or not is indeterminable. In size and in its most distinguishable characters, it closely approaches *Eocitharia* Fisher (1883), but owing to the incomplete nature of the material, comparison is difficult. It is very tempting to synonymize *Eoharpa* with *Eocitharia*, 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

1955. *Eoharpa sinuosa* Stephenson, U.S. Geol. Survey Prof. Paper 274–E, p. 132, pl. 23, figs. 3–6.

Diagnosis.—A harpid 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 harpid character.

Types: Holotype USNM 20400; paratype USNM 128205.
Occurrence: Mississippi: Owl Creek Formation at loc. 46. Missouri: Owl Creek Formation.

Subfamily MITRINAE

Genus PALEOFUSIMITRA Sohl, 1963

Type species, Paleofusimitra elongnata 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 columellar 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 columellar plication and suppression of the subsutural ornament.

Paleofusimitra elongata Sohl

Plate 37, figures 1–3, 6, 7

1963. *Paleofusimitra elongata* Sohl Jour. Paleontology, v. 37, 750, pl. 89, figs. 11–15.

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 flat-sided, 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 appressed. 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 opisthocline 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 columellar plications that are weak near the aperture but strengthened interiorly.

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

Loc.	*H*	*MD*
6 (holotype)	20.7	6.3
12 (paratype)	23.9+	7.6
Do	28.2+	8.4

Discussion.—*Paleofusimitra 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 VOLUTODERMINAE

Genus LONGOCONCHA Stephenson, 1941

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

Diagnosis.—Elongate slim subcylindrical shells that have an evenly tapering spire of 1/3–1/5 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 sinused 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.—*Longoconcha* 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 *Longoconcha* from *Volutoderma s. s.* He did, however, propose a number of subgenera (*Rostellinda*, *Rostellana*, *Rostellaca*) that Pilsbry and Olsson (1954, p. 19) subsequently raised to generic rank.

The following species should be assigned to *Longoconcha.*

Rostellites angulatus Whitfield, Navesink Formation, New Jersey
Volutoderma appressa Wade, Ripley Formation, Tennessee
Volutoderma (*Longoconcha*) *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
Volutilithes navarroensis Shumard (= *Volutoderma texana* (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 *Longoconcha.* 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

1926. *Volutoderma tennesseensis* Wade, U.S. Geol. Survey Prof. Paper 137, p. 115, pl. 41, figs. 1, 5.

1926. *Volutoderma protracta* Dall. Wade, U.S. Geol. Survey Prof. Paper 137, p. 115, pl. 39, fig. 4.

1926. *Volutoderma appressa* Wade, U.S. Geol. Survey Prof. Paper 137, p. 115, pl. 39, figs. 2, 6.

1941. *Volutoderma (Longoconcha) tennesseensis* Wade. Stephenson, Texas Univ. Bull. 4101, p. 358.

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 plait is always more widely separated, and when it is posterior to first pair it is almost parallel, but when the third plait 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 quadrilirata Sohl, n. sp.

Plate 37, figures 8, 9, 16, 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 lirae 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 *Longoconcha quadrilirata* are incomplete but show a constancy in bearing three columellar 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.

Longoconcha protracta (Dall) from the Ripley Formation of Alabama occurs at about the same level as *L. quadrilirata* but differs by possessing only three cords on the penultimate whorl. *L. navarroensis*, 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 *Exogyra 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.

Occurence: Mississippi: Ripley Formation at locs. 6, 18, 26, 33(?).

Longoconcha dalli (Stephenson)?

Plate 37, figures 15, 19, 20

1907. *Volutoderma texana* (Conrad). Dall, Smithsonian Misc. Colln., v. 50, pt. 1, no 1704, p. 20, fig. 9 (in part).

1907. *Volutoderma protracta* Dall, Smithsonian Misc. Colln., v. 50, pt. 1, no. 1704, p. 21 (in part, USNM 20430).

1941. *Volutoderma (Longoconcha) dalli* Stephenson, Texas Univ. Bull. 4101, p. 359, pl. 70, figs. 13, 14.

Discussion.—Stephenson (1941 p. 359) proposed *Longoconcha dalli* for specimens from the Kemp Clay which differ from *L. navarroensis* 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 over which there are a number of wide-spread weak spiral cords. Like the holotype of *L. dalli*, its subsutural imbrications of the growth lines are not as strong as those of either *L. protracta* Dall or *L. quadrilirata* 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.

Longoconcha 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 *Longoconcha*. These molds appear to be separable into two distinct types. Berguist (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, *Volutilithes conradi* Gabb, 1860.

Diagnosis.—Large elongate subfusiform shells have a low to moderately low spire and a surface glazed by callus. Sutures indistinct because of a covering welt 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 sinused 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 volutid that bears the impression, on its spire, of strong transverse ribs and possesses a single highly oblique and strong plication on the columella. 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 *Volutomorpha conradi* from as low in the New Jersey section as the Cliffwood clay of the Magothy 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 *Volutomorpha*, as was done by Pilsbry and Olsson (1954, p. 19), who synonymized it with *Volutoderma*. Wenz (1941) preferred to deal with it as a subgenus of *Volutoderma*. *Volutomorpha*, 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. *Volutoderma* 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 columellar plications number three or more. In *Volutomorpha* there is generally a complete shell coating 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 *Volutoderma*. *Longoconcha* is much slimmer, lacks surface glaze, and possesses three or more oblique columellar plications.

Numerous species have been assigned to *Volutomorpha*. 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 *Volutomorpha*.

A. Well preserved.
- *Volutomorpha dumasensis* Dall. Ripley Formation of Mississippi
- *Volutolithes eufaulensis* Conrad, Ripley Formation of Alabama
- *Volutomorpha lioica* Dall, Ripley Formation of Alabama (= *V. dumasensis* Dall)
  - *retifera* Dall, Nacatoch Sand of Texas
  - *gigantea* Wade, Ripley Formation of Tennessee
  - *mutabilis* Wade, Ripley Formation of Tennessee
- *Volutomorpha? novamexicana* Herrick and Johnson, Fox Hills Sandstone of New Mexico
- *Volutomorpha valida* Sohl, Ripley Formation of Mississippi

B. Internal molds:
- *Volutomorpha 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:
- *Volutomorpha turricula* Dall, Ripley Formation of Mississippi (holotype missing)
  - *bella* Gabb, Navesink Formation of New Jersey

Species not belonging in *Volutomorpha:*
- *Volutomorpha mucronata* Gabb, Navesink Formation of New Jersey
  - *kanei* Gabb, Navesink Formation of New Jersey
  - *aspera* Dall, Owl Creek Formation of Mississippi (= *Drilluta?*)
  - *peronata* Gardner, Monmouth Formation of Maryland (= *Duessenia?*)
  - *tarensis* Stephenson, Black Creek Formation of North Carolina (= *Liopeplum*)
- *Volutomorpha graysonensis* (Cragin) Stephenson, Woodbine Formation of Texas
- Fasciolaridae?
  - *Volutomorpha similis* Riedel, Cameroons, Africa
  - *aspera* Dall, Reidel, Cameroons, Africa
  - *aspera* Dall, Reidel, Cameroons, Africa
  - *horrida* Reidel, Cameroons, Africa
  - *horrida* Riedel of Darteville, Congo, Africa
- *Volutomorpha? mungoensis* Reyment, Nigeria, Africa

As can be noticed on the preceding list *Volutomorpha* 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 *Deussenia* Stephenson and *Tryonella* Stephenson.

In the Ripley and Owl Creek Formations and their equivalents of the gulf coast, the species here assigned to *Volutomorpha* 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.
- *Volutomorpha valida*
  - *dumasensis*

Group B. Body whorl rounded to subshouldered and bearing ornate sculpture; columella with two or three strong plications.
- *Volutomorpha 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.
- *Volutomorpha producta*

Volutomorpha valida Sohl, n. sp.

Plate 38, figures 2–5, 8; Plate 39, figures 7, 11

1907. *Volutomorpha eufaulensis* (Conrad). Dall, Smithsonian Misc. Colln., v. 50, pt. 1, p. 14, fig. 1.

Diagnosis.—Shell slim for genus; pleural angle 40°–45°; sculpture of strong transverse ribs that are noded by low broad spiral cords on spire, but both

become subdued on body and are covered by callus glaze.

Description.—Shell large, elongate, slim, 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 opisthocline in trend, swinging back to mainly orthocline over the periphery but may become faintly opisthocline 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 plait followed above by a slight swelling; plait obscure at aperture strengthening within; columella flattens somewhat anteriorly on the apertural side of the siphonal fasciole.

Measurements.—The most complete specimen, the holotype, measures 169 + 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 eufaulensis* (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. eufaulensis* (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. retifera* 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 denticulations 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 dumasensis Dall

Plate 38, figures 1, 6; Plate 39, figures 3, 5, 9; Plat 40, figures 1, 2, 5

1907. *Volutomorpha dumasensis* Dall, Smithsonian Misc. Colln., v. 50, pt. 1, p. 16, fig. 4.

1907. *Volutomorpha lioica* 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 subsidiary 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 adaperaturally sinused above, gently opisthocline 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 denticulate 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 lioica* 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 dumasensis* 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 lioica*, 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, forces one to the conclusion that the two specific names are synonymous. Dall's figure of the holotype of *V. lioica* (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. lioica* 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. dumasensis* and on other Mississippi specimens assignable to that species. The holotype of *V. dumasensis* (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. lioica*. Although the type material of *V. lioica* is better preserved than that of *V. dumasensis* 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 columellar 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 shouldering of the whorls.

Types: Holotype USNM 20503; holotype of *V. lioica* 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. 37, fig. 10, pl. 40, figs. 6, 9.

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

Loc.	H	MD	HB
Holotype	152	60	118
Topotype	179	52.5	134
Paratype	87	38.3	69
Topotype	88	37.8	69
Do	63	28.5	49
Do	52	23.2	42

in the Ripley Formation (*Exogyra cancellata* zone) on Coon Creek, McNairy County, Tenn. The immature individuals show relative uniformity in shape, proportions, and ornament, but the larger the individuals become the greater the variability in proportions and ornament. The largest specimen measured (USNM 130684) shows a distinctly slimmer outline than the average. The holotype (pl. 40, fig. 6) retains strong ornament to an advanced state, but some individuals, especially those that tend to a more obese outline, show a suppression of ornament on the body accompanied by a loss of the shoulder and yet they retain a poorly defined subsutural excavated area and collar.

Volutomorpha gigantea Wade, a rather rare species at Coon Creek, is very similar and one hesitates to distinguish it from the variable *V. mutabilis*, but some differences appear to be constant and, therefore, the distinction is maintained here. *V. gigantea* possesses close-spaced spiral cords on the subsutural collar and arcuate growth lamellae corrugate the collar. In addition, the transverse ribs carry up across the excavated area, which is barren of ribs in the mature *V. mutabilis*.

Types: Holotype USNM 32858a; paratype USNM 32858b; hypotypes USNM 130680–130683.

Occurrence: Tennessee: Ripley Formation at loc. 1.

Volutomorpha gigantea Wade

Plate 39, figures 8, 10; plate 40, figure 4

1926. *Volutmorpha gigantea* Wade, U.S. Geol. Survey Prof. Paper 137, p. 114, pl. 37, figs. 2, 3, 5–7, pl. 38, fig. 1, pl. 39, figs. 1, 3.

Diagnosis.—Shell very large, spire low, pleural angle about 70°, body strongly ornamented; subsutral collar marked by numerous close-spaced spiral cords and imbricate lamellar growth rugae that are continuous with the transverse ribs.

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

Loc.	H	MD	HA
Holotype	157	57.4	112
Paratype	61.4	31.4	45.5
Do	52.0	24.1	42.4
Do	39.3	22.3	32.2

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 subsutural 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; topotype USNM 130681.

Occurrence: Tennessee: Ripley Formation at loc. 1.

Volutomorpha retifera Dall

Plate 40, figure 3; plate 41, figures 1, 2, 5, 7

1907. *Volutomorpha retifera* Dall. Smithsonian Misc. Colln., v. 50, pt. 1, p. 15, figs. 2, 3.

1941. *Volutomorpha retifera* Dall. Stephenson, Texas Univ. Bull. 4101, p. 355, pl. 68, figs. 1–4.

Diagnosis.—Shell large, spire rather low; pleural angle 40°–50° on large specimens; body ornamented by both spiral and transverse elements; subsutural 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).

Loc.	H	MD	HB
Lectotype	135+	49+	103
Cotype	120	51	78
Hypotype	70+	36.6	54+
Do	195+	90	135

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 nodings of the subsutural collar and in its sharper and better defined ornament. The lack of imbrications upon the subsutural collar differentiates this species from *V. gigantea* Wade.

Types: Lectotype USNM 20996a; cotypes USNM 20996, 20996b, c; hypotypes 130685–130687.

Occurrence: Mississippi: Ripley Formation at locs. 7, 18, 23, 33?

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; whorls strongly shouldered and constricted anteriorly; body ornamented by strong transverse ribs and numerous low broad spiral cords or ribbons.

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. Whorls posteriorly constricted to a subsutural 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 widespaced ribs per whorl; ribs interrupted above shoulder and dying out on anterior slope; spiral cords and ribbons 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 prosocline 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 whorls.

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 whorls and very strong and sinuous transverse ribs that are overridden by broad spiral ribbons are reminiscent of *V. producta*. However, the growth lines are raised to an imbrication on the subsutural 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, 80, 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.

?1926. *Volutomorpha aspera* Dall. Wade, U.S. Geol. Survey Prof. Paper 137, p. 113, pl. 37, figs. 1, 9.

?1941. *Volutomorpha?* 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 questionably 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 *Exogyra costata* zone.

Types: Holotype USNM 20404; hypotypes USNM 32855, 130694, 130695.

Occurrence: Mississippi: Owl Creek Formation at loc. 46. Prairie Bluff Chalk at loc. 55. ?Ripley Formation at locs. 9, 14, 18, 29. Tennessee: Ripley Formation at loc. 1. Texas: Kemp Clay.

Subfamily ATHLETINAE

Genus LIOPEPLUM Dall, 1890

Type by original designation, *Volutilithes (Athleta) leioderma* Conrad, 1860.

Synonymy.—*Lioderma* Conrad, 1865 (not Marseul, 1857).

Diagnosis.—Medium-sized strombiform 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 plications 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. ruhlei* 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 *Exogyra ponderosa* zone. In the Coniacian of the Cameroons, however, Riedel (1932, p. 107) has described, as *Volutilithes guillemaini*, 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 Senonian of Angola and assigned it to *Liopeplum*. Darteville and Brébion (1956, p. 86) noted Riedel's species as high as upper Senonian 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 cretacea* 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:
- *Volutilithes (Athleta) leioderma* Conrad (=*L. spillmani* Dall)
- *Lioderma thoracica* (Conrad)
- *Liopeplum canalis* Wade
  - *leioderma tabulatum* Stephenson
  - *carinatum* Wade

Group 2. Ribs restricted to early whorls; callus ridge suppressed:
- *Volutilithes cretacea* Conrad (includes, *Liopeplum monmouthensis* Gardner)
- *Volutomorpha tarensis* Stephenson
- *Liopeplum ruhlei* 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

1860. *Volutilithes (Athleta) leioderma* Conrad, Philadelphia Acad. Nat. Sci. Jour., 2d ser., v. 4, p. 292, pl. 46, fig. 32.
1865. *Lioderma lioderma* Conrad, Philadelphia Acad. Nat. Sci. Proc., p. 184.
1890. *Liopeplum lioderma* (Conrad). Dall, Wagner Free Inst. Sci. Trans., v. 3, pt. 1, p. 73.
1890. *Liopeplum spillmani* (Tuomey). Dall, Wagner Free Inst. Sci. Trans., v. 3, pt. 1, p. 83.

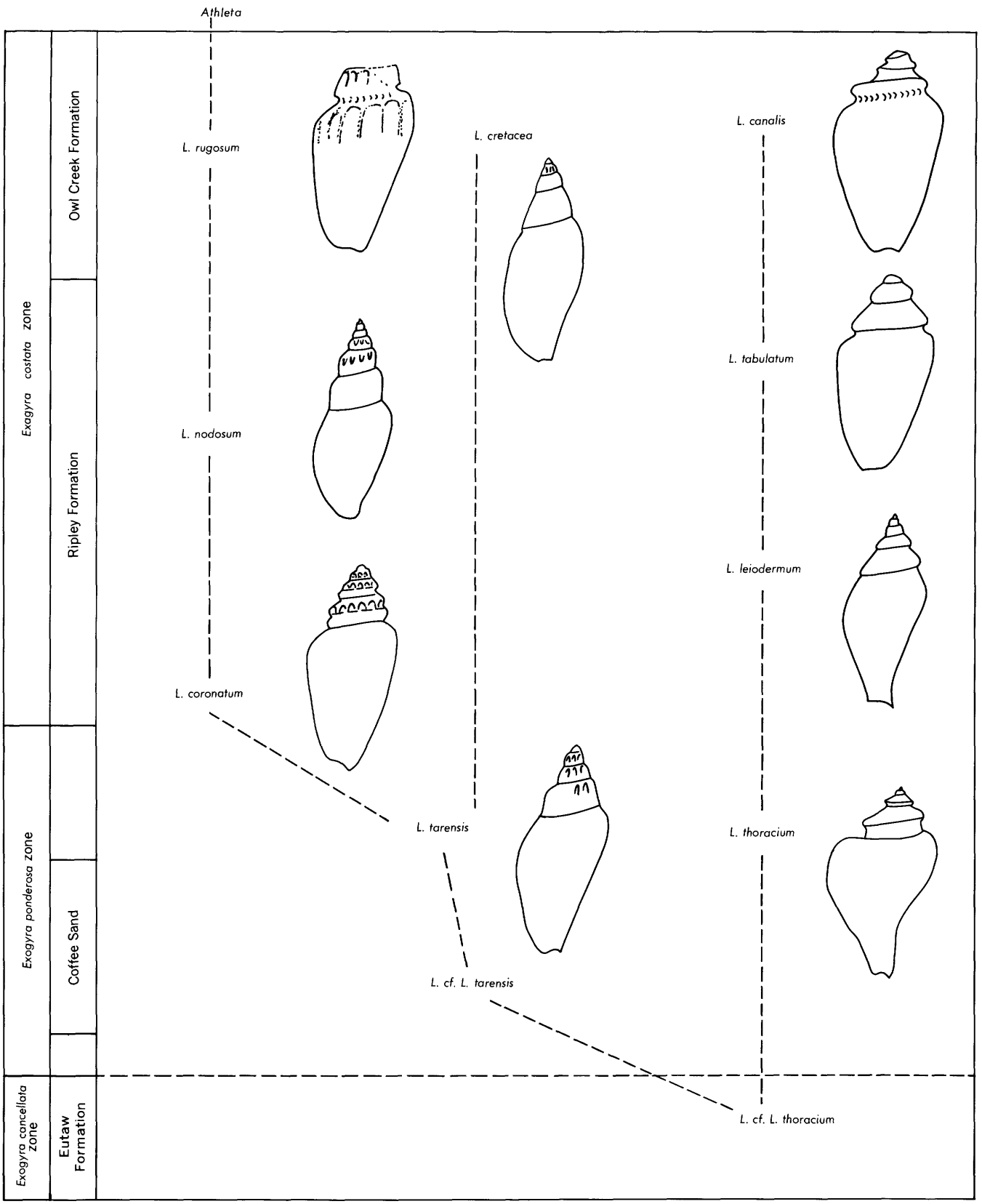


FIGURE 18.—Suggested phylogeny of *Liopeplum* in the Upper Cretaceous of the Gulf and Atlantic Coastal Plains.

1926. *Liopeplum leiodermum* (Conrad). Wade, U.S. Geol. Survey Prof. Paper 137, p. 119, pl. 42, figs. 3, 4.
1926. *Liopeplum canalis* (Conrad). Wade, U.S. Geol. Survey Prof. Paper 137, p. 119, pl. 42, figs. 5, 6.
1941. *Liopeplum leioderma* var. *longum* Stephenson, Texas Univ. Bull. 4101, p. 350, pl. 67, figs. 11, 12.
1941. *Liopeplum leioderma* var. *breve* Stephenson, Texas Univ. Bull. 4101, pl. 67, figs. 9, 10.
1943. *Liopeplum leioderma* (Conrad). Wenz, Handbuch der Paläozoologie; Gastropoda, v. 6, p. 1323, fig. 3760.

Diagnosis.—Shell of medium size, moderately slim; callus ridges of moderate development; body lacks a well-defined shoulder.

Loc.	*H*	*MD*	*HB*	*H:D*
1	38.7	16.6	25.8	2.3
1	54.7	23.8	38.5	2.3
6	46.8	19+	32.2	2.4−
6	35.7	15.0	29.8	2.4
12	40.0	17.9	26.5	2.2
12	35.5	14.0	24.8	2.5
12	29.0	13.4	18.7	2.2
16	54.6	20.5	35.0	2.7
16	46.5	19.2	30.6	2.4
16	35.8	15.7	23.7	2.3
17	48.4+	22.3	31.8+	2.2
17	40.4	17.0	27.4	2.4
17	41.5	17.0	27.8	2.4
18	51.0	23.3	34.1	2.2
29	46.8	18.3	29.7	2.6
Texas	48.2	24.0	33.0	2.0
Do	34.6	16.5	24.1	2.1
Do	38.0	18.0	27.9	2.1

Discussion.—Liopeplum leioderma (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. leioderma—breve*, *longum*, and *tabulatum*—to cover the variation of the species in Texas. His *L. leioderma 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. leioderma*-type specimens from the *Exogyra cancellata* zone at Coon Creek, Tenn., into three species *L. canalis* (Conrad), *L. carinatus* Wade, and *L. leioderma* (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 liodermum*. 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 spillmani* (Tuomey) belongs to *Liopeplum leioderma*. Tuomey's species, *Voluta spillmani*, 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 Toumey'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. leiodermum* and more closely akin to *L. canalis* (Conrad), an interpretation which would be more in keeping with its association in Maryland with *L. cretacea* (Conrad) and *Sphenodiscus*.

Liopeplum leiodermum (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 columellar 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 32099 (Mississippi) (=*Liopeplum spillmani* (Tuomey) of Dall); hypotype USNM 20471 (Mississippi); hypotype USNM 130696–130702, 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 breve* Stephenson).

Occurrence: Mississipi: Ripley Formation at locs. 6, 12, 15–18, 24, 27, 29, 32? Tennessee: Ripley Formation at loc. 1. Texas: Nacatoch Sand. Alabama and Georgia: Ripley Formation.

Liopeplum canalis (Conrad)

Plate 43, figures 4, 5, 17, 18, 23

1858. *Conus canalis* Conrad, Philadelphia Acad. Nat. Sci. Jour, 2d ser., v. 3, p. 331, pl. 35, fig. 22.
1940. *Liopeplum canalis* (Conrad). Stephenson and Monroe, Mississippi Geol. Survey Bull. 40, pl. 13, figs. 4, 5.

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).

Loc.	*H*	*MD*	*HB*	*H:D*
46 (hypotype)	66.4	25.5	50.5	2.6
Do	62.5	35.1	46+	1.8
Do	22.3	12.0	15.5	1.9
40	75.1	28.8	50.5	2.6
40	71.5	32.0	48.6	2.2

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 Nacatoch Sand of Texas, but that species is shorter and proportionally broader with a less well developed channel. Though *L. thoracicum* 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 20437.

Occurrence: Mississippi: Owl Creek Formation at locs. 42, 45, 46. Tennessee: Clayton Formation (Owl Creek reworked at base) at loc. 40.

Liopeplum cretaceum (Conrad)

Plate 43, figures 3, 21, 22, 24, 25

1858. *Volutilithes cretacea* Conrad, Philadelphia Acad. Nat. Sci. Jour., 2d ser., v. 3, p. 333, pl. 35, fig. 16.
1877. *Leioderma canalis* Conrad. Gabb, Philadelphia Acad. Nat. Sci. Proc., v. 28, p. 292.
1916. *Liopeplum cretaceum* (Conrad). Gardner, Maryland Geol. Survey, Upper Cretaceous, p. 431, pl. 15, fig. 5.
1916. *Liopeplum monmouthensis* Gardner, Maryland Geol. Survey, Upper Cretaceous, p. 432, pl. 15, figs. 6, 7.
1962. *Liopeplum cretaceum* (Conrad). Richards and Ramsdell, Cretaceous Fossils, pt. II, New Jersey Geol. Survey, Bull. 62, p. 83, pl. 56, fig. 7.

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 topotype 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. 35, 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. *Volutomorpha tarensis* 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. cretaceum* 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 callus ridge, which is lacking in *L. cretaceum*.

Types: Holotype, lost; hypotypes USNM 130705–130707.

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

1926. *Liopeplum subjugosum* (Gabb). Wade, U.S. Geol. Survey Prof. Paper 137, p. 118, pl. 41, figs. 2, 3, 4.

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; callus 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).

Loc.	*H*	*MD*	*HB*	*H:D*
1 (holotype)	75.5	30	46	2.5
1 (paratype)	50.2	22.9	35	2.2
1 (hypotype)	53.5	21.0	38	2.6
Do	54.2	23.8	38	2.3
Topotype (1)	57.8	26.8	40.5	2.2
Do	42.3	19.6	28.5	2.2

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 callus ridge.

Types: Holotype and paratype USNM 32869; paratypes USNM 130708–130710.

Occurrence: Tennessee: Ripley Formation at loc. 1.

Liopeplum rugosum Stephenson

Plate 43, figure 8

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

1955. *Liopeplum rugosum* Stephenson, U.S. Geol. Survey Prof. Paper 274–E, p. 130, pl. 22, figs. 1–5.

Diagnosis.—A medium-sized *Liopeplum*; transverse ribs elongate and strong on both spire and body; callus ridge strong, body well shouldered; columellar plications numerous and strong, placed on a broad raised columellar welt.

Measurements.—(All specimens are incomplete.) Explanation of measurement and symbols used in the following table appear in the section "Measurements of specimens" (p. 172).

Loc.	*H*	*MD*	*HB*
46 (holotype)	47+	22+	32
46? (hypotype)	40+	19.5	30
46 (paratype)	25+	12.5	19.5

Discussion.—*Liopeplum rugosum* Stephenson is the most highly ornamented species of the genus *Liopeplum* and one of the most distinctive. In general, species of *Liopeplum* have their transverse ornament restricted to the earlier whorls of the spire and even these ribs may become obscured by callus at a later stage. This species differs both by sculpture and by columellar features from its allies, *Liopeplum nodosum* Sohl and *L. coronatum* Sohl, from the Ripley Formation.

Stephenson (1955, p. 130) stated that Wade's form differs in that

> The axials are shorter, and, though present in medium strength on the penultimate whorl, they are much more numerous and become successively weaker forward on the body whorl, and on adults they fade out to a smooth surface before reaching the aperture; the ridge of callus above the suture is smoother and more uniformly developed, and the columellar plaits are fewer, weaker, and are not mounted on a thickened part of the inner lip.

Stephenson (1955, p. 130–131) reviewed the nomenclatoral problems surrounding Tuomey's *Voluta jugosa* and Gabb's *Liopeplum subjugosum* to which Dall and Wade both indiscriminately assigned strongly ornamented shells of this genus.

As known, *Liopeplum rugosum* Stephenson is restricted to the Owl Creek Formation of the northern part of the Mississippi embayment area of Mississippi and Missouri, but it has also been noted as probably present in the Prairie Bluff Chalk and definitely present as a reworked element in the Clayton Formation in Mississippi.

Types: Holotype USNM 128200; paratype USNM 128197–128199; hopotype USNM 111801.

Occurrence: Mississippi: Owl Creek Formation 44, 46. Clayton Formation (Owl Creek reworked at base) at loc. 49. Prairie Bluff Chalk questionably present at loc. 53. Missouri: Owl Creek Formation.

Liopeplum 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; columella bears two moderately low folds.

Description.—Shell of medium size, substrombiform, 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 sinused 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. Columella bears two rather low oblique folds situated submedially.

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

Loc.	*H*	*MD*	*H*	*H:D*
Alabama (holotype)	51.5	18.2	25.5	2.8
Alabama (paratype)	55.0+	20.5	31.5	2.7
Do	45.4+	18.8	26.8	----------
Mississippi (paratype)	34.4+	16.3	22.0	----------

Discussion.—This scarce species fills a gap between *Liopeplum 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 stronge 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 columellar plications and more continuous transverse ribs, where as *L. coronatum* has more numerous ribs.

Liopeplum nodosum appears to be restricted to the lower and medial parts of the Ripley formation, above the *Exogyra cancellata* zone.

Types: Holotype USNM 130711; paratypes USNM 130712–130714; paratype USNM 20473.

Occurrence: Mississippi: Ripley Formation at loc. 16. Alabama: Ripley Formation of the Chattahoochee River region.

Genus PARVIVOLUTA Wade, 1926

Type by original designation, *Parvivoluta concinna* Wade.

Diagnosis.—Small subfusiform volutids with a shell surface marked by strong transverse ribs and finer spiral lirae. Aperture lenticular, siphonal canal short and open; columella 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 *Volutilithes orbignyana* Mueller from the Aachen Cretaceous 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 specimens Wade assigned to *Parvivoluta* are crushed and incomplete, which further clouds the relationship of the genus. Wenz (1943, p. 1318) assigned *Parvivoluta* 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 TECTAPLICA Wade, 1916

Type by original designation, *Tectaplica simplica* 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 florencis* 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. Pchelintsef (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 *Volutocorbis* Conrad. *Tectaplica* does appear close to both *Volutocorbis* 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 simplica Wade

Plate 44, figures 19–21

1916. *Tectaplica simplica* Wade, Philadelphia Acad. Nat. Sci. Proc., v. 68, p. 457, pl. 23, fig. 4.
1925. *Tectaplica simplica* Wade. Cossmann, Essais Paléconchologie Comparée, v. 13, p. 242, pl. 8, fig. 33.
1943. *Volutocorbis* (*Tectaplica*) *simplica* (Wade). Wenz, Handbuch der Paläozoologie 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 32875.
Occurrence: Tennessee: Ripley Formation at loc. 1.

Subfamily SCAPHELLINAE?

Genus PARAFUSUS, Wade 1918

Type by original designation, *Hyllus callilateris* 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 sinused 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 *Gilvastia* 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 *Exogyra costata* zone of the Gulf Coastal Plain. Wade (1926, p. 122) assigned *Ancilla cretacensis* 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. 359), followed by Harbison (1945, p. 86), questioned the advisability of assigning species such as *Parafusus callilateris* 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 callilateria Wade

Plate 44, figures 22, 23, 26

1917. *Hyllus callilateris* Wade, Philadelphia Acad. Nat. Sci. Proc., v. 69, p. 282, pl. 17, figs. 5, 6.
1918. *Parafusus callilateras* Wade, Am. Jour. Sci., 4th ser., v. 45, p. 334 (error for *P. callilateris*).
1925. *Haplovoluta callilateris* Wade. Cossmann, Essais Paléoconchologie Comparée, v. 13, p. 241, pl. 8, fig. 6.
1926. *Parafusus callilateris* Wade, U.S. Geol. Survey Prof. Paper 137, p. 120, pl. 43, figs. 11, 12.
1943. *Parafusus callilateris* Wade. Wenz, Handbuch der Paläozoologie; Gastropoda, v. 6, pt. 6, p. 1352, fig. 3827.

Diagnosis.—Medium to moderately large parafusids of rather obese 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).

Loc.	*H*	*MD*	*HB*	*H:D*
1 (holotype) [1]	88.6	57.5	66.6	1.6
5	78.8	41.7	53.2	1.8
7	59.2	31.4	40.9	1.8
12	35.9	18.0	16.5	1.9

[1] Estimated 95.

Discussion.—Compared with the holotype from the Ripley Formation at Coon Creek, McNairy County, Tenn., the specimens from the Ripley Formation of Mississippi appear to be slimmer, 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 saffordi* Sohl (H:B 2.0–2.1). This latter species differs not only by having a higher spire and by being slimmer 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 columellar plications, the anterior of which is the strongest.

Types: Holotype USNM 32879; hypotypes USNM 20506.

Occurrence: Mississippi: Ripley Formation at locs. 5, 7, 12, 18. Tennessee: Ripley Formation at loc. 1. Alabama and Georgia (Chattahoochee River region): Ripley Formation.

Parafusus saffordi Sohl, n. sp.

Plate 44, figures 24, 28

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 sinused 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, sinused 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).

Loc.	*H*	Estimated *H*	*MD*	*HB*	*H:D*
40 (holotype)	87.7	-------	41.0	57	2.1
40 (paratype)	61.7	68.0	34.3	43.5	2.0
45 (paratype)	62.8	67	31.0	42.2	2.0

Discussion.—Both the holotype and one paratype of *Parafusus saffordi* 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 saffordi.*

Parafusus callilateris Wade, a closely related species from the Ripley Formation, is more obese and also possesses a distinct callus ridge on the body, which is lacking in *P. saffordi. Parafusus coloratus* Wade differs primarily by its possession of two strong columellar 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

1917. *Hyllus coloratus* Wade, Philadelphia Acad. Nat. Sci. Proc., 69, p. 283, pl. 17, figs. 3, 4.
1918. *Parafusus coloratus* Wade, Am. Jour. Sci., 4th Ser., v. 45, p. 334.
1925. *Haplovoluta colorata* Wade. Cossmann, Essais Paléoconchologie Comparée, v. 13, p. 342, pl. 11, fig. 17.
1926. *Parafusus coloratus* Wade, U.S. Geol. Survey Prof. Paper 137, p. 121, pl. 43, figs. 8, 9.
?1941. *Parafusus*? sp., Stephenson, Texas Univ. Bull. 4101, p. 359, pl. 69, figs. 12, 13.

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. 359) 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.

Occurrence: Tennessee: Ripley Formation at loc. 1. Mississippi: Ripley Formation, questionably at loc. 18. Texas: Nacatoch Sand, questionably present.

Genus MYOBARBUM Sohl, 1963

Type species, *Myobarbum laevigatum* Sohl.

Etymology.—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 subshouldered. Aperture lenticular; posteriorly sinused; 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. *Monotygma* Lea of the gulf coast Eocene is similar but possesses a fasciolar band terminating in an outer lip tooth and lacks the truncate columella of *Myobarbum.* *Myobarbum* 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, *Myobarbum* resembles *Scaphella* 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 Scaphellinae. *Myobarbum* ranges through the Ripley and Owl Creek Formations and has been noted from Mississippi to Georgia.

Myobarbum laevigatum Sohl

Plate 44, figures 15–17

1963. *Myobarbum aevigatum* Sohl, Jour. Paleontology, v. 67, p. 751, pl. 90, figs. 18–20.

Description.—Moderately small stout shells with an oliviform outline. Spire one-third or 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 sinused posteriorly, very gently prosocline below. Aperture narrowly elongate, posteriorly channeled, siphonal canal open, inclined, siphonal notch shallow and broad. Outer lip posteriorly sinused. 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).

Loc.	H	MD	H:D
46 (holotype)	18.5	9.6	1.9
5	18.5+	9.2	2.0
22	16.8	7.9	2.1
22 (hypotype)	14.2	6.9	2.0
Providence Sand, Georgia	[1] 21.0	10.0	2.1
Do	10.9	5.2	2.1
Do	10.9	5.8	1.9

[1] Estimated.

Discussion.—The holotype of *Myobarbum 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 MATAXA Wade, 1916

Type by original designation, *Mataxa 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 denticulate 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 *Mataxa* is nearer the rare recent subgenus *Massyla* * * * *Mataxa* 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 *Mataxa 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 Arialoor 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 are features not typical of *Mataxa* although two immature specimens have been noted that possess a parietal tooth.

Wenz (1943, p. 1271) placed this genus in the Pseudolivinae of the Olividae and close to *Hydrotribulus*, but I believe the generic features fit better in the Cancellaridae, where it was placed by Wade.

Mataxa elegans Wade

Plate 45, figures 20–27

1916. *Mataxa elegans* Wade, Philadelphia Acad. Nat. Sci. Proc., v. 68, p. 456, pl. 23, figs. 1, 2, 3.

1925. *Mataxa elegans* Wade. Cossmann, Essais Paléoconchologie Comparée, v. 13, p. 255, pl. 11, figs. 7, 8.

1926. *Mataxa elegans* Wade, U.S. Geol. Survey Prof. Paper 137, p. 109, pl. 35, figs. 9, 10.

1941. *Mataxa valida* Stephenson, Texas Univ. Bull. 4101, p. 365, pl. 70, figs. 1–3.

1943. *Mataxa elegans* Wade. Wenz, Handbuch der Paläzoologie; Gastropoda, v. 6, pt. 6, p. 1271, fig. 3617.

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).

Loc.	H	MD
1 (holotype)	23.5	13.8
1 (topotype)	23.4	13.6
Do	20.0	13.1
Do	19.5	12.7
Do	10.2	5.4
5	14.1	8.7
9	15.8	8.6
M. valida Stephenson (holotype)	16.7	9.8
M. valida Stephenson (paratype)	11.2	6.9

Discussion.—*Mataxa 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 topotypes available, minor variation in shape, ornament, and height of protoconch are common. The topotype 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.

Occurrence: Tennessee: Ripley Formation at loc. 1. Mississippi: Ripley Formation at locs. 5–7, 16. Alabama and Georgia (Chattahoochee River region): Ripley Formation.

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 ripleyana*, described herein, lacks the loose coiling of the type species. If one

treats *Trigonostoma* in the strictest sense, *T. ripleyana* probably would not belong, yet it does have a narrow umbilicus, 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 ripleyana 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 ripleyana Sohl, n. sp.

Plate 44, figures 25, 27

Diagnosis.—Medium sized trionostomids with a very narrow umbilicus 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 85°. 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 subsutural 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 cover the shell surface and are superimposed on the strong cords. Transverse sculpture is weaker and takes the form of imbricate incrementals 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 sinused on excavated area, becoming rather steeply prosocline over basal slope. Aperture subtriangular; outer lip lirate within; inner lip strongly callused with edge of callus 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. Aperture lenticular; siphonal canal narrow, short, and twisted; outer lip lirate within, thick; inner lip glazed by callus. 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 Cancellaridae are known from the Mesozoic. Wenz, 1943, listed only *Uxia* Jousseaume, *Bonnellitia* Jousseaume, and *Babylonella* Conrad as having a range extending down into the latest Cretaceous (Senonian-Maestrichtian). 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, cancellarids 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 mcnairyensis*, but his *Cancellaria?* sp. looks like a fusiform shell similar to *Hercorhyncus or Ornopsis* (*Ripleyella*) with the siphonal canal broken.

Cancellaria? macnairyensis 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 ribbons.

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 lirae 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-sided 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 *Sveltia* Jousseaume or *Sveltella* 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 *Sveltia, 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 *Sveltella*, 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 (Colubraria) 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. bellsana.* 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

1926 *Cancellaria acuta* Wade, U.S. Geol. Survey Prof. Paper 137, p. 108, pl. 35, figs. 4, 5.
1941 *Caveola acuta* (Wade). Stephenson, Texas Univ. Bull. 4101, p. 363.
?1941 *Caveola acuta* (Wade)? Stephenson, Texas Univ. Bull. 4101, p. 363, pl. 70, figs. 8–10.

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).

Loc.	H	MD	H:D
1 (holotype)	18.4	7.8	2.4
1 (topotype)	19.6	8.1	2.4
Do	16.5	7.3	2.3
Do	15.2	7.4	2.1
Do	16.9	8.1	2.1
Do	12.1	5.4	2.2
Do	10.3	5.5	1.9
Do	8.7	4.6	1.9

690-081 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 32844; hypotypes USNM 130493, 130494, 130554.

Occurrence: Tennessee: Ripley Formation at loc. 1.

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).

Loc.	H	MD	H:D
6	11.1	5.3	2.1
18	11.4	5.0	2.3
16	8.9	4.6	2.0
17	8.9	4.4	2.0

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 slimness 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 these 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 130495; paratypes USNM 130496, 130726.

Occurrence: Mississippi: Ripley Formation at locs. 6, 15–18.

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 130497–130499.

Occurrence: Mississippi: Owl Creek Formation at locs. 41, 45, 46.

Family PALADMETIDAE

Genus PALADMETE Gardner, 1916

Type by original designation, *Trichotropis cancellaria* 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 holostomous; 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 *Trichotropis 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 columellar plications. Both Cossmann (1925) and Wenz (1940) 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 Cancellaridae. 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 Cancellaridae, ignoring his previous designation.

The lack of columellar plications and the common lack of lirations or denticles on the interior of the outer lip makes a strong argument for distinguishing *Paladmete* from the Cancellaridae. 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 Cancellaridae. It seems best to place *Paladmete* in a separate family close to Cancellaridae.

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
Trichotropis cancellaria Conrad, Owl Creek Formation of Mississippi
Paladmete corbuliformis Stephenson, Navarro Group of Texas
cavcola Stephenson, Eutaw Formation of Mississippi
densata Wade, Ripley Formation of Tennessee
elegans Stephenson, Navarro Group of Texas
Cancellaria eufaulensis Gabb, Ripley Formation of Alabama
Paladmete gardnerae Wade, Ripley Formation of Tennessee
inaequalis Stephenson, Navarro Group of Texas
**Neptunea perforata* Gabb, Cretaceous of California
Paladmete poecilma Harbison, Ripley Formation of Misssissippi
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 columellar 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

1858. *Trichotropis cancellaria* Conrad, Philadelphia Acad. Nat. Sci. Jour., 2d ser. ? v. 3, p. 333, pl. 35, fig. 8.
1860. *Cancellaria eufaulensis* Gabb, Philadelphia, Acad. Nat. Sci. Jour. 2d. ser., v. 4, p. 390, pl. 68, fig. 8.
1916. *Paladmete cancellaria* (Conrad). Gardner, Maryland Geol. Survey, Upper Cretaceous, p. 413, pl. 18, figs. 14, 15.
1925. *Paladmete cancellaria* (Conrad). Cossman, Essais Paléoconchologie Comparée, v. 13, p. 27, pl. 11, figs. 15, 16.
1926. *Paladmete cancellaria* (Conrad). Wade, U.S. Geol. Survey Prof. Paper 137, p. 107, pl. 35, figs. 1, 2.
1926. *Paladmete densata* Wade, U.S. Geol. Survey Prof. Paper 137, p. 108, pl. 35, fig. 7, 8.
1940. *Trichotropis (Palaeadmete) cancellaria* Conrad. Wenz, Handbuch der Paläozoologie; Gastropoda, v. 6, pt. 4, p. 891, fig. 2621.
1945 *Paladmete poecilma* Harbison, Philadelphia Acad. Nat. Sci. Proc., v. 97, p. 75–92.

Diagnosis.—Shell large for genus; bears a rather sharply defined shoulder and strong transverse ribs that are overridden by spiral ribbons 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 round-sided whorls, the first 1½ 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; ½–¾ 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 subshouldered 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 32; 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, fig. 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, gerontic 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 *Exogyra 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 prosocline 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 topotype 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 *Urceolabrum* cf. *U. tuberculatum* Wade are also included. Other specimens in these collections assigned to *Trichotropis*? 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 eufaulensis*, 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 eufaulensis* Gabb ANSP 14962; Hypotype Gardner collection USNM 20529 (Mississippi); hypotype USNM 32842 (Tennessee); holotype of *P. densata* Wade USNM 32845 (Tennessee); hypotypes USNM 130500–130505 (Mississippi).

Occurrence: Mississsippi: Owl Creek Formation at locs. 40–43, 45–47. Ripley Formation at locs. 4–7, 10, 14–19, 22–24, 29. Tennessee: Ripley Formation at loc. 1. Alabama and Georgia: Ripley Formation. Maryland: Monmouth Formation.

Paladmete gardnerae gardnerae Wade

Plate 45, figures 43–45

1926. *Paladmete gardnerae* Wade, U.S. Geol. Survey Prof. Paper 137, p. 108, pl. 35, figs. 3, 6.

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 volution. Suture impressed. Whorls round sided, plump, with a tendency to become flatter on larger specimens. Sculpture begins on the first teloconch 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 to opisthocline on periphery and retracting strongly to prosocline on basal slope. Aperture holostomous, broadly subovate 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 on "Measurements of specimens" (p. 172).

Loc.	H	MD	H:D
1 (holotype)	13.3	9.6	1.4
1 (topotype)	14.0	9.0	1.6
Do	11.8	8.1	1.4
Do	11.1	7.6	1.5
Do	11.4	8.1	1.4
Do	10.1	6.7	1.5
Do	9.0	6.0	1.5
Do	12.0	7.9	1.5
Do	10.6	6.9	1.5
Do	10.3	7.8	1.3
Average	11.4	7.8	1.5

Discussion.—This species although similar in the ornament of its first teloconch whorl to *Paladmete cancellaria* (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 subduing 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 *Exogyra cancellata* zone.

Types: Holotype USNM 32843; hypotypes USNM 130552.

Occurrence: Tennessee: Ripley Formation at loc. 1. Delaware: Mount Laurel Sand.

Paladmete gardnerae pygmaea Sohl, n. subsp.

Plate 45, figures 36–40

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).

Loc.	Number of specimens	Range of height	Average height	Range of *MD*	Average *MD*	Average *HD*
6	10	10.6–7.0	8.5	7.0–4.9	5.7	1.5
7	5	11.6–6.4	8.7	7.0–4.7	5.8	1.5
15	8	8.6–6.1	7.2	5.4–4.0	5.0	1.4
16	10	8.9–6.0	7.2	6.3–4.4	5.2	1.4
18	10	10.4–7.5	8.9	7.0–5.1	6.1	1.5

Discussion.—*Paladmete gardnerae pygmaea* differs from *P. gardnerae gardnerae* of the *Exogyra 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 ribbons are absent, but a few specimens show narrow ribbons 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 inaequalis 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 130506; paratypes USNM 130507, 130508, 130553.

Occurrence: Mississippi: Ripley Formation at locs. 5–7, 15–18, 22, 24, 29, 32.

Paladmete laevis Sohl, n. sp.

Plate 45, figures 35, 41, 42, 46–48

Diagnosis.—Paladmetes whose ornament becomes suppressed and that develop a channeled suture and coarse subsutural 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 2¾–3 smooth well rounded whorls; the first of which is even with the upper surface of the second whorl. Suture deeply impressed on first teloconch 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 teloconch 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 subsuturally 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).

Loc.	*H*	*MD*	*HD*
18 (holotype	11.1	7.8	1.4
7 (paratype)	11.0	6.5	1.7
Do	14.8	7.9+	----
12 (paratype)	11.5	7.9	1.5

Discussion.—*Paladmete laevis* differs from all other species of the genus by possessing a channeled suture and lacking varices. The species is, however, decidedly a *Paladmete* in its early developmental stages as the channeled suture does not develop until after the first teloconch 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 varices, lacks the channeled suture, generally retains transverse sculpture other than subsutural nodes, and has a distinctly curved columella. *Paladmete 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 course 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).

Paladmete 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 130509; 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 taxons, *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 teloconch 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 macnairyensis* 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 macnairyensis Wade. In addition he described three additional new species from the Navarro Group of Texas, *A. venustum*, *A. baylei*, and *A. curvovostatum*. Of these, *A. venustum* appears to be based on an immature shell more closely related to *Remnita*. In addition, he suggested that *Exilia ripleyana* Wade also belonged to *Amuletum*. The later species, for reasons cited under the discussion of *A. macnairyensis*, 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.

Lutema 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 nodose character of the transverse ribs as they cross the shoulder. *Lutema* 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 is clouded by a great abundance of proposed turrid genera and species that are based on small relative differences.

Amuletum (Amuletum) macnairyensis macnairyensis (Wade)

Plate 45, figures 1–5

1926. *Turricula macnairyensis* Wade, U.S. Geol. Survey Prof. Paper 137, p. 113, pl. 36, figs. 8, 9.
1926. *Exilia ripleyana* Wade, U.S. Geol. Survey Prof. Paper 137, p. 128, pl. 45, figs. 13, 14.
1940. *Exilia ripleyana* Bentson, California Univ. Bull. 25, no. 5, p. 205, pl. 2, figs. 14, 18.
1941. *Amuletum macnairyensis* Stephenson, Texas Univ. Bull. 4101, p. 369.
1941. *Amuletum curvocostatum* Stephenson Texas Univ. Bull. 4101, p. 370, pl. 71, figs. 1, 2 (in part).

Diagnosis.—Moderately small slim fusiform shells with a weak posterior whorl constriction and numerous narrow low collabral transverse ribs that are overridden 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 teloconch whorl, whorls develop a weak posterior constriction below which the body inflates to a well-rounded periphery; whorl then constricts rapidly over the moderately steep basal slope to the extended tapering pillar. Sculpture ornate, initiated abruptly on first teloconch whorl by rather strong widespaced transverse ribs that are followed by the development of broad close-spaced spiral cords on the second half of the first teloconch 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 abaperatural sinus over the collar, are opisthocline over the periphery, swing back arcuately to prosocline over the basal slope, and become gently prosocline 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).

Loc.	*H*	*MD*	*HD*
1 (holotype)	7.3	2.3	3.2
Exilia ripleyana holotype	11.8	3.6	3.2
Topotype	6.4	2.3	2.8
Do	5.3	1.8	3.0

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 topotypes of a size equivalent to the holotype are present, but they are too incomplete for measurement. Among the topotype 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 macnairyensis* and to *Exilia ripleyana*. 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 whorls. 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. macnairyensis macnairyensis* 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. macnairyensis torquatum.*

Types: Holotype USNM 32852; holotype (*E. ripleyana*) USNM 32890; holotype (*A. curvicostatum*) USNM 77146; hypotypes USNM 130514, 130515.

Occurrence: Tennessee: Ripley Formation at loc. 1. Texas: Neylandville Marl.

Amuletum (Amuletum) macnairyensis torquatum Sohl, n. subsp.

Plate 45, figures 6–9

Diagnosis.—This subspecies differs from *Amuletum macnairyensis macnairyensis* 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).

Loc.	*H*	*MD*	*HD*
6 (holotype)	15.4	4.2	3.7
18 (paratype)	11.9	3.6	3.3
Do	8.8	3.1	2.8
6 (topotype)	9.6	3.3	2.9
Do	10.3	3.4	3.0
18	10.3	3.6	2.9

Discussion.—In addition to the more noticeable characters previously listed, *Amuletum macnairyensis torquatum* also differs from *A. macnairyensis macnairyensis* by having proportionally stronger spiral cords and a greater opisthocline 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 whorls and lower less flexed transverse ribs.

Types: Holotype USNM 130516; paratypes USNM 130517, 130518.

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 collabral 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 whorls that become increasingly roundsided with increased size. Suture impressed. Whorls develop a moderate posterior constriction after the first teloconch 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 teloconch whorl with faint low arcuately opisthocline transverse ribs that strengthen and become less opisthocline on the second half of the first teloconch whorl; as the collar forms on the second teloconch whorl the ribs diminish in vigor over the collar and become sinused; 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 teloconch whorl as faint broad cords; on later whorls 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 abaperaturally sinused over collar, gently opisthocline over periphery, slightly prosocline on basal slope, and almost orthocline 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).

Loc.	*H*	*MD*	*HD*
7 (holotype)	12.5	3.6	3.5
7 (paratype)	11.7+	3.8	
18 (paratype)	17.2	4.9+	
Do	16.6+	5.2+	

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 macnairyensis 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

1945. *Amuletum wadei* Harbison, Philadelphia Acad. Nat. Sci. Proc., v. 97, p. 88, pl. 6, figs. 41, 42.

Diagnosis.—A highly ornate *Amuletum* bears a strongly defined posterior whorl constriction and very sinuous collabral 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 turriculate and less than half total shell height; pleural angle 25°–30°. Protoconch proportionally large, consisting of about four smooth convex-sided whorls that expand disproportionally to the rate of increase of the teloconch. Suture impressed. Whorls strongly constricted posteriorly to a weltlike 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 teloconch 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 teloconch whorl. Spiral sculpture begins after one-third of a turn of the first teloconch whorl and consists of a few broad ribbons separated only by thin impressed lines; by the second teloconch 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 sinused on the excavated band, strongly opisthocline over the shoulder and periphery surging to moderately prosocline on the basal slope, then back to orthocline 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).

Loc.	*H*	*MD*	*HD*
18 (holotype)	14.6	4.2	3.5
6 (hypotype)	8.6	2.7	3.2

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.*) *macnairyensis* (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 speciments labeled *A. wadei* in the Harbison collections from locality 18 now in the Academy of Natural Sciences belong in that species.

Types: Holotype USNM 103750; paratype ANSP 16690; hypotypes USNM 130524, 130525.

Occurrence: Mississippi: Ripley Formation at locs. 5, 6, 16, 18.

Amuletum (Amuletum) fasciolatum (Wade)

Plate 46, figures 1–3

1926. *Turricula fasciolata* Wade, U.S. Geol. Survey Prof. Paper 137, p. 112, pl. 36, figs. 3, 4.

1941. *Remnita fasciolata* (Wade), Stephenson, Texas Univ. Bull. 4101, p. 379.

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 teloconch 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; hypotypes USNM 130526, 130527.

Occurrence: Tennessee: Ripley Formation at loc. 1.

Subgenus LUTEMA, Stephenson, 1941

Type by original designation, *Lutema simpsonensis* Stephenson.

Diagnosis.—Medium sized fusiform to subfusiform *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 *Lutema 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 *Lutema simpsonensis*, 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 *Lutema simpsonensis*, 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 *Lutema* outside of Texas is scant and restricted to the Ripley Formation of Mississippi.

Amuletum (Lutema) 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 sinused at shoulder, becoming opisthocline below, and swinging almost to orthocline 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* (*Lutema*) *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 levels 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.* (*Lutema*) 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 (Lutema) 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 *Lutema*. 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 teloconch 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 ribbons 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

1926. *Turricula biacuminata* Wade, U.S. Geol. Survey Prof. Paper 137, p. 112, pl. 36, figs. 13, 14.
1941. *Remnita biacuminata* (Wade). Stephenson Texas Univ. Bull 4101, p. 379, pl. 72, figs. 19, 20.

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 anomalofusus* begins its development gradually with very faint spiral cords appearing on the last half whorl of the protoconch. The first and second teloconch whorls are more flatsided 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. anomalocostata*. The latter species also develops coarse transverse ribs that are noded at the shoulder.

Types: Holotype USNM 32854; hypotype USNM 77173; hypotype 130531.
Occurrence: Tennessee: Ripley Formation at loc. 1. Texas: Nacatoch Sand.

Remnita anomalocostata (Wade)

Plate 46, figure 9

1926. *Turricula anomalocostata* Wade, U.S. Geol. Survey Prof. Paper 137, p. 113, pl. 37, figs. 4, 8, 11.
1941. *Remnita anomalocostata* (Wade). Stephenson, Texas Univ. Bull. 4101, p. 379.

Diagnosis.—Medium-sized fusiform shells; whorls with a subangulate periphery at maturity that is noded by coarse broad transverse ribs.

Measurements.—The holotype measures 28.5(+) mm in height and 10.5 mm in diameter.

Discussion.—The subangulate periphery, more distinct subsutural collar, and the presence of transverse sculpture all serve to distinguish *Remnita anamalocostata* from *Remnita biacuminata.*

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 sinused between the suture and whorl angulation, strongly prosocline over the upper periphery and swing back to orthocline over the basal slope and pillar.

The species is not common and is known only from its type locality in the *Exogyra cancellata* zone on Coon Creek, McNairy County, Tenn.

Types: Holotype and paratype USNM 32857; hypotype USNM 130532.

Occurrence: Tennessee: Ripley Formation at loc. 1.

Remnita hastata Sohl, n. sp.

Plate 46, figures 10, 11

Diagnosis.—Medium-sized fusiform remnitids 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, constricting 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 opisthocline over the upper part of the periphery and swinging arcuately back until they become gently prosocline low on the basal slope, then becoming virtually orthocline on the basal slope. Aperture narrowly lenticular; siphonal canal narrow, slightly inclined to the left, and longer than the aperture. Outer lip thin, sinused posteriorly, arcuate medially, straight below and crenulate where intersected by the spiral ribbons. Inner lip lightly callused. 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 biacuminata*, 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. biacuminata* 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. biacuminata* 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), *Pleurotoma gemmata* Hinds (*in* Reeve), 1843.

Diagnosis.—Shell fusiform, spire high. Whorls posteriorly constricted to a subsutural collar and bearing a strong usually noded subangulate shoulder below which the body rounds down to the pillar. Transverse sculpture of later whorls restricted to shoulder nodings. Growth line sinused 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 sinus 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 subangulate shoulder. Growth line sinused 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 teleconch 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 peripheral shoulder. On later whorls subsutural welt and band become less pronounced and merge to form a subsutural collar. On body the nodes become subdued and the body rounds off below the periphery to an elongate pillar. Sculpture begins by the appearance of several highly opisthocline incomplete sharp and narrow ribs that are followed by arcuately opisthocline ribs of lesser inclination. These, after the first ⅓–½ turn of the first teloconch 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 teloconch whorl and with its development the ribs begin to retract until, on about the third teloconch whorl, the transverse sculpture is restricted to strong nodes at the periphery. These nodes continue but usually become subdued 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).

Loc.	*H*	*MD*
Holotype	9.6	3.2
Paratype	11.6	3.2

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 turriculate 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 collabral 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 *Fusimilis* make them rather unusual turrids. Other genera, such as *Turris* Roeding, *Fusiturris* Thiele, and *Pleurolira* 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. ornatula*, and *B.? elongata* all described by him from the Navarro Group of Texas. In addition he also included: *Turris ripleyana* Conrad, Ripley Formation of Mississippi; *Surcula amica* Gardner, Monmouth Formation of Maryland; *Turricula ripleyana* (Conrad) of Wade, *Turricula gracilis* Wade, and *Turricula 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 occurence 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

1858. *Turris ripleyana* Conrad, Philadelphia Acad. Nat. Sci. Jour, 2d ser., v. 3, p. 332, pl. 35, fig. 21.
1876. *Drillia georgiana* Gabb, Philadelphia Acad. Nat. Sci. Proc., v. 28, p. 280.
?1916. *Surcula amica* Gardner, Maryland Geol. Survey, Upper Cretaceous, p. 420, figs. 8, 9.
1941. *Beretra ripleyana* (Conrad). Stephenson, Texas Univ. Bull. 4101, p. 375.
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 (1905) 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).

Bereta 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 highiy compressed. Both specimens come from a locality that is probably in 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

1926. *Turricula gracilis* Wade, U.S. Geol. Survey Prof. Paper 137, p. 111, pl. 36, figs. 11, 12.
1926. *Turricula amica* (Gardner). Wade, U.S. Geol. Survey Prof. Paper 137, p. 112, pl. 36, figs. 1, 2.

1941. *Beretra gracilis* (Wade). Stephenson Texas Univ. Bull. 4101, p. 375.

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).

Loc.	*H*	*MD*	*Estimated H*
Holotype	58.7	14.5	66
18	50.9	13.5	55
18	46.7	12.8	55
7	51.5	12.5	53

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 *Turricula ripleyana* Wade and *Turricula amica* (Gardner) appear to represent end members of an intergradational 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 noding 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 *Exogyra cancellata* zone in the Ripley Formation in Mississippi show similar variations within collections from given localities.

Compared with *Beretra firma* Stephenson, the type species from the Nacatoch 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 Nacatoch 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 ripleyana* (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 130538–130540.

Occurrence: Tennessee: Ripley Formation at loc. 1. Mississippi: Ripley Formation at locs. 4?, 6, 7, 14–18, 22, 27? 29. Georgia and Alabama: Ripley Formation.

Beretra speciosa Sohl, n. sp.

Plate 46, figures 22, 23

1926. *Turricula ripleyana* (Conrad) Wade, U.S. Geol. Survey Prof. Paper 137, p. 111, pl. 36, figs. 6, 7.

Diagnosis.—A *Beretra* bearing 10–13 strong wide-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 noded 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 sinused on subsutural collar, arcuately opisthocline over whorl sides, becoming orthocline 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. ripleyana* (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. gracila* (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 32851; paratype 130541.
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 sinused 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 *Drillia novemcostata* from the Owl Creek Formation of Mississippi. The two species from the Ripley Formation of Tennessee appear to be synonyms. *Turris monmouthensis* from the Monmouth Formation of Maryland belongs in *Fusimilis* along with an undescribed species from the Ripley Formation of Alabama. One additional species, *Fusimilis kummeli* from the Ripley Formation of Mississippi, is described herein.

Outside of North America the genus may also be present in west Africa in *Fusimilis aurilotoralis* Cox (1952, p. 28; Darteville and Brébion, 1956, p. 92).

Fusimilis proxima (Wade)

Plate 46, figures 26, 27, 34, 35

1926. *Turris proxima* Wade, U.S. Geol. Survey Prof. Paper 137, p. 110, pl. 35, figs. 11, 12.
1926. *Turris constricta* Wade, U.S. Geol. Survey Prof. Paper 137, p. 110, pl. 36, figs. 5, 10.
1941. *Fusimilis proxima* (Wade). Stephenson, Texas Univ. Bull. 4101, p. 378.
1941. *Fusimilis constricta* (Wade). Stephenson, Texas Univ. Bull. 4101, p. 378.

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 lirae may be present on the posterior constriction. Growth lines are strong on later whorls, arcuately prosocline over posterior constriction, sinused at the shoulder, gently opisthocline on periphery, swinging to prosocline on basal slope, and shallowly sinused 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 lip callused with callus heaviest on parietal lip. Columella smooth.

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

Loc.	*H*	*MD*
1 (holotype)	88.0	25.5
F. constrictus 1 (holotype)	63.0	18.5
1 (topotype)	57.5	15.5

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 topotypes 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 32847; holotype (*T. constrictus*) USNM 32850; hypotypes USNM 130542, 130543.

Occurrence: Tennessee: Ripley Formation at loc. 1.

Fusimilis kummeli Sohl, n. sp.

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, suture 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 collabral 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 ribbons 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 Chattahoochee River at Eufala. 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 sutural 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 sutural 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.

Occurrence: Alabama: Ripley Formation at Eufaula. Mississippi: Ripley Formation at locs. 6, 18.

Fusimilis novemcostatus (Conrad)

Plate 46, figures 28, 37, 38

1926. *Drillia novemcostata* (Conrad), Philadelphia Acad. Nat. Sci. Jour., v. 3, p. 331, pl. 35, fig. 13.

1941. *Fusimilis novemcostata* (Conrad), Stephenson, Texas Univ. Bull. 4101, p. 378.

Diagnosis.—An elongate slim fusimilid with a narrow but prominent subsutural welt and a strong shoulder. Transverse ribs restricted to elongate shouldering 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 noded 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 whorls 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 sinused over sutural welt swinging back to a stronger and broader abapertural sinus over the shoulder, becoming prosocline on whorl sides, and shallowly sinused 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, sinused in harmony with growth lines. Inner lip lightly callused over parietal surface, but callus thickens to a slight welt 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 whorls it is almost an exact duplicate of the holotype.

The distinctive multiple sinused growth line and the restriction of the ribs on later whorls, as well as the very narrow excavated band, separates this species from other members of the genus.

Types: Holotype lost; hypotypes USNM 20420, 130547.
Occurrence: Mississippi: Owl Creek Formation at locs. 45, 46.

Fusimilis tippanus (Conrad)?

Plate 46, figures 31, 36

1858. *Drillia? tippana* Conrad, Philadelphia Acad. Nat. Sci. Jour., 2d ser., v. 3, p. 331, pl. 35, fig. 5.

Discussion.—Conrad's illustration and description of *Drillia? 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 whorls, a less sinuous growth line, lower transverse ribs, and a less prominent shoulder and subsutural 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 (reworked 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 (Cossmann, 1889, *Pleurotoma filosa* Lamarck, 1804.

Diagnosis.—Shells small to moderately large, biconical. Spire almost half total shell height. Protoconch small, first whorl somewhat deviated. Whorls slightly constricted posteriorly, periphery rounded, basal slope almost flat; body proportionately large. Sculpture dominated by spiral cords. Growth line strongly sinused subsuturally. Aperture moderately narrow, sublenticular; siphonal canal poorly developed; inner lip slightly excavated medially and very lightly callused.

Discussion.—Cryptoconus is primarily an Eocene and and Oligocene genus, but is also known from the Paleocene. The only Cretaceous species assigned is *Conorbis macnairyensis* Wade. Although none of the specimens retain a well-preserved protoconch, there is no indication of resorption of whorls 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? macnairyensis (Wade)

Plate 47, figures 6–9

1917. *Conorbis macnairyensis* Wade, Philadelphia Acad. Nat. Sci. Proc., v. 69, p. 280, pl. 17, figs. 1, 2.

1925. *Cryptoconus macnairyensis*. (Wade). Cossmann, Essais Paléoconchologie Comparée, v. 13, p. 240, pl. 10, figs. 28, 37.

1926. *Conorbis macnairyensis* Wade, U.S. Geol. Survey Prof. Paper 137, p. 107, pl. 34, figs. 23, 24.

Diagnosis.—Whorls somewhat constricted posteriorly and shouldered weakly. Sculpture of moderately strong broad spiral cords. Callus thick on columellar 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? macnairyensis* is known only from specimens lacking the nuclear whorls. The tendency for the formation of a shoulder is unusual but admissable. 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 columella 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; hypotypes USNM 130550, 130551.

Occurrence: Tennessee: Ripley Formation at loc. 1.

Subclass OPISTHOBRANCHIA
Order CEPHALASPIDEA
Superfamily ACTEONACEA
Family ACTEONIDAE
Subfamily ACTEONINAE

Genus ACTEON Montfort, 1810

Type by original designation, *Voluta tornatilis* 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 affiinities. 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 Sohl, n. sp.

Plate 47, figures 24–28

1927. *Acteon modicellus* Conrad. Wade, U.S. Geol. Survey Prof. Paper 137, p. 102, pl. 33, figs. 14, 15.

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 punctuate 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 columella. 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).

Loc.	*H*	*MD*	*HB*	*H:D*
1 (holotype)	4.8	2.6	3.0	1.8
1 (paratype)	4.9	2.3	2.7	2.1
Do	4.0	2.3	2.5	1.7
1 (topotypes)	4.5	2.2	2.3	2.0
Do	4.6	2.2	2.5	2.1
Do	4.7	2.7	2.9	1.7
6	3.3	1.9	1.7	1.8
6	2.7	1.6	1.6	1.8
6	3.2	1.7	1.7	1.9
15	2.8	1.5	1.7	1.9
15	3.4	1.8	2.1	1.9
15	3.4	1.8	1.8	1.9
17	2.8	1.7	1.5	1.7
17	2.7	1.7	1.5	1.6

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 Formatiou 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 rotund to rather slender. Similarly minor differences in the spacing of the incised grooves is also present. Care must be exercised in using the columellar 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 spire, a longer body, a longer aperture, and is more suitably placed in *Eoacteon*.

Types: Holotype USNM 130555; paratypes 130556–130558.
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 interspiral 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, round-topped 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 Mississipi.

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 ¼–⅓ 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.

Eoacteon 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 *Troostella* Wade.

Eoacteon is very close to *Acteon* and an argument could be made for consideration of *Eoacteon* 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, *Eoacteon* is here accepted as a full genus.

Eoacteon linteus (Conrad)

Plate 47, figures 5, 10–12

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

?1916. *Acteon linteus* (Conrad). Gardner, Maryland Geol. Survey, Upper Cretaceous, p. 397, pl. 18, figs. 3, 4 (assignment questionable).

1955. *Eoacteon linteus* (Conrad) Stephenson, U.S. Geol. Survey, Prof. Paper 274–E, p. 133, pl. 23, figs. 8–10.

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 128208) measures 18.3 mm in height and 7.8 mm in diameter.

Discussion.—Specimens of *Eoacteon 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 stratigraphic level as the type locality. Gardner's specimen is retained in *Eoacteon linteus* questionably, 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 *Eoacteon percultus* differing from *E. linteus* by its slimmer outline, broader spiral grooves, a distinctly channeled suture, and by having a proportionally higher spire. The suture of *E. linteus* is channeled but only faintly so.

Types: Holotype lost; hypotypes USNM 130559–130561.

Occurrence: Mississippi: Owl Creek Formation at locs. 45, 46. Maryland: Questionably in the Monmouth Formation.

Eoacteon percultus Sohl, n. sp.

Plate 47, figure 15

1926. *Acteon solidulus* (Conrad). Wade, U.S. Geol. Survey Prof. Paper 137, p. 101, pl. 33, figs. 5, 6.

Diagnosis.—Spire proportionally high for genus, suture distinctly channeled.

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 callused over the curving columellar lip. Columella short with a low rounded fold that is suppressed on the columellar lip.

Measurements.—The holotype measures 16.4 mm height and 7.3 mm in diameter.

Discussion.—*Eoacteon percultus* Sohl is a rare species and known only from its type locality on Coon Creek, McNairy 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. perculatus* differs from Conrad's species significantly by having a well-developed channeled 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, *Troostella sublinearis* Stephenson, of the Nacatoch Sand, here assigned to *Eoacteon*, 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

1926. *Acteon ellipticus* Wade, U.S. Geol. Survey Prof. Paper 137, p. 102 pl. 33, fig. 16, 17.
1941. *Acteon? throckmortoni* Stephenson, Texas Univ. Bull. 4101, p. 380, pl. 72, figs. 5, 6.

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 32828; 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 NONACTEONINA 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. 382–385) 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)

1926. *Acteonina orientalis* Wade, U.S. Geol. Survey Prof. Paper 137, p. 104, pl. 34, figs. 8, 9.

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. Columella bears one highly oblique low 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 Nacatoch 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

1926. *Acteon substriatus* Wade, U.S. Geol. Survey Prof. Paper 137, p. 102, pl. 33, figs. 10, 11.
1941. *Troostella substriatus* (Wade). Stephenson, Texas Univ. Bull. 4101, p. 381.

Diagnosis.—Subglobose 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.

1926. *Troostella perimpressa* Wade, U.S. Geol. Survey Prof. Paper 137, p. 103, pl. 34, figs. 3, 4.

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 belle* 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, roundly 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 (1895, 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.

1926. *Tornatellaea cretacea* Wade, U.S. Geol. Survey Prof. Paper 137, p. 103, pl. 34, figs. 3, 4.
1941. *Tornatellaea cretacea* var. *hebes*, Stephenson, Texas Univ. Bull. 4101, p. 386, p. 73, figs. 12, 13.

Diagnosis.—Spire les 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-

Loc.	H	MD	H:D
1 (holotype)	8.6	4.6	1.9
1 (topotype)	6.5	3.8	1.7
Do	7.4	4.4	1.7
Do	7.3	4.4	1.7
Do	6.0	3.6	1.7
Do	6.1	3.7	1.6
22	10.3	5.8	1.8
22	8.7	5.0	1.7

tion of *T. grandis* 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 *Tornatellaea 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 spalled 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.

Tornatellaea scatesi Stephenson, from the Nacatoch Sand of Texas, has lower columellar plications, is more obese, has a proportionally higher more evenly tapering spire, and has a closely appressed suture. *Tornatellaea cretacea appressa*, 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.

Occurrence: Tennessee: Ripley Formation at loc. 1. Mississippi: Ripley Formation at loc. 22 Texas: Neylandville Marl.

Tornatellaea globulosa Wade

Plate 47, figures 1, 2.

1926. *Tornatellaea globulosa* Wade, U.S. Geol. Survey Prof. Paper 137, p. 104, pl. 34, figs. 3, 4.

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. 172).

Loc.	H	MD	H:D
1 (holotype)	7.1	4.9	1.5
1 (topotype)	4.7	3.0	1.6
Do	4.6	3.1	1.5

Discussion.—This scarce species is known only from its type locality on Coon Creek, McNairy County, Tenn. It is distinguished from *Tornatellaea 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 PARIETIPLICATUM 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, columellar 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

1926. *Acteon conicus* Wade, U.S. Geol. Survey Prof. Paper 137, p. 102, pl. 33, figs. 12, 13.

1963. *Parietiplicatum conicum* Sohl, Jour. Paleontology, v. 37, p. 752, pl. 90, figs. 23–25.

Description.—Medium to moderately small shells with a spire about three-fifths the total shell length; pleural angle of about 40°. Teloconch 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 prosocline trend over the upper two-thirds of the whorl. Aperture angular posteriorly, rounding interiorly; outer lip thickened and lirate within. Inner lip callus moderate, well margined. 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).

Loc.	*H*	*MD*
1 (holotype)	7.4+	4.7
1 (topotype)	11.3	6.1
Do	11.6	5.6

Discussion.—*Parietiplicatum 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 callused. 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 denticulate 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 Cenomanian 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 acutispira Shumard, Eagle Ford Formation, Texas
arlingtonensis Stephenson, Woodbine Formation, Texas
clarki Gardner, Monmouth Formation, Maryland
culbertsoni Stephenson, Kemp Clay, Texas
pulchella Shumard, Nacatoch Sand, Texas
subpellucida Shumard, Eagle Ford Formation, Texas
sufflata Stephenson, Kemp Clay, Texas
yochelsoni Sohl, Ripley Formation, Mississippi
"*Ringicula*" *varia* (Gabb) Stewart, Upper Cretaceous, California
Ringicula codellana Kauffman and Pope, Carlile Formation, Colorado
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 *Ringiculina* Monterosato (1884). The placement of *Ringicula acuta* 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; columellar 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 *Ringiculina*.

Subgenus RINGICULA Deshayes, 1838

Ringicula (Ringicula) pulchella Shumard

Plate 48, figures 1, 2, 6–17

1861. *Ringicula pulchella* Shumard, Boston Soc. Nat. History Proc., v. 8, p. 192.
1926. *Ringicula pulchella* Shumard. Wade, U.S. Geol. Survey Prof. Paper 137, p. 105, pl. 34, figs. 10, 11.
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 columellar fold bifurcated and parietal fold lengthened above to a ridge paralleling posterior channel.

690-081 O - 64 - 7

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

Loc.	Number of specimens	Range in *H*	Average *H*	Range in *D*	Average *D*	Range in *H:D*
5	1	7.3	7.3	5.1	5.1	1.4
7	11	4.0–7.2	6.0	3.1–5.6	4.2	1.3–1.5
16	8	6.6–8.4	7.4	4.6–6.0	5.1	1.4–1.5
18	7	4.0–7.4	6.5	3.0–5.9	5.0	1.3–1.5

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 surafce 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 specimen 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 32835 (Tennessee); hypotypes 130570–130576 (Mississippi).

Occurrence: Mississippi: Ripley Formation at locs. 2, 5, 6, 11, 12, 14–18, 24, 29, 30. Tennessee: Ripley Formation at loc. 1. Texas: Nacatoch Sand. Alabama and George (Chattahooche River region): Ripley Formation.

Ringicula (Ringicula) yochelsoni Sohl, 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-margined 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 columellar 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.) yochelsoni* is moderately common at several localities all within the Ripley

Loc.	H	MD	H:D
6	4.1	2.9	1.4
6	4.0	2.8	1.4
6	4.1	2.9	1.4
6	3.9	2.8	1.4
6	4.4	3.1	1.4
18	3.9	2.9	1.4
18	3.9	2.8	1.4
18	4.3	3.1	1.4
18	4.0	2.8	1.4
18	4.0	3.1	1.4
18	3.7	2.7	1.4
18	4.2	3.2	1.3
18	3.8	2.8	1.4
18	3.9	2.9	1.3

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 columellar fold and the siphonal notch (pl. 48, fig. 24).

Although the species occurs with *Ringicula 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. yochelsoni* 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. Yochelson 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

Ringicula (Ringiculina) cf. R. clarki Gardner

Plate 48, figures 18, 19.

1916. *Ringicula clarki* Gardner, Maryland Geol. Survey, Upper cretaceous, p. 400, pl. 18, figs. 1, 2.

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 *Ringicula 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.

Genus OLIGOPTYCHA Meek, 1876

Type by original designation, *Actaeon 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 denticulate. Columella bears a strong anterior fold with no to two weaker parietal folds.

Discussion.—Meek originally proposed *Oligoptycha* as a subgenus of *Cinulia* 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, *Oligoptycha* and *Avellana* appear to the most similar. Meek (1876, p. 283) diagnosed *Oligoptycha* 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 *Oligoptycha* by Stephenson (1941, p. 390). Another species *Oligoptycha 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. *Oligoptycha americana* (Wade) occurs at the lowest position in the *Exogyra cancellata* zone and is the smallest species. It possesses the typical single columellar 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 Hills 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 *Oligoptycha*, trouble arises. *Avellana* d'Orbigny is differentiated from *Oligoptycha* on the basis of having one columellar and generally two parietal folds and in having a denticulate outer lip. Although these are features not found in the type species of *Oligoptycha*, they are found in *O. americana* (Wade). In fact, *Avellana subincrassata* d'Orbigny, as figured by Popenoe (1957, pl. 50, fig. 2), is exceedingly close to the typical shape and sculpture of *Oligoptycha*. The temptation exists to synonymize *Oligoptycha* 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 *Oligoptycha* 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 *Oligoptycha* 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 *Oligoptycha*. Of these, *O. obliqua* (Gabb) Stewart (1927, p. 436) from the Senonian of California has been reassigned by Popenoe (1957, p. 435) to his genus *Biplica*. The other species *O.? popenoei* Allison (1955, p. 430) is very suggestive of *Oligoptycha*, 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*.

Oligoptycha americana (Wade)

Plate 48, figures 27, 30–33.

1926. *Eryptycha? americana* Wade, U.S. Geol. Survey Prof. Paper 137, p. 105, pl. 34, figs. 13, 14.

1941. *Oligoptycha americana* (Wade). Stephenson, Texas Univ. Bull. 4101, p. 390.

Diagnosis.—A small oligoptychid possessing a strong posterior channel, a strongly denticulate outer lip, and two parietal folds.

Description.—Small low-spired globose shells. Protoconch deviated, consisting of about 1½ smooth round-topped whorls, the first of which is always depressed below plane of teloconch volution. Suture impressed. Sculpture begins as a few thin faint incised lines on the first teloconch 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).

Loc.	*H*	*MD*	*H:D*
1 (topotype)	3.5	3.1	1.1
Do	3.2	3.0	1.1
Do	3.5	3.3	1.1
Do	3.2	2.8	1.1
Do	3.5	3.2	1.1
Do	3.3	3.0	1.1
Do	3.4	3.0	1.1
Do	3.4	3.3	1.0
Do	3.1	2.7	1.1
Do	3.4	3.2	1.1

Discussion.—As is easily discernible from the measurements, *Oligoptycha 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 *Oligoptycha 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 130583–130585.

Occurrence: Tennessee: Ripley Formation at loc. 1.

Oligoptycha 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 whorls, the initial half whorl of which is depressed. Suture faintly impressed. Teloconch whorls well rounded and have 2–2½ whorls. 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 exsert 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).

Loc.	*H*	*MD*	*H:D*
18 (holotype)	7.0	6.0	1.2
18 (paratype)	6.4	6.3	1.0
6 (paratype)	6.6	6.2	1.1
18 (topotype)	6.3	5.7	1.1

Discussion.—*Oligoptycha 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 *Oligoptycha americana* Wade from the *Exogyra cancellata* zone of Tennessee, this species lacks a second parietal fold, has a weaker transverse callus ridge on the parietal surface, is larger, has more numerous spiral grooves, and has a weaker siphonal canal.

Types: Holotype: USNM 130586; paratypes USNM 130587, 130588.

Occurrence: Mississippi: Ripley Formation at locs. 6, 13, 16, 18, 29.

Oligoptycha sp.

1941. *Oligoptycha 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 *Oligoptycha*. 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 130589 (Mississippi).

Occurrence: Mississippi: Owl Creek Formation at locs. 44. Texas: Kemp Clay.

Family SCAPHANDRIDAE

The species described below under the name *Ellipsoscapha* 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 Retusidae Lemche (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 ELLIPSOSCAPHA 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 *Ellipsoscapha* in shape but lacks spiral sculpture over the medial 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 *Ellipsoscapha* herein might just as well be assigned to *Haminaea*. *Ellipsoscapha* 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.

Ellipsoscapha mortoni (Forbes)?

Plate 48, figures 34, 35, 38, 39; plate 49, figures 4, 5.

1845. *Bulla mortoni* Forbes, Geol. Soc. London Quart. Jour., v. 1, p. 63, fig. A.
1864. *Solidula mortoni* (Forbes). Conrad, *in* Cook, Geol. of New Jersey, p. 728.
1892. *Bulla mortoni* Forbes. Whitfield, U.S. Geol. Survey Mon. 18, p. 165, pl. 20, figs. 7–9.
1907. *Haminaea mortoni* (Forbes). Weller, New Jersey, Geol. Survey, Paleontology, v. 4, p. 812, pl. 99, figs. 14–16.
1941. *Ellipsoscapha mortoni* (Forbes). Stephenson, Texas Univ. Bull. 4101, p. 391.

Diagnosis.—Medium-sized elongate subelliptical shells, apical perforation narrow; columella proportionally short.

Discussion.—The internal molds here tentatively assigned to *Ellipsoscapha 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 *Ellipsoscapha 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 *Ellipsoscapha* 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 130590–130592.

Occurrence: Mississippi: Prairie Bluff Chalk at locs. 57, 67, 72, 82, 87, 94. Owl Creek Formation at loc. 46. Alabama: Prairie Bluff Chalk, New Jersey: Atlantic Highlands.

Ellipsosoapha sp.

Discussion.—*Ellipsoscapha* 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.

Ellipsoscapha? 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 *Ellipsoscapha*. The two specimens illustrated show the extremes of obesity, but other specimens are somewhat less so. Although in his definition of *Ellipsoscapha*, Stephenson emphasized the character of slimness, he included in the genus *Haminaea minor* (Meek) a form having an outline not unlike the smaller Prairie Bluff specimens discussed here.

Types: Figured specimens 130593, 130594.

Occurrence: Mississippi: Prairie Bluff Chalk at locs. 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 upon Wade's figures. At best the species should be listed as *Scaphander? rarus* Wade.

Family ACTEOCINIDAE

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; columellar 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 specimen from the Woodbine Formation of Texas belongs to *Cylichna*, the genus is present in this area from the Cenomanian through the Maestrichtian.

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 26, 27

1861. *Cylichna secalina* Shumard, Boston Soc. Nat. History Proc., v. 8, p. 195.

1941. *Cylichna secalina* Shumard. Stephenson, Texas Univ. Bull. 4101, p. 394, pl. 74, figs. 4–6.

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 suites of specimens from the type area in the Nacatoch 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 punctations as those on *C. incisa* Stephenson.

Types: "Neotype" USNM 77214; hypotype USNM 77215; hypotype USNM 130595.

Occurrence: Mississippi: Ripley Formation at locs. 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 interspiral 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 thinly 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).

Loc.	*H*	*MD*
95 (holotype)	12.2	[1] 5.9
45 (paratype)	10.6	[1] 5.7
46	9.1	4.4
46	12.0	5.6
44	11.4	5.4
41	6.4	3.0

[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; paratype USNM 130597.
Occurrence: Mississippi: Owl Creek Formation at locs. 41, 44–46.

Cylichna incisa Stephenson

Plate 49, figures 18–21, 28–31.

1941. *Cylichna incisa* Stephenson, Texas Univ. Bull. 4101, p. 395, pl. 74, figs. 7, 8.

Diagnosis.—A moderately small *Cylichna* that bears punctate spiral sculpture.

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

Loc.	*H*	*MD*	*H:D*
Texas (paratype)	6.0	2.7	2.2
6 (hypotype)	4.4	2.2	2.0
16 (hypotype)	3.6	1.8	2.0
29 (hypotype)	5.6	2.7	2.1

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 differs 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 cancellata* 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 77218a; paratypes USNM 77218b–e; hypotypes USNM 130598–130601.

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, 16, 18, 24, 29, 34. Owl Creek Formation at loc. 46. Alabama and Georgia (Chattahoochee River region): Ripley Formation.

Cylichna intermissia intermissia Sohl, n. sp.

Plate 49, 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; columellar 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).

Loc.	*H*	*MD*
15	3.2	1.7
15	3.1	1.6
16	4.0	2.1
16	3.7	1.6

Discussion.—The lack of a pronounced columellar 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 130603.
Occurrence: Tennessee: Ripley Formation at loc. 1. Mississippi: Ripley Formation at locs. 15, 16, 18, 29.

Cylichna intermissia curta Sohl, n. subsp.

Plate 49, figure 25.

Description.—Resembling *C. intermissia* 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 columellar features are like those of *Cylichna intermissia intermissia*, 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.

Cylichna 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 spiced incised spiral grooves over the anterior ⅓–⅖ and on the posterior ¼ 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 columellar 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 *Cylichna intermissia*, this species differs by possessing an apical plug, a more curving columellar lip, and more reflexed callus of the columellar 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.

Cylichna sp.

Specifically indeterminable specimens of *Cylichna* 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 CYLINDROTRUNCATUM Sohl, 1963

Type species, *Cylindrotruncatum demersum* Sohl.

Etymology.—Compounded 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 *Cylichna 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. *Cylichna* and other similar genera, although occasionally exhibiting moderately open apical pits, do not possess a pit bordered by a sharp carina. In addition *Cylindrotruncatum* lacks any columellar plications, has a very narrow and deep posterior notch, and has distinctive ornament on the posterior part of the whorl.

Cylindrotruncatum demersum Sohl

Plate 49, figures 8–12.

1927. *Cylichna recta* Gabb. Wade, U.S. Geol. Survey Prof. Paper 137, p. 106, pl. 34, figs. 18–20.

1963. *Cylindrotruncatum demersum* Sohl, Jour. Paleontology, v. 37, no. 4, p. 753, pl. 90, figs. 11–15.

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 collabral transverse threads and fine spiral threads form a subcancellate sculptured band over the posterior one-twelfth of the whorl. Growth lines abaperaturally arcuate on upper whorl surface reflecting posterior notch, somewhat opisthocline just below carinate whorl edge, orthocline over most of whorl surface below, becoming prosocline anteriorly. Aperture narrow and notched posteriorly, expanding anteriorly; outer lip thin at edge; inner lip thin above, thickening at posterior notch, callus of columellar lip thicker and reflexed. Columella smooth, truncate below.

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

Loc.	*H*	*MD*
1 (topotype)	5.7	2.3
Do	5.2	2.1
Do	5.5	2.2
Do	6.1	2.5
Do	5.2	2.2
Cylichna carinata Stephenson (holotype)	4.7	2.2

Discussion.—*Cylindrotruncatum demersum* is moderately common at its type locality in the Ripley Formation on Coon Creek, Tenn. The topotypes 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.

Cylindrotruncatum carinatum (Stephenson) [*Cylichna*] 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 *Cylichna 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 *Cylichna.*

Types: Holotype USNM 130606; paratypes USNM 130607, 130608; hypotype USNM 32838.

Occurrence: Tennessee: Ripley Formation at loc. 1. Mississippi: Ripley Formation questionably at loc. 18.

Genus GONIOCYLICHNA Wade, 1926

Type by original designation, *Goniocylichna bisculpturata* 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 columella bearing a distinct fold at top of columellar lip that begins just behind aperture.

Discussion.—The above diagnosis of *Goniocylichna* is emended to emphasize a feature overlooked by Wade (1926, p. 106) in his original diagnosis. That is the presence of a columellar plication high on the columellar 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 *Goniocylindrites* Meek, and in fact it is

so similar to the former that if it were not for the lack of the distinctive columellar plait in *Retusa*, the two would be difficult to distinguish. *Goniocylindrites* is based on *Cylindrites brevis* Morris and Lycett (1854, p. 101) from the Jurassic, a form with a totally truncate spire. In addition, Wade stated (1926, p. 106) "The spire of *Goniocylichna* Wade is intermediate in form between *Goniocylindrites* Meek and *Conacteon* Meek." With the additional knowledge of the presence of a columellar plication, the genus, *Goniocylichna* appears to be more closely related to the genus *Acteocina* especially those forms possessing subtruncate posterior whorl surfaces. *Goniocylichna* differs from *Acteocina* by the placement of the fold and by its extremely truncate posterior surfaces.

Of the two other species that Wade included in *Goniocylichna*, *Cylichna greisbachi* Etheridge and *Trochacteon semicostatus* Whiteaves, we must await further information as to the presence or absence of columellar plications before accepting them in this genus.

Goniocylichna elongata Sohl, n. sp.

Plate 49, figures 39, 40

Diagnosis.—Shell small, cylindrical; protoconch submerged; transverse ribs flat topped.

Description.—Shell moderately small, cylindrical, and slender. Spire turreted and low. Protoconch submerged. Teloconch 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.

Goniocylichna bisculpturata 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 submerged protoconch, broader incised spirals, and a less oblique columellar plication.

Type: Holotype USNM 130609.

Occurrence: Mississippi: Ripley Formation at loc. 22.

Goniocylichna bisculpturata Wade

Plate 49, figures 32, 33, 37, 38

1926. *Goniocylichna bisculpturata* Wade, U.S. Geol. Survey Prof. Paper 137, p. 106, pl. 34, figs. 15–17.

Diagnosis.—Shell small and cylindrical; protoconch partly submerged; spire very low.

Description.—Shell small, cylindrical; spire low and turreted. Protoconch smooth, heterostrophic, resting at an angle of about 90° to the teloconch axis and partly submerged below the plane of the first teloconch volution. 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 columellar lip. Columella bears one low fold high on the columella 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).

Loc.	*H*	*MD*
1 (holotype)	4.7	2.6
16 (hypotype)	5.7	3.0
16	3.7	2.0

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.

Goniocylichna elongata Sohl differs from *G. bisculpturata* by its much greater size at the same growth

stage, by its more slender outline, and by having a totally submerged protoconch.

Types: Holotype USNM 32837; hypotypes USNM 130610, 130611.

Occurrence: Tennessee: Ripley Formation at loc. 1. Mississippi: Ripley Formation at locs. 6, 16, 22, 24, 29. Georgia and Alabama (Chattahoochee River region): Ripley Formation.

ZIKKURATIA Sohl, 1963

Type species, *Zikkuratia tabanneensis* Sohl.

Etymology.—Zikkurat, a Babylonian temple with a stair-stepped profile.

Diagnosis.—Small subcylindrical shells with a turreted 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 *Acteocina* 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 *Retusa* Brown. In the lack of columellar folds and the possession of an exposed spire, this genus may be closer to *Acteonina* d'Orbigny, *Ovacteonina* 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 *Acteocina* having an exposed protoconch and spire, and *Zikkuratia* is here provisionally placed in the family Acteocinidae.

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 turreted 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, are accentuated across the shoulder, and diminish on the body 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. Columellar lip thin, reflexed, and smooth.

Measurements.—The holotype from the Ripley Formation at the old site of Mercers Mill on Tabannee 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 Tabannee Creek near Georgetown, Quitman County, Ga., (USGS 25923) 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.

Types: Holotype USNM 130612; paratypes USNM 130613–130615.

Occurrence: Mississippi: Ripley Formation at loc. 6. Georgia: Ripley Formation.

Genus SCOBINIDOLA Sohl, 1963

Type species, *Scobinidola guttata* Sohl.

Etymology.—Compounded from the Latin, Scobina (rasp, file) and dolo (hew, cut).

Diagnosis.—Shells small, involute, subglobose, 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 medially, 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 globose 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 *Scobinidola guttata* but to erect a new genus.

Scobinidola guttatus Sohl

Plate 50, figures 1–5

1963. *Scobinidola guttatus* Sohl, Jour. Palentology, v. 37, no. 4, p. 753, pl. 90, figs. 6–10.

Diagnosis.—Small obese 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 overridden 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 callused over parietal surface, columellar 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 symbols used in the following table appears in the section "Measurements of specimens" (p. 172).

Loc.	*H*	*MD*
Georgia (holotype)	1.8	1.3
Georgia (paratype)	1.9	1.4
Do	1.9	1.4
29 (paratype)	2.6	1.5+

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 Tabannee 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 columellar fold above the highly oblique basal columellar 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.

Occurrence: Mississippi: Ripley Formation at locs. 16, 29. Georgia: Ripley Formation.

Genus SULCORETUSA Burch, 1945

(= *Sulcularia* Dall, 1921, not *Sulcularia* Rafinesque, 1831).

Type by original designation (Dall, 1921, p. 61, 202), *Bulla sulcata* d'Orbigny, 1841.

Diagnosis.—Small involute slender subcylindrical shells that expand somewhat anteriorly. Apical pit wide and deep. Sculpture of transverse collabral threads. Aperture narrow, expanding anteriorly. Outer lip thin, inner lip reflexed over a narrow umbilical slit. Columella short and smooth.

Discussion.—*Sulcularia* 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 *Sulcoretusa*, 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 columellar 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 *Sulcularia* 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 MONILIRETUSA Sohl, 1963

Type species, *Sulcoretusa* (*Moniliretusa*) *spinosa* Sohl.

Diagnosis.—Shells have the shape and form of *Sulcoretusa* 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 *Sulcoretusa* in shape, lack of a columellar plait, possession of transverse sculpture, and a thin columellar lip reflexed over a narrow umbilical slit. The differences noticed in the above diagnosis, however, seem sufficient to warrant a subgeneric degree of separation.

Sulcoretusa (Moniliretusa) spinosa Sohl

Plate 49, figures 6, 7

1963. *Sulcoretusa (Moniliretusa) 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 Tabannee 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 *Scobinidola 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 BULLIDAE

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 *Hydatina* Schumacher in the Aplustridae. Cossmann (1895, 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 bullid, 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. cretaceous* 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 50, figures 9–16

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

1860. *Bullopsis cretacea* Conrad, Philadelphia Acad. Nat. Sci. Jour., 2d ser., v. 4, p. 46, fig. 27.

1895. *Bullopsis cretacea* Conrad. Cossmann, Essais Paléoconchologie Comparée, v. 1, p. 111, fig. 40.

1896. *Bullopsis cretacea* Conrad. Cossmann, Essais Paléoconchologie Comparée, v. 2, p. 168, pl. 4, figs. 4–6.

1955. *Bullopsis cretacea* Conrad. Stephenson, U.S. Geol. Survey Prof. Paper 274–E, p. 133, pl. 23, figs. 11–19.

Diagnosis.—Shells reaching medium size, surface sculpture subdued 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. Teleconch 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 opisthocline 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).

Loc.	H	MD	H:D
46 (topotype)	17.8	13.5	1.3
Do	11.5	9.4	1.2
Do	13.3	10.2	1.3
Do	16.1	13.5	1.2
Do	15.4	13.4	1.1
Do	13.4	10.0	1.3
Do	13.0	10.1	1.3
Do	18.2	12.1	1.5
Do	9.7	7.8	1.2
Do	10.5	7.7	1.4
45	9.5	7.7	1.2
45	13.4	10.5	1.3
45	7.5	5.5	1.4
45	8.2	6.5	1.3

Discussion.—*Bullopsis 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 riblets. 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.

Bullopsis 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 128221, 128241, 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. 40. Missouri: Owl Creek Formation.

Bullopsis demersus Sohl, n. sp.

Plate 50, figures 6–8

Diagnosis.—Small bullopsids with a narrow apical pit, short transverse riblets 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. Teleconch whorls strongly rounded above and into apical pit and broadly rounded over the whorl sides. Transverse riblets 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 callus over parietal lip but thickens 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).

Loc.	H	MD	H:D
29 (holotype)	2.0	1.3	1.5
29 (paratype)	2.3	1.7	1.4
Do	2.1	1.4	1.5

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 *Bullopsis* columella. Compared with the type species, *Bullopsis 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 ampulla* 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 callused, 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 (1954).

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.

Bulla? sp.

Plate 50, figures 17–20

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 bullids. On the other hand, the shell material is very thin and more on the order of *Haminea* Leach. *Haminea* 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 pyramidellids 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.

Diagnosis.—Small-sized subulate shells with an evenly tapering straight to curved spire. Protoconch inclined to teleconch axis. Whorl sides generally flat; surface smooth and glazed. Aperture auriform, posteriorly angulated, anteriorly well rounded; outer lip generally thickened. Columella smooth.

Discussion.—*Eulima* Risso (1826) has been most commonly applied to these small smooth glazed shells, in spite of the recognized priority of *Melanella*. *Melanella* Bowdich (1822) is poorly defined and, according to Winckworth (1934), should be suppressed. The genus is not well known in the Cretaceous and most authors, like Gardner (1916, p. 480), have considered that most of the Mesozoic forms falling in this category belong to *Pseudomelania*. The Pseudomelanidae are considered by many as ancestral to the Eulimidae. The Pseudomelanidae although generally similar in gross shape are much larger, more commonly sculptured, have a distinctly different nucleus, and, as known, evidently lack the typical surface glaze of forms such as Eulima. The small Ripley and Owl Creek species described here definitely do belong in the Eulimidae.

Eulima persimplica Wade

Plate 50, figures 35, 36

1926. *Eulima persimplica* Wade, U.S. Geol. Survey Prof. Paper 137, p. 174, pl. 58, figs. 14, 15.

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 patulously 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.? clara* 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

1926. *Eulima laevigata* Wade, U.S. Geol. Survey Prof. Paper 137, p. 174, pl. 58, figs. 16, 17.
1941. *Pseudomelania runnelsi* Stephenson, Texas Univ. Bull. 4101, p. 265, pl. 48, figs. 4, 5.

Diagnosis.—Small mellanellids wtih flat-sided smooth and glazed whorls. Suture indistinct. Body sharply rounded to subangular between whorl sides and base. Aperture patulous anteriorly.

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

Loc.	*H*	*MD*	*H:D*
1 (holotype)	3.2	1.3	2.5
18 (holotype)	6.8	2.6	2.6
6	3.9	1.5	2.6
6	5.3	2.2	2.4
6	4.5	1.8	2.5
6	3.2	1.3	2.5
P. runnelsi Stephenson (holotype)	7.0	2.6	2.6

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. gracilistylis* or *E. persimplica.*

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 that species.

Types: Holotype USNM 73091; holotype (*Pseudomelania runnelsi* Stephenson) USNM 76809; hypotype USNM 130665.

Occurrence: Tennessee: Ripley Formation at loc. 1. Mississippi: Ripley Formation at locs. 6, 15–18, 24, 27. Texas: Kemp Clay. Georgia: Ripley Formation.

Eulima gracilistylis 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 2¼ volutions, smooth, round sided with the initial whorl small, bulbous, and lying at a small angle to later whorls. As many as 10 whorls glazed and flat sided on early whorls; later whorls 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).

Loc.	*H*	*MD*	*H:D*
16 (holotype)	[1] 93+	3.1	3.2
17 (paratype)	[2] 8.0+	2.5	3.2
6	7.4	2.3	3.2
18	9.7	2.8	3.1
18	7.0	2.3	3.0
18	6.3	2.1	3.0

[1] Estimated to be 100.
[2] Estimated to be 8.6.

Discussion.—*Eulima gracilistylis* 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 130666; paratype USNM 130667.

Occurrence: Mississippi: Ripley Formation at locs. 6, 15–18, 29. Owl Creek Formation questionably at loc. 46. Georgia: Ripley Formation.

Eulima cf. E. monmouthensis (Gardner)

Plate 50, figures 37, 38

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 whorls 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 130668.

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

Eulima? clara Wade

Plate 50, figure 28

1926. *Eulima clara* Wade, U.S. Geol. Survey Prof. Paper 137, p. 174, pl. 58, figs. 20, 21.
1941. *Eulima clara* Wade. Stephenson, Texas Univ. Bull. 4101, p. 263, pl. 47, figs. 22, 23.

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 whorls. 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 whorls 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 73093; hypotype USNM 76802.

Occurrence: Tennessee: Ripley Formation at loc. 1. Mississippi: Ripley Formation at loc. 16. 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 whorls coiled normal to teleconch axis. Whorls flat sided, glazed, and unornamented. Suture impressed. Aperture subovate, posteriorly angulate; inner 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* Linnaeus. It also has no trace of an umbilicus. Some species of *Tiberia* Monterosato, especially in the subgenera *T.* (*Cossmannica*) *and T.* (*Loxoptyxis*), show a closer approach in shape, but all the members of this genus possess only two columellar plications.

Creonella is known only from the *Exogyra costata* zone of the Gulf Coastal Plain but is one of the more common pyramidellids in the fauna.

Creonella triplicata Wade

Plate 51, figures 7, 8

1917. *Creonella triplicata* Wade, Philadelphia Acad. Nat. Sci. Proc. v. 69, p. 303, pl. 19, fig. 8.
1925. *Creonella triplicata* Wade. Cossman, Essais de Paléoconchologie Comparée, v. 13, p. 292, pl. 11, fig. 26.
1926. *Creonella triplicata* Wade, U.S. Geol. Survey Prof. Paper 137, p. 173, pl. 58, figs. 8, 25.
1941. *Creonella triplicata* Wade. Stephenson, Texas Univ. Bull. 4101, p. 264, pl. 48, figs. 8, 9.

Diagnosis.—Shell small, outline slim, whorls flat sided with a rounded basal periphery.

Description.—Shell small to moderately small, anomphalous. Protoconch erect and heterostrophic, consisting of about 2½ smooth whorls. Teloconch whorls flat sided, glazed, and smooth, and may number as many as eleven. Suture impressed. Sculpture absent save for faint mainly orthocline growth lines. Body whorl with a well-rounded periphery and very steep basal slope. Aperture subovate, posteriorly angulated; 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).

Loc.	*H*	*MD*
1 (topotype)	6.8+	2.2
Do	4.3	0.5
6	8.3	3.9
6	3.7+	1.4
16	5.0	1.9
16	6.5	2.1
17	5.4	2.0

The holotype is missing about four whorls 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 *Exogyra cancellata* zone of Tennessee.

Creonella triplicata 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 subangulate periphery that lends the aperture a more subquadrate outline and, in addition, that species is proportionally wider. *C. deusseni* Stephenson (1941, p. 265), from the Kemp Clay of Texas, occurs at a higher stratigraphic level but is exceedingly close to *C. triplicata.* Stephenson stated that *C. triplicata* is more slender and has a less deeply impressed canal.

Types: Holotype and paratype USNM 73086; holotypes USNM 130628, 130629.

Occurrence: Tennessee: Ripley Formation at loc. 1. Mississippi: Ripley Formation at locs. 6, 15–18, 24, 29. Georgia and Alabama: Ripley Formation. Texas: Nacatoch Sand.

Creonella subangulata Sohl, n. sp.

Plate 51, figures 3–6, 9

1926. *Liostraca cretacea* (Conrad). Wade, U.S. Geol. Survey Prof. Paper 137, p. 172, p. 58, figs. 6, 7.

Diagnosis.—*A Creonella* with smooth whorls and a subangulate periphery that lends the aperture a subquadrate outline.

Description.—Moderately small anomphalous subulate shells. Protoconch heterostrophic, erect, consisting of about 2½ smooth whorls that reach a slightly greater diameter than the first teleconch whorl. Teloconch 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 subangulate 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 6.4 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 stairstepped 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 normal-sized 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 triplicata* this species differs not only by its less rounded base and subangulate 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 cretacea* (Conrad) bears the typical columellar 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 *Exogyra 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.

Occurrence: Tennessee: Ripley Formation at loc. 1. Mississippi: Ripley Formation at locs. 2, 4–6, 14–18, 22, 24, 27, 29. Georgia and Alabama: Ripley Formation.

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 130664.

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

Creonella turretiforma 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 heterostrophic, 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 plait strongest on largest individuals; on shells of only about 2½ whorls only medial plait visible, at four whorls the parietal plait appears and at five whorls the anterior plait is apparent, but weak.

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

Loc.	*H*	*MD*
27 (holotype)	2.7	1.0
27 (paratype)	1.1	.5
29	2.5	1.5
29	2.3	1.0
29	2.2	.7

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 130632; paratype USNM 130633.
Occurrence: Mississippi: Ripley Formation at locs. 27, 29.

Genus LACRIMIFORMA Sohl, 1963

Type species, *Creonella secunda* Wade, 1926.

Etymology.—Compounded from the Latin *Lacrima* (tear drop). Gender, feminine.

Diagnosis.—Small fragile subulate shells having an evenly tapering spire of about three-fifths total shell length. Protoconch heterostrophic. Whorl sides flat to gently convex and glazed, with body more rounded than preceding whorls. 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 orthocline 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 plaits and lacks striations on the interior of the outer lip.

Lacrimiforma secunda (Wade)

Plate 50, figures 21–27

1926. *Creonella secunda* Wade, U.S. Geol. Survey Prof. Paper 137, p. 173, pl. 58, fig. 12.
1926. *Odostomia plicata* Wade, U.S. Geol. Survey Prof. Paper 137, p. 173, pl. 58, figs. 18, 19.
1926. *Odostomia impressa* Wade, U.S. Geol. Survey Prof. Paper 137, p. 174, pl. 58, figs. 9, 10.
1963. *Lacrimiforma secunda* (Wade) Sohl. Jour. Paleontology, v. 37, no. 4, p. 751, pl. 89, figs. 1–7.

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

Loc.	*H*	*MD*	*HB*
1 (holotype)	3.7	1.8	1.7
1 *O. plicata* (holotype)	3.4	2.0	1.75
Do	7.5	2.5	2.2
1 (hypotype)	5.0	2.2	2.0
Topotype	4.4	2.2	1.7
Do	2.3	1.1	1.25

Discussion.—Wade's (1926, p. 173) description of *Creonella secunda* is not clear as to its columellar plications. 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 columella. 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 *C. 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 whorl 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 73092; holotype (*O. impressa*) USNM 73087; hypotype USNM 130634.

Occurrence: Tennessee: Ripley Formation at loc. 1.

Superfamily EPITONIACEA

The placement of the superfamily Epitoniacea within the Opisthobranchiata 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 Opisthobranchiata. 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 clathrus* (Linné) and *Philine*, an opisthobranch. How much weight should be given to such similarities is questionable, but these certainly should be investigated.

Family EPITONIIDAE
Subfamily ACIRSINAE

Genus ACIRSA Mörch, 1857

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

Diagnosis.—Small to medium-sized moderately thick turriculate anomphalous 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.* (*Plesioacirsa*) and the latter belongs in *Bellascala*. 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 Boury, 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

1917. *Hemiacirsa cretacea* Wade, Philadelphia Acad. Nat. Sci. Proc., v. 69, p. 302, pl. 19, fig. 5.
1925. *Acirsa* (*Hemiacirsa*) *cretacea* Wade. Cossmann, Eassais Paléoconchologie Comparée, v. 13, p. 280, pl. 8, fig. 1.
1926. *Hemiacirsa cretacea* Wade, U.S. Geol. Survey Prof. Paper 137, p. 170, pl. 35, fig. 9.

Diagnosis.—Shell moderately large for genus. Transverse ribs straight on early whorls but developing a decided sinuousity 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.

Acirsa (Hemiacirsa) americana (Wade)

Plate 51, figures 24–28

1926. *Proscala americana* Wade, U.S. Geol. Survey Prof. Paper 137, p. 170, pl. 60, figs. 10, 11.

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 Cossmann, to which Wade assigned this species, is based upon the type species *Scalaria 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 *Scalaria canaliculata* d'Orbigny and *S. clementina* 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 *Acirsa* (*Hemiacirsa*) *cretacea* (Wade) is found. This species differs by attaining greater size, by having coarser spiral sculpture, and by developing numerous transverse ribs. *A.* (*Hemiacirsa*) *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.

Acirsa (Hemiacirsa) flexicostata Sohl, n. sp.

Plate 51, figures 29–31

1941. *Proscala americana* Wade?. Stephenson, Texas Univ. Bull. 4101, p. 267, pl. 48, fig. 11.

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 subsutural 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 subangulate. Transverse sculpture of 12–14 strong raised collabral 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.—*Acirsa* (*Hemiacirsa*) *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 *Acirsa* (*Hemiacirsa*) *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.

Acirsa (Hemiacirsa) clathrata Sohl, n. sp.

Plate 51, figures 32–36

Diagnosis.—Moderately small shells bearing moderately strong transverse ribs and numerous rather fine spiral lirae with punctate interspaces.

Description.—Moderately small rather 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 lirae 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, reflexed 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.—*Acirsa (Hemiacirsa) 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 weltlike 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 PLESIOACIRSA de Boury, 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 ribbons 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. *Acirsa (Hemiacirsa)* possesses stronger transverse but weaker spiral elements and has an auriform aperture.

A. (Plesioacirsa) 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 densestriata* Kaunhowen from the Maestrichtian of Belgium.

Acirsa (Plesioacirsa) microstriata Wade

Plate 51, figures 37, 38

1917. *Acirsa microstriata* Wade, Philadelphia Acad. Nat. Sci. Proc., v. 69, p. 399, pl. 18, fig. 8.

1925. *Acirsa (Plesioacirsa) microstriata* (Wade). Cossmann, Essais Paléoconchologie Comparée, v. 13, p. 279, pl. 8, fig. 2.

1926. *Acirsa microstriata* Wade, U.S. Geol. Survey Prof. Pa-137, p. 168, pl. 60, fig. 12.

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.—*Acirsa (Plesioacirsa) 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 punctations.

The holotype from the Ripley Formation on Coon Creek in McNairy 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. (Plesioacirsa) wadei* as belonging to this species.

Type: Holotype USNM 32953.

Occurrence: Tennessee: Ripley Formation at loc. 1.

Acirsa (Plesioacirsa) wadei Cossmann

Plate 51, figures 14–16

1917. *Acirsa corrugata* Wade, Philadelphia Acad. Nat. Sci. Proc., v. 69, p. 300, pl. 18, fig. 9.
1925. *Acirsa (Plesioacirsa) wadei* Cossmann, Essais Paléoconchologie Comparée, v. 13, p. 279.
1926. *Acirsa corrugata* Wade, U.S. Geol. Survey Prof. Paper 137. p. 169, pl. 60, fig. 13.

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).

Loc.	*H*	*MD*
1 (holotype)	11.5+	4.3
18	14.0+	5.8

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 topotype (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 *Acirsa (Plesioacirsa)* 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 1¾ whorls with the initial stages somewhat deviated. Transverse sculpture begins abruptly, with the spiral elements beginning almost immediately thereafter. Later whorls display well the suppression of the transverse elements typical of the subgenus.

Compared with *Acirsa (Plesioacirsa) 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.

Types: Holotype USNM 32954; hypotype USNM 130645.
Occurrence: Tennessee: Ripley Formation at loc. 1. Mississippi: Ripley Formation at loc. 18.

Acirsa (Plesioacirsa?) implexa 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 prosocline, inclined at about 20° to teloconch 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 *Acirsa* 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. (Plesioacirsa)* dubious, but it differs to an even greater extent from *A. (Hemiacirsa)*.

Type: Holotype USNM 130647.
Occurrence: Mississippi: Ripley Formation at loc. 16.

Genus BELLISCALA Stephenson, 1941

Type by original designation, *Belliscala 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 *Belliscalla* in the family Scalaridae is unknown, but its lack of a distinct basal disc suggests placement close to *Acirsa*.

Stephenson erected the genus for three very closely related species from the Nacatoch 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. *Acirsa? cerithiformis* (Meek and Hayden) of Wade (1926, p. 169) belongs in *Belliscala* as does *Scalaria cerithiformis* Meek and Hayden from the western interior.

Belliscala cf. B. rockensis Stephenson

1926. *Acirsa? cerithiformis* Meek and Hayden. Wade, U.S. Geol. Survey Prof. Paper 137, p. 169, pl. 54, figs. 9, 22.

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. rockensis* 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 *Cirsostrema* Mörch, a well-known Recent and Tertiary genus, and are especially close to those forms called *Cirsostrema* (*Cirsostremopsis*) Theile, an invalid subgenus according to Clench and Turner (1950, p. 226). This genus differs from *Cirsostrema* by its much more poorly defined spiral sculpture, by never developing a coalescense of the lamellar varices, and also by lacking the incipient siphonal canal. However, *Striaticostatum* should be placed with Cirsostrema in the Acirsinae.

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.

Striatiscostatum bexarense (Stephenson)

Plate 52, figures 8, 14, 20

1941. *Epitonium bexarense* Stephenson, Texas Univ. Bull. 4101, p. 266, pl. 48, figs. 19–21.
1963. *Striaticostatum bexarense* (Stephenson) Sohl, Jour. Paleontology, v. 37, no. 4, p. 748.

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 separates the rounded whorl sides from the flattened base; ribs formed by numerous lamellar layers that are crenulated 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 reflexed 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).

Loc.	Number of whorls	*H* of Specimen	*H*	*MD*	Pleural angle (degrees)	Number of ribs per whorl
Texas (holotype)	12	41.9	53	19.1	27	20
18 (fig. spec.)	11–12	44.4	50	21.0	28	22
18	9	20.0	22	9.5	26	16
18		16.8		11.4	27	17
6	10	27.4	29	12.5	26	18
6	8	15.3	17	8.3	30	14
15	10–11	33.9	35	14.0	28	17

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 bexarense* 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 they are close to the holotype, although a comparison of the finer details of sculpture is difficult.

Stephenson (1941, p. 266) stated:

> Compared with *E. sillimani* (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 76811; 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 sillimani* (Morton). Wade (in part) U.S. Geol. Survey Prof Paper 137, p. 168, pl. 54, figs. 13, 15, 16 [not fig. 12].

1941. *Epitonium pondi*, Stephenson. Texas University Bull. 4101, p. 266, pl. 48, figs. 22, 23.

1963. *Striaticostatum pondi* (Stephenson). Sohl, Jour. Paleontology, v. 37, no. 4, p. 748.

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).

Loc.	Number of whorls (estimated)	Specimen *H*	*H* (estimated)	*MD*	Pleural angle (degrees)	Number of costae
Holotype	13	23.8	35.0	12.2	22.5	12
Topotype	12	31.2	36.0	12.8	22	12
Do	13	26.8	40.0	13.4	24	12
Do	10	20.1	20.2	9.0	24	13
Do	11	25.3	28.0	12.1	23	14

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 sillimani* Morton. He stated:

> This species differs from *E. sillimani* (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 abaperturally 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. 12) figured a small specimen as an immature individual of *Scala sillimani* and Stephenson later reassigned it to his new species as a paratype of *Epitonium pondi*. This specimen is here transferred to *Opalia* (*Pliciscala*).

Striaticostatum pondi differs from *S. bexarense* by its slimmer outline, by its fewer wider spaced transverse ribs, and by its narrower basal disk.

Types: Holotype USNM 32942; hypotype 130649.

Occurrence: Tennessee: Ripley Formation at loc. 1. Texas: Nacatoch? Sand.

Striaticostatum harbisoni Sohl

Plate 52, figures 24–27

1963. *Striaticostatum harbisoni* Sohl, Jour. Paleontology, v. 37, no. 4, p. 748, pl. 89, 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 prosocline over rounded whorl sides, then becoming strongly flexed to an abaperatural 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 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 override 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).

Loc.	Number of whorls (estimated)	*H* of specimen	*MD*	Pleural angle (degrees)	Number of ribs
Holotype	11	35.9	18.4	33	12
Paratype	11	36.9	17.9	31	12

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 abapertural 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 sillimani (Morton)

Plate 52, figures 11, 17, 22

1834. *Scalaria sillimani* Morton, Synopsis of the organic remains of the Cretaceous group of the United States, p. 47, pl. 13, fig. 9.
1861. *Scala sillimani* (Morton). Gabb, Synopsis of the Mollusca of the Cretaceous formations, p. 79, Am. Philos. Soc. Proc., v. 8, p. 138.
1892. *Scalaria sillimani* (Morton). Whitfield, U.S. Geol. Survey Mon. 18, p. 138, pl. 18, fig. 2.
1907. *Scala sillimani* (Morton). Weller, (part) New Jersey Geol. Survey, Paleontology, v. 4, p. 473, pl. 76, fig. 2 [not 3].

Diagnosis.—Medium-sized shells with short whorls; pleural angle 26°–28°. Whorls bear 16–18 thin close-spaced transverse ribs per whorl.

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 sillimani.*

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 *Striaticostatum* 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. *Striaticostatum pondi* Stephenson has fewer wider spaced costae and is more slender. *Striaticostatum bexarense* 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 10835.
Occurrence: Mississippi: Prairie Bluff Chalk at locs. 66, 71, 74, 81, 87, 90, 92, 96. Alabama: Prairie Bluff Chalk. New Jersey: Questionably in the Monmouth Group.

Striaticostatum asperum Sohl, n. sp.

Plate 52, figures 28, 29, 30

Diagnosis. — Medium-size slender *Striaticostatum* 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 34.3 mm in height and 15.4 mm in diameter but is missing several millimeters of the apical tip.

Discussion.—Compared with *Striaticostatum sillimani* (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 harbisoni* 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 sillimani* (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 OPALIINAE

Genus OPALIA H. and A. Adams, 1858

Type by subsequent designation (de Boury, 1886), *Scalaria 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 taxons involved. In part this is due to the many subdivisions proposed by de Boury. Frequently they appear to be little more than categories representing arbitrary morphologic types rather than having any phylletic 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?) fistulosa 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 welts 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 epitonids.

Type: Holotype USNM 130658.
Occurrence: Mississippi: Ripley Formation at loc. 1.

Subgenus PLICISCALA de Boury, 1887

Type by original designation, *Scalaria gouldi* de Boury, 1887.

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.* (*Dentiscala*) the ribs are suppressed and the basal ridge becomes obsolete or may even be lacking. *O.* (*Nodiscala*) 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.* (*Pliciscala*), where the species is here placed, generally has finer transverse elements but agrees in other characters.

Korobkov (1955, p. 151) followed Cossman and has raised *Pliciscala* to generic rank and has placed *Punctiscala* de Boury, *Nodiscala* de Boury, and *Tuniscala* de Boury as subgenera thereunder. This arrangement has certain merits, but with such minor differences involved between the subgenera a grouping under *Opalia* appears to be more realistic.

Opalia (Pliciscala) wadei Sohl, n. sp.

Plate 52, figures 5, 6

1926. *Scala sillimani* (Morton). Wade [in part], U.S. Geol. Survey Prof. Paper 137, p. 168, pl. 54, fig. 12 (not figs. 15, 16).

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 whorls 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 reflexed 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 epitonids, which he assigned to *Scala sillimani* Morton. Stephenson (1941, p. 266) selected the larger specimen (figs. 13, 15, 16) to serve as the holotype of his new species *Epitonium 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 *Epitonium*, is not conspecific with *Striaticostatum pondi* (Stephenson), and is here described as the holotype and only known specimen of *Opalia* (*Pliciscala*) *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 ACICULISCALA Sohl, 1963

Type species, *Aciculiscala 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 whorls. Teleconch whorls 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 whorls, 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 Epitoninae 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 future 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 3–3½ whorls; first whorl smooth globular; whorls becoming medially carinate after about the first 1½; junction with teloconch abrupt, marked by a transverse line beyond which normal teloconch sculpture begins. Teleconch 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 roundly 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).

Loc.	*H*	*MD*
29 (holotype)	4.2	1.0
29 (paratype)	3.9	1.0
1	2.2	.7
Georgia	3.7	1.0
Do	3.9	.9
Do	3.4	.9

Discussion.—The very narrow, needlelike form alone is sufficient to distinguish *Aciculiscala acutalis* from the other species of the epitonids 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 130659; paratypes USNM 130660, 130661.

Occurrence: Mississippi: Ripley Formation at loc. 29. Tennessee: Ripley Formation at loc. 1. Georgia: Ripley Formation.

Order BASOMMATOPHORA
Superfamily SIPHONARIACEA
Family SIPHONARIIDAE

Genus SIPHONARIA G. B. Sowerby, 1823

Type by monotypy, *Siphonaria sipho* Sowerby, 1823.

Diagnosis.—Moderately small, thin patelliform shells with a central to slightly subcentral apex. 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 Cossman (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* Binckhorst (1873, p. 60), a designation later accepted by Kaunhowen (1898, p. 113). 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 *Anisomyon weiseri* Wade is not that of an *Anisomyon* but is typical of *Siphonaria.* The third species is *Siphonaria lessoni* form *pampa* von Ihering (1914) from Argentina. Hubendick (1945, 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 weiseri* (Wade) discussed as follows may be somewhat older.

Siphonaria wieseri (Wade)

Plate 52, figures 3, 4

1926. *Anisomyon wieseri* Wade, U.S. Geol. Survey Prof. Paper 137, p. 180, pl. 60, fig. 10.

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 73109.
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 decribed 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. 152), 3½ miles south of Enville, 7½ miles north of Adamsville, and 2½ miles northeast of Leapwood, McNairy County, Tenn. USGS 10198, Bruce Wade, 1917; USGS 16951, G. A. Cooper, H. D. Miser, and R. D. Mesler, 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 Wenasoga, Alcorn County, Miss. SW¼SW¼ sec. 17, T. 1 S., R. 7 E. USGS 6877, L. W. Stephenson, 1910; USGS 17234, L. W. Stephenson and W. H. Monroe, 1936.
3. Coon Creek Tongue. Bluff on Hatchie River at Crums' old millsite near Alcorn County line, 13.3 miles (airline) northeast of Ripley, Tippah County, Miss. NE¼SE¼ SE¼ sec. 3, T. 3 S., R. 5 E. USGS 552, L. C. Johnson, 1888; USGS 6462, L. W. Stephenson, 1910.
4. Coon Creek Tongue, Bluff of Cox (Davis?) Branch of Big Hatchie Creek, Tippah County, Miss., SE¼ sec. 10, T. 5 S., R. 5 E. USGS 543 and 603, L. C. Johnson, 1888.
5. Sands of the upper part of the Ripley. Bullock's old overshot mill, 2 miles south of Dumas, Tippah County, Miss., sec. 36, T. 5 S., R. 4 E. USGS 542, L. C. Johnson, 1888; USGS 708, T. W. Stanton, 1889.
6. Coon Creek Tongue. Roadcut on northeast-facing slope of Hall Creek, a tributary of Tallahatchie River, 2.9 miles (airline) southwest of Dumas, Tippah County, Miss., center S½NW¼ 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., NE¼ sec. 35, T. 5 S. R. 4 E. USGS 709, T. W. Stanton, 1909.
8. Upper part of the Ripley (Chiwapa Member). "Naber's coal bluff" on the land of the Reverend W. M. Nabers, about 1 mile south-southeast of Dumas, Tippah County, Miss., sec. 23., T 5 S., R. 4 E. USGS 551, L. C. Johnson; USGS 710, T. W. Stanton, 1889.
9. 9a Chiwapa Member. Landers' millsite on Cane Creek, 5.75 miles east of Dumas, Tippah County, Miss., SE¼ sec. 24, T. 5 S., R. 3 E. USGS 714. T. W. Stanton, 1889(9); USGS 26346, N. F. Sohl and H. I. Saunders, 1956; (9a).
10. Coon Creek (?) Tongue Dea's Bluff on Mooney's Branch of Big Hatchie Creek, Tippah County, Miss. USGS 548, L. C. Johnson, 1888.

Locality

11. Chiwapa Member. Head of ravine, underpass and roadcut 100 yd north of Y-road fork, 0.75 mile south of Dumas, Tippah County, Miss., center of eastern ridge of SE¼ sec. 24, T. 5 S., R. 4 E. USGS 25416, N. F. Sohl, 1950–51.
12. Coon Creek Tongue, Bed of Hall Branch of Tallahatchie River on C. R. Hall's farm, Union County, Miss., sec. 5, T. 6 S., R. 4 E. USGS 711, T. W. Stanton, 1889.
13. Coon Creek Tongue Bluff on North Branch of Wilhite Creek, 3 miles south of Molino and 0.8 mile south of Mount Olivet School, Union County, Miss., NW¼ sec. 21, T. 6 S., R. 4 E. USGS 712, T. W. Stanton, 1889.
14. Coon Creek Tongue. "Lee's old millsite, on a headwater branch of Tallahatchie River (sec. 17, T. 6 S., R. 4 E.), 1. 5 miles northeast of Keownville, Union County, Mississippi." (Stephenson and Monroe, 1940, p. 182). USGS 6873, L. W. Stephenson, 1910; USGS 17277, W. H. Monroe, 1936.
15. Coon Creek Tongue. Lee's old millsite, roadcut on northeast-facing slope of Tallahatchie River valley, 2 miles north-northeast of Keownville, Union County, Miss. NW¼NE¼ sec. 17, T. 6 S., R. 4 E. USGS 25408, N. F. Sohl, 1950–52.
16. Coon Creek Tongue. Locality as above, but from a higher level. USGS 25409, N. F. Sohl, 1950–52.
17. Coon Creek Tongue. Roadcut on east-facing slope of Hall Branch, 0.9 mile west of Molino, Union County, Miss., SW¼NE¼ sec. 8, T. 6 S., R. 4 E. USGS 25410, N. F. Sohl, 1950–52.
18. Coon Creek Tongue. Scraped area immediately north of dam of Union County Lake, 1.1 miles northeast of Pleasant Ridge, Union County, Miss. NW¼NE¼NE¼ sec. 11, T. 6 S., R. 4 E. USGS 18078, 18629, L. C. Conant and A. Brown, 1939; USGS 18616, L. W. Stephenson and W. H. Monroe, 1940; USGS 25411, N. F. Sohl, 1950–52, 1955.
19. Coon Creek Tongue. Ravine east of Union County Lake, about one-third of a mile east of loc. 18, Union County, Miss. NW¼NW¼NW¼ sec. 12, T. 6 S., R. 4 E. USGS 25412, N. F. Sohl, 1950.
20. Coon Creek 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. NE¼ sec. 21, T. 6 S., R. 5 E., USGS 25413, N. F. Sohl, 1950.
21. Coon Creek 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., NW¼SW¼NE¼ sec. 21, T. 6 S., R. 5 E. USGS 25414, N. F. Sohl, 1950.
22. Coon Creek 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. SW¼SW¼NE¼ sec. 21, T. 6 S., R. 5 E. USGS 25587, L. W. Stephenson and N. F. Sohl, 1955.
23. Coon Creek Tongue. Roadcut on new Mississippi State Route 30, east slope of Sweden Hill, 0.45 mile northwest of Graham, Union County, Miss. 6W¼NE¼NW¼ sec. 20, T. 6 S., R. 5 E. USGS 25494, L. W. Stephenson and N. F. Sohl, 1955.

Locality

24. Eight miles northeast of New Albany near top of a four-way divide, Union County, Miss., SE¼(?) sec. 23, T. 6 S., R. 4 E. USGS 13122, E. W. Shaw, 1925.
25. Chiwapa Member. Roadcut on Mississippi State Route 30, 4.9 miles northeast of junction of Mississippi State Routes 30 and 15, Union County, Miss., SW¼SE¼ sec. 31, T. 6 S., R. 4 E. USGS 25504, N. F. Sohl and L. W. Stephenson, 1955.
26. Sands of the upper part of the Ripley Formation. Roadcut, 4 miles east-northeast of Wallerville, Union County, Miss., N½ sec. 21, T. 7 S., R. 4 E. USGS 17276. W. H. Monroe, 1936.
27. Sands of the upper part of the Ripley Formation. Small bluff below bridge of St. Louis-San Francisco Railway over East Branch of Okannatie Creek, 2.5 miles east-northeast of Blue Springs, Union County, Miss., center E½ sec. 5, T. 8 S., R. 3 E. USGS 9508, 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 Wilhite Creek valley about 0.7 mile south of Keownville, Union County, Miss. (about 139 ft. below the base of the Prairie Bluff). SE¼SW¼NE¼ sec. 30, T. 6 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. Chiwapa 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.
31. Chiwapa Member. Locality as above, but in the SE¼ sec. 30 and 16 ft. below base of Prairie Bluff Chalk. USGS 25508, L. W. Stephenson and N. F. Sohl, 1955.
32. Chiwapa Member. North-facing slope of hill on land of J. A. Roberts, locally known as "The Caves," north of Mississippi State Route 30, 5.5 miles northeast of New Albany, Union County, Miss., SW¼ sec. 31, T. 6 S., R. 4 E. USGS 6466, 9522, L. W. Stephenson, 1909 and 1915.
33. Limestone of the lower part of the Ripley Formation. Roadcut on the west wall of Tallabinnela Creek, 0.25 mile east of Troy, Pontotoc County, Miss., NE¼NE¼ sec. 21, T. 11 S., R. 4 E. USGS 6471, L. W. Stephenson, 1909; USGS 18628, W. H. Monroe, 1941; USGS 25417, N. F. Sohl, 1951.
34. Transitional clay. Roadcut on east-facing slope of Muddy Creek Pontotoc County, Miss., SE¼SE¼SE¼ sec. 4, T. 10 S., R. 4 E. USGS 25481, L. W. Stephenson and N. F. Sohl, 1955.
35. Chiwapa Member. Pit of the Mississippi Minerals Co., 3.4 miles northeast of Pontotoc, Pontotoc County, Miss., NE¼NW¼ 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. NE¼ sec. 6, T. 10 S., R. 4 E. USGS 19086, W. H. Monroe, 1940.

Locality

37. Chiwapa(?) Member Pontotoc-Aberdeen road, 6 miles southeast of Pontotoc County, Miss. USGS 6469, L. W. Stephenson, 1909.
38. Chiwapa Member. Roadcuts on an east-facing slope of new Mississippi State Route 6, 3.5 miles east of Pontotoc, Pontotoc County, Miss. NE¼SW¼ sec. 35, T. 9 S., R. 3 E. USGS 25418 N. F. Sohl, 1951–53.
39. Chiwapa Member. Roadcuts on old Mississippi State Route 3, about 4.7 miles west of Buena Vista, on west-facing slope of a tributary of Houlka 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 Trimm'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.
41. At springs in gullies at edge of Chalybeate Springs, Tippah County, Miss. SE¼SW¼SE¼ sec. 3, T. 2 S., R. 4 E. USGS 9516, L. W. Stephenson, 1915.
42. Roadcuts on Braddock's farm on south-facing slopes of Walnut Creek valley, 3.75 miles east-southeast of Faulkner, Tippah County, Miss. NE¼SE¼SE¼ sec. 16, T. 3 S., R. 4 E. USGS 713, T. W. Stanton, 1889; USGS 25421, N. F. Sohl, 1950–51.
43. Roadcut on the north-facing slope of Yancy Hill overlooking Owl Creek valley, Tippah County, Miss. NE¼ NE¼ sec. 17, T. 4 S., R. 4 E. USGS 26354, N. F. Sohl, and H. I. Saunders, 1956.
44. Place of Charles Alexander on White Oak Creek, 5½ miles northeast of Ripley, Tippah County, Miss., center sec. 33, T. 3 S., R. 4 E. USGS 6875, L. W. Stephenson, 1910.
45. Roadcuts on north-facing slope of a tributary of Fourth Creek, 0.9 mile north of Providence School, Tippah County, Miss., NE¼NW¼ sec. 27, T. 2 S., R. 4 E. USGS 25422, N. F. Sohl, 1950–53.
46. Bluffs on right bank of Owl Creek, 2.5 miles northeast of Ripley, Tippah County, Miss. N½SE¼ sec. 7, T. 4 S., R. 3 E. USGS 541, 546, L. C. Johnson, 1888; USGS 594, C. A. White, 1888; USGS 707, T. W. Stanton, 1889; USGS 6464, 6876, L. W. Stephenson, 1909, 1910; USGS 25423, N. F. Sohl, 1950.
47. Roadcut and excavation for underpass at head of southwest trending ravine on Dumas-Pleasant Ridge Road, 0.8 mile south 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 SW¼SW¼ 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

Locality

County, Miss. NW¼NW¼ sec. 29, T. 7 S, R. 3 E. USGS 26088, N. F. Sohl, 1949–53.

50. Owl Creek Formation or Prairie Bluff Chalk. Roadcut on old New Albany-Ecru road, 3 miles south of New Albany on the north-facing slope of Kings Creek valley, Union County, Miss. USGS 6782, 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. NE¼SE¼ sec. 26, T. S., R. 3 E. USGS 9509, L. W. Stephenson, 1910.
52. Owl Creek Formation or Prairie Bluff Chalk. Roadcut on old Pontotoc-Houston Road, ½–¾ of a mile south of Pontotoc, Pontotoc, County, Miss. USGS 6470, L. W. Stephenson, 1909.

LOCALITIES IN THE PRAIRIE BLUFF CHALK

Locality

53. Same locality as 47 and overlies that unit. Tippah County, Miss. USGS 25488, L. W. Stephenson and N. F. Sohl, 1955.
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 crossroads, Union County, Miss., SE¼ SE¼NW¼ sec. 1, T. 7 S., R. 3 E. USGS 25516, L. W. Stephenson and N. F. Sohl, 1955.
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 Keownville crossroads, Union County, Miss. SE¼SW¼SE¼ sec. 31, T. 7 S., R. 4 E. USGS 25489, L. W. Stephenson and N. F. Sohl, 1955.
57. Roadcuts on the new Mississippi State Route 6, 3.5 miles east of Pontotoc, Pontotoc County, Miss. NE¼SW¼ sec. 35, T. 9 S., R. 3 E. Collector: USGS 25425, N. F. Sohl, 1951–53.
58. 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.
59. Exposure along the right bank of a small creek ⅛–¼ 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.
60. Cut on the Gulf, Mobile, and Ohio Railroad half a mile south of Pontotoc, Pontotoc County, Miss. USGS 6854, L. W. Stephenson, 1910.
61. Roadcuts on Mississippi State Route 15, 2 miles south of Pontotoc on the north-facing slope of Chiwapa Creek valley, Pontotoc County, Miss. NW¼NW¼ sec. 16, and NE¼NE¼ sec. 17, T. 10 S., R. 3 E. USGS 25426, N. E. Sohl, 1951.
62. Roadcut 0.4 mile east of Mississippi Route 15, 2 miles north of old Houlka, Chickasaw County, Miss., NW¼ sec. 4, T. 12 S., R. 3 E. USGS 19064, L. W. Stephenson and W. H. Monroe, 1938.
63. Roadcut 2.25 miles (airline) northeast of Houlka, Chickasaw County, Miss., NW¼ sec. 4, T. 12 S., R. 3 E. USGS 25427, N. F. Sohl, 1951.
64. Roadcut 5.5 miles south-southeast of Houlka, Chickasaw County, Miss., SE. cor. sec. 3, T. 13 S., R. 3 E. USGS 17215, W. H. Monroe, 1936.

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 6849, L. W. Stephenson, 1910.
66. Bluffs of Houlka Creek, 0.5 mile (?) east of Houston, Chickasaw County, Miss. USGS 612, T. W. Stanton, 1889.
67. East-facing slope of Houlka Creek about 1.25 miles east of the Court House at Houston, Chickasaw County, Miss. USGS 8306, E. N. Lowe and C. W. Cooke, 1912.
68. Roadcut on east-facing slope of Socktahoomak Creek (Houlka Creek?) on the Houston-Buena Vista (old Mississippi Route 8), 2 miles east of Houston, Chickasaw County, Miss. S½ 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 4053, 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 bald 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. SW¼NE¼ sec. 10, T. 15 S., R. 3 E. USGS 25428, N. F. Sohl, 1951–52.
72. Roadcut 5.9 miles (airline) north-northeast of Montpelier, Clay County, Miss., NW¼ 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. NE¼SW¼ 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., N½ 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., SW¼ sec. 8, T. 15 S., R. 4 E. USGS 17228, L. W. Stephenson and W. H. Monroe, 1936.
77. Roadcut 2.5 miles south-southwest of Montpelier, Clay County, Miss. SW¼SW¼ 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.
79. Roadcut on Mississippi State Highway 10, 2.5 miles east of Pheba, Clay County, Miss. Center sec. 23, T. 20 N., R. 13 E. USGS 17225, W. H. Monroe, 1936.
80. Gullies and bald 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. NW¼NW¼ 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., NW¼ sec. 23, T. 19 N., R. 14 E. USGS 25435, N. F. Sohl, 1951.
83. Roadcut at crossroads 3.7 miles (airline) north of Starkville, Oktibbeha County, Miss NW¼SW¼NW¼ sec. 14, T. 14 N., R. 14 E. USGS 25436, N. F. Sohl, 1951.
84. Gullies near Starkville-Osborn road about 3 miles northeast 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., NW¼NE¼ 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 495, L. C. Johnson, 1889.
87. Gullies on grounds of Mississippi State College at Starkville, Oktibbeha County, Miss. USGS 3186, 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-southeast of Starkville, Oktibbeha County, Miss., SE¼NE¼ sec. 32, T. 18 N., R. 15 E. USGS 25438, N. F. Sohl, 1951.
89. Bluff on Noxubee River 1 mile (airline) west of Horse Creek bridge, Noxubee County, Miss. SW¼SW¼SW¼ sec. 16, T. 15 N., R. 16 E. USGS 17241, W. H. Monroe, 1936.
90. Bald spots on north-facing slope of Dry Creek, Noxubee County, Miss., N½ sec. 13, T. 14 N., R. 16 E. USGS 17242, W. H. Monroe and P. A. Bethany, 1936.
91. Cuts on U.S. Highway 45, 0.6 mile south of Running Water Creek, 5 miles due south of the Noxubee River bridge in Macon, Noxubee County, Miss. USGS 6479, L. W. Stephenson, 1909; USGS 17210, L. W. Stephenson and W. H. Monroe, 1936.
92. Roadcut and bald spots in fields east of U.S. Highway 45 on north-facing slope of Shuqualak Creek Valley, 3 miles north of the Kemper-Noxubee County line, Miss., NE¼ sec. 22, T. 13 N., R. 17 E. USGS 25439, N. F. Sohl, 1951.
93. Roadcut on old U.S. Highway 45, 1 mile north of Wahalak Creek, Kemper County, Miss. USGS 17430, W. H. McGlamery and W. H. Monroe, 1937.
94. Roadcut on old U.S. Highway 45 at top of north-facing slope of Wahalak Creek Valley, 6 miles north of Scooba, Kemper County, Miss., sec. 9, T. 12 N., R. 18 E. USGS 6480, L. W. Stephenson, 1909; USGS 25440, N. F. Sohl, 1951.
95. Lacy-Ford Road, 3,000 ft south of State road to Gainesville and 2.5 miles east of Scooba, Kemper County, Miss. USGS 8307, C. W. Cooke, 1912.
96. Scooba-Giles Road 3 miles east of Scooba, Kemper County, Miss. USGS 6835, L. W. Stephenson, 1910.

REFERENCES

Abbott, R. T., 1954, American seashells: New York, D. Van Nostrand Co., 541 p., 40 pls.

Adams, Henry, and Adam, Arthur, 1858, The genera of Recent Mollusca: arranged according to their organization: London, v. 1, 256 p., 138 pls., atlas.

Allison, E. C., 1955, Middle Cretaceous Gastropoda from Punta China, Baja California, Mexico: Jour. Paleontology, v. 29, no. 3, p. 400–432, pls. 40–44.

Anderson, F. M., 1958, Upper Cretaceous of the Pacific Coast: Geol. Soc. America Mem. 71, 378 p., 75 pls.

Applin, P. L., and Applin, E. R., 1944, Regional subsurface stratigraphy and structure of Florida and southern Georgia: Am. Assoc. Petroleum Geologists Bull., v. 28, no. 12, p. 1673–1753.

Arkell, W. J., 1957, Introduction to Mesozoic Ammonoidea, *in* R. C. Moore, ed. Pt. L. Mollusca 4, Cephalopoda, Ammonoidea: Treatise on invertebrate paleontology, p. L. 81–L. 129.

Baer, J. G., 1951, Ecology of animal parasites: Urbana, Ill., Univ. Illinois Press, 224 p.

Basterot, B. de, 1825, Description géologique du Bassin Tertiaire du sud-ouest de la France: Paris, 100, p., 7 pls.

Bellardi, Luigi, 1884, I molluschi dei terziarii del Piemonte e della Liquria: Torino, v. 4, 62 p., 2 pls.

Bergquist, H. R., 1943, Clay County (Geology): Mississippi Geol. Survey Bull. 53, p. 11–71.

———1944, Cretaceous of the Mesabi Iron range, Minnesota: Jour. Paleontology, v. 18, no. 1, p. 1–30, pls. 1–11.

Berry, E. W., 1925, the flora of the Ripley formation: U.S. Geol. Survey Prof. Paper 136, 94 p., 23 pls.

Berry, Willard and Kelley, Louis, 1929, The Foraminifera of the Ripley formation on Coon Creek Tennessee: U.S. Natl. Mus. Proc., v. 76, p. 1–20, pls. 1–3.

Binckhorst, J. T., 1873, Monographie des Gasteropodes et des Cephalopodes de la Craie superieure du Limbourg: Brussels-Leipzig, 83 p., 10 pls. (Gastropoda).

Blainville, H. M. de, 1827, Manuel de Malacologie et de Conchyliologie: Paris and Strasburg, 664 p., 109 pls.

Blanckenhorn, Max, 1890, Beiträge zur Geologie Syriens: Kassel, 135 p., 11 pls.

———1927, Die fossilen Gastropoden und Scaphopoden der Kreide von Syrien-Palästina: Paleontographica, v. 69, p. 111–186, pls. 5–10.

Boettger, C. R., 1954, Die Systematik der euthyneuren schnecken: Deutschen Zool. Gesellschaft, Supp. Bd. 18, no. 22, p. 253–280.

Böhm, Johannes, 1885, Der Grünsand von Aachen und seine Mollusken fauna: Naturh. Ver, preuss, Rheinlande, u. Westfalens, Situngsber., v. 42, p. 1–152, pls. 1–2.

———1898, Ueber *Ammonites pedernalis* von Buch: Deutsche geol. Gesell. Zeitschr., v. 50, p. 193–197.

Böse, Emilio, 1906, La fauna de moluscos del Senoniano de Cárdenas, San Luis Potosi: Inst. Geol. de México Bol. 24, 95 p., 18 pls.

———1923, Alqunas faunas Cretacicas de Zacatecas Durango y Guerrero: Inst. geol. de México, Bol. 42, 219, p., 19 pls.

Boule, Marcellin, and Thevenin, Armand, 1906, Paleontologie de Madagascar, Fossiles de la Côte Orientale; Annales Paléontologie, v. 1, pts. 1, 2, p. 1–17, pls. 1, 2.

De Boury, Eugene, 1886, Monograph des Scalidae vivants et fossils I. Subgenera *Crisposcala*: Paris, 52 p., 6 pls.

———1887, Etude sur les Sous-genres de Scalidae du Bassin de Paris. Théméricour par Vigny & Paris, 43 p.

———1890, Etude critique des Scalidae miocènes et pliocènes d'Italie: Bull. Soc. Malacol. Italy, v. 15, p. 81–213, 4 pls.

———1909, Catalogue des sous-genres de Scalidae: Jour. Conchyliologie, p. 255–258.

Bowdich, T. E., 1822, Elements of conchology, including the fossil genera and animals, Paris and London, v. 1, 79 p., 19 pls.; v. 2. 40 p., 8 pls.

Brocchi, G. B., 1814, Conchiologia fossile Subapennina con osservazione geologiche sulgi Appennini e sul suolo adiaciente: Milano, 2 vols.

Burch, J. Q., 1945, Distributional lists of the West American marine Mollusca from San Diego, California to the Polar Sea: [Extracts from the] Minutes of the Conchological Club of Southern California, pt. 2, v. 1–2, (Gastropoda) nos. 46–63.

Bushinsky, G. I., 1935, Structure and origin of the phosphorites of the USSR: Jour. Sed. Petrology, v. 5., p. 81–92.

Cantraine, F., 1837, Mollusca Mediterreanean: Bull. de l'Acad. de Bruxelles, v. 2, p. 379–402.

Carriker, M. R., 1951, Observations on the penetration of tightly closing bivalves by *Busycon* and other predators: Ecology, v. 32, no. 1, p. 73–83.

Carter, C. W., 1937, The Upper Cretaceous deposits of the Chesapeake and Delaware Canal: Maryland Geol. Survey [Rept.], v. 13, p. 239–281.

Casey, Raymond, 1961, The stratigraphical paleontology of the lower Greensand: Paleontology, v. 3, pt. 4, p. 487–629.

Chavan, A., 1946, L'Evolution des Faunes Marine de Molusques dans le Nord-Ouest de l'Europe de la Fin du Crétacé a celle de l'Éocenè: Soc. géol. France Bull., 5th serv., v. 16, pt. 4, 5, 6, p. 193–212.

Choffat, Paul, 1886–1902, Recueil d'études paleontologiques sur la faunes cretacique du Portugal: Sec. des travaux géologiques de Portugal, ser. 1–4, 171 p., 56 pls.

Chubb, L. J., 1959, Upper Cretaceous of central Chiapas, Mexico: Am. Assoc. Petroleum Geologists Bull., v. 43, no. 4, p. 725–756.

Clench, W. J., and Turner, R. D., 1950, The genera *Stenorhytis*, *Cirsostrema*, *Acirsa*, *Opalia*, and *Amaea* in the Western Atlantic: Johnsonia, v. 2 no. 29, p. 221–248.

———1951, the genus *Epitonium* in the Western Atlantic, pt. 1: Johnsonia, v. 2, no. 30, p. 249–288.

———1952, The genera *Epitonium* (pt. II), *Depressiscala*, *Cylindriscala*, *Nystiella*, and *Solutiscala* in the Western Atlantic: Johnsonia, v. 2 no. 31, p. 289–356.

Cloud, P. E., 1955, Physical limits of glauconite formation: Am. Assoc. Petroleum Geologists Bull., v. 39, p. 484–492.

Cobban, W. A., and Reeside, J. B., Jr., 1952, Correlation of the Cretaceous formations of the western interior of the United States: Geol. Soc. America Bull., v. 63 p. 1011–1044, 2 figs., 1 pl.

Collignon, Maurice, 1931, Faunes Senoniennes du nord et de L'ouest de Madagascar: Ann. géol. du Service des Mines, pt. 1, 66 p., 9 pls.

———1933, Fossiles Cenomaniens d'Antsat-Ramahavelona: Ann. géol. du Service des Mines, pt. 3, pl. 1–32, pls. 5, 6.

———1934, Fossiles Turoniens d'Antantilaky: Ann. géol. du Service des Mines, pt. 4, p. 1–59, pls. 1–6.

———1949a Le Crétacé Superieur d'Antonibe: Ann. géol. du Service des Mines, pt. 19, 72–188, pls. 12–20.

———1949b. Faune Maestrichtienne de la Côte d'Ambatry: Ann. géol. du Service des Mines, pt. 19, p. 14–72, pls. 8–12.

Conrad, T. A. 1843, Description of new genus and twenty-nine new Miocene and one Eocene fossil shells: Philadelphia Acad. Nat. Sci. Proc., v. 1, p. 305–311.

Conrad, T. A., 1857, Description of Cretaceous and Tertiary fossils, *in* W. H. Emory, Report of the United States and Mexican Boundary Survey, v. 1, pt. 2, p. 141–174, pls. 1–21.

———1858, Observations on a group of Cretaceous fossil shells, found in Tippah County, Mississippi, with descriptions of fifty-six new species: Philadelphia Acad. Nat. Sci. Jour., 2d ser., v. 3, p. 323–336.

———1860, Descriptions of new species of Cretaceous and Eocene fossils of Mississippi and Alabama: Philadelphia Acad. Nat. Sci. Jour., 2d ser., v. 4, p. 275–298, 2 pls.

———1865, Observations on American fossils with descriptions of two new species: Philadelphia Acad. Nat. Sci. Proc., v. 16, p. 211–214.

———1869, Notes on recent and fossil shells with descriptions of new genera: Am. Jour. Conchology, v. 4, (1868–69), pt. 4, p. 246–249.

Cooper, G. A., and Williams, Alwyn, 1952, Significance of the Stratigraphic distribution of brachiopods: Jour. Paleontology, v. 26, no. 3, p. 326–337.

Cossmann, Maurice, 1889, Catalogue illustrédes Coquilles fossiles de l'Éocenè des Environs de Paris: Belgique Soc. Royal Malacol. Annales, v. 24, pt. 4, 385, p., 12 pls.

———1895–1925, Essais de Paléoconchologie Comparée: Paris, Presses Universitaires de France, no. 1, 159 p., 41 text figs., 7 pls. 1 table, 1895: no. 2, 179 p., 48 text figs., 8 pls. 1896; no. 3, 201 p., 34 text figs., 8 pls., 1899; no. 4, 293 p., 31 text figs., 10 pls., 1901; no. 5, 215 p., 16 text figs., 9 pls., 1903; no. 6, 151 p., 14 text figs., 9 pls; 1904; no. 7, 261 p., 22 text figs., 14 pls., 1906; no. 8, 248 p., 87 text figs., 4 pls., 1909; no. 9, 215, p., 18 text figs., 10 pls. 1912; no. 10, 292 p., 63 text figs., 12 pls., 1915 (1916); no. 11, 388 p., 128 text figs., 11 pls., 1918; no. 12, 349 p., 121 text figs., plates A–D and 1–6, 1921; no. 13, 345 p., 11 pls., 1925.

Cossmann, Maurice, 1896, Observations sur quelques coquilles Crétaciques recueillies en France: Assoc. Francaise pour L'Avancement des Sci., p. 1–27, pls. 1–2.

———, 1898, Observations sur quelques espéces Crétaciques recueillies en France: Acad. sci. Paris Comptes rendus, p. 1–8, pl. 2.

———, 1899, Observations sur quelques coquilles Crétaciques recueilles e France: Acad. sci. Paris Comptes rendus, p. 1–8, pl. 1.

———, 1902, Observations sur quelques coquilles Crétaciques reuceillies en France: Acad. sci. Paris Comptes rendus, p. 1–15, pls. 3, 4.

———, 1920, Rectifications de nomenclature: Rev. géologie, v. 1, no. 9, p. 375–376.

Cox., L. R., 1952, Cretaceous and Eocene fossils from the Gold Coast: Gold Coast Geol. Survey Bull. no. 17, 68 p., pls. 1–5.

———, 1955 Observations on Gastropod descriptive terminology Malacological Soc. Proc., London, p. 190–202.

Cox, L. R., and Arkell, W. J., 1948, A survey of the Mollusca of the British Great Oolite Series, Pt. 2: Paleontographical Soc., London, p. 49–105.

Cushman, J. A., 1946, Upper Cretaceous Foraminifera of the Gulf coastal region of the United States and adjacent areas: U.S. Geol. Survey Prof. Paper 206, 160 p., 66 pls.

Dacque, Edgar, 1903 Mittheilungen ueber den Kreidecomplex vom. Abu Roasch bei Cairo: Paleontographica, v. 30, pt. 11, p. 337–392, pls. 34–36.

Dall, W. H., 1889, A preliminary catalogue of the shell bearing Marine mollusks and brachiopods of the Southeastern Coast of the United States: U.S. Natl. Mus. Bull. 37, 232 p., 95 pls.

———1890–1903, Contributions to the Tertiary fauna of Florida: Wagner Free Inst. Sci. Trans., v. 3, pts. 1–6, 1654 p., 60 pls.

———1907, Notes on some Upper Cretaceous Volutidae with descriptions of new species and a revision of the groups to which they belong: Smithsonian Misc. Colln., v. 50, pt. 1., p. 1–23.

———1909, Contributions to the Tertiary paleontology of the Pacific coast: I, The Miocene of Astoria and Coos Bay, Oregon: U.S. Geol. Survey Prof. Paper 59, 278 p., 23 pls.

———1921, Summary of the marine shellbearing mollusks of the Northwest Coast of America: U.S. Natl. Mus. Bull. 112, 217 p.

Darteville, Edmond, and Brébion, Phillipe, 1956, Mollusques fossiles du Crétacé de la Côte occidentale d'Afrique du Cameroun à l'Angola; I, Gastéropodes. Annales mus. Royal Congo Belge (Tervuren) (Belgique), ser. in–8°, v. 15, 128 p.

Darteville, Edmond, and Casier, Edgard, 1943, Les poissons fossiles du Bas-Congo et des régions voisines: Annales mus. Royal Congo Belge (Tervuren), A, ser. 3, v. 2, pt. 1, Intro., p. 1–87.

Darteville, Edmond, and Freneix, S., 1957, Mollusques fossiles du Crétacé de la Côte occidentale d'Afrique du Cameroun à l'Angola; II, Lamellibranches: Annales mus. Royal Congo Belge (Tervuren), ser. in-8°, v. 20, 271, p., 35 pls.

Davis, A. M., 1934, Tertiary faunas, The Sequence of Tertiary faunas, v. 2: London, Murby and Co., 252 p.

Delpey, Geneviève, 1939, Les Gastéropodes Mésozoiques de la Region Libanaise: Notes et Mém. de la Sec. d'Etudes géol. du Haut-Commisariat de la Republique France en Syrie et au Liban, 292 p., 189 figs., 11 pls., 4 maps.

———, 1942, Gastéropodes du Crétacé Superieur dans le Sud-ouest de la France (Groupe 1): Soc. d'Histoire Naturelle de Toulouse Bull., v. 77, p. 161–197, 31 figs.

———, 1949, Gasteropodes Mesozoiques de L'ouest de Madagascar: Annales géol. du service des Mines, Pt. 15, p. 1–35.

DeShayes, G. P., 1838, Traité elementaire de Conchylologie avec l'application de cette Science à la Géologie: Paris, 2 vs.

———, 1864–65, Description des Animaux sans Vertebrés decouverts dans le Bassin de Paris, pour servir de Supplément à la Description des Coquilles fossiles**; Paris, v. 3, 656 p., pls. 65–107.

Donovan, Edward, 1799–1804, The natural history of British shells: London, 5 v., 180 pl.

Douvillé, Henri, 1904, Mollusques fossiles [Persia]: Mission scientifique en Perse (par. J. de Morgan), v. 3, Études géol., pt. 4, Paléontologie, 380 p., pls. 25–50.

Dumble, E. T., 1911, Rediscovery of some Conrad forms: Science, new ser., v. 33, p. 970–971.

Dunbar, C. O., 1928, On an ammonite shell investing commensal Bryozoa: Am. Jour. Sci., 5th ser., v. 16, p. 164–165.

Duncan, Helen, 1957, Bryoyoans, *in* H. S. Ladd, ed., Treatise on marine ecology and paleoecology, v. 2. Paleoecology: Geol. Soc. America Mem. 67, p. 783–800.

Earland, Arthur, 1943, Chalk: its riddles and some possible solutions: Trans. Hertfordshire Nat. History Soc., v. 21, p. 6–37.

Fenton, C. L., and Fenton, M. A., 1932, A new species of *Cliona* from the Cretaceous of New Jersey: Am. Midland Naturalist, v. 13, no. 2, p. 54–62.

Fretter, Vera and Alastair Graham, 1949, The structure and mode of life of the Pyramidellidae, parasitic opisthobranchs: Marine Biol. Assoc. U. K., Jour. v. 28, p. 493–532.

Fischer, P. H., 1880–87, Manuel de Conchyliogie et de Paléontologie Conchyliologique: Paris, 1367 p.

Gabb, W. M., 1860a, Description of some new species of Cretaceous fossils from South America in the collection of the Academy: Philadelphia Acad. Nat. Sci. Proc., v. 4, p. 197–198, pl. 3.

———1860*b*, Descriptions of some new species of Cretaceous fossils: Philadelphia Acad. Nat. Sci. Jour., 2d ser., v. 4, p. 299–305, pls. 47, 48.

———1864, Description of the Cretaceous fossils: California Geol. Survey, Paleontology, v. 1, p. 55–236, pls. 9–32.

———1877, Notes on American Cretaceous fossils with descriptions of some new species: Philadelphia Acad. Nat. Sci. Proc., 1876, p. 276–324.

Gardner, J. A., 1916, Systematic paleontology, Mollusca, *in* W. B. Clark, and others: Maryland Geol. Survey, Upper Cretaceous, p. 371–733, pls. 12–45.

———1936–47, The molluscan fauna of the Alum Bluff group of Florida: U.S. Geol. Survey Prof. Paper. 142, p. 1–656, pls. 1–62.

———1957, Little Stave Creek, Alabama—Paleoecologic study, *in* H. S. Ladd, ed., Treatise on marine ecology and paleoecology, v. 2. Paleoecology: Geol. Soc. America Mem. 67, p. 573–588.

Gignoux, Maurice, 1950, Stratigraphic Geology: San Francisco, Freeman and Co., 682 p., 155 figs.

Gmelin, J. F., 1788–91, Caroli a Linné Systema Naturae*** 13th ed.: Lipiae, v. 1, 4120 p.; v. 2, 1661 p.; v. 3, 476 p.

Grabau, A. W., 1904, Phylogeny of Fusus and its allies: Smithsonian Misc. Colln. 44, no. 1417, 192 p.

Gray, J. E., 1830–34, Illustrations of Indian Zoology: London, 2 vs., 202 pls.

———1847, A list of the genera of recent mollusca, their synonyms and types: Zool. Soc. London, Proc. 15, p. 129–219.

Griesbach, C. L., 1871, On the Geology of Natal in South Africa: Geol. Soc. London Quart. Jour., v. 27, p. 53–72, pls. 2, 3.

Groot, J. J., Organist, D. M., and Richards, H. G., 1954, Marine Upper Cretaceous formations of the Chesapeake and Delaware Canal: Delaware Geol. Survey Bull. 3, 64 p., 7 pls.

Gunter, Gordon, 1957, Temperature, *in* Joel Hedgpeth, ed., Treatise on marine ecology and paleoecology, v. 1. Ecology: Geol. Soc. America Mem. 67, p. 159–184.

Haas, Otto, 1953, Late Triassic gastropods from central Peru, *in* Mesozoic invertebrate faunas of Peru: Am. Mus. Nat. History Bull., pts. 1 and 2, v. 101, 328 p., 18 pls.

Hall, James, and Meek, F. B., 1854, Descriptions of new species of fossils from the Cretaceous formations of Nebraska: Am. Acad. Arts Sci. Mem., v. 5, no. 5, p. 379–411, pls. 1–8.

Hamilton, E. S., 1953, Upper Cretaceous, Tertiary, and Recent planktonic Foraminifera from mid-Pacific flat-topped seamounts: Jour. Paleontology, v. 27, no. 2, p. 204–237.

Harbison, Anne, 1945, Upper Cretaceous Mollusks of the Lower Ripley Formation near Dumas, Mississippi: Philadelphia Acad. Nat. Sci. Proc., v. 97, p. 75–92, pls. 1–6.

Harris, G. D., 1937, Turrid illustrations: Paleontographica Americana, v. 2, no. 7, 96 p., 14 pls.

Haug, Emile, 1908–1911, Traité de Géologie, pt. 2, Les Périodes géologiques: Paris, Colin, p. 539–1396.

Hedgpeth, J. W., 1953, An introduction to the zoogeography of the northwestern Gulf of Mexico with references to the invertebrate fauna: Inst. Marine Sci. Pub., Texas Univ., v. 3, no. 1, p; 107–224.

———1957, Sandy beaches, *in* J. W. Hedgpeth, ed., Treatise on marine ecology and paleoecology, v. 1. Ecology: Geol. Soc. America Mem. 67, p. 587–608.

Helbling, G. S., 1779, Beitrage zur Kenntniss neuer und seltener Konchylien: Abh. Privatges, Böhmen, v. 4, p. 102–131.

Henderson, Junius, 1908, New Species of Cretaceous invertebrates from northern Colorado: U.S. Natl. Mus. Proc., v. 34, p. 259–264, pl. 13.

Herrick, C. L., and Johnson, D. W. 1900, The Geology of the Albuquerque Sheet: Denison Univ. Sci. Lab., Bull., v. 11, art. 9, p. 173–239, pls. 27–58.

Herrmannsen., A. N. 1852, Indicea Generum Malacozoorum Supplementa et Corrigenda: London, Paris, Cassellis, 140 p.

Hinds, R. B., 1843, *Pleurotoma*, *in* Reeve, L. A. Conchologica iconica: London, v. 1, species 83 (pages unnumbered).

Holzapfel, Eduard, 1888, Die Mollusken der Aachener Kreide: Paleontographica, v. 34, p. 29–180, pls. 4–21.

Howell, B. F., 1943, *Hamulus*, "*Falcula*", and other Cretaceous Tubicola of New Jersey: Philadelphia Acad. Nat. Sci. Proc., v. 95, p. 139–166, pls., 19, 20.

Hubendick, Bengt, 1945, Phylogenie und Tiergeographie der Siphonaridae: (Dissert) Uppsala, 216 p.

Huddleston, W. H., 1887–96, A monograph of the inferior oolite gastropoda. Being pt. 1 *of* the British Jurassic Gastropoda: Paleontographical Society, v. 40 (1887), v. 41 (1888), v. 42 (1889), v. 43 (1890), v. 45 (1892), v. 46 (1892), v. 48 (1894), v. 49, (1895), v. 50 (1896), 514 p. 44 pls.

Ihering, H. von, 1914, Cataloque de mollusques cretaces e terciarias de Argentina du collecao do auctor: Rev. Mus São Paulo, v. 1, no. 1.

Imlay, R. W., 1937 Stratigraphy and paleontology of the Upper Cretaceous beds along the eastern side of Laguna de Mayran, Coahuila, Mexico: Geol. Soc. America Bull., v. 48, p. 1785–1872, 26 pls., 4 figs.

———1944, Cretaceous formations of Central America and Mexico: Am. Assoc. Petroleum Geologists Bull., v. 28 p. 1077–1195.

———1944, Correlation of the Cretaceous formations of the Greater Antilles, Central America, and Mexico: Geol. Soc. America Bull., v. 55, p. 1005–1046; 3 pls.

Jeffreys, J. G., 1867, British Conchology: London, v. 4, 486 p. 8 pls.

Johnson, C. W., 1898, New Cretaceous fossils from an artesian wellboring at Mount Laurel, N.J.: Philadelphia Acad. Nat. Sci. Proc., v. 50, p. 461–464.

———1905, Annotated list of the types of Invertebrate Cretaceous fossils in the collection of the Academy of Natural Sciences, Philadelphia: Philadelphia Acad. Nat. Sci. Proc., v. 57, p. 4–28.

———1934, List of Marine Mollusca of the Atlantic Coast from Labrador to Texas: Boston Soc. Nat. History Proc., v. 40, no. 1, 204 p.

Jourday, E., 1924, Histoire naturelle des *Exogyres:* Annales de paléontologie, v. 13, pts. 1–2, p. 1–104.

Jurine, L., 1807, Nouvelle Methode de classer les Hymenpteres et les Dipteres, v. 1, Hymenopteres; Genève, 319, p., 14 pls.

Kaunhowen, Friederich, 1898, Die Gastropoden der Maestrichter Kreide: Paleont. Abh. v. 8, 132 p., 13 pls.

Keen, A. M., and Pearson, J. C., 1952, Illustrated key to west North American Gastropod Genera: Stanford, Calif. Stanford Univ. Press, 39 p.

Kittl, Ernst, 1891–94, Die Gastropoden der Schichten von St. Cassian der südelpinen Trias: K. K. Naturhist. Hofmus. Annalen, pt. 1, v. 6 (1891), p. 166–262, pls. 1–7; pt. 2, v. 7, (1892), p. 35–97, pls. 5–9; pt. 3, v. 9 (1894), p. 143–277, pls. 4–12.

Kittl, Ernst, 1895, Die triadischen Gastropoden der Marmolata und verwanter Fundstellen in den weissen Riffkalken Südtrols: Jahrb. K. K. Geol. Reichsanst., v. 44, p. 99–182, pls. 1–6.

———, 1899, Die Gastropoden der Esinokalke, nebst einer Revision der Gastropoden der Marmolatakalke: K. K. Naturhist. Hofmus, Annalen, v. 14, p. 1–237, 112 text figs., pls. 1–18.

Knight, J. B., 1941, Paleozoic Gastropod genotypes: Geol. Soc. America, Spec. Paper 32, 510 p., 96 pls.

———, and others, 1960, Mollusca, pt. 1, of Moore, R. C., ed. Treatise on Invertebrate Paleontology, Part I., 351 p., 216 figs.

———, J. B., Batten, R. L., and Yochelson, E. L., 1954, Gastropoda, *in* Mollusca, pt. 5 of Kummel, B., Jr., ed., Status of invertebrate paleontology, 1953: Harvard Colln. Comp. Zoology Bull., v. 112, no. 3, p. 173–179.

Koch, C. L., 1847, Die Arachniden: Nürnberg., v. 5, p. 161.

Korobkov, I. A., 1955, Handbook and methodical manual for Tertiary Mollusca; Gastropoda: 795 p., 117 pls.

Koenen, A. von, 1867, Uber *Conorbis & Cryptoconus*, Zischen formen Zwischen den Mollusken-Gattungen *Conus* und *Pleurotoma*: Palaeontographica, v. 16, p. 159–174.

Krumbeck, Lothar, 1906, Beiträge zur Geologie und Paleontologie von Tripolis: Palaeontographica, v. 53, p. 51–136, pls. 7–9.

Krumbeim, W. C., and Sloss, L. L., 1951, Stratigraphy and sedimentation: San Francisco, W. H. Freeman, 497 p.

Ladd, H. S., ed., 1957, Paleoecological evidence in treatise on marine ecology and paleoecology, v. 2, Paleoecology: Geol. Soc. America Mem., v. 67, p. 31–66.

Lamarck, J. B., 1799, Prodome d'un nouvelle classification des coquilles: Paris Soc. Hist. Nat. Mém., v. 1, p. 63–91.

———1803, Suite des mémoires sur les fossiles des environ de Paris: Mus. d'Histoire Naturelle Ann., v. 1, pt. 6, p. 475.

———1804, Suite des mémoires sur le fossiles des environ de Paris: Mus. d'Histoire Naturelle Ann., v. 3, pt. 15, p. 164.

———1811, Determination des espèces de mollusques testaces: Continuation du genre Ovule, Torriore, Ancillaire et Olive: Mus. d'Histoire Naturelle Ann., v. 16, for 1810, p. 89–114, 300–328.

———1822, Histoire naturelle des animaux sans vertébres; Paris.

Lemche, Henning, 1948, Northern and Arctic Tectibranch Gastropodes: Det. Kongel. Danske Vidensk. selsk. Biologiske. Skr., v. 5, no. 3, 136 p.

Linnaeus, Carolus, 1758, Systema naturae per regna tria naturae *** edito decima, reformata: Stockholm, 10th ed., 824 p.

———1767, idem, 12th ed., 1327 p.

Loeblich, A. R., Jr., and Tappan, Helen, 1957, Planktonic Foraminifera of Paleocene and Early Eocene age from the Gulf and Atlantic Coastal Plains, *in* Loeblich A. R., and others, Studies in Foraminifera: U.S. Natl. Mus. Bull. 215, p. 173–198, pls. 40–64.

Loven, P. M., 1846, Index Molluscorum litora Scandinaviae occidentalia habitantium: Öfvers, kgl. Vetensk. Akad. Förh, Stockholm, v. 3, p. 134–160, 182–204.

Lowenstam, H. A., 1954, Systematic, paleoecologic and evolutionary aspects of skeletal building materials, [pt.] 11 *of* Kummel, B., Jr., ed., Status of invertebrate paleontology, 1953: Harvard Colln. Mus. Comp. Zoology Bull., v. 112, no. 3, p. 287–317.

Lowenstam, H. A., and Epstein, Sam, 1954, Paleotemperatures of the post-Aptian Cretaceous as determined by the oxygen isotope method: Jour. Geology, v. 62, p. 207–248.

MacGillavry, H. J., 1934, Some rudistids from the Alta Verapaz, Guatemala: Koninkl. Akad. wetensch. Amsterdam Proc., v. 37, no. 4, p. 232, 238, 1 pl.

———1937, Geology of the province of Camaguey, Cuba, with revisional studies in rudist paleontology: Geog. geol. Mededeel. Phys. Geol. Reeks, no. 14, 169 p., 3 pls.

MacGinitie, G. E., and MacGinitie, Nettie, 1949, Natural History of Marine Animals: New York, McGraw-Hill Book Co., 473 p.

Martin, G. C., 1904, Mollusca, *in* Clark, W. B., and others, Maryland Geological Survey, Miocene: 543 p., 135 pls.

Matsumoto, Tatsuro, 1953. The Cretaceous system in the Japanese Islands: Japan Soc. for Promotion of Science, Ueno, Tokyo, 324 p., 20 pls.

———1959, Upper Cretaceous ammonites of California, pt. 1: Mem. of the Faculty of Science, Kyushu Univ., ser. D, v. 8, no. 4, p. 91–171, pls. 30–45.

Mattson, P. H., 1957, Geology of the Mayaguez area Puerto Rico: Puerto Rico Econ. Devel. Adm., Dept. Indus. Res., 170 p.

Maury, C. J., 1930, O Cretaceo du Parahyba du norte: Servico Geol. Mineralog. do Brasil Mon. 8, 305 p., 35 pls.

Meek F. B., 1864, Check list of invertebrate fossils of North America; Cretaceous and Jurassic: Smithsonian Misc. Colln., v. 7, p. 1–40.

———1876, A report on the invertebrate Cretaceous and Tertiary fossils of the upper Missouri country. U.S. Geol. and Geog. Survey Terr. 9th ann. Rept. LXIV, 629 p., 45 pls.

Meek, F. B., and Hayden, F. V., 1857, Descriptions of new species of Gastropoda from the Cretaceous formations of Nebraska: Philadelphia Acad. Nat. Sci. Proc. for 1856, v. 8, p. 63–69.

———1858, Description of new species and genera of fossils, collected by Dr. F. V. Hayden in Nebraska Teritory: Philadelphia Acad. Nat. Sci. Proc. for 1857, v. 9, p. 117–148.

———1860a, Systematic catalogue with synonyma of Jurassic, Cretaceous, and Tertiary fossils collected in Nebraska *** Philadelphia Acad. Nat. Sci. Proc., v. 12, p. 417–432.

———1860b, On a new genus of patelliform shells from the Cretaceous rocks of Nebraska: Am. Jour. Sci., 2d ser., v. 29, p. 33–35, pl. 1.

Mellen, F. F., 1958, Cretaceous shelf sediments of Mississippi: Mississippi Geol. Survey Bull. 85, 112 p.

Merriam, C. W., 1941, Fossil Turritellas from the Pacific Coast region of North America: California Univ. Dept. Geol. Sci. Bull., v. 26, no. 1, p. 1–214, pls. 1–41, 19 text figs., 1 map.

Michelotti, Giovanni, 1846, Description des fossiles des Terrains Miocenese de l'Italie septentrionale: Haarlem, 408 p., 17 pls.

Mighels, J. W., and Adams, C. B., 1842, Description of twenty-four species of the shells of New England. Boston Nat. History, Soc. Jour., v. 4, no. 1, p. 37–54.

Monroe, W. H., 1941, Notes on deposits of Selma and Ripley age in Alabama: Alabama Geol. Survey Bull. 48, 150 p.

———1953, General geologic features of the Atlantic and Gulf Coastal Plain: Kentucky Geol. Survey Spec. Pub. 1, p. 5–16.

Monterosato, T. A. Di, 1884, Nomenclatura generica e specifica di alcune Conchiglie mediterranee pel Marchese di Monterosato: Palermo, 152 p.

Montfort, P. D. de, 1810, Conchyliogie systématique et classification méthodique des coquilles; affrant leur figures, leur arrangement générique, leurs descriptions charactéristiques, leurs noms; ainsi que leur synonymie en plusieurs langues: Paris, v. 2, 676 p.

Mörch, O. A., 1857, Fortegneese over Grønlands Bødlgr, *in* Rink H., Grønland geographisk og statistisk beskrevet af. H. Rink: Copenhagen, v. 2, app., no. 4, 75 p.

Moricke, W., 1895, Die Gastropoden und Bivalven der Quiriquina-Schichten; pt. D, *in* Steinman, O. and others, Das Alter und die Fauna der Quiriquina Schichten: Neues Jahrb. Geologie u. and Palaeontologie Abh., v. 10, p. 95–114.

Morris, J., and Lycett, John, 1854, A monograph of the Mollusca from the Great Oolite, pt. 1, Univalves: London, Paleontographical Soc., 130 p., 15 pls.

Mortensen, Theodor, 1948, A monograph of the Echinoidea; IV.1, Holectypodiea, Cassiduloida: Copenhagen, Reitzel, 371 p., 14 pls.

Morton, J. E., 1958, Molluscs, an introduction to their form and function: London, Hutchinson and Co., 232 p.

Morton, S. G., 1834, Synopsis of the organic remains of the Cretaceous group of the United States: Philadelphia, Pa., 84 p., 19 pls.

Mülleried, F. K. G., 1934, Sobre el hallayzgo de paquidontos gigantescos en el Cretácico de Chiapas: Inst. biologia México Anales, v. 5, no. 1, p. 81–82, 1 fig.

———1936, Estratigrapfia preterciaria preliminar del Estado de Chiapas: Soc. geol. mexicana Bol., v. 9, p. 31–41.

Nagao, Takumi, 1939, Some molluscan fossils from the Cretaceous deposits of Hokkaido and Japanese Saghalien, pt. 2, Gastropoda: Hokkaido Imp. Univ. Jour., Faculty Sci., ser. 4, Geology and Mineralogy, v. 4, no. 3–4, p. 213–239, pls. 20–22.

Nagao, Takumi, and Otatume, Kenitiro, 1938, Molluscan fossils of the Hakobuti sandstone of Hokkaido: Hokkaido Imp. Univ. Jour., Faculty Sci., ser. 4, v. 4, nos. 1–2, p. 31–56, pls. 1–4.

Natland, M. L., 1957, Paleoecology of West Coast Tertiary sediments, *in* H. S. Ladd, ed., Treatise of marine ecology and paleoecology, v. 2, Paleoecology: Geol. Soc. America Mem. 67, p. 543–587.

Neverson, E., 1955 Stratigraphical Paleontology, 2d ed.: Oxford, Clarendon Press, 806 p., 16 pls.

Noetling, Fritz. 1897, Fauna of the Upper Cretaceous beds of the Mari Hills: Geol. Survey India, Palaeontologia India, ser. 16, Fauna of Baluchistan, v. 1, pt. 3, 79 p., 23 pls.

Old, M. C., 1943, As quoted on p. 2–3 *of* Report of the Committee on marine ecology as related to paleontology 1942–43: Natl. Research Council, Div. Geology and Geography, Rept. no. 3.

Olsson, A. A., 1944, Contributions to the Paleontology of northern Peru, pt. 7, The Creetaceous of the Paita Region: Am. Paleontology Bull., v. 28, no. 111, 147 p., 17 pls.

Olsson, A. A., and Harbison, Anne, 1953, Pliocene Mollusca of Southern Florida: Philadelphia Acad. Nat. Sci. Mon. 8, 457 p., 65 pls.

d'Orbigny, Alcide, 1842–1847, Description des animaux invertébrés; 2 Gastéropodes: Paléontologie française, terrain Crétacé, 1e ser., v. 2, 456 p., pls. 149–236.

Palmer, K. van Winkle, 1937, The Claibornian Scaphopoda, Gastropoda, and Dibranchiate Cephalopoda of the southern United States: Am. Paleontology Bull., v. 7, no. 32, 730 p., 90 pls.

Palmer, R. H., 1933, Nuevos Rudistas de Cuba: Revista de Agricultura, v. 14, no. 15, 16, p. 95–125.

Pchelintsef, V. F., 1953, Gastropod fauna of the Upper Cretaceous deposits of Transcaucasia and Central Asia: Izvestiya Akad. Nauk USSR, 388 p., 51 pls., 47 text figs.

———1954, Gastropods from the Upper Cretaceous beds of the Armyansku S.S.R. and overlying parts of Azerbaidzhan SSR: Izvestiya Akad. Nauk USSR, 178 p. 23 pls. 52 text figs.

Pennant, Thomas, 1777, British Zoology, 4th ed.: Warrington and London, v. 4, 100 p.

Perry, George, 1811, Conchology or the natural history of shells: London, 61 pls.

Pervinquière, L., 1912, Etudes de paléontologie tunisienne; II. Gastéropodes et Lamellibranches des terrains crétacés: Direction gén. Travaux publics, carte géol. de la Tunisie, 352 p., 23 pls.

Picard, Leo, 1930, Upper Cretaceous Gastropoda and Pelecypoda from Palestine: Annals and Mag. Nat. History, ser. 10, v. 5, p. 513–543, pls. 21–22.

Pictet, F. J., and Roux, W., 1847–1849, Descriptions des Mollusques Fossiles qui se trouvent dans les gres vert des environs, de Genève: Fick Genève, p. 1–287, pl. 1–27.

Pilsbry, H. A., and Olsson, A. A., 1954, Systems of the Volutidae: Am. Paleontology Bull., v. 35, no. 152, p. 275–306, 4 pls.

Popenoe, W. P., 1942, Upper Cretaceous formations and faunas of Southern California: Am. Assoc. Petroleum Geologists Bull., v. 26, no. 2, p. 162–187.

———1954, Mesozoic formation and faunas, southern California and northern Baja California (Mexico), pt. 3, *in* Jahns, R. H., ed., Geology of southern California: Calif. Dept. Nat. Resources, Div. Mines Bull. 170, p. 15–21.

———1957, The Cretaceous Gastropod genus *Biplica*, its evolution and biostratigraphic significance: California Univ., Publications in Geology, v. 30, no. 6, p. 425–454, pls. 50–51.

Pryor, W. A., 1960, Cretaceous sedimentation in Upper Mississippi Embayment: Am. Assoc. Petroleum Geologists Bull., v. 44, no. 9, p. 1473–1504.

Quaas, Arthur, 1902, Die fauna der Obervegeschichten und der Blatterthöne in der Libyschen Wüste: Paleontographica, v. 30, Abt. 2, p. 153–334, pls. 20–33.

Rafinesque, C. S., 1815, Analyses de la nature ou tableau de l'universe et des corps organises: Palermo, 224 p.

———1831, Continuation of a monograph of the bivalve shells of the River Ohio: Philadelphia.

Reeside, J. B., Jr., 1927, Cephalopods from the lower part of the Cody Shale of Oregon Basin, Wyoming: U.S. Geol. Survey Prof. Paper 150–A, p. 1–19, pls. 1–8.

———1947, Upper Cretaceous ammonites from Haiti: U.S. Geol. Survey Prof. Paper 214–A, p. 1–5, 3 pls.

Reeside, J. B., Jr., 1957, Paleoecology of the Cretaceous Seas of the Western Interior of the United States, *in* H. S. Ladd, ed., Treatise on marine ecology and paleoecology, v. 2, Paleoecology: Geol. Soc. America Mem. 67, p. 505–542.

Rennie, J. V. L., 1929, Cretaceous fossils from Angola (Lamellibranchia and Gastropoda): South African Mus. Annals, v. 28, pt. 1, p. 1–54, pls. 1–4.

———1930, New Lamellibranchia and Gastropoda from the Upper Cretaceous of Pondoland: South African Mus. Annals, v. 28, pt. 2, p. 159–260, pls. 16–31.

———1945, Lamellibranquios e Gastropodos do Cretacio superior de Angola: Rep Portuguesa, Min. Col. Junta Miss. Geog. e Invest. Col. Mem. Serie Geologica, 141 p., 4 pls.

Richards, H. G., 1943, Fauna of the Raritan Formation of New Jersey: Philadelphia Acad. Nat. Sci. Proc., v. 95, p. 15–32, pls. 4–7.

Richards, H. G., and others, 1958, The Cretaceous fossils of New Jersey, Pt. 1: New Jersey Bur. Geology and Topography, Paleont. ser., p. 1–266, pls. 1–46.

Riedel, L., 1932, Die Oberkreide vom Mungofluss in Kamerun und ihre Fauna - Beitrage n. Geol. Erforsch: Der Deutsch Schutzgebeite, Preuss. geol. Landesanstalt abh. 155 p., 32 pls.

Risso, A., 1826, Histoire naturelle des principales production de l'Europe meridionale, etc.: Paris, v. 1–5.

Roger, Jean, 1939, Le Genre *Chlamys* dans les Formation Neogenes de l'Europe: Soc. géol. France Mém., new ser., v. 17, pts. 2–4, Mém. 40, p. 1–294, pls. 1–28.

Scott, Gayle, 1940, Paleoecological factors controlling the distribution and mode of life of Cretaceous ammonoids in the Texas area: Jour. Paleontology, v. 14, no. 4, p. 299–333.

Shumard, B. F., 1861, Descriptions of new Cretaceous fossils from Texas: Boston Soc. Nat. History Proc., v. 8, p. 188–205.

Sohl, N. F., 1960, Archeogastropoda, Mesogastropoda, and stratigraphy of the Ripley, Owl Creek, and Prairie Bluff formations: U.S. Geol. Survey Prof. Paper 331–A, 151 p., 18 pls. [1961].

Sohl, Norman F., 1963, New gastropod genera from the late Upper Cretaceous of the east Gulf Coastal Plain: Jour. Paleontology, v. 37, no. 4, p. 747–757, pl. 89, 90.

Sowerby, G. B., 1823, The Genera of recent and fossil shells for the use of students in Conchology and Geology: London, pt. 21 (unnumbered pages).

Spath, L. F., 1925, On Senonian Ammonoidea from Jamaica: Geol. Mag., v. 62, p. 28–32, 1 pl.

Stanton, T. W., 1893, The Colorado formation and its invertebrate fauna: U.S. Geol. Survey Bull. 106, p. 1–288, pls. 1–45.

———1947, Studies of some Comanche pelecypods and gastropods: U.S. Geol. Survey Prof. Paper 211, 256 p., 67 pls.

Stach, L. W., 1936, Correlation of zoarial form with habitat: Jour. Geology, v. 44, p. 60–65.

Stearns, R. G., 1957, Cretaceous, Paleocene and lower Eocene geologic history of the northern Mississippi embayment: Geol. Soc. America Bull., v. 68, p. 1077–1100.

Stearns, R. G., and Armstrong, C. A., 1955, Post-Paleozoic stratigraphy of Western Tennessee and adjacent portions of the upper Mississippi embayment: Tennessee Dept. Conserv. Div. Geology Rept. Inv. no. 2, 29 p.

Steinmann, G., 1895, Die Cephalopoden de Quiriquina Schichten, *in* Steinmann and others, Das Alter und die fauna der Quiriquina Schichnten: Neues Jahrb. Beilage-Band 10, p. 64–94, pls. 4–6.

Stenzel, H. B., 1945, Paleoecology of some oysters: Natl. Research Council, Div. Geology and Geography Ann. Rept., App. H, Rept. no. 5, p. 37–46.

Stephenson, L. W., 1915, The Cretaceous-Eocene contact in the Atlantic and Gulf Coastal Plain: U.S. Geol. Survey Prof. Paper 90–J, p. 155–182, pls. 11–19, figs. 13–20.

———1922, Some Upper Cretaceous shells of the rudistid group from Tamaulipas, Mexico: U.S. Natl. Mus. Proc., v. 61, art. 1, p. 1–28, pls. 1–15.

———1923, Cretaceous formations of North Carolina: North Carolina Geol. and Econ. Survey, v. 5, p. 604, pls. 1–102.

———1927, Additions to the Upper Cretaceous invertebrate faunas of the Carolinas: U.S. Nat. Mus. Proc., v. 72, art. 10, no. 2706, p. 1–25, pls. 1–9.

———1941, The larger invertebrate fossils of the Navarro Group of Texas: Texas Univ. Bull. 4101, 641 p., 95 pls.

———1943, *Tryonella* a new name for *Tryonia* Stephenson: Jour. Paleontology, v. 17, no. 3, p. 309.

———1947, New Upper Cretaceous fossils from Mississippi and Texas: U.S. Geol. Survey Prof. Paper 210–E, p. 161–196, pls. 31–33.

———1952, The larger invertebrate fossils of the Woodbine formation (Cenomanian) of Texas. U.S. Geol. Survey Prof. Paper 242, 226 p., 59 pls., [1953].

———1955, Owl Creek (Upper Cretaceous) fossils from Crowleys Ridge, southeastern Missouri: U.S. Geol. Survey Prof. Paper 274–E, p. 97–140, pls. 14–24.

———1956, Fossils from the Eutaw formation, Chattahoochee River region, Alabama-Georgia: U.S. Geol. Survey Prof. Paper 274–J, p. 227–250, pls. 38–45, [1957].

Stephenson, L. W., King, P. B., Monroe, W. H., and Imlay, R. W., 1942, Correlations of the outcropping Cretaceous formations of the Atlantic and Gulf Coastal Plain and Trans-Pecos, Texas: Geol. Soc. America Bull., v. 53, p. 435–448, chart.

Stephenson, L. W., and Monroe, W. H., 1940, The Upper Cretaceous deposits: Mississippi Geol. Survey Bull. 40, p. 1–296, pls. 1–15.

Stephenson, L. W., and Reeside, J. B., Jr., 1938, Comparison of Upper Cretaceous deposits of gulf region and western interior region: Am. Assoc. Petroleum Geologists Bull., v. 22, no. 12, p. 1629–1638.

Stewart, R. B., 1927, Gabb's California fossil type gastropods: Philadelphia Acad. Nat. Sci. Proc., v. 78, p. 287–447, pls. 20–32.

———1930, Gabb's California Cretaceous and Tertiary type lamellibranches: Philadelphia Acad. Nat. Sci. Spec. Pub. 3, 314 p., 17 pls.

Stoliczka, Ferdinand, 1865, Eine Revision der Gastropoden der Gosau schichten in den Ostalpen: Sitzungsber de Kaiserlichen Akad. der Wiss. v. 52, pt. 1, p. 104–233, 1 pl.

———. 1867–68, Cretaceous fauna of southern India; The Gastropoda of the Cretaceous rocks of southern India: India Geol. Survey Mem., Paleontographica India, v. 2, ser. 5, pts. 1–10, 497 p., 28 pls.

Swainson, William, 1840, A treatise on malacology or shells and shell fish: London, 419 p., 130 text figs.

Taylor, D. W., and Sohl, N. F., 1962, An outline of gastropod classification: Malacologia v. 1, p. 7–32.

Termier, Geneviève, 1954, Gastéropodes du Crétacé supérieur dans le Sud Ouest de la France (Group II): Toulouse Soc. Histoire Nat. Bull. p. 323–382, 74 figs.

Termier, Henri, and Termier, Geneviève, 1952, Histoire géologique de la biosphère Paris, Masson, 721 p., 8 pls., 117 text figs.

Theile, Johannes, 1929, Handbuch der Systematichen Weichtierkunde: Jena, Germany, pt. 1, 376 p., 470 figs.

Thomas, Phillip, and Peron, Alphonse, 1889, Description des Mollusques fossiles des terrains crétacés de la region sud des Hauts-Plateux de la Tunisie: Paris, 405 p., 32 pls.

Thorson, Gunnar, 1946, Reproduction and larval development of Danish Marine Bottom Invertebrates: Medd. Fra Kommissionen fur Danmarks Fiskeri - og Havunder. Serie: Plankton, v. 4, no. 1, 523 p. 190 text figs.

Tikasingh, E. S., and Pratt, Ivan, 1961, The classification of endoparasitic gastropods: Systematic Zoology, v. 10, p. 65–69.

Trechmann, C. T., 1924, The Cretaceous limestones of Jamaica and their Mollusca: Geol. Mag., v. 61, p. 2–19.

———1927, The Cretaceous shales of Jamaica: Geol. Mag., v. 64, p. 27–41, 49–65.

Tryon, G. W., 1883, Structural and systematic conchology: Philadelphia Acad. Nat. Sci., v. 2, 430 p., pls. 23–91.

Ulrich, E. O., and Scofield, W. H., 1897, The Lower Silurian Gastropoda of Minnesota: Minnesota Geol. Survey Final Rept. 3, pt. 2, p. 813–1081.

Vaughan, T. W., and Wells, J. W., 1943, Revision of the suborders, families, and genera of the Scleractinia: Geol. Soc. America Spec. Paper 44, 363 p., 51 pls.

Wade, Bruce, 1916, New genera and species of Gastropoda from the Upper Cretaceous: Philadelphia Acad. Nat. Sci. Proc., v. 68, p. 455–471, pls. 23–24.

———1917, New and little known Gastropoda from the Upper Cretaceous of Tennessee: Philadelphia Acad. Nat. Sci. Proc., v. 69, p. 280–304, pls. 17–19.

———1918, New generic names for Upper Cretaceous Gastropoda: Am. Jour. Sci., 4th ser., v. 45, p. 334.

———1926, The fauna of the Ripley formation on Coon Creek, Tennessee: U.S. Geol. Survey Prof. Paper 137, 272 p., 72 pls., 2 figs.

Walther, Johannes, 1910, Die Sedimente der Taubenbank im Golfe von Neapel: K. preuss. Akad. Wiss., Phys.-Math. Kl., Jahrb. 1910, Abh. 3, 49 p., 2 pls.

Wanner, Johannes, 1902, Die Fauna de obersten weissen Kreide der libyschen Wüste: Paleontographica, v. 30, p. 92–151, pls. 13–19.

Warren, Shields, 1916, Feeding habits of *Busycon:* Nautilus, v. 30, no. 6, p. 66–68.

Weinkauff, H. C., 1875, Über eine Kritische Gruppe des Genus *Pleurotoma* Lam. sensu stricto: Jahrb deutsch. Malakozool., Gesell. 2, p. 285–292.

Weinzittle, Valentin, 1910, Gastropoda českého Křídovéhoúfvaru: Paleontographica Bohemiae, no. 8, 56 p., 7 pls.

Weller, Stuart, 1907, Cretaceous faunas: New Jersey Geol. Survey, Paleontology, v. 4, 1106 p., 111 pls.

Wenz, Wilhelm, 1938–49, Gastropoda, *in* Schindewolf, O. H., Handbuch der Paläzoologie: Berlin, v. 6, xii 1639 p., 4211 text figs. (pts. 1, 2, 1938; pt. 3, 1939; pt. 4, 1940; pt. 5, 1941; pt. 6, 1943; pt. 7, 1944.)

Wetzel, Wilhelm, 1930, Die Quiriquina-Schichten als sediment und Paläontologisches: Paläontographica, v. 73, p. 49–106, pls. 9–14.

White, C. A., 1880, Contributions to invertebrate paleontology, no. 2; Cretaceous fossils of the Western States and Territories: U.S. Geol. and Geog. Survey Terr. (Hayden) 12th Ann. Rept. for 1878, pt. 1, p. 1–38, pls. 11–18, (1883).

———, 1888 Contributions to the Paleontology of Brazil, Cretaceous Invertebrate fossils: Mus. nac. Rio de Janiero Archivos, v. 7, 273 p., 28 pls.

———1889, On invertebrate fossils from the Pacific Coast: U.S. Geol. Survey Bull. 51, 102 p., 14 pls.

Whitfield, R. P., 1892, Gastropoda and Cephalopoda of the Raritan Clays and Greensand Marls of New Jersey: U.S. Geol. Survey Mon. 18, 402 p., 50 pls.

———1897a, Descriptions of Species of Rudistae from the Cretaceous Rocks of Jamaica, W. I., collected and presented by F. C. Nicholas: Am. Mus. Nat. History Bull., v. 9, art. 12, p. 185–196, pls. 6–22.

———1897b, Observations on the genus *Barrettia* Woodward, with descriptions of two new species: Am. Mus. Nat. History Bull., v. 9, art. 20, p. 233–246, pls. 27–38.

Wilckens, Otto, 1904, Revision der Quiriquina-Schichten: Neues Jahrb. Beilage-Band. 18, p. 181–284.

———1922, The Upper Cretaceous Gastropods of New Zealand: Dept. of Mines, Geol. Survey Branch, Paleontological Bull. 9, 42 p., 5 pls.

Willis, L. J., 1952, Paleogeographical Atlas of the British Isles and adjacent parts of Europe: London, Blackie & Son, 64 p., 22 pls.

Winkworth, R. A., 1934, Names of British Mollusca, pt. 2: Jour. Conchology, v. 20, p. 9–15.

Woodring, W. P., 1928, Miocene Mollusca from Bowden, Jamaica, Pt. 2, Gastropoda: Carnegie Inst. Washington, Pub. no. 385, 594 p., 40 pls.

Woods, Henry, 1897, Mollusca of the Chalk Rock, Pt. 2: Geol. Soc. London Quart. Jour., v. 53, p. 377–403.

———1899–1903, A monograph of the Cretaceous Lamellibranchia of England: Palaeont. Soc. Mon., v. 1, pts. 1–5, 232 p., 42 pls.

———1906, The Cretaceous fauna of Pandoland: South African Mus. Annals, v. 4, pt. 7, p. 245–350, pls. 33–44.

Yabe, Hisakatsu, 1927, Cretaceous stratigraphy of the Japanese Islands: Tohuku Imp. Univ. Sci. Repts., 2d ser., v. 11, no. 1, 74 p., 7 pls.

Yonge, C. M., 1937, The biology of *Aporrhais pespelecani* (*L.*) and *A. servesiana* (Mich.): Jour. Marina Biol. Assoc., (new ser.), v. 21, no. 2, p. 687–704.

Zekeli, Friedrich, 1852, Die Gastropoden der Gosaugebilde: K. K. geol. Reichsanstalt Abh., v. 7, Abt. 2, no. 2, 124 p., 24 pls., Wien.

Zittle, K. D., 1865–66, Die Bivalven de Gosaugebilde in den Nordostlichen Alpen: Benkschr. K. Akad. Wissen, Wien, Math.-Naturw. Kl., v. 24, p. 105–177; v. 25, p. 77–198, 27 pls.

INDEX

[Italic page numbers indicate descriptions]

A Page

Aciculiscala ... *321*, tab. 2
acuta ... 171, 321, *322*, pl. 51, tab. 1
Acirsa ... *313*, 316
cerithiformis ... 171, 313, 316
corrugata ... 313, 316
microstriata ... 313, 315
(*Acirsa*) ... 313
(*Hemiacirsa*) ... 159, 163, 171, 313, 315, 316, tab. 2
americana ... *314*, pl. 51, tab. 1
clathrata ... 170, *315*, pl. 51, tab. 1
cretacea ... *313*, 314, 315, pl. 51, tab. 1
flexicostata ... 170, *314*, pl. 51, tab. 1
(*Plesioacirsa*) ... 313, 315, 316, tab. 2
impleva ... 170, *316*, pl. 51, tab. 1
microstriata ... 313, *315*, 316, pl. 51, tab. 1
wadei ... *315*, pl. 51, tab. 1
(*Acirsa*), *Acirsa* ... 313
Acirsinae ... 313, tab. 2
Acmaea ... 159, tab. 2
Acmaeidae ... tab. 2
Acmainae ... tab. 2
Acrocoelum ... tab. 2
Actaeon concinnus ... 295
Acetocina ... 303, 304
Acteocinidae ... 299
Acteon ... *287*, 288, tab. 2
cicatricosus ... 170, *288*, pl. 47, tab. 1
conicus ... 171, 292
ellipticus ... 171, 290
linteus ... 288, 289
modicellus ... 287, 288
mülleri ... 166
pistiliformis ... 170, *287*, 288, pl. 47, tab. 1
solidulus ... 171, 289
substriatus ... 291
throckmortoni ... 171, 288, 290
sp ... *288*, tab. 1
Acteonacea ... 287
Acteonella ... 163
Acteonidae ... 287, tab. 2
Acteonina orientalis ... 171, 290
Acteoninae ... 287, tab. 2
Actinocamax ... 166
Actinotrophon ... 174
acuta, Aciculiscala ... 171, 321, *322*, pl. 51, tab. 1
Cancellaria ... 269
Caveola ... 269, 270, pl. 44, tab. 1
acuta, Caveola ... *269*, 270, p 44
Caveola acuta ... *269*, 279, pl. 44
Ringicula ... 293
speciosa, Caveola ... 170, *270*, pl. 44, tab. 1
acutula, Ancilla (*Ancillus*) ... *248*, pl. 36, tab. 1
Eoancilla ... 247, 248
acutalis, Aciculiscala ... 322
acutispira, Ringicula ... 293
Admete ... 271
Afer (*Hercorhyncus*) *tippanus* ... 221
(*Afer*) *bellaliratus, Fusus* ... 171, 200
africana, Pyropsis ... 235
alabamaensis, Pyropsis ... 235
albensis, Scalaria ... 314
Aliofusus ... 168, 184, 185, *187*, 228, tab. 2
reagani ... 187, 188
subtilis ... 184, 187
stamineus ... 170, *187*, 188, pl. 22, tab. 1

Page

alta, Paladmete ... 271
Amaea ... 314
Amaurellina ... tab. 2
Amauropsis ... 166
americana, Acirsa (*Hemiacirsa*) ... *314*, pl. 51, tab. 1
Calliomphalus (*Calliomphalus*) ... 166
Eryptycha ... 295, 296
Oligoptycha ... 295, *296*, 297, pl. 48, tab. 1
Proscala ... 171, 314
amica, Surcula ... 171, 281, 282
Turricula ... 171, 281, 283
Amoria ... 266
ampla, Ancilla ... 248
Voluta ... 247
ampulla, Bulla ... 307
(*Ampulella*), *Globularia* ... tab. 2
Ampullinidae ... tab. 2
Amuletum ... 158, 171, *274*, 275, 277, 278, 279, 280, tab. 2
baylei ... 275
corvocostatum ... 171, 275
macnairyensis ... 171, 275, pl. 45, tab. 1
macnairyensis ... 276
torquatum ... 170, 276, 277, pl. 45, tab. 1
venustum ... 275
(*Amuletum*) ... 279
curvicostatum ... 276
dumasensis ... 170, *276*, 277, pl. 45, tab. 1
fasciolatum ... *278*, pl. 46, tab. 1
macnairyensis ... 277
macnairyensis ... *275*, pl. 45
torquatum ... *276*, pl. 45
ripleyana ... 276
venustum ... 276
wadei ... 170, 275, *277*, 278, pl. 45, tab. 1
(*Lutema*) ... 279, tab. 2
hubbardi ... 278
limbatum ... 170, *278*, 279, pl. 46, tab. 1
munda ... 278
sp ... *279*, pl. 46, tab. 1
(*Amuletum*), *Amuletum* ... 279
curvicostatum, Amuletum ... 276
dumasensis, Amuletum ... 170, *276*, 277, pl. 45, tab. 1
fasciolatum, Amuletum ... *278*, pl. 46, tab. 1
macnairyensis, Amuletum ... 277
macnairyensis, Amuletum ... *275*, pl. 45
torquatum, Amuletum ... *276*, pl. 45
ripleyana, Amuletum ... 276
venustum, Amuletum ... 276
wadei, Amuletum ... *277*, pl. 45
Anchura ... 159, 205, 226, tab. 2
monmouthensis ... 205
pergracilis ... 171, 226
Ancilla ... *247*, 248, 266
ampla ... 248
buccinoides ... 247
cretacensis ... 264
ancilla, Gemmula ... 280
Ancilla (*Ancilla*) ... 247
(*Ancillus*) ... 171, 247, 248, tab. 2
acutula ... *248*, pl. 36, tab. 1
(*Ancilla*), *Ancilla* ... 247
Ancillus ... *247*
(*Ancillus*) *acutula, Ancilla* ... *248*, pl. 36, tab. 1
Ancilla ... 171, 247, 248, tab. 2
andoorensis, Rapa ... 235

Page

Angaridae ... tab. 2
angulatus, Rostellites ... 171, 250
angulicostatus, Bellifusus ... 170, 203, *204*, pl. 25, tab. 1
angusta, Ringicula ... 293
Anisomyon ... 164, 322, *323*, tab. 2
borealis ... 323
centrale ... 323
wieseri ... 171, 322
sp ... *323*, pl. 52, tab. 1
anomalocostata, Remnita ... *279*, 280, pl. 46, tab. 1
Turricula ... 279
Anomalofusus ... *229*, 231, tab. 2
bellulus ... 229, 230
lemniscatus ... 170, *230*, pl. 31, tab. 1
anomalofusus, Remnita ... 279
Anomalofusus subnodosus ... 170, *230*, pl. 31, tab. 1
substriatus ... *229*, 230, pl. 31, tab. 1
sp ... *231*, pls. 31, 32, tab. 1
(*Anomalofusus*) *substriatus, Fusus* ... 229
Anteglosia ... tab. 2
antiqua, Siphonaria ... 322
Aporrhaidae ... tab. 2
Aporrhais (*Arrhoges*) *pelecyphora* ... 166
(*Cultigera*) *propingua* ... 166
Archaeogastropoda ... tab. 2
Architectonicidae ... tab. 2
Arcotia vanhoepeni ... 168
arlingtonensis, Ringicula ... 293
armenica, Tectaplica ... 264
Arrhoges (*Latiala*) ... 166, tab. 2
(*Latiala*) *lobata* ... 166, 168
(*Arrhoges*) *pelecyphora, Aporrhais* ... 166
(*Asketomathilda*), *Mathilda* ... tab. 2
asper, Hydrotribulus ... 245, 246
Volutomorpha ... 253, 257, pls. 41, 42, tab. 1
asperum, Striaticostatum ... 170, *319*, 320, pl. 52, tab. 1
Astandes ... 166, tab. 2
Athleta ... 155, 264
(*Athleta*) *leioderma, Volutilithes* ... 258
Athletinae ... 258, tab. 2
attenuata, Fulgerca ... *247*, pl. 36, tab. 1
Pseudoliva ... 247
aurantiacus, Latirus ... 219
Auricula ringens ... 293
aurilitaralis, Fusimilis ... 167, 284
australis, Odontobasis ... *192*, 193, pl. 23, tab. 1
Scalaria ... 320
Avellana ... 295, 296
subincrassata ... 296
averilli, Fusus ... 250

B

Babylonella ... 268
Baculites carinatus ... 161
Baculites ovatus ... 298
bairdi, Pyropsis ... 235, 238, pl. 33
Basommatophora ... 322, tab. 2
baylei, Amuletum ... 275
baylyi, Dicroloma (*Perissoptera*) ... 168
Solarium ... 168
Belemnitella mucronata ... 166
bella, Cymella ... 163
Morea marylandica ... 178
Tornatellaea ... 291
Volutomorpha ... 253

Page

bellalirata bellalirata, Deussenia 200, pl. 25, tab. 1
costata, Deussenia 170, 200, pl. 25, tab. 1
Deussenia 200, 201, tab. 1
Deussenia bellalirata 200, pl. 25, tab. 1
bellaliratus, Fusus 199
Fusus (Afer) 171, 200
Bellascala 313
Bellifusus 163, 202, 203, 204, 205, 209, 215, tab. 2
angulicostatus 170, 202, 203, 204, pl. 25, tab. 1
buffaloensis 202
coronatus 202, 203, 204
crassicostatus 202
crenulatus 202
curvicostatus 171, 202, 203, 204, pls. 25, 26, tab. 1
crenulatus 170, 203, pl. 26, tab. 1
curvicostatus 202, pl. 25
deatsvillensis 202, 203
multicostatus 202
parvilirae 202
robustus 202
spinosus 170, 202, 203, pl. 25, tab. 1
tenuistriatus 171, 202, 203
sp 202, 204, pl. 26, tab. 1
Belliscala 171, 316, tab. 2
rockensis 316, 317, tab. 1
bellsana, Caveola 269
bellulus, Anomalofusus 229, 230
Beretra 163, 226, 281, 282, 283, 284, tab. 2
contracta 171, 281, 283
elongata 281
firma 171, 281, 283
gracilis 171, 281, 283, pl. 46, tab. 1
ornatula 281
ripleyana 171, 281, 282, 283, pl. 46, tab. 1
speciosa 170, 171, 285, pl. 46, tab. 1
striata 171, 281, 282
besairie, Turritella (Zaria) 168
bexarense, Epitonium 171, 317
Striatiscostatum 317, 318, 319, pl. 52, tab. 1
biacuminata, Remnita 279, 280, pl. 46, tab. 1
Turricula 279
bicarinata, Brucia 223
Euthriofusus (Haplovoluta) 223
Haplovoluta 222, 223
Hercorhyncus (Haplovoluta) 223
bicarinata, Parafusus 223
Scobina 223
bicarinatus, Hercorhyncus (Haplovoluta) 223, 224, pl. 30, tab. 1
bilira, Turritella 159, 160, 164, 165
binodosum, Protobusycon 170, 194, 195, pl. 24, tab. 1
Biplica 164, 170
biplicata, Drilluta 205
bisculpturata, Goniocylichna 302, 303, pl. 49, tab. 1
Boltenella 116, 220, 224, 225, tab. 2
excellens 224, 225, pl. 31, tab. 1
(Boltenella) excellens, Euthriofusus 225
bonei, Turritella (Zaria) 168
Bonnellitia 268
borealis, Anisomyon 323
Scalaria 313
breantiana, Turritella 168
breve, Liopeplum leioderma 260, 261
brevis, Cylindrites 303
brevispira, Drilluta 205, 206
Troostella 171, 291
bronni, Turbinella 209
Brucia 222
bicarinata 223
buboanus, Drilluta 170, 205, 207, 208, pls. 26, 27, tab. 1
Buccinacea 184, tab. 2
Buccinidae 184, tab. 2
buccinoides, Ancilla 247
Buccinopsis 159, 161, 171, 188, 192, tab. 2
crassa 189, 190, pl. 22, tab. 1
crassicostata 189, 190, 191, pl. 23, tab. 1
dorothiella 170, 188, 189, 190, 191, pl. 23, tab. 1
perryi 188, 189, pl. 23

Buccinopsis—Continued Page
solida 189, 190, 192, pl. 22, tab. 1
solida 189, 190, pl. 22
sulcata 170, 190, pl. 22, tab. 1
sp 192, pl. 22, tab. 1
buffaloensis, Bellifusus 202
Bulla 158, 298, 307, tab. 2
ampulla 307
cylindracea 299
lignaria 299
mortoni 298
sulcata 305
sp 308, pl. 50, tab. 1
Bullidae 306, tab. 2
Bullopsis 163, 306, 307, tab. 2
cretacea 306, 307, pl. 50, tab. 1
demersus 170, 307, pl. 50, tab. 1
burdigalensis, Euthriofusus 225
Fusus 225
Busycon 193, 194
(Busycon) 193, 194
(Protobusycon) cretaceum 193, 194
(Busycon), Busycon 193, 194

C

calamistrata, Scalaria 167
callilateris, Haplovoluta 265
Hyllus 264, 265
Parafusus 264, 265, 266, pl. 44, tab. 1
Calliomphalus 159, 160, 166
(Calliomphalus) 163, tab. 2
americana 166
(Planolateralis) 163, tab. 2
(Calliomphalus) americana, Calliomphalus 166
Calliomphalus 163, tab. 2
Calyptraeacea tab. 2
Campanile 169
canaliculata, Scalaria 314
canalis, Conus 261
Leioderma 261
Liopeplum 258, 260, 261, 262, pl. 43, tab. 1
Cancellaria 166, 268, 269, tab. 2
acuta 269
eufaulensis 171, 271, 272
macnairyensis 170, 268; pl. 44 tab. 1
matsoni 268, 269
producta 269
quantula 269
subalta 269
sp 268
cancellaria, Morea 175, 176, 177, 178, pl. 20
corsicanensis, Morea 170
crassa, Morea 176
languida, Morea 170
Paladmete 171, 271, 272, 273, 274, pl. 45, tab. 1
Palaeadmete 271
Trichotropis 270, 271
Cancellaridae 267, tab. 2
cancellata, Exogyra 155, 176, 177, 185, 190, 194, 212, 224, 226, 228, 232, 247, 252, 257, 260, 262, 263, 267, 270, 272, 273, 278, 280, 283, 285, 288, 292, 294, 295, 297, 300, 311, 314, 323
Graphidula 211, pl. 28. tab. 1
Morea 179
Rapa 235
cancellatus, Graphidula 212
Piestochilus 211
Cantharus 179
(Paramorea) litratus 179
Capulidae tab. 2
Capulinae tab. 2
Capulus 166, tab. 2
spangleri 163
Caricella 264
carinata, Cylichna 171, 302
carinatum, Cylindrotruncatum 302
Liopeplum 258, 261

Page
carinatus, Baculites 161
Liopeplum 260
Caveola 269, 270, tab. 2
acuta 269, 270, pl. 44, tab. 1
acuta 269, 270, pl. 44
speciosa 170, 270, pl. 44, tab. 1
bellsana 269
pinguis 269
producta 270
speciosa 270
sp 270, pl. 44, tab. 1
caveola, Paladmete 271, 274
ceden, Tritonium (Colubraria) 269
centrale, Anisomyon 323
Cephalaspidea 287, tab. 2
certithiformis, Acirsa 171, 313, 316
Scalaria 171, 316, 317
Cerithiidae tab. 2
Cerithiopsidae tab. 2
Cerithium 166, 169, tab. 2
nodoliratum 164
traffrarium 205
weeksi 169
chalybeatensis, Turritella 166
Charonia tab. 2
Chemnitzia interrupta 184, 186
(Chemnitzia) laqueata, Turbonilla 205, 206
melanopsis, Turbonilla 171, 211, 212
cheyennensis, Gladius 231
chicoensis, Turritella 164
childreni, Gemmula 280
cibolensis, Deussenia 199, 200
cicatricosus, Acteon 170, 288, pl. 47, tab. 1
Cirsostrema 317
(Cirsostremopsis) 317
(Cirsostremopsis), Cirsostrema 317
clara, Eulima 308, 310, pl. 50, tab 1
clarki, Ringicula 293, 295, tab. 1
(Ringiculina) 295, pl. 48
clathrata, Acirsa (Hemiacirsa) 170, 315, pl. 315, tab. 1
(Clathrobaculus), Promathilda tab. 2
clathrus, Scala 313
Clavoscala 314
clementina, Scalaria 314
Clione 208
Coahuilites 161
codellana, Ringicula 293
Coleophysis 305
Colombellina tab. 2
Colombellinidae tab. 2
coloradoensis, Pyropsis 235
colorata, Haplovoluta 265
coloratus, Hyllus 265
Parafusus 264, 265, 266, pl. 44, tab. 1
(Colubraria) ceden, Tritonium 269
colus, Murex 227
communis, Drilluta 205, 206, 207, 208, pl. 27, tab. 1
Conacteon 303
Conchothyris 170
concinnus, Actaeon 295
Oligoptycha 295
concinna, Parvivoluta 263, tab. 1
condoni, Trophon 164
congestum, Striaticostatum 167, 170, 320, pl. 52, tab. 1
conicum, Parietiplicatum 292, pl. 48, tab. 1
conicus, Acteon 171, 292
Conorbis 286, 287
macnairyensis 286, 287
conradi, Volutilithes 252, 253
Volutomorpha 253, 254
constricta, Fusimilis 284
Odontobasis 192, pl. 23
Turris 171, 284, 285
constrictus, Fusus 192, 193
Odontobasis 193
contracta, Beretra 171, 281, 283
Conus canalis 261

Page

convexus, Euthriofusus ... *225*, 226, pl. 31, tab. 1
Falsifusus ... 171, 225
coonensis, Morea corsicanensis ... 170, 176, *177*, pl. 20, tab. 1
Coralliophila ... 182
corbis, Deussenia ... 200
corbuliformis, Paladmete ... 271, 272
cornatus, Hemifusus ... 166
cornutas, Pyropsis ... 170, 235, *237*, 239, 240, pl. 34, tab. 1
coronale, Hercorhyncus ... 171, 220, 221, 222
coronatum, Liopeplum ... 170, 258, *262*, 263, pl. 43, tab. 1
coronatus, Bellifusus ... 202, 203, 204
corrina, Pyropsis (Rapa) ... 235
corrugata, Acirsa ... 313, 316
Oligoptycha ... 170, 295, *297*, pl. 48, tab. 1
corsicanensis coonensis, Morea ... 170, 176 *177*, pl. 20, tab. 1
Morea ... 170, *176*, 177, pl. 20, tab. 1
cancellaria ... 170
corvocostatum, Amuletum ... 171, 275
(Cossmannica), Tiberia ... 310
costata, Deussenia bellalirata ... 170, *200*, pl. 25, tab. 1
Exogyra ... 154, 156, 157, 159, 160, 161, 162, 163, 167, 174, 180, 188, 202, 217, 222, 229, 232, 242, 244, 249, 258, 264, 279, 281, 288, 300, 301, 310.
costulata, Scalaria ... 313
crassa, Buccinopsis ... *189*, 190, pl. 22, tab. 1
Morea cancellaria ... 176
Seminola ... 171, 188, 189
crassicostata, Buccinopsis ... 171, 189, 190, *191*, pl. 23, tab. 1
Drilluta ... 205, 206
Fascioloria ... 188
(Cryptorhytis) ... 171, 191, 231
longa, Drilluta ... 206
crassicostatus, Bellifusus ... 202
Pugnellus ... 169
crassus, Pyrifusus ... 170, 196, *197*, pl. 24, tab. 1
crenulatus, Bellifusus ... 202
curvicostatus ... 170, *203*, pl. 26, tab. 1
Creonella ... 160, *310*, 311, 312, tab. 2
deusseni ... 311
secunda ... 171, 312, 313
subangulata ... 170, 171, *311*, pl. 51, tab. 1
triplicata ... *310*, 311, pl. 51, tab. 1
turretiforma ... 170, *311*, 312, pl. 51, tab. 1
whitei ... 312
cretacea, Acirsa (Hemiacirsa) ... *313*, 314, 315, pl. 51, tab. 1
Bullopsis ... *306*, 307, pl. 50, tab. 1
Exilia ... 226
Fasciolaria ... 171, 211
Gemmula ... 170, 280, 281, pl. 46, tab. 1
hebes, Tornatellaea ... 292
Hemiacirsa ... 313
Liopeplum ... 258, 260, 261
Liostraca ... 171, 311
Lirosoma ... 195
Lomirosa ... *195*
Tornatellaea ... *291*, 292, pl. 47, tab. 1
Volutilithes ... 258, 261
Volutomorpha ... 254
cretacensis, Ancilla ... 264
cretaceum, Busycon (Protobusycon) ... 193, 194
Fulgur (Protobusycon) ... 194
Liopeplum ... 171, *261*, 262, pl. 43, tab. 1
Protobusycon ... *194*, 195, pl. 23, tab. 1
Tritonium ... 166
Crucibulum ... tab. 2
Cryptoconidae ... tab. 2
Cryptoconinae ... 286
Cryptoconus ... *286*, 287, tab. 2
macnairyensis ... *287*, pl. 47, tab. 1

Page

Cryptorhytis ... *187*, 201, 215, *231*
nobilis ... 171, *231*, 232, pl. 32, tab. 1
pseudorigida ... 171, 200, 228
rigida ... 168, 221
torta ... 171, 231, 238
(Cryptorhytis) crassicostata, Fasciolaria ... 171, 191, 232
kerri, Fasciolaria ... 231
obliquicostata, Fasciolaria ... 231
cucullata, Lowenstamia ... 170, 182, *183*, pl. 21, tab. 1
culbertsoni, Fusus ... 171, 211
Piestochilus ... 211
Ringicula ... 293
(Cultigera) propinqua, Aporrhais ... 166
curta, Cyclichna intermissia ... 170, *301*, pl. 49, tab 1
Drilluta ... 205
curvicostata, Bellifusus ... 171
Odontofusus ... 202
curvicostatum, Amuletum (Amuletum) ... 276
curvicostatus, Bellifusus ... 171, 202, 203, 204, pls. 25, 26, tab.1
curvicostatus ... *202*, pl. 25, 26
crenulatus, Bellifusus ... 170, *202*, pl. 26, tab. 1
curvicostatus, Bellifusus ... *202*, pl. 25, 26
curvilirata, Rimella ... 171, 211, 214
curviliratus, Piestochilus ... *214*, pl.2 9, tab. 1
Cyclichna ... 160, 166, 297, 298, 299, 300, 301, 302, tab. 2
carinata ... 171, 302
diversilirata ... 170, *299*, 300, pl. 49, tab. 1
greisbachi ... 303
incisa ... 299, *300*, pl. 49, tab. 1
intermissia curta ... 170, *301*, pl. 49, tab. 1
intermissia ... 170, *300*, 301, pl. 49, tab. 1
pessumata ... 170, *301*, pl. 49, tab. 1
recta ... 171, 300, 302
secalina ... *299*, 300, pl. 49, tab. 1
striatella ... 298
sp. ... *301*, tab. 1
cylindracea, Bulla ... 299
Cylindrites brevis ... 303
Cylindrotruncatum ... 171, *301*, 302, tab. 2
carinatum ... 302
demersum ... 171, 301, *302*, pl. 49, tab. 1
Cymatidae ... tab. 2
Cymella bella ... 163

D

dalli, Longoconcha ... *252*, pl. 37, tab. 1
Volutoderma (Longoconcha) ... 250, 252
Damesia ... 166, tab. 2
deatsvillensis, Bellifusus ... 202, 203
decora, Remera ... 226, 227
decussata, Scalaria ... 315
Delphinula trigonostoma ... 267
demersum Cylindrotruncatum ... 171, 301, *302*, pl. 49, tab. 1
demersus, Bullopsis ... 170, 307, pl. 50, tab. 1
densata, Paladmete ... 171, 271, 272
densatus, Pugnellus ... 160
densestriata, Scalaria ... 315
(Dentiscala), Opalia ... 321
depressa, Schizobasis ... *180*, pls. 20, 21, tab. 1
desortorum, Scalaria ... 167, 168
deusseni, Creonella ... 311
Deussenia ... 171, *199*, 200, 201, 202, 253
bellalirata ... 200, 201, tab. 1
bellalirata ... *200*, pl. 25, tab. 1
costata ... 170, *200*, pl. 25, tab. 1
cibolensis ... 199, 200
corbis ... 200
microstriata ... *201*, pl. 24, tab. 1
multilirae ... 200
ripleyana ... *200*, 201, pl. 25, tab. 1
travisana ... 200, *201*, pl. 25, tab. 1
sp. ... *201*, *202*, pl. 25. tab. 1
Diaphana ... 298
Dicroloma (Perissoptera) baylyi ... 168

Page

digressa, Ornopsis ... 215, 217
(Pornosis) ... 215, 216, *217*, 218, pl. 29, tab. 1
dimurorum, Drilluta ... 205, 208
Dircella ... 164, tab. 2
Discohelix simplex ... 166
distans, Drillia ... 205, 206
Drilluta ... 205, *206*, 207, 208, pl. 27, tab. 1
diversilirata, Cyclichna ... 170, *299*, 300, pl. 49, tab. 1
dolabrata, Pyramidella (Pyramidella) ... 310
Dolicholatirus ... 158, *209*, tab. 2
perexilis ... 209
torquatus ... 170, *209*, pl. 26, tab. 1
dorothiella, Buccinopsis ... 170, 188, 189, *190*, 191, pl. 23, tab. 1
Drepanochilus ... tab. 2
Drillia distans ... 205, 206
georgiana ... 171, 281, 282
novemcostata ... 284, 285
tippana ... 171, 286
Drilluta ... 162, 163, 166, 169, 202, *205*, 206, 207, 208, 209, 214, 253, tab. 2
biplicata ... 205
brevispira ... 205, 206
buboanus ... 170, 205, *207*, *208*, pls. 26, 27, tab. 1
communis ... *205*, 206, 207, 208, pl. 27, tab. 1
crassicostata ... 205, 206
longa ... 206
curta ... 205
dimurorum ... 205, 208
distans ... 205, *206*, 207, 208, pl. 27, tab. 1
lemniscata ... 170, 205, *207*, pl. 27, tab. 1
major ... 205, 207, *208*, pl. 26, tab. 1
paucicostata ... 206
tenuitsriatus ... 202
sp. ... *208*, pl. 26, tab. 1
dumasensis, Amuletum (Amuletum) ... 170, 277, *276*, pl. 45, tab. 1
Volutomorpha ... 171, 253, 254, *255*, pls. 38, 39, 40, tab. 1
Durania ... 165

E

Ecphora ... 158, *173*, 174, tab. 2
proquadricostata ... 173, pl. 19, tab. 1
quadricostatas ... 173
ejunidus, Pyrifusus ... 170, *198*, pl. 24, tab. 1
elegans, Hydrotribulus ... 170, *246*, pl. 36, tab. 1
Mataxa ... 171, *267*, pl. 45, tab. 1
Paladmete ... 271
elevata, Ornopsis ... 215, 216
(Ripleyella) ... 215, *216*, 217, pl. 29, tab. 1
Pyropsis ... 235
Ellipsoscapha ... 297, *298*, 299. tab. 2
mortoni ... *298*, pls. 48, 49, tab. 1
striatella ... 298
sp. ... *298*, pl. 49, tab. 1
ellipticus, Acteon ... 171, 290
Eoacteon ... 171, *290*, pl. 47, tab. 1
elongata, Beretra ... 281
elongata, Goniocylichna ... 170, *303*, pl. 49, tab. 1
Voluta ... 171, 250
elongatus, Medionapus ... 235
Pyropsis ... 239
elongnata, Paleofusimitra ... 249, *250*, pl. 37, tab. 1
Eoacteon ... 171, *288*, 289, 290, 291, tab. 2
ellipticus ... 171, *290*, pl. 47, tab. 1
linteus ... *289*, 290, pl. 47, tab. 1
percultus ... 170, 171, *289*, pl. 47, tab. 1
sp. ... *290*, pl. 47, tab. 1
Eoancilla ... 171, 247, 248
acutula ... 247, 248
Eocitharia ... 249
Eoharpa ... 155, 249, tab. 2
sinuosa ... *249*
Epitomiidae ... 313, tab. 2
Epitoniacea ... 313, tab. 2
Epitoniinae ... 321

Page

Epitonium 317, 321, 322
bexarense 171, 317
jacobsi 322
pondi 171, 318, 321
Eryptycha americana 295, 296
Eubaculities 164
eufaulensis, Cancellaria 171, 271, 272
Volutolithes 253
Volutomorpha 253, 254
Eulima 166, *308*, 309, tab. 2
clara 308, *310*, pl. 50, tab. 1
gracilostylis 170, *309*, pl. 50, tab. 1
laevigata 171, *308*, 309, pl. 50, tab. 1
monmouthensis *309*, pl. 50, tab. 1
persimplica *308*, 309, pl. 50, tab. 1
Eulimidae 308, tab. 2
Euomphalacea tab. 2
Euspira 159, 166, tab. 2
rectilabrum 163
Euthriofusus 171, 220, 222, *225*, tab. 2
burdigalensis 225
convexus *225*, 226, pl. 31, tab. 1
mesozoicus *225*, 226, pl. 31, tab. 1
tenuous 225
(*Bontenella*) *excellens* 225
(*Haplovoluta*) *bicarinata* 223
Eutrochus 166
excellens, Boltenella 224, *225*, pl. 31, tab. 1
Euthriofusus (*Boltenella*) 225
Exilia cretacea 226
Exilia ripleyana 171, 275
eximia, Narona 267
exima, Tudicla 235
Exogyra 159
cancellata 155, 176, 177, 185, 190, 194, 212, 224, 226, 228, 232, 247, 252, 256, 257, 260, 262, 263, 267, 270, 272, 273, 278, 280, 283, 285, 288, 292, 294, 295, 297, 300, 311, 314, 323.
costata 154, 156, 157, 158, 159, 160, 161, 162, 163, 167, 174, 180, 188, 202, 217, 222, 229, 232, 242, 244, 249, 258, 264, 279, 281, 288, 300, 301, 310.
overwegi 167
ponderosa 159, 162, 163, 174, 175, 185, 188, 224, 226, 242, 258, 281, 311

F

Falsifusus convexus 171, 225
mesozoicus 225
Fasciolaria 231
crassicostata 188
cretacea 171, 211
juncea 226
lyelli 170, 185
ripleyana 171, 248, 249
rugosa 170, 184, 185
slackii 202
(*Cryptorhytis*) *crassicostata* 171, 191, 231
kerri 231
obliquicostata 231
(*Piestochilus*) *senecta* 214
sp 205
Fasciolaridae 202, 253, tab. 2
Fasciolarinae 202, tab. 2
fasciolata, Remnita 278
Turricula 171, 278, 279
fasciolatum, Amuletum (*Amuletum*) *278*, pl. 46, tab. 1
Faunus 169
fenestratus, Strombus 166
Ficus octoliratus 242, 243
filosa, Pleurotoma 286
firma, Beretra 171, 281, 283
fistulosa, Opalia (*Opalia*) 170, *320*, 321, pl. 52, tab. 1
flexicostata, Acirsa (*Hemiacirsa*) 170, *314*, pl. 51, tab. 1
Remera 170, *227*, pl. 31, tab. 1

Page

florencis, Voluta 264
forgemolli, Turritella 160, 167, 168, 169
fragilis, Napulus 170, 242, *243*, 244, pl. 35, tab. 1
Fulgerca 159, *246*, 247, tab. 2
attenuata *247*, pl. 36, tab. 1
venusta 246, 247
Fulgur (*Protobusycon*) *cretaceum* 194
funiculus, Lowenstamia 170, *182*, 183, pl. 21, tab. 1
fusiformis, Rostellaria 231
Fusimilis 159, 167, 171, *284*, 285, 286, tab. 2
aurilitaralis 167, 284
constricta 284
kummeli 170, 284, *285*, pl. 46, tab. 1
monmouthensis 286
novemcostatus 284, *285*, 286, pl. 46, tab. 1
proxima 171, *284*, 285, pl. 46, tab. 1
robustus 284, 285
tippanus *286*, pl. 46, tab. 1
sp *286*, pl. 46, tab. 1
Fusimitra 155, 249
polita 249
Fusininae 220, tab. 2
Fusinus 171, *227*, 228, tab. 2
macnairyensis *228*, pl. 31, tab. 1
(*Woodsella*) *typicus* 228
Fusiturris 281
Fusus 227
averilli 250
bellaliratus 199
burdigalensis 225
constrictus 192, 193
culbertsoni 171, 211
intertextus 198
mcnairyensis 171
newberryi 198
novemliratus 205, 207
quadricostatus 173
retifer 242
scarboroughi 211
subturritus 198
tippana 220
(*Afer*) *bellaliratus* 171, 200
(*Anomalofusus*) *substriatus* 229
(*Pleurotoma*) *scarboroughi* 213
sp 184

G

gabbi, Volutomorpha 253
gabriellensis, Graphidula 211, 213
gardnerae gardnerae, Paladmete *272*, 273
Paladmete 271, *272*, 273, 274
gardnerae *272*, 273
pygmaea, Paladmete 170, *275*, pl. 45, tab. 1
Gastropoda tab. 2
Gegania 159, tab. 2
parabella 168
gemmata, Gemmula 280
Pleurotoma 280
Gemmula *280*, 281, tab. 2
ancilla 280
childreni 280
cretacea 170, 280, 281, p. 46, tab. 1
gemmata 280
geniculata, Lutema 278
georgiana, Drillia 171, 281, 282
geversi, Pyropsis 168, 170, 174, 235
gigantea, Volutomorpha 253, 254, 255, *256*, 257, pls. 39, 40, tab. 1
Gilvastia 264
Gladius cheyennensis 231
glenni, Ornopsis 215, 216
(*Ornopsis*) *215*, pl. 29, tab. 1
globosa, Nassa 171, 188, 191
Globularia tab. 2
(*Ampulella*) tab. 2
globulosa, Tornatellaea *292*, pl. 47, tab. 1
Goniocylichna *302*, 303, tab. 2
Goniocylichna bisculpturata 302, *303*, pl. 49, tab. 1
elongata 170, *303*, pl. 49, tab. 1

Page

Goniocylindrites 303
gouldi, Scalaria 321
Graciliala tab. 2
gracilis, Beretra 171, 281, *283*, pl. 46, tab. 1
Hercorhyncus 171, 221
Pyropsis 235
Tudicla 235
Turricula 281, 283
gracilostylis, Eulima 170, *309*, pl. 50, tab. 1
grandis, Tornatellaea 292
granulata, Trochus rimosus 166
Graphidula 163, 171, *210*, 211, 213, 214, 226, 248, tab. 2
cancellata *211*, pl. 28, tab. 1
cancellatus 212
gabriellensis 211, 213
melanopsis 171, 211, 212, 213, pl. 28, tab. 1
multicostata 211, 213, pl. 28, tab. 1
obscura 211, *212*, pl. 28, tab. 1
pergracilis *211*, 212, pl. 28
terebreformis *210*, 211, *212*, pl. 28, tab 1
tippahensis 171, 211, 212, 213
sp *213*, pl. 29, tab. 1
graphoides, Nonacteonina 290
graysonensis, Volutomorpha 253
greenensis, Seminola 188
greisbachi, Cylichna 303
guillemaini, Volutilithes 258
guttatus, Scobinidola 304, *305*, 306, pl. 50, tab. 1
(*Gymnarus*), *Pugnellus* 164, tab. 2
Gyrodinae tab. 2
Gyrodes 159, 161, 166, 168, tab. 2
spillmani 168
tenellus 168

H

halli, Morea marylandica 170, *178*, pl. 20, tab. 1
Haminaea 298, 308
minor 299
subcylindrica 298
Hamulus onyx 164
hancocki, Pyropsis 235
Haplovoluta 171, 220, *222*, 223, 264
bicarinata 222, 223
callilateris 265
colorata 265
(*Haplovoluta*) *bicarinata, Euthriofusus* 223
bicarinatus, Hercorhyncus *223*, 224, pl. 30, tab. 1
Hercorhyncus 171, 220
quadriliratus, Hercorhyncus 170, *224*, pl. 30, tab. 1
triliratus, Hercorhyncus 170, *223*, 224, pl. 30, tab. 1
harbisoni, Striaticostatum *317*, 320, pl. 52, tab. 1
Harpa 155
Harpidae 249, tab. 2
Harpinae 249
harisi, Latirus 209
hastata, Remnita 170, *280*, pl. 46, tab. 1
Haustator submorgani 169
Haydenia 164
hebes, Tornatellaea cretacea 292
Helcion patelliformis 323
Helicaulax 166, tab. 2
Hemiacirsa *313*
cretacea 313
(*Hemiacirsa*), *Acirsa* 159, 163, 171, 313, 315, 316, tab. 2
americana, Acirsa *314*, pl. 51, tab. 1
clathrata, Acirsa 170, *315*, pl. 51, tab. 1
cretacea, Acirsa *313*, 314, 315, pl. 51, tab. 1
flexicostata, Acirsa 170, *314*, pl. 51, tab. 1
Hemifusus cornatus 166
Hercorhyncus 163, 166, *220*, 221, 222, 225, 235, 245, 268, tab. 2
coronale 171, 220, 221, 222
gracilis 171, 221
malleiforme 221
mundum 171, 196, 220
tennesseensis 222

Page

Hercorhyncus—Continued
tippanus 220, 222
triliratus 224
vadosum 171, 221, 222
(*Haplovoluta*) 171, 220, tab. 2
bicarinatus *223*, 224, pl. 30, tab. 1
quadriliratus 170, *224*, pl. 30, tab. 1
triliratus 170, *223*, 224, pl. 30, tab. 1
(*Hercorhyncus*) 220
malleiforme 222
pagodiformis 170, 221, *222*, pl. 30, tab. 1
tennesseensis *222*, pl. 30, tab. 1
tippanus 171, *220*, 221, 222, pl. 30, tab. 1
vadosum 221
(*Hercorhyncus*), *Hercorhyncus* 220
malleiforme, *Hercorhyncus* 222
pagodiformis, *Hercorhyncus* 170, 221, *222*, pl. 30, tab. 1
tennesseensis, *Hercorhyncus* *222*, pl. 30, tab. 1
tippanus, *Afer* 221
Hercorhyncus 171, *220*, 221, 222, pl. 30, tab. 1
Streptosiphon 220
vadosum, *Hercorhyncus* 221
Hillites 174, 180
multilirae 174
Hippocampoides 170, 181, 182
liratus 170, 181, 182, 183
serratum 181
serratus 170, 181
sp. 182
(*Hippocampoides*) *serratus*, *Nummocalcar* 181
hippocrepis, *Scaphites* 166
horrida, *Volutomorpha* 253
hubbardi, *Amuletum* (*Lutema*) 278
humerosa, *Odontobasis* 192
Hydatina 306
Hydrotribulus *245*, 246, 267, tab. 2
asper 245, 246
elegans 170, *246*, pl. 36, tab. 1
nodosus *245*, 246, pl. 36, tab. 1
sp. *246*, pl. 36, tab. 1
Hyllus callilateris 264, 265
coloratus 265

I

Idonearca wadei 163
immersa, *Schizobasis* *180*, pl. 20, tab. 1
implexa, *Acirsa* (*Plesioacirsa*) 170, *316*, pl. 51, tab. 1
impressa, *Odostomia* 171, 312, 313
inaequalis, *Paladmete* 271, 273, 274
incisa, *Cylichna* 299, *300*, pl. 49, tab. 1
inornata, *Ptychosyca* *244*, 245, pl. 35, tab. 1
intermissia curta, *Cylichna* 170, *301*, pl. 49, tab. 1
Cylichna intermissia 170, *300*, 301, pl. 49, tab. 1
intermissia, *Cylichna* 170, *300*, 301, pl. 49, tab. 1
interrupta, *Chemnitzia* 184, 186
Stantonella *186*, 187, pl. 22, tab. 1
Strepsidura 170, 184, 187
interstriatus, *Medionapus* 239
Pyropsis *239*, pl. 33, tab. 1
Trochifusus 171, 235, 239
intertextua, *Rhombopsis* 199
intertextus, *Rhombopsis* 199
Fusus 198

J

jacobsi, *Epitonium* 322
janja, *Mesalia* 165
juncea, *Fasciolaria* 226
Remera 226

K

kanei, *Volutomorpha* 253
Kelletia 228
keownvillensis, *Latirus* 170, 219, *220*, pl. 30, tab. 1
kerri, *Fasciolaria* (*Cryptorhytis*) 231
kummeli, *Fusimilis* 170, 284, *285*, pl. 46, tab. 1

L

Page

Lacrimiforma 171, *312*, tab. 2
secunda 171, *312*, pl. 50, tab. 1
laevigata, *Eulima* 171, *308*, 309, pl. 50, tab. 1
laevigatum, *Myobarbum* *266*, pl. 44, tab. 1
laevigatus, *Piestochilus* 214
laevis, *Ornopsis* (*Pornosis*) *modica* 170, 217, *219*, pl. 29, tab. 1
Paladmete 170, *273*, 274, pl. 45, tab. 1
lanceolata, *Turbo* 313
languida, *Morea cancellaria* 170
marylandica 170, 176, 178
lanhamii, *Pyropsis* 235, 236, 237, 241
laqueata, *Turbonilla* 206
(*Chemnitzia*) 205, 206
(*Latiala*), *Arrhoges* 166, tab. 2
lobata, *Arrhoges* 166, 168
Latiaxis 170, *181*, 182, tab. 2
pilsbryi 181, 182, pl. 21
serratus *181*, 182, pl. 21, tab. 1
Latiromitra 248
Latirus *219*, tab. 1
aurantiacus 219
harrisi 209
keownvillensis 170, 219, *220*, pl. 30, tab. 1
tribulus 219, 220
Laxispira 166, 167, tab. 2
(*Loxoptyxis*), *Tiberia* 310
leioderma breve, *Liopeplum* 260, 261
Leioderma canalis 261
leioderma, *Liopeplum* *258*, 260, pls. 42, 43, tab. 1
longum, *Liopeplum* 260, 261
tabulatum, *Liopeplum* 260
Volutilithes (*Athleta*) 258
leiodermum, *Liopeplum* 260
lemniscata, *Drilluta* 170, 205, *207*, pl. 27, tab. 1
lemniscatus, *Anomalofusus* 170, *230*, pl. 31, tab. 1
Lemniscolittorina tab. 2
lenolensis, *Pyropsis* 171, 235, 242
lessoni pampa, *Siphonaria* 322
levis, *Piestochilus* 211, 214
Libycoceras 167
Libycus, *Vermetus* 167
lignaria, *Bulla* 299
limbatum, *Amuletum* (*Lutema*) 170, *278*, 279, pl. 46, tab. 1
Limorosa *195*
linteus, *Acteon* 288, 289
Eoacteon *289*, 290, pl. 47, tab. 1
Solidulus 288, 289
lioica, *Volutomorpha* 171, 253, 255
Liocum 164
Lioderma lioderma 258
lioderma, *Lioderma* 258
Liopeplum 258
Lioderma thoracica 258
Liopeplum 155, 159, 161, 163, 171, 253, *258*, 262, tab. 2
canalis 258, 260, *261*, 262, pl. 43, tab. 1
carinatum 258, 261
carinatus 260
coronatum 170, 258, *262*, 263, pl. 43, tab. 1
cretacea 258, 260, 261
cretaceum 171, *261*, 262, pl. 43, tab. 1
leioderma *258*, 260, pls. 42, 43, tab. 1
breve 260, 261
longum 260, 261
tabulatum 258, 260
leiodermum 260
lioderma 258
monmouthensis 171, 258, 261
nodosum 170 262, *263*, pl. 43, tab. 1
rugosum 258, 260, *262*, 263, pl. 43, tab. 1
ruhlei 258
spillmani 258, 260, 261
subjugosum 258, 262
tabulatum 261
thoracicum 261
Liostraca cretacea 171, 311
Liotia 166
lirata, *Paramorea* *179*, 180, pl. 19, tab. 1
liratas, *Paramorea* 179

Page

liratus, *Cantharus* (*Paramorea*) 179
Hippocampoides 170, 181, 182, 183
Lowenstamia 182, *183*, pl. 21, tab. 1
Paramorea 179
Lirosoma 195
cretacea 195
Lispodesthes schlotheimi 166
Lissapiopsis 163
Littorinidae tab. 2
lobata, *Arrhoges* (*Latiala*) 166, 168
Lomirosa 195, 211, 231, tab. 2
cretacea *195*, pl. 24, tab. 1
longa, *Drilluta crassicostata* 206
Longoconcha 159, 162, 163, 171, *250*, 252, 253, tab. 2
dalli *252*, pl. 37, tab. 1
navarroensis 251, 252
protracta 251, 252
quadrilirata 170, *251*, 252, pl. 37, tab. 1
tennesseensis *251*, 252, pls. 36, 37, tab. 1
sp. A tab. 1
sp. B tab. 1
sp. P *252*, pl. 37
(*Longoconcha*) *dalli*, *Volutoderma* 250, 252
tennesseensis, *Volutoderma* 251
Volutoderma 171
longum, *Liopeplum leioderma* 260, 261
Lowenstamia 160, 170, 181, *182*, 183, 184, tab. 2
cucullata 170, 182, *183*, pl. 21, tab. 1
funiculus 170, *182*, 183, pl. 21, tab. 1
liratus 182, *183*, pl. 21, tab. 1
subplanus *184*, pl. 21, tab. 1
Lunatia 166
Lupira 171, 196, *232*
polycyma 171, 232, 233
pyriformis 171, 232, *233*, 234, pl. 32, tab. 1
turbinea 170, 232, 233, *234*, pl. 32, tab. 1
variabilis *232*, 233, 234, pl. 32, tab. 1
sp. *234*, pl. 32
Lutema 274, 275, *278*, 279
geniculata 278
simpsonensis 278
(*Lutema*), *Amuletum* 279, tab. 2
hubbardi, *Amuletum* 278
limbatum, *Amuletum* 170, *278*, 279, pl. 46, tab. 1
munda, *Amuletum* 278
sp., *Amuletum* *279*, pl. 46, tab. 1
lyelli, *Fasciolaria* 170, 185
Lyria turgidula 169
Lysis 164

M

macnairyensis, *Amuletum* 171, 275, pl. 45, tab. 1
macnairyensis 276
(*Amuletum*) 277
macnairyensis *275*, pl. 45
Cancellaria 170, *268*, pl. 44, tab .1
Conorbis 286, 287
Cryptoconus *287*, pl. 47, tab. 1
Fusinus *228*, pl. 31, tab. 1
macnairyensis, *Amuletum* 276
(*Amuletum*) *275*, pl. 45
torquatum, *Amuletum* 170, 276, 277, pl. 45, tab. 1
(*Amuletum*) *276*, pl. 45
Turricula 274, 275
Magilidae 181, tab. 2
major, *Drilluta* 205, 207, *208*, pl. 26, tab. 1
Xancus 232, 234
malleiforme, *Hercorhyncus* 221
(*Hercorhyncus*) 222
Margaritella 164, 168, tab. 2
marylandica bella, *Morea* 178
halli, *Morea* 170, *178*, pl. 20, tab. 1
languida, *Morea* 170, 176, 178
marylandica, *Morea* *177*, pl. 20
Morea 175, 176, 177, 178, 179, tab. 1
marylandica *177*, pl. 20
(*Pseudomorea*) 177
Rostellites 205

Page

marylandicus, Pyrifusus 196, 215
Rostellites 205
Massyla 267
Mataxa 267, tab. 2
elegans 171, *267*, pl. 45, tab. 1
subteres 267
valida 171, 267
Mathilda tab. 2
(*Asketomathilda*) tab. 2
Mathilidae tab. 2
matsoni, Cancellaria 268, 269
mawae, Pyrula 181
maxeyi, Ornopsis 215
mcnairyensis, Fuscus 171
medians, Odontofusus 202, 205
Medionapsus 171, 235, 238
elongatus 235
interstriatus 239
spinosus 238
Melanatria tab. 2
Melanatriinae tab. 2
Melanella 160, 308
Melanopis 169
melanopsis, Graphidula 171, 211, 212, 213, pl. 28, tab. 1
Turbonilla (*Chemnitzia*) 171, 211, 212
Melongenidae 193, tab. 2
meridionalis, Rhombopsis 199
Mesalia janja 165
Mesogastropoda tab. 2
Mesorhytis 248
obscura 211, 212, 248
mesozoicus, Euthriofusus *225*, 226, pl. 31, tab. 1
Falsifusus 225
microstriata, Acirsa 313, 315
(*Plesioacirsa*) 313, *315*, 316, pl. 51, tab. 1
Deussenia *201*, pl. 24, tab. 1
Remera 226, *227*, pl. 31, tab. 1
Rhombopsis 171, 200, 201
minor, Haminaea 299
mississippensis, Trichotropis 268
Mitra murchisoni 171, 250
Mitridae 248, tab. 2
Mitridomus 171, *248*, tab. 2
Mitridomus ripleyana *249*, pl. 37, tab. 1
Mitrinae 249
Mitrininae tab. 2
modica laevis, Ornopsis (*Pornosis*) 170, 217, *219*, pl. 29, tab. 1
modica, Ornopsis (*Pornosis*) 217, 218, 219
Ornopsis (*Pornosis*) 170, 215, *218*, 219, pl. 29, tab. 1
(*Pornosis*) *modica* 217, 218, 219
modicellus, Acteon 287, 288
molinoensis, Rhombopsis 170, *199*, pl. 24, tab. 1
monheimi, Rapa 166, 220, 245
Moniliretusa 305
(*Moniliretusa*) *spinosa, Sulcoretusa* *305*, 306, pl. 49, tab. 1
Sulcoretusa tab. 2
monmouthensis, Anchura 205
Eulima *309*, pl. 50, tab. 1
Fusimilis 286
Liopeplum 171, 258, 261
Pseudomelania 309
Pyrifusus 170, 184, 187, 196
Turris 171, 284
Monotygma 266
Morea 163, 170, 174, 176, 179, tab. 2
cancellaria *175*, 176, 177, 178, pl. 20
corsicanensis 170
crassa 176
languida 170
cancellata 179
corsicanensis 170, *176*, 177, pl. 20, tab. 1
coonensis 170, 176, *177*, pl. 20, tab. 1
marylandica 175, 176, 177, 178, 179, tab. 1
bella 178

Morea—Continued Page
marylandica—Continued
halli 170, *178*, pl. 20, tab. 1
languida 170, 176, 178
marylandica *177*, pl. 20
naticella 175
reticulata 175, pl. 20
rotunda 170, 175, *177*, 179, pl. 20, tab. 1
transenna *178*, 179, pl. 20, tab. 1
(*Pseudomorea*) *marylandica* 177
sp. *179*, pl. 20, tab. 1
Moreinae 175, tab. 2
morgani, Procerithium 169
Turritella 160, 168, 169
mortoni, Bulla 298
Ellipsoscapha *298*, pls. 48, 49, tab. 1
Solidula 298
mucronata, Belemnitella 166
Volutomorpha 253
mülleri, Acteon 166
multicostata, Graphidula 211, 213, pl. 28, tab. 1
multicostatus, Bellifusus 202
multilirae, Deussenia 200
Hillites 174
munda, Amuletum (*Lutema*) 278
mundum, Hercorhyncus 171, 196, 220
mungoensis, Volutomorpha 253
murchisoni, Mitra 171, 250
Murex 174
colus 227
Muricace 173, tab. 2
Muricidae 173, tab. 2
mutabilis, Paleopsephaea 168, *209*, 210, pl. 28, tab. 1
Volutilithes (*Paleopsephaea*) 209
Volutomorpha 253, *255*, 256, 257, pls. 38, 39, 40, tab. 1
Myobarbum *266*, tab. 2
laevigatum *266*, pl. 44, tab. 1

N

nana, Volutolithes 166, 209
Napulus 171, 172, 235, *241*, 242, 243, tab. 2
fragilis 170, 242, *243*, 244, pl. 35, tab. 1
octoliratus *243*, 244, pl. 35, tab. 1
reesidei 170, 241, *242*, 243, 244, pl. 35, tab. 1
tuberculatus 242, 243
whitfieldi 242
sp. *244*, pl. 35, tab. 1
Narona eximia 267
Nassa globosa 171, 188, 191
Rostellites 171, 250
Naticacea tab. 2
naticella, Morea 175
Naticidae tab. 2
Naticinae tab. 2
naticoides, Pyropsis 235
navarroensis, Longoconcha 251, 252
Volutilithes 250
Volutoderma 250
Neogastropoda 173, tab. 2
Neptunea perforata 271
Neptunella 196, 198, 200
Nerinea 163
quettensis 160
Neritacea tab. 2
Neritina 159, tab. 2
newberryi, Fusus 198
nobilis, Cryptorhytis 171, *231*, 232, pl. 32, tab. 1
nodifera, Rapa 235
Nodiscala 321
(*Nodiscala*), *Opalia* 321
nodoliratum, Cerithium 164
nodosum, Liopeplum 170, 262, *263*, pl. 43, tab. 1
nodosus, Hydrotribulus *245*, 246, pl. 36, tab. 1
Nonacteonina 166, 171, *290*, tab. 2
graphoides 290
orientalis *290*, tab. 1
novamexicana, Volutomorpha 253
novemcostata, Drillia 284, 285

Page

novemcostatus, Fusimilis 284, *285*, 286, pl. 46, tab. 1
novemliratus, Fusus 205, 207
Nucella 175
Nudivagus 167, tab. 2
Nummocalcar (*Hippocampoides*) *serratus* 181

O

obesa, Pyropsis 235
obliqua, Oligoptycha 296
obliquicostata, Fasciolaria (*Cryptorhytis*) 231
obscura, Graphidula 211, *212*, pl. 28, tab. 1
Mesorhytis 211, 212, 248
octolirata, Pyropsis 235
octoliratus, Ficus 242, 243
Napulus *243*, 244, pl. 35, tab. 1
o'donelli, Paleopsephaea 209
Odontobasis *192*, 193, tab. 2
australis *192*, 193, pl. 23, tab. 1
constricta 192, pl. 23
constrictus 193
humerosa 192
sulcata 170, *193*, pl. 23, tab. 1
ventricosa 192, 193
Odontofusus curvicostata 202
medians 202, 205
slackii 202
typicus 202
Odostomia 313
impressa 171, 312, 313
plicata 171, 312, 313
Oligoptycha *295*, 296, 297, tab. 2
americana 295, *296*, 297, pl. 48, tab. 1
concinnus 295
corrugata 170, 295, *297*, pl. 48, tab. 1
obliqua 296
popenoei 296
sp. *297*
Olivella 248, 266
Olividae 244, tab. 2
Olivinae 247
onyx, Hamulus 164
Opalia *320*, 321
(*Dentiscala*) 321
(*Nodiscala*) 321
(*Opalia*) 321
fistulosa 170, *320*, 321, pl. 52, tab. 1
(*Pliciscala*) 318, 321, tab. 2
wadei 170, *321*, pl. 52, tab. 1
(*Opalia*) *fistulosa, Opalia* 170, *320*, 321, pl. 52, tab. 1
Opalia 321
Opaliinae 320, tab. 2
Opisthobranchia 287, tab. 1, tab. 2
orbignyana, Volutilithes 263
orientalis, Acteonina 171, 290
Nonacteonina *290*, tab. 1
Rhombopsis *199*, pl. 24, tab. 1
ornata, Scalaria 317
ornatula, Beretra 281
Ornopsis 166, 167, *215*, 219
digressa 215, 217
elevata 215, 216
glenni 215, 216
maxeyi 215
pulchra 215
solistrella 215
(*Ornopsis*) 216, 217, tab. 2
glenni *215*, pl. 29, tab. 1
(*Pornosis*) 170, 218, 219, 231, tab. 2
digressa 215, 216, *217*, 218, pl. 29, tab. 1
modica 170, 215, *218*, 219, pl. 29, tab. 1
laevis 170, 217, *219*, pl. 29, tab. 1
modica 217, 218, 219
solistella 215, 217, 218
sp. *219*, pl. 29, tab. 1
(*Ripleyella*) 171, 217, 268, tab. 2
elevata 215, *216*, 217, pl. 29, tab. 1
pulchra 215, 217
sp. *216*, tab. 1

Page

(*Ornopsis*) *glenni*, *Ornopsis* ... *215*, pl. 29, tab. 1
Ornopsis ... 216, 217, tab. 2
Ostrea ... 159
Ovacteonina ... 304
ovatus, *Baculites* ... 298
overwegi, *Exogyra* ... 167

P

pagodiformis, *Hercorhyncus* (*Hercorhyncus*) ... 170, 221, *222*, pl. 30, tab. 1
Paladmete ... 159, 164, *270*, 271, 274, tab. 2
alta ... 271
cancellaria ... 171, *271*, 272, 273, 274, pl. 45, tab. 1
caveola ... 271, 274
corbuliformis ... 271, 272
densata ... 171, 271, 272
elegans ... 271
gardnerae ... 271, *272*, 273, 274, pl. 45, tab. 1
gardnerae ... *272*, 273
pygmaea ... 170, *273*, pl. 45, tab. 1
inaequalis ... 271, 273, 274
laevis ... 170, *273*, 274, pl. 45, tab. 1
perforata ... 271
poecilma ... 171, 271
pristina ... 271
turbiniformis ... 271
Paladmetidae ... 270, tab. 2
Palaeadmete cancellaria ... 271
(*Palaeadmete*) *cancellaria*, *Trichotropis* ... 271
Paleofusimitra ... 155, *249*, tab. 2
elongnata ... 249, *250*, pl. 37, tab. 1
Paleopsephaea ... 166, 167, *209*, 210, tab. 2
mutabilis ... 168, *209*, 210, pl. 28, tab. 1
o'donelli ... 209
pergracilis ... *210*, pl. 28, tab. 1
scalaris ... 168, 209
tenuilirata ... 170, *210*, pl. 28, tab. 1
(*Paleopsephaea*) *mutabilis*, *Volutilithes* ... 209
sulcata, *Voluta* ... 209
pampa, *Siphonaria lessoni* ... 322
Panamorea liratus ... 179
parabella, *Gegania* ... 168
Parafusus ... 222, *264*, 266, tab. 1
bicarinate ... 223
callilateris ... 264, *265*, 266, pl. 44, tab. 1
coloratus ... 264, *256*, 266, pl. 44, tab. 1
saffordi ... 170, *265*, pl. 44, tab. 1
sp. ... 265
Paramorea ... *179*, tab. 2
lirata ... *179*, 180, pl. 19, tab. 1
Paramorea liratas ... 179
Paramorea liratus ... 179
(*Paramorea*) *liratus*, *Cantharus* ... 179
Parapachydiscus ... 166
Parietiplica ... tab. 2
Parietiplicatum ... 171, *292*
conicum ... *292*, pl. 48, tab. 1
parkiana, *Procancellaria* ... 170
parvilirae, *Bellifusus* ... 202
Parvivoluta ... *263*, tab. 2
concinna ... 263, tab. 1
patagonicus, *Pyropsis* ... 235
Patellacea ... tab. 2
patelliformis, *Helcion* ... 323
paucicostata, *Drilluta* ... 206
pelcyphora, *Aporrhais* (*Arrhoges*) ... 166
percultus, *Eoacteon* ... 170, 171, *289*, pl. 47, tab. 1
perexilis, *Dolicholatirus* ... 209
perforata, *Neptunea* ... 271
Paladmete ... 271
pergracilis, *Anchura* ... 171, 226
Graphidula ... *211*, 212, pl. 28
Paleopsephaea ... *210*, pl. 28, tab. 1
Piestochilus ... 211
perimpressa, *Troostella* ... 290, *291*, pl. 47, tab. 1
Perissolax ... 242
trivolva ... 242
whitfieldi ... 241, 242

Page

(*Perissoptera*) *baylyi*, *Dicroloma* ... 168
perlata, *Pyropsis* ... 234, *235*, 236, 237, 239, 240, 241, pl. 33, tab. 1
Tudicla ... 235
(*Pyropsis*) ... 234, 235, 236
peronata, *Volutomorpha* ... 253
perornatus, *Pyropsis* ... *239*, 240, 241, pl. 34, tab. 1
Trochifusus ... 171, 235, 239
perryi, *Buccinopsis* ... 188, 189, pl. 23
persimplica, *Eulima* ... *308*, 309, pl. 50, tab. 1
pessumata, *Cyclichna* ... 170, *301*, pl. 49, tab. 1
Philine ... 313
Piestochilus ... 171, 211, *213*, 214, tab. 2
cancellatus ... 211
culbertsoni ... 211
curviliratus ... *214*, pl. 29, tab. 1
laevigatus ... 214
levis ... 211, 214
pergracilis ... 211
scarboroughi ... 211, 214
sp. ... *214*, pl. 29
(*Piestochilus*) *senecta*, *Fasciolaria* ... 214
pilsbryi, *Latiaxis* ... 181, 182, pl. 21
Pinella ... 170, 175
reticulata ... 170, 175
pinguis, *Caveola* ... 269
Pirena ... 169
pistiliformis, *Acteon* ... 170, 287, 288, pl. 47, tab. 1
plana, *Turritella* ... 166
planimarginata, *Pyropsis* ... 235
(*Planolateralis*), *Calliomphalus* ... 163, tab. 2
Pleisiotriton ... 158, tab. 2
Plesioacirsa ... *315*
(*Plesioacirsa*), *Acirsa* ... 313, 315, 316, tab. 2
implexa, *Acirsa* ... 170, *316*, pl. 51, tab. 1
microstriata, *Acirsa* ... 313, *315*, 316, pl. 51, tab. 1
wadei, *Acirsa* ... *315*, pl. 51, tab. 1
Pleurolira ... 281
Pleurotoma filosa ... 286
gemmata ... 280
(*Pleurotoma*) *scarboroughi*, *Fusus* ... 213
plicata, *Odostomia* ... 171, 312, 313
Turbo ... 312
Pliciscala ... *321*
(*Pliciscala*), *Opalia* ... 318, 321, tab. 2
wadei, *Opalia* ... 170, 321, pl. 52, tab. 1
poecilma, *Paladmete* ... 171, 271
poinsettiformis, *Pterocerella* ... 166
Polinices ... tab. 2
polita, *Fusimitra* ... 249
polycyma, *Lupira* ... 171, 232, 233
Polygyrulina ... 310
ponderosa, *Exogyra* ... 159, 162, 163, 174, 175, 185, 188, 224, 226, 242, 258, 281, 311
Volutomorpha ... 253
pondi, *Epitonium* ... 171, 318, 321
Striaticostatum ... *318*, 319, 321, pl. 52, tab. 1
popenoei, *Oligoptycha* ... 296
Pornosis ... 215, *217*
(*Pornosis*) *digressa*, *Ornopsis* ... 215, 216, *217*, 218, pl. 29, tab. 1
modica laevis, *Ornopsis* ... 170, 217, *219*, pl. 29, tab. 1
modica, *Ornopsis* ... 217, 218, 219
Ornopsis ... 170, 215, *218*, 219, pl. 29, tab. 1
Ornopsis ... 170, 218, 219, 231, tab. 2
solistella, *Ornopsis* ... 215, 217, 218
sp., *Ornopsis* ... *219*, pl. 29, tab. 1
Potamidae ... tab. 2
Potamides ... 169
pristina, *Paladmete* ... 271
Procancellaria parkiana ... 170
Procerithidae ... tab. 2
Procerithiinae ... tab. 2
Procerithium ... 169
Procerithium morgani ... 169
producta, *Cancellaria* ... 269
Caveola ... 270
Volutomorpha ... 170, 254, 255, *257*, pl. 42, tab. 1

Page

prolixa, *Pyropsis* ... 237, *240*, 241, pls. 33, 34, tab. 1
Promathilda ... tab. 2
(*Clathrobaculus*) ... tab. 2
propinqua, *Aporrhais* (*Cultigera*) ... 166
proquadriocostata, *Ecphora* ... 173, pl. 19, tab. 1
Proscala ... 314
americana ... 171, 314
Prosobranciata ... tab. 2
Protobusycon ... *193*, 194, tab. 2
binodosum ... 170, *194*, 195, pl 24, tab. 1
sp. ... *195*, pl. 23, tab. 1
cretaceum ... *194*, 195, pl. 23, tab. 1
(*Protobusycon*) *cretaceum*, *Busycon* ... 193, 194
Fulgur ... 194
protracta, *Longoconcha* ... 251, 252
Volutoderma ... 171, 251, 252
proxima, *Fusimilis* ... 171, *284*, 285, pl 46, tab. 1
Pyropsis ... 235, 236, *237*, 239, 240, pl. 33, tab. 1
Turris ... 284
Pseudocucullaea ... 165, 167
Pseudoliva attenuata ... 247
Pseudolivinae ... 244, tab. 2
Pseudamaura ... tab. 2
Pseudomalaxis ... 166, tab. 2
Pseudomelania ... 308
monmouthensis ... 309
runnelsi ... 171, 308, 309
Pseudomorea ... 170, 175
(*Pseudomorea*) *marylandica*, *Morea* ... 177
pseudorigida, *Cryptorhytis* ... 171, 200, 228
Pterocerella ... 162, tab .2
poinsettiformis ... 166
Ptychosyca ... 163, *244*, tab. 2
inornata ... *244*, 245, pl. 35, tab. 1
Pugnellus ... 158, 163, 168, 170
crassicostatus ... 169
densatus ... 160
(*Gynmarus*) ... 164, tab. 2
(*Pugnellus*) ... tab. 2
(*Pugnellus*), *Pugnellus* ... tab. 2
pulchella, *Ringicula* ... 293, 294, 295, pl. 48, tab. 1
(*Ringicula*) ... *293*, pl. 48
pulchra, *Ornopsis* ... 215
(*Ripleyella*) ... 215, 217
Puncticula ... 321
pygmaea, *Paladmete gardnerae* ... 170, *273*, pl. 45, tab. 1
Pyramidella ... 312
(*Pyramidella*) ... 310
dolabrata ... 310
(*Pyramidella*) *dolabrata*, *Pyramidella* ... 310
Pyramidella ... 310
Pyramidellacea ... 308, tab. 2
Pyramidellidae ... 310, tab. 2
Pyrazus ... 156, 169
pyriformis, *Lupira* ... 171, 232, *233*, 234, pl. 32, tab. 1
Pyrifusus ... 166, 171, *195*, 196, 197, 198, 199, 200, 232, tab. 2
crassus ... 170, 196, *197*, pl. 24, tab. 1
ejunidus ... 170, *198*, pl. 24, tab.1
marylandicus ... 196, 215
monmouthensis ... 170, 184, 187, 196
subdensatus ... 195, *196*, 197, 198, pl. 24, tab. 1
subliratus ... 196, *197*, 198, pl. 24, tab. 1
vitatus ... 196
sp. ... *198*, pl. 24, tab. 1
Pyropsis ... 166, 168, 169, 171, *234*, 235, 236, 237, 238, 241, 242, tab. 2
africana ... 235
alabamaensis ... 235
bairdi ... 235, 238, pl. 33
coloradoensis ... 235
cornutas ... 170, 235, *237*, 239, 240, pl. 34, tab. 1
elevata ... 235
elongatus ... 239
geversi ... 168, 170, 174, 235
gracilis ... 235
hancocki ... 235
interstriatus ... *239*, pl. 33, tab. 1

Pyropsis—Continued Page
lanhamii 235, 236, 237, 241
lenolensis 171, 235, 242
obesa 235
octolirata 235
naticoides 235
patagonicus 235
perlata 234, *235*, 236, 237, 239, 240, 241, pl. 33, tab. 1
perornatus *239*, 240, 241, pl. 34, tab. 1
planimarginata 235
prolixa 237, *240*, 241, pls. 33, 34, tab. 1
proxima 235, 236, *237*, 239, 240, pl. 33, tab. 1
pyruloidea 235
quinquecostata 235
reileyi 235
retifer 235
richardsonii 235, 241
septemlirata 235, 241
spinosus *238*, 239, 240, 241, pls. 33, 34, tab. 1
trochiformis 235
typica 235
whitfieldi 235, 242
(*Rapa*) *corrina* 235
sp. A *237*, pl. 33, tab. 1
sp. B *241*, pl. 33, tab. 1
sp. C *241*, pl. 32, tab. 1
sp. D *241*, pl. 32, tab. 1
sp. E *241*, pl. 32, tab. 1
sp *241*
(*Pyropsis*) *perlata*, *Tudicla* 234, 235, 236
Pyrula mawae 181
pyruloidea, *Pyropsis* 235

Q

quadricarinata, *Tudicla* 166
quadricinta, *Turritella* 167
quadricostata, *Ecphora* 173
quadricostatus, *Fusus* 173
quadrilia, *Turritella* 159, 160
quadrilirata, *Longoconcha* 170, *251*, 252, pl. 37, tab. 1
quadriliratus, *Hercorhyncus* (*Haplovoluta*) 170, *224*, pl. 30, tab. 1
quantula, *Cancellaria* 269
quettensis, *Nerinea* 160
quinquecostata, *Pyropsis* 235

R

Rapa andoorensis 235
cancellata 235
monheimi 166, 220, 245
nodifera 235
(*Rapa*) *corrina*, *Pyropsis* 235
Rapana 174
stantoni 173, 174
Rapanidae 173, tab. 2
rarus, *Scaphander* 299
reagani, *Aliofusus* 187, 188
subtilis, *Aliofusus* 184, 187
recta, *Cylichna* 171, 300, 302
rectilabrum, *Euspira* 163
reesidei, *Napulus* 170, 241, *242*, 243, 244, pl. 35, tab. 1
reileyi, *Pyropsis* 235
Remera 162, 171, *226*, 227, tab. 2
decora 226, 227
flexicostata 170, *227*, pl. 31, tab. 1
juncea 226
microstriata 226, *227*, pl. 31, tab. 1
stephensoni *226*, 227, pl. 31, tab. 1
Remnita 274, 275, *279*, tab. 2
anomalocostata *279*, 280, pl. 46, tab. 1
anomalofusus 279
biacuminata *279*, 280, pl. 46, tab. 1
fasciolata 278
hastata 170, *280*, pl. 46, tab. 1
reticulata, *Morea* 175, pl. 20
Pinella 170, 175
Voluta 268
retifer, *Fusus* 242
Pyropsis 235
retifera, *Volutomorpha* 253, 254, 255, *256*, *257*, pls. 39, 40, 41, 42, tab. 1
Retusa 302, 304
Rhombopsis 196, *198*, 199, 200, 201, tab. 2
intertextua 199
intertextus 199
meridionalis 199
microstriatus 171, 200, 201
molinoensis 170, *199*, pl. 24, tab. 1
orientalis *199*, pl. 24, tab. 1
richardsonii, *Pyropsis* 235, 241
rigida, *Cryptorhytis* 168, 228
Voluta 171, 200, 228
Rimella curvilirata 171, 211, 214
rimosus granulata, *Trochus* 166
ringens, *Auricula* 293
Ringicula 159, 160, 163, 166, *293*, tab. 2
acuta 293
acutispira 293
angusta 293
arlingtonensis 293
clarki 293, 295, tab. 1
codellana 293
culbertsoni 293
pulchella 293, 294, 295, pl. 48, tab. 1
subpellucida 293
sufflata 293
varia 293
yochelsoni 170, 293, 295, pl. 48
(*Ringicula*) *pulchella* *293*, pl. 48
yochelsoni *294*, pl. 48
(*Ringiculella*) 293, tab. 2
(*Ringiculina*) *clarki* *295*, pl. 48
(*Ringicula*) *pulchella*, *Ringicula* *293*, pl. 48
yochelsoni, *Ringicula* *294*, pl. 48
(*Ringiculella*), *Ringicula* 293, tab. 2
Ringiculidae 293, tab. 2
Ringiculina *295*
(*Ringiculina*) *clarki*, *Ringicula* *295*, pl. 48
ripleyana, *Amuletum* (*Amuletum*) 276
Beretra 171, 281, *282*, 283, pl. 46, tab. 1
Deussenia *200*, 201, pl. 25, tab. 1
Exilia 171, 275
Fasciolaria 171, 248, 249
Mitridomus *249*, pl. 37, tab. 1
Stantonella 184, *185*, 186, 187, pl. 22, tab. 1
Strepsidura 170, 184, 185, 186
Trigonostoma 170, 267, *268*, pl. 44, tab. 1
Turricula 171, 281, 283
Turris 281, 282
Ripleyella 171, 215
(*Ripleyella*) *elevata*, *Ornopsis* 215, *216*, 217, pl. 29, tab. 1
Ornopsis 171, 217, 268, tab. 2
pulchra, *Ornopsis* 215, 217
Ripleyia 188, 189, *216*
solida 189
Rissoacea tab. 2
Rissoidae tab. 2
robustus, *Bellifusus* 202
Fusimilis 284, 285
rockensis, *Belliscala* *316*, 317, tab. 1
roemeri, *Volutoderma* 209
Rostellaca 250
Rostellana 250
Rostellinda 250
Rostellaria fusiformis 231
Rostellites angulatus 171, 250
marylandica 205
marylandicus 205
texturatus 171, 250
nasutus 171, 250
rotunda, *Morea* 170, 175, *177*, 179, pl. 20, tab. 1
rugosa, *Fasciolaria* 170, 184, 185
Stantonella 185
rugosum, *Liopeplum* 258, 260, *262*, 263, pl. 43, tab. 1
ruhlei, *Liopeplum* 258
runnelsi, *Pseudomelania* 171, 308, 309

S

saffordi, *Parafusus* 170, *265*, pl. 44, tab. 1
saposa, *Turritella* 165
Sargana 163, 164, 170, *173*, 174, 235, tab. 2
stantoni 168, *174*, pl. 19, tab. 1
Sauvagesia 165
Scala 169
clathrus 313
sillimani 171, 318, 319, 321
Scalaria albensis 314
australis 320
borealis 313
calamistrata 167
canaliculata 314
cerithiformis 171, 316, 317
clementina 314
costulata 313
decussata 315
densestriata 315
desortorum 167, 168
gouldi 321
ornata 317
sillimani 319
scalaris, *Paleopsephaea* 168, 209
Scaphander 158, 298, *299*, tab. 2
rarus 299
Scaphandridae 297, tab. 2
Scaphella 264, 266
Scaphellinae 264, tab. 2
Scaphites hippocrepis 166
scarboroughi, *Fusus* 211
(*Pleurotoma*) 213
Piestochilus 211, 214
scatesi, *Tornatellaea* 292
Schizobasis 174, *180*, tab. 2
depressa *180*, pls. 20, 21, tab. 1
immersa *180*, pl. 20, tab. 1
schlotheimi, *Lispodesthes* 166
schuleri, *Turritella* 159
Scobina 222
bicarinata 223
Scobinidola *304*, tab. 2
Scobinidolas guttatus 304, *305*, 306, pl. 50, tab. 1
secalina, *Cylichna* *299*, 300, pl. 49, tab. 1
secunda, *Creonella* 171, 312, 313
Lacrimiforma 171, *312*, pl. 50, tab. 1
Seila tab. 2
semicostatus, *Trochacteon* 303
Seminola 171, 188
crassa 171, 188, 189
greenensis 188
solida 171, 188, 189
Seminole 188
senecta, *Fasciolaria* (*Piestochilus*) 214
septemlirata, *Pyropsis* 235, 241
seriatimgranulata, *Turritella* 159
serratum, *Hippocampoides* 181
serratus, *Hippocampoides* 170, 181
Lativaris 181, 182, pl. 21, tab. 1
Serrifusus tennesseensis 222
sillimani, *Scala* 171, 318, 319, 321
Scalaria 319
Striaticostatum *319*, 320, pl. 52, tab. 1
similis, *Volutomorpha* 253
simplex, *Discohelix* 166
simplica, *Tectaplica* 169, 263, *264*, pl. 44, tab. 1
Volutocorbis (*Tectaplica*) 264
simpsonensis, *Lutema* 278
sinuosa, *Eoharpa* *249*
sipho, *Siphonaria* 322
Siphonaria 171, *322*, 323, tab. 2
antiqua 322
lessoni pampa 322
sipho 322
variabilis 322
weiseri *322*, pl. 52, tab. 1
Siphonariacea 322
Siphonaridae 322, tab. 2
Skeneidae tab. 2

Page

slackii, Fasciolaria 202
Odontofusus 202
Solarium baylyi 168
solida, Buccinopsis 189, 190, 192, pl. 22, tab. 1
Buccinopsis solida *189*, 190, pl. 22
Seminola 171, 188, 189
solida, Buccinopsis *189*, 190, pl. 22
sulcata, Buccinopsis 170, *190*, pl. 22, tab. 1
Solidula mortoni 298
solidulus, Acteon 171, 289
Solidulus linteus 288, 289
solistella, Ornopsis (Pornosis) 215, 217, 218
solistrella, Ornopsis 215
spangleri, Capulus 163
sparsum, Striaticostatum 170, *320*, pl. 52, tab. 1
speciosa, Beretra 170, 171, *283*, pl. 46, tab. 1
Caveola 270
acuta 170, *270*, pl. 44, tab. 1
Sphenodiscus 161, 166, 167, 260
spillmani, Gyrodes 168
Liopeplum 258, 260, 261
Voluta 260
spinosa, Sulcoretusa (Moniliretusa) 305, 306, pl. 49, tab. 1
spinosus, Bellifusus 170, 202, *203*, pl. 25, tab. 1
Medionapus 238
Pyropsis *238*, 239, 240, 241, pls. 33, 34, tab. 1
Trochifusus 171, 235, 238
stamineus, Aliofusus 170, *187*, 188, pl. 22, tab. 1
Stantonella 159, 161, 170, *184*, 185, 187, 196, 228, tab. 2
interrupta *186*, 187, pl. 22, tab. 1
ripleyana 184, *185*, 186, 187, pl. 22, tab. 1
rugosa 185
subnodosa 184, *185*, 186, pl. 22
sp 185, *187*, pls. 22, 23, tab. 1
stantoni, Rapana 173, 174
Sargana 168, *174*, pl. 19, tab. 1
stephensoni, Remera *226*, 227, pl. 31, tab. 1
Straparolus subplanus 170, 184
Strepsidura 245
interrupta 170, 184, 187
ripleyana 170, 184, 185, 186
turgida 245
Streptosiphon 220
(Hercorhyncus) tippanus 220
striata, Beretra 171, 281, 282
striatella, Cylichna 298
Ellipsoscapha 298
Striaticostatum 167, 169, 171, 317, 319, 320, 321, tab. 2
congesta 170
aspera 170
asperum *319*, 320, pl. 52, tab. 1
bexarense *317*, 318, 319, pl. 52, tab. 1
congestum 167, *320*, pl. 52, tab. 1
harbisoni *317*, 320, pl. 52, tab. 1
pondi *318*, 319, 321, pl. 52, tab. 1
sillimani *319*, 320, pl. 52, tab. 1
sparsum 170, *320*, pl. 52, tab. 1
Strombacea tab. 2
Strombidae tab. 2
Strombus fenestratus 166
subalta, Cancellaria 269
subangulata, Creonella 170, 171, *311*, pl. 51, tab. 1
subcylindrica, Haminaea 298
subdensatus, Pyrifusus 195, *196*, 197, 198, pl. 24, tab. 1
subincrassata, Avellana 296
subjugosum, Liopeplum 258, 262
sublinearis, Troostella 171, 289, 291
subliratus, Pyrifusus 196, *197*, 198, pl. 24, tab. 1
submorgani, Haustator 169
subnodosa, Stantonella 184, *185*, 186, pl. 22
subnodosus, Anomalofusus 170, *230*, pl. 31, tab. 1
subpellucida, Ringicula 293
subplanus, Lowenstamia *184*, pl. 21, tab. 1
Weeksia 184
Straparolus 170, 184

Page

subsimplicata, Volutolithes 166
subsimplicatus, Volutilithes 209
substriatus, Acteon 291
Anomalofusus *229*, 230, pl. 31, tab. 1
Fusus (Anomalofusus) 229
Troostella *291*, pl. 47, tab. 1
subteres, Mataxa 267
subtilis, Aliofusus reagani 184, 187
subturritus, Fusus 198
subulatus, Turbo 308
sufflata, Ringicula 293
sulcata, Buccinopsis solida 170, *190*, pl. 22, tab. 1
Bulla 305
Odontobasis 170, *193*, pl. 23, tab. 1
Voluta (Paleopsephaea) 209
Sulcoretusa *305*
(Moniliretusa) tab. 2
spinosa 305, 306, pl. 49, tab. 1
Sulcularia 305
Surcula amica 171, 281, 282
Sveltella 269
Sveltia 269
varicosa 269
Sycodes 164

T

tabanneensis, Zikkuratia *304*, pl. 49, tab. 1
tabulatum, Liopeplum 261
leioderma 258, 260
tarensis, Volutomorpha 171, 253, 258, 262
Tectaplica 169, *263*, 264, tab. 2
armenica 264
simplica 169, 263, *264*, pl. 44, tab. 1
(Tectaplica) simplica, Volutocorbis 264
Teinostoma tab. 2
tenellus, Gyrodes 168
tennesseensis, Hercorhyncus 222
(Hercorhyncus) *222*, pl. 30, tab. 1
Longoconcha *251*, 252, pls. 36, 37, tab. 1
Serrifusus 222
Volutoderma 171, 250, 251
(Longoconcha) 251
tenuilirata, Paleopsephaea 170, *210*, pl. 28, tab. 1
tenuistriatus, Bellifusus 171, 202, 203
Drilluta 202
tenuous, Euthriofusus 225
terebreformis, Graphidula *210*, 211, *212*, pl. 28, tab. 1
Tessarolax 164, 170
texana, Volutoderma 250, 252
texturatus, Rostellites 171, 250
Thais 175
Thiaridae tab. 2
Thylacus tab. 2
Tiberia 310, 312
(Cossmannica) 310
(Loxoptyxis) 310
Tintoris tab. 2
tippahensis, Graphidula 171, 211, 212, 213
tippana, Drillia 171, 286
tippanus, Afer (Hercorhyncus) 221
Hercorhyncus 220, 222
(Hercorhyncus) 171, *220*, 221, 222, pl. 30, tab. 1
Titanocarcolites 163
thoracica, Lioderma 258
thoracium, Liopeplum 261
throckmortoni, Acteon 171, 288, 290
tippana, Fusus 220
Fusimilis *286*, pl. 46, tab. 1
Streptosiphon (Hercorhyncus) 220
Tonnacea tab. 2
Tornatellaea 166, *291*, tab. 2
belle 291
cretacea *291*, 292, pl. 47, tab. 1
hebes 292
grandis 292
globulosa *292*, pl. 47, tab. 1
scatesi 292
tornatilis, Voluta 287

Page

torquatum, Amuletum macnairyensis 170, 276, 277, pl. 45, tab. 1
(Amuletum) macnairyensis *276*, pl. 45
torquatus, Dolicholatirus 170, *209*, pl. 26, tab. 1
torta, Cryptorhytis 171, 231, 232
traffrarium, Cerithium 205
transenna, Morea *178*, 179, pl. 20, tab. 1
travisana, Deussenia 200, *201*, pl. 25, tab. 1
tribulus, Lotirus 219, 220
Trichotropidae tab. 2
Trichotropinae tab. 2
Trichotropis 166, tab. 2
cancellaria 270, 271
mississippensis 268
(Palaeadmete) cancellaria 271
sp 272
Trigonostoma *267*, 268, tab. 2
trigonostoma, Delphinula 267
Trigonostoma ripleyana 170, 267, *268*, pl. 44, tab. 1
trilira, Turritella 159, 164, 165, 167, 168
triliratus, Hercorhyncus 224
(Haplovoluta) 170, *223*, 224, pl. 30, tab. 1
triplicata, Creonella *310*, 311, pl. 51, tab. 1
Tritonium cretaceum 166
(Colubraria) ceden 269
trivolva, Perissolax 242
Trobus tab. 2
Trochacea tab. 2
Trochacteon semicostatus 303
trochiformis, Pyropsis 235
Trochifusus 235
interstriatus 171, 235, 239
perornatus 171, 235, 239
spinosus 171, 235, 238
Trochus rimosus granulata 166
Troostella 289, *290*, 291, tab. 2
brevispira 171, 291
perimpressa 290, *291*, pl. 47, tab. 1
sublinearis 171, 289, 291
substriatus *291*, pl. 47, tab. 1
Trophon condoni 164
Tryonella 185, 253
Tubinopsis tab. 2
tuberculatus, Napulus 242, 243
Tudicla 234, 235
exima 235
gracilis 235
perlata 235
quadricarinata 166
(Pyropsis) perlata 234, 235, 236
Tuniscala 321
turbinea, Lupira 170, 232, *234*, pl. 32, tab. 1
Turbinella bronni 209
Turbinidae tab. 2
turbiniformis, Paladmete 271
Turbo, plicata 312
lanceolata 313
subulatus 308
Turboella tab. 2
Turbonilla laqueata 206
(Chemnitzia) laqueata 205, 206
melanopsis 171, 211, 212
turgida, Strepsidura 245
turgidula, Lyria 169
turretiforma, Creonella 170, *311*, 312, pl. 51, tab. 1
Turricula amica 171, 281, 283
anomalocostata 279
biacuminata 279
fasciolata 171, 278, 279
gracilis 281, 283
macnairyensis 274, 275
ripleyana 171, 281, 283
turricula, Volutomorpha 253, 258
Turridae 274, tab. 2
Turris 281
constricta 171, 284, 285
monmouthensis 171, 284
proxima 284
ripleyana 281, 282

Page

Turritella 159, 161, 166, 172
bilira 159, 160, 164, 165
breantiana 168
chalybeatensis 166
chicoensis 164
forgemolli 160, 167, 168, 169
morgani 160, 168, 169
plana 166
quadricinta 167
quadrilia 159, 160
saposa 165
schuleri 159
seriatimgranulata 159
trilira 159, 164, 165, 167, 168
vertebroides 164, 167
(Zaria) besairie 168
bonei 168
figarii 167
typica, Pyropsis 235
Woodsella 168, *228*, pl. 31, tab. 1
typicus, Fusinus (Woodsella) 228
Odontofusus 202

U

Urceolabrum 160, 166, tab. 2
tuberculatum 272
Uxia 268

V

vadosum, Hercorhyncus 171, 221, 222
(Hercorhyncus) 221
valida, Mataxa 171, 267
Volutomorpha 170, *253*, *254*, 255, pls. 38, 39, tab. 1
vanhoepeni, Arcotia 168
varia, Ringicula 293
variabilis, Lupira *232*, 233, 234, pl. 32, tab. 1
Siphonaria 322
Xancus 171, 232
varicosa, Sveltia 269
Vasinae 234, tab. 2
ventricosa, Odontobasis 192, 193
venusta, Fulgerca 246, 247
venustum, Amuletum 275
(Amuletum) 276
Vermetidae tab.2
Vermetus libycus 167
vertebroides, Turritella 164, 167
Vexillinae 248, tab. 2
Vexillum 248
vitatus, Pyrifusus 196

Page

Voluta ampla 247
elongata 171, 250
florencis 264
reticulata 268
rigida 171, 200, 228
spillmani 260
tornatilis 287
(Paleopsephaea) sulcata 209
Volutacea 244, tab. 2
Volutidae 250, tab. 2
Volutilithes conradi 252, 253
cretacea 258, 261
guillemaini 258
navarroensis 250
orbignyana 263
subsimplicatus 209
(Athleta) leioderma 258
(Paleopsephaea) mutabilis 209
Volutocorbis 263, 264
(Tectaplica) simplica 264
Volutoderma 164, 166, 170, 250, 251, 253
appressa 171, 250, 251
navarroensis 250
protracta 171, 251, 252
roemeri 209
tennesseensis 171, 250, 251
texana 250, 252
(Longoconcha) 171
dalli 250, 252
tennesseensis 251
Volutoderminae 250, tab. 2
Volutol'thes eufaulensis 253
nana 166, 209
subsimplicata 166
Volutomorpha 244, 250, *252*, 253, 254, 256, 257, 258, tab. 1
aspera 253, 257, pls. 41, 42, tab. 1
bella 253
conradi 253, 254
cretacea 254
dumasensis 171, 253, 254, *255*, pls. 38, 39, 40, tab. 1
eufaulensis 253, 254
gabbi 253
gigantea 253, 254, 255, *256*, 257, pls. 39, 40, tab. 1
graysonensis 253
horrida 253
konei 253
lioica 171, 253, 255
mucronata 253
mungoensis 253
mutabilis 253, *255*, 256, 257, pls. 38, 39, 40, tab. 1
novamexicana 253

Page

Volutomorpha peronata 253
ponderosa 253
producta 170, 254, 255, *257*, pl. 42, tab. 1
retifera 253, 254, 255, *256*, *257*, pls. 39, 40, 41, 42, tab. 1
similis 253
tarensis 171, 253, 258, 262
turricula 253, 258
valida 170, *253*, *254*, 255, pls. 38, 39, tab. 1
sp *257*, pl. 37, tab. 1

W

wadei, Acirsa (Plesiocirsa) *315*, pl. 51, tab. 1
Amuletum (Amuletum) 170, 275, *277*, 278, pl. 45, tab. 1
Opalia (Pliciscala) 170, *321*, pl. 52, tab. 1
Idonearca 163
Wadia 264
weeksi, Cerithium 169
Weeksia 184, tab. 2
subplanus 184
weiseri, Siphonaria *322*, pl. 52, tab. 1
whitei, Creonella 312
whitfieldi, Napulus 242
Perissolax 241, 242
Pyropsis 235, 242
wieseri, Anisomyon 171, 322
Woodsella 168, 187, 215, *228*, tab. 2
typica 168, *228*, pl. 31, tab. 1
(Woodsella) typicus, Fusinus 228

X

Xancidae 232, tab. 2
Xancininae 232
Xancus major 232, 234
variabilis 171, 232
Xenophora 166, tab. 1
Xenophoridae tab. 2

Y

yochelsoni, Ringicula 170, 293, 295, pl. 48
(Ringicula) *294*, pl. 48

Z

(Zaria) besairie, Turritella 168
bonei, Turritella 168
figarii, Turritella 167
Zikkuratia 160, *304*, tab. 2
Zikkuratia tabanneensis *304*, pl. 49, tab. 1

U. S. GOVERNMENT PRINTING OFFICE : 1964 O - 690-081

PLATES 19–52

PLATE 19

FIGURES 1, 5. *Ecphora 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. *Paramorea lirata* Wade (p. 179).

2, 4. Front and back views of a topotype (× 4) from the Ripley Formation at loc. 1. USGS 25406, USNM 130209.

3, 8. Front and back views of a topotype (× 4) from the same locality. USGS 25406, USNM 130210.

6, 10. Back and front views of a topotype (× 4) from the same locality that preserves the features of the outer lip. USGS 25406, USNM 130208.

7, 9, 11–25. *Sargana stantoni* (Weller) (p. 174).

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 180190.

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.

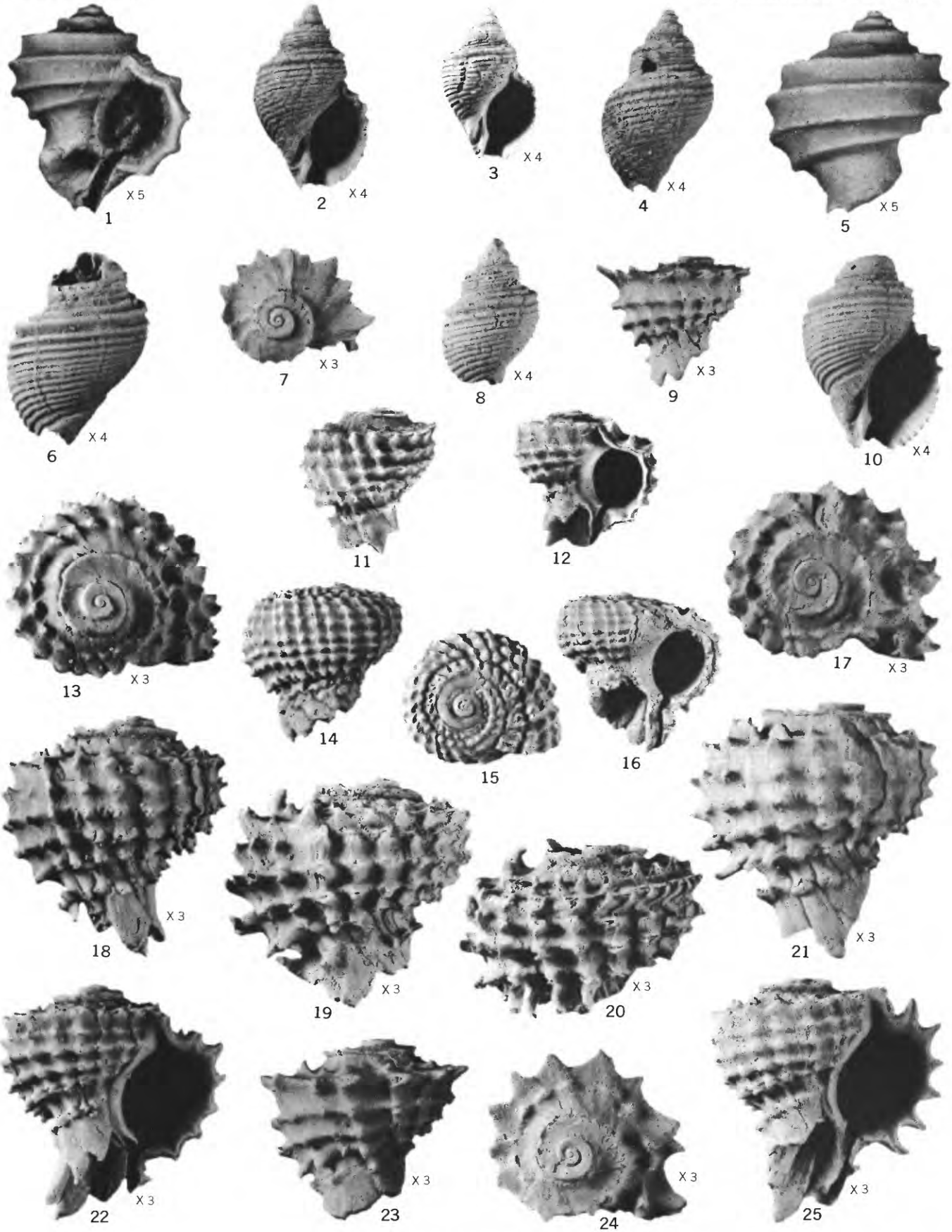
14–16. Back, apical, and front views of a specimen (× 1) from the same locality showing an exceptional number of spiral cords. USGS 25411, USNM 130186.

17, 21, 25. Apical, back, and front views of a specimen (× 3) from the same locality. USGS 25411, USNM 130188.

19. Back view of a specimen (× 3) from the Ripley Formation at loc. 1. USGS 25406, USNM 130193.

20. Back view of a specimen (× 3) from the same locality showing extreme development of spinose sculpture. USGS 25406, USNM 130192.

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

PLATE 20

FIGURES 1, 8. *Morea corsicanensis corsicanensis* Stephenson (p. 176).
Front and back views of a specimen (× 1½) from the Ripley Formation at loc. 6. USGS 25407, USNM 130196.

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 *Pinella* Stephenson).

4–6, 10, 19–22, 25, 26. *Morea marylandica marylandica* Gardner (p. 177).
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.

7, 13. *Morea cancellaria* Conrad (p. 176).
Front and back views of a topotype (× 1) from the Ripley Formation in bluffs of the Chattahoochee River at Eufaula, Ala. USGS 279, USNM 21169.

9. *Morea corsicanensis coonensis* Sohl, n. subsp. (p. 177).
Front view of the holotype (× 1) from the Ripley Formation at loc. 1. USNM 32917.

11, 12. *Morea rotunda* Sohl, n. sp. (p. 177).
Front and back views of the holotype (× 1) from the Ripley Formation at loc. 16. USGS 25409, USNM 130197.

14, 15. *Morea marylandica halli* Sohl, n. subsp. (p. 178).
Front and back view of the holotype (× 2) from the Ripley Formation at loc. 10. USGS 711, USNM 130205.

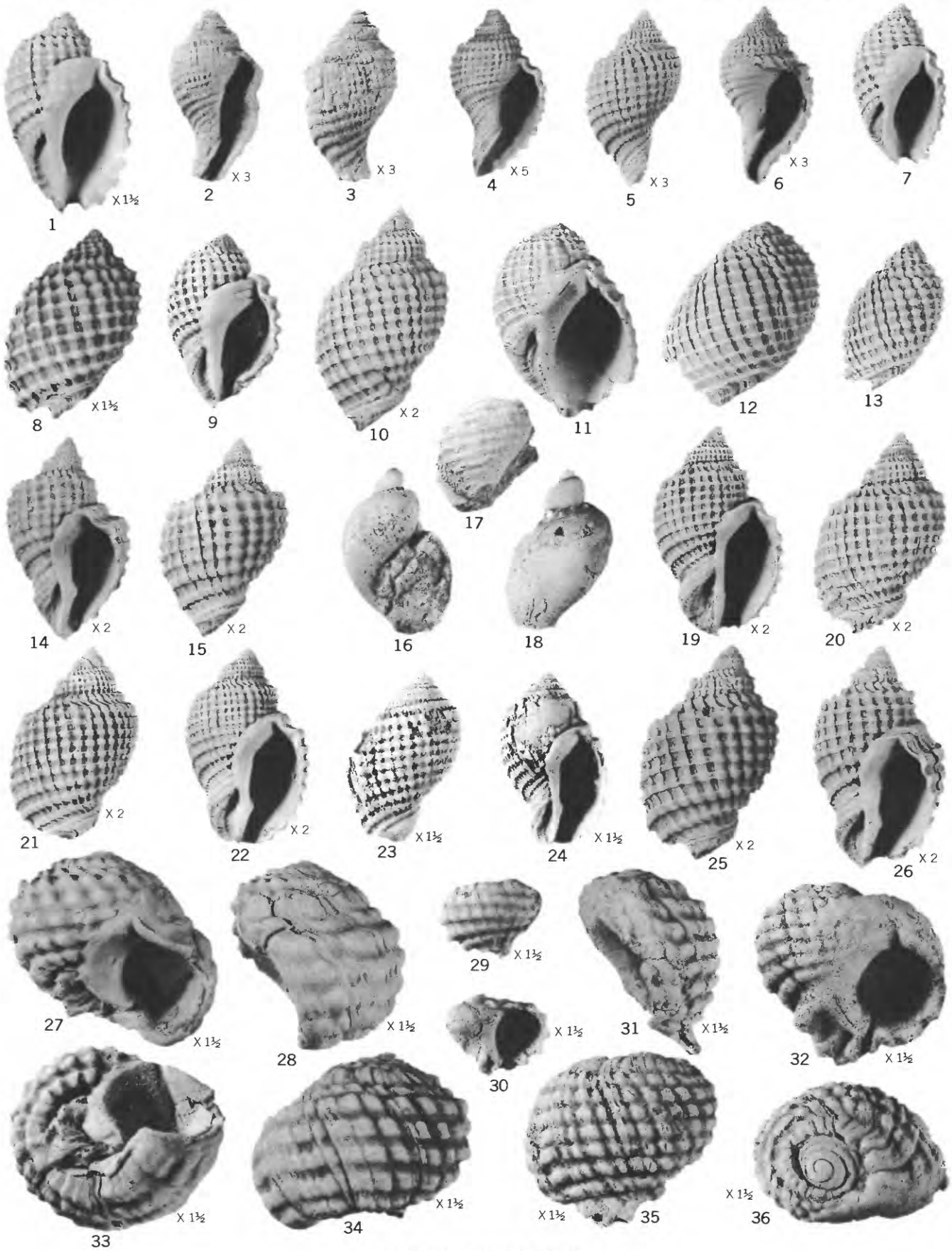
16, 18. *Morea* sp. (p. 179).
Front and back view of an internal mold (× 1) from the Prairie Bluff Chalk at loc. 87. USGS 3186, USNM 130206.

17. *Morea*? sp. (p. 179).
Back view of an internal mold (× 1) from the Ripley Formation at loc. 27. USGS 9508, USNM 130207.

23, 24. *Morea transenna* Stephenson (p. 179).
Back and front views of the holotype (× 1½) from the Owl Creek Formation at loc. 46. USGS 707, USNM 128193.

27–30, 33, 34. *Schizobasis depressa* Wade (p. 180).
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.

31, 32, 35, 36. *Schizobasis immersa* Wade (p. 180).
Side, front, back, and apical views of the holotype (× 1½) from the Ripley Formation at loc. 1. USGS 10198, USNM 73103.



MOREA, SCHIZOBASIS

PLATE 21

FIGURES 1–4. *Schizobasis depressa* Wade (p. 180).
Front, top, back, and basal views of a topotype (× 1½) from the Ripley Formation at loc. 1. USGS 25406, USNM 130211.

5–6, 11–13. *Latiaxis serratus* (Wade) (p. 181).
5. Front view of a topotype (× 3) from the Ripley Formation at loc. 1. USGS 25406, USNM 130215.
6. Front view of the holotype (× 3) from the same locality. USGS 10198, USNM 73099.
11–13. Apical, back, and front views of a topotype (× 3) from the same locality. USGS 25406, USNM 130214.

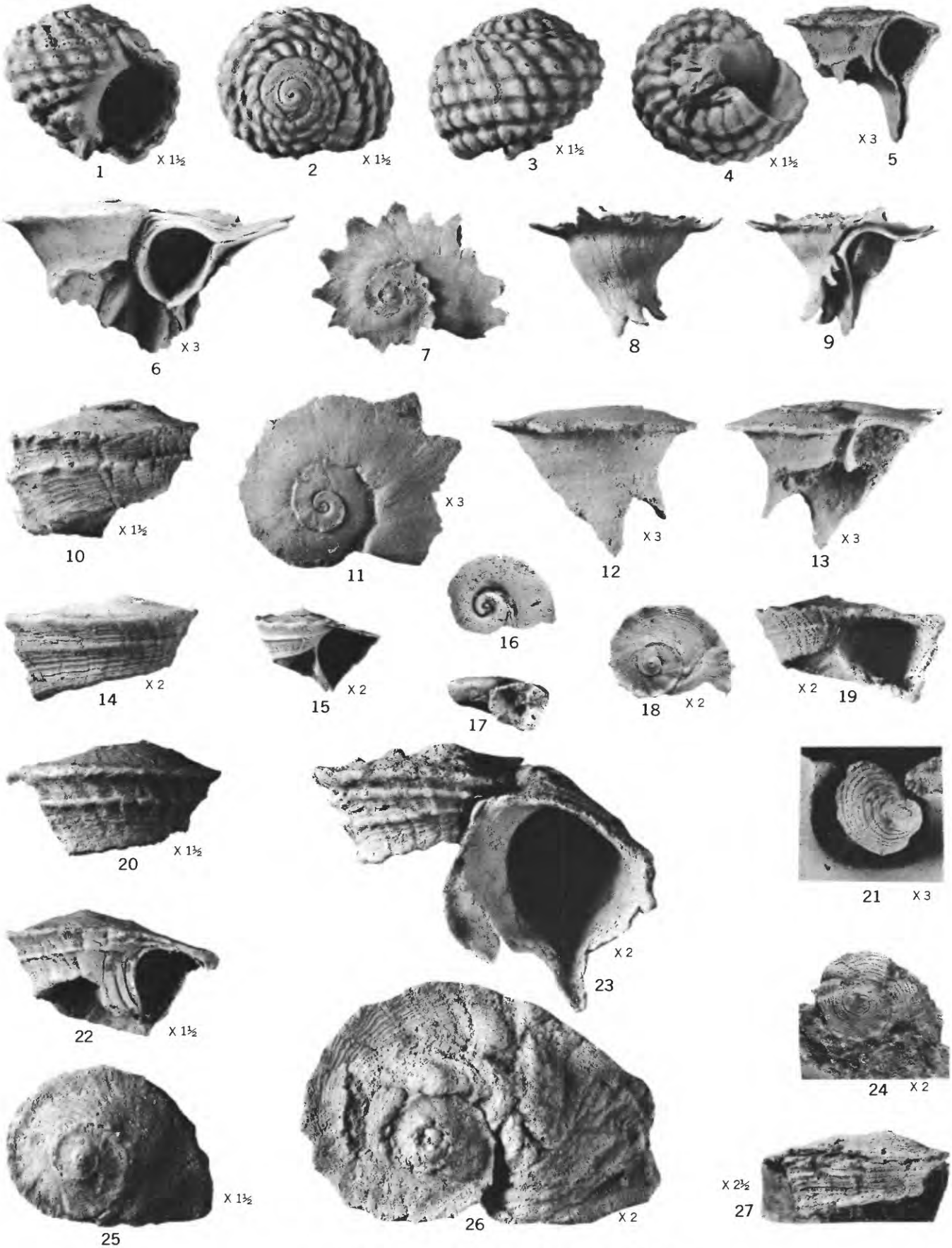
7–9. *Latiaxis pilsbryi* Hirasae (p. 181).
Top, back, and front views of s specimen (× 1) from Dept. Molluscs, USNM 344199.

10, 14, 15, 18–20, 22, 25. *Lowenstamia liratus* (Wade) (p. 183).
10. Back view of a specimen (× 1½) from the Ripley Formation at loc. 5. USGS 708, USNM 130217.
14, 19. Back and front views of a topotype (× 2) from the Ripley Formation at loc. 1. USGS 16951, USNM 130219.
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, 21. *Lowenstamia cf. L. subplanus* (Gabb) (p. 184).
16, 17. Apical and front views of an internal mold (× 1) from the Prairie Bluff Chalk at loc. 82. USGS 25435, USNM 130222.
21. View of part of an internal mold (× 3) from the Prairie Bluff Chalk of Union County, Miss., exhibiting the sculpture of the umbilical walls. USGS 25507, USNM 130221.

23, 26. *Lowenstamia funiculus* Sohl, n. sp. (p. 182).
Front and apical views of the holotype (× 2) from the Coffee Sand of Lee County, Miss. USGS 26338, USNM 130216.

24, 27. *Lowenstamia cucullata* Sohl, n. sp. (p. 183).
Apical and back views of the holotype (× 2 and × 2½) from the Owl Creek Formation at loc. 46. USGS 707, USNM 20455.



SCHIZOBASIS, LATIAXIS, LOWENSTAMIA

PLATE 22

FIGURES 1, 2. *Buccinopsis crassa* (Wade) (p. 189).
Back and front views of a topotype (× 1) from the Ripley Formation at loc. 1. USGS 10198, USNM 130234.

3. *Buccinopsis*? sp. (p. 192).
Front view of an internal mold (× 1) from the Prairie Bluff Chalk at loc. 87. USGS 6843, USNM 130243.

4, 5. *Buccinopsis solida solida* (Wade) (p. 189).
Front and back views of a specimen (× 1) from the Ripley Formation at loc. 18. USGS 25411, USNM, 130235.

6, 7. *Buccinopsis solida sulcata* Sohl, n. subsp. (p. 190).
Front and back views of a specimen (× 1½) from the Clayton Formation at loc. 40. USGS 25420, USNM 130236.

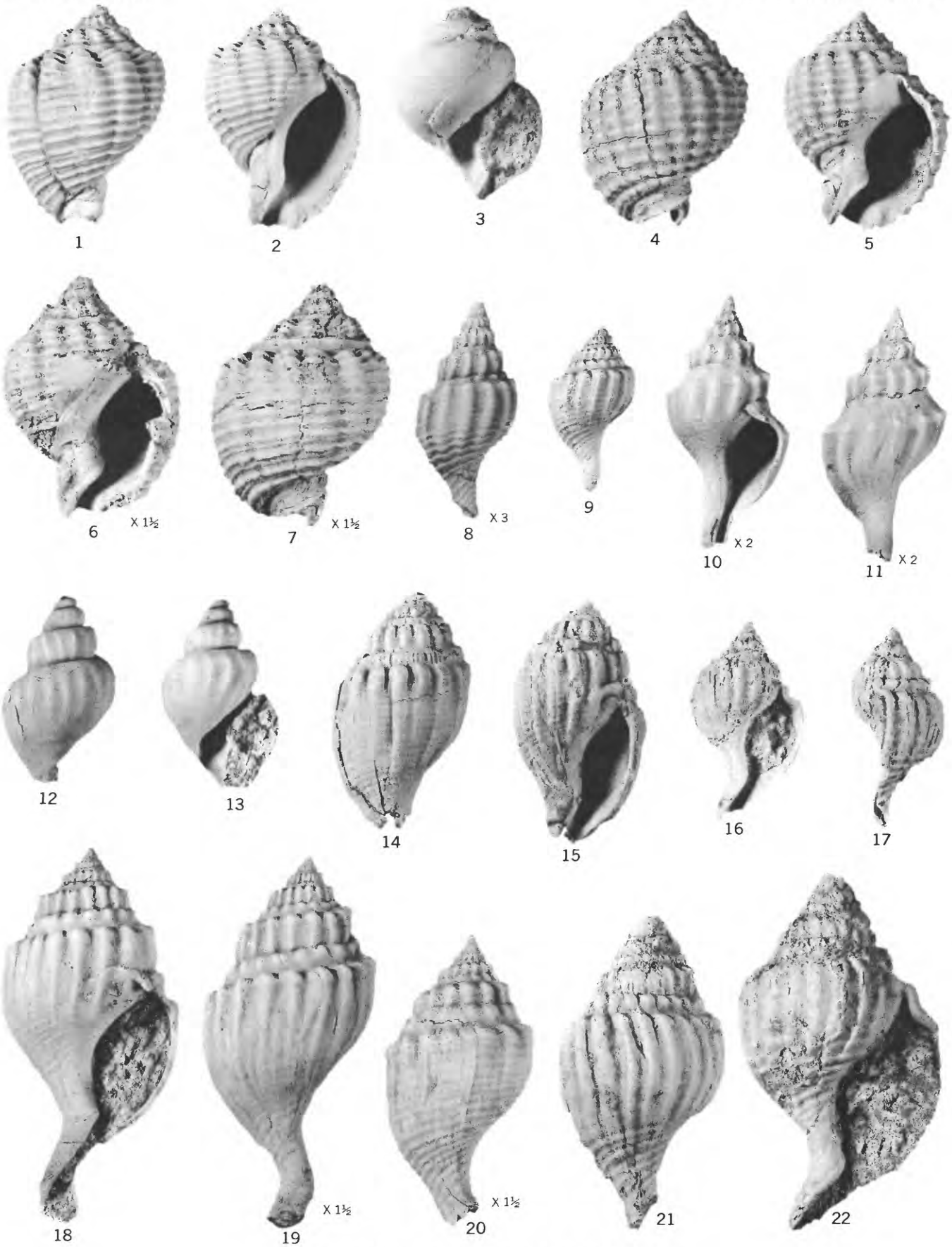
8, 9, 18–20. *Stantonella ripleyana* Conrad (p. 185).
8. Back view of an immature specimen (× 3) from the Ripley Formation at loc. 6. USGS 25407, USNM 130224.
9. Back view of the holotype (× 1) from the Ripley Formation of Tippah County, Miss., AMNH 9063.
18, 19. Front and back views of a specimen (× 1½) from the Ripley Formation at loc. 6. USGS 25407, USNM 130223.
20. Back view of a specimen (× 1½) from the Ripley Formation at loc. 16. USGS 25409, USNM 130225.

10, 11. *Aliofusus stamineus* Sohl (p. 187).
Front and back views of the holotype (× 2) from the Ripley Formation at loc. 6. USGS 25407, USNM 130232.

12, 13. *Stantonella*? sp. (p. 187).
Front and back views of an internal mold (× 1) from the Prairie Bluff Chalk at loc. 90. USGS 17484, USNM 130229.

14, 15. *Stantonella subnodosa* Wade (p. 185).
Back and front views of the holotype (× 1) from the Ripley Formation at loc. 1. USGS 10198, USNM 32887.

16, 17, 21, 22. *Stantonella interrupta* (Conrad) (p. 186).
16, 17. Front and profile views of a topotype (× 1) from the Owl Creek Formation at loc. 46. USGS 707, USNM 130228.
21. Back view of a topotype (× 1) from the same locality. USGS 707, USNM 130227.
22. Front view of a topotype (× 1) from the same locality. USGS 707, USNM 130226.



BUCCINOPSIS, STANTONELLA, ALIOFUSUS

PLATE 23

FIGURES 1–4. *Odontobasis sulcata* Sohl, n. sp. (p. 193).

1, 2. Front and back views of the holotype (× 3) from the Ripley Formation at loc. 18. USGS 25411, USNM 130245.

3, 4. Front and back views of a paratype (× 3) from the Ripley Formation at loc. 18. USGS 25411, USNM 130246.

5, 6. *Odontobasis australis* Wade (p. 192).

Back and front views of a topotype (× 3) from the Ripley Formation at loc. 1. USGS 25406, USNM 130244.

7, 8. *Odontobasis constricta* (Hall and Meek) of Meek (p. 192).

(Back and front views of specimen figured by Meek (1876, p. 352, figs. 41, 42) from the Fox Hills Sandstone of South Dakota. USNM 1943.

9–13. *Buccinopsis dorothiella* Sohl, n. sp. (p. 190).

9–11. Back, front, and profile views of the holotype (× 1½) from the Ripley formation of Georgia. USGS 25923, USNM 130237.

12, 13. Back and front views of a paratype (× 1½) from the Ripley Formation at loc. 18. USGS 25411, USNM 130239.

14–17. *Buccinopsis crassicostata* (Gabb) (p. 191).

14. Back view of a specimen (× 1) from the Owl Creek Formation at loc. 46. USGS 25423, USNM 130241.

15. Front view of a specimen (× 1) from the same locality. USGS 25423, USNM 130242.

16, 17. Front and back views of a specimen (× 1) from the same locality. USGS 707, USNM 130240.

18, 19, 26. *Stantonella*? sp. (p. 187).

18, 19. Back and front views of an internal mold (× 1). From the Prairie Bluff Chalk at loc. 92. USGS 25439, USNM 130231.

26. Front view of an internal mold (× 1) from the Prairie Bluff Chalk at loc. 90. USGS 17484, USNM 130230.

20–22. *Protobusycon* sp. (p. 195).

20–21. Front and back views of a specimen (× 1) from the Ripley Formation at loc. 16, USGS 25409. USNM 132151.

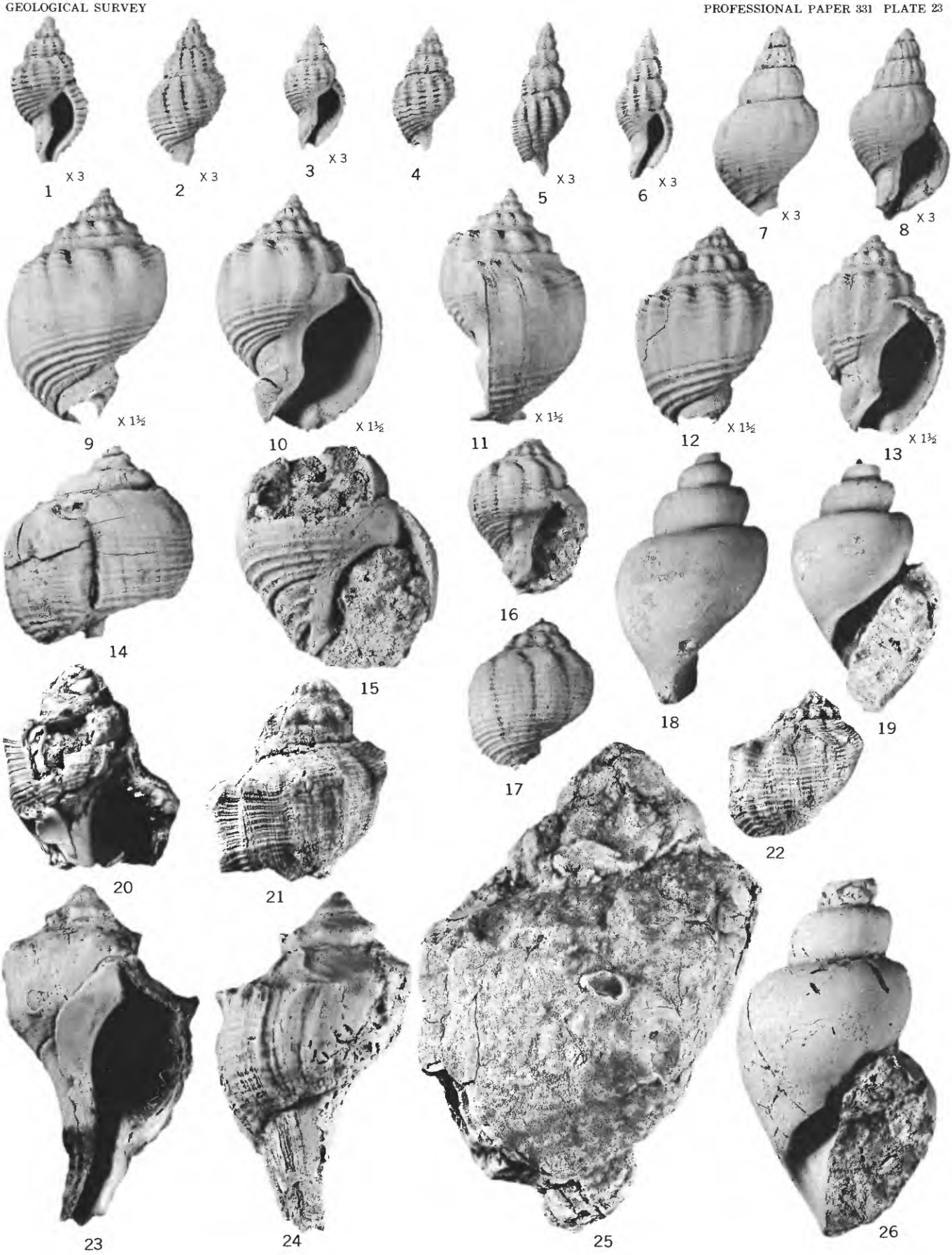
22. Back view of a specimen (× 1) from the same locality. USGS 25409. USNM 132152.

23, 24. *Protobusycon cretaceum* Wade (p. 194).

Front and back views of the holotype (× 1) from the Ripley Formation at loc. 1. USGS 10198, USNM 32897.

25. *Buccinopsis perryi* Conrad (p. 188).

Back view of a specimen (× 1) from the Escondido Formation of Texas. USGS 10854, USNM 130716.



ODONTOBASIS, BUCCINOPSIS, PROTOBUSYCON

PLATE 24

FIGURES 1–4. *Pyrifusus subdensatus* Conrad (p. 196).

1. Front view of a specimen (× 1½) from the Owl Creek Formation at loc. 45. USGS 25422, USNM 130250.
2. Back view of a topotype (× 1½) from the Owl Creek Formation at loc. 46. USGS 707, USNM 130251.
3, 4. Front and back views of a topotype (× 1½) from the Owl Creek Formation at loc. 46. USGS 707, USNM 130249.

5. *Rhombopsis? orientalis* Wade (p. 199).
Back view of a topotype (× 1) from the Ripley Formation at loc. 1. USGS 25406, USNM 130263.

6, 7. *Deussenia? microstriatus* (Wade) (p. 201).
Front and back views of the holotype (× 1½) from the Ripley Formation at loc. 1. USNM 32907.

8, 9, 10, 18, 20. *Pyrifusus* sp. (p. 198).

8. Back view of an internal mold (× 1) from the Prairie Bluff Chalk at loc. 87. USNM 28334.
9. Back view of an internal mold (× 1) from the Prairie Bluff, Chalk at loc. 71. USGS 25428, USNM 130261.
10. Back view of internal mold (× 1) from the Prairie Bluff Chalk at loc. 71. USGS 25428, USNM 130260.
18, 20. Back and front views of an internal mold (× 1) from the Prairie Bluff Chalk at loc. 98. USGS 6480, USNM 130262.

11, 21. *Pyrifusus subliratus* Wade (p. 197).

11. Back view of a topotype (× 1½) from the Ripley Formation at loc. 1. USGS 10198, USNM 130257.
21. Front view of a topotype (× 1½) from the same locality. USGS 10198, USNM 130256.

12, 16, 17. *Pyrifusus crassus* Sohl (p. 197).

12. Back view of a paratype (× 1½) from the Ripley Formation at loc. 18. USGS 25411, USNM 130254.
16, 17. Back and front views of the holotype (× 1½) from the Ripley Formation at loc. 6. USGS 25407, USNM 130252.

13, 19. *Lomirosa cretacea* (Wade) (p. 199).

13. Front view of a paratype (× 1) from the Ripley Formation at loc. 1. USNM 32898.
19. Back view of the holotype (× 1) from the same locality. USNM 32898.

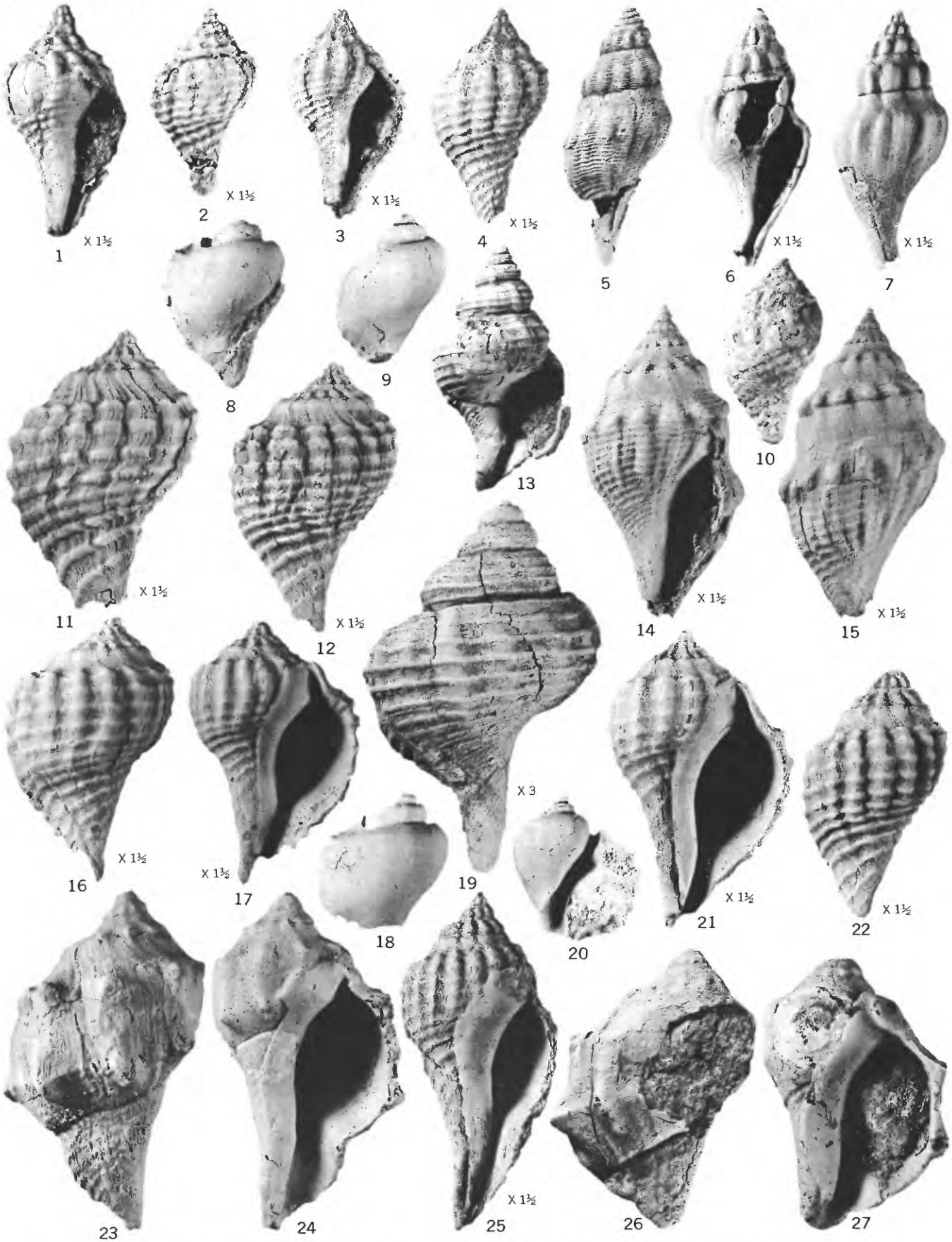
14, 15. *Rhombopsis molinoensis* Sohl (p. 199).
Front and back views of the holotype (× 1½) from the Ripley Formation at loc. 12. USGS 711, USNM 20474.

22, 25. *Pyrifusus ejundicus* Sohl (p. 198).

22. Back view of a paratype (× 1½) from the Ripley Formation at loc. 1. USGS 10198, USNM 130258.
25. Front view of a paratype (× 1½) from the same locality. USGS 10198, USNM 130259.

23, 24, 26, 27. *Protobusycon binodosum* Sohl, n. sp. (p. 194).

23, 24. Back and front views of the holotype (× 1) from the Ripley Formation at loc. 18. USGS 18078, USGS 130247.
26, 27. Back and front views of a paratype (× 1) from the Ripley Formation at loc. 6. USGS 25407, USNM 130248.



PYRIFUSUS, RHOMBOPSIS, DEUSSENIA, LOMIROSA, PROTOBUSYCON

PLATE 25

FIGURES 1, 2, 5–7, 11–13. *Deussenia ripleyana* Harbison (p. 200).

1. Back view of a topotype (× 1) from the Ripley Formation at loc. 18. USGS 25411, USNM 130268.
2. Back view of a specimen (× 1) from the Ripley Formation at loc. 6. USGS 25407, USNM 130266.

5–7. Front, back, and side views of a topotype (× 1) from the Ripley Formation at loc. 18. USGS 25411, USNM 130269.

11. Back view of a specimen (× 1½) from the Ripley Formation at loc. 6. USGS 25407, USNM 130720.

12, 13. Front and back views of a specimen (× 1) from the same locality showing a weak shoulder development. USGS 25407, USNM 130267.

3, 4. *Deussenia bellalirata costata* Sohl (p. 200).

3. Back view of a paratype (× 1) from the Owl Creek Formation at loc. 45. USGS 25422, USNM 130265.
4. Back view of a holotype (× 1) from the Owl Creek Formation at loc. 45. USGS 25422, USNM 130264.

8, 9. *Deussenia bellalirata bellalirata* (Conrad) (p. 200).

Front and back views of the holotype (× 1½) from the Owl Creek Formation of Tippah County, Miss. AMNH 9066.

10. *Deussenia cf. D. travisana* Stephenson (p. 201).

Back view of a specimen (× 1) from the Owl Creek Formation at loc. 46. USGS 707, USNM 130772.

14, 16. *Deussenia* sp. (p. 201).

14. Back view of a specimen (× 1) from the Ripley Formation at loc. 18. USGS 25411, USNM 130271.
16. View of spire of a specimen (× 1) from the same locality. USGS 25411, USNM 130270.

15, 18–20, 25, 26. *Bellifusus angulicostata* Sohl (p. 204).

15. Front view of a paratype (× 1½) from the Ripley Formation at loc. 16. USGS 25409, USNM 130283.

18–20. Enlarged segment (× 4) front and back views of a paratype (× 1½) from the Ripley Formation on the Chattahoochee River, 4 miles below Eufaula, Ala. USNM 130282.

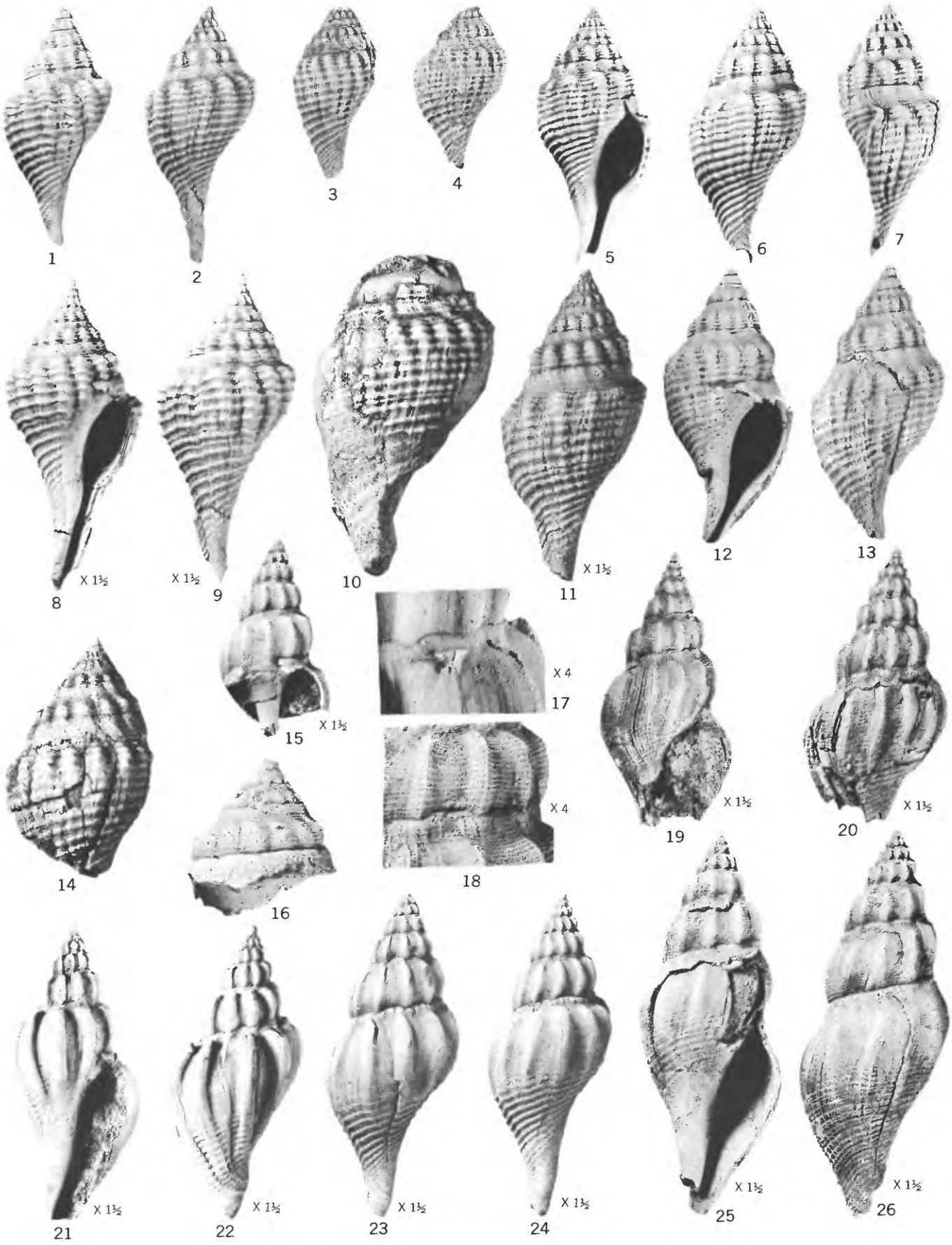
25, 26. Front and back views of the holotype (× 1½) from the Ripley Formation at loc. 1. USGS 25406, USNM 130281.

17, 21, 22. *Bellifusus spinosus* Sohl, n. sp. (p. 203).

Enlarged segment, (× 4*f*) back and front views of the holotype (× 1½) from the Owl Creek Formation at loc. 45. USGS 25422, USNM 130279.

23, 24. *Bellifusus curvicostatus curvicostatus* (Wade) (p. 202).

23. Back view of a topotype (× 1½) from the Ripley Formation at loc. 1. USGS 16951, USNM 130275.
24. Back view of a specimen (× 1½) from the Ripley Formation at loc. 6. USGS 25407, USNM 130273.



DEUSSENIA, BELLIFUSUS

PLATE 26

FIGURES 1, 2, 15. *Drilluta*? sp. (p 208.).
Back and front views of an internal mold (× 1) from the Prairie Bluff chalk at loc. 94. USGS 648C, USNM 130310.

3–7. *Bellifusus*? sp. (p. 204).
3. Back view of an internal mold (× 1) from the Prairie Bluff Chalk at loc. 83. USGS 6843, USNM 130284.
4, 5. Back and front views of an internal mold (× 1) from the Prairie Bluff Chalk at loc. 71. USGS 25428, USNM 130287.
6. Front view of an internal mold (× 2) from the Prairie Bluff Chalk at loc. 83, broken back to show the columellar features. USGS 6843, USNM 130285.
7. Front view of an internal mold (× 1) from the Prairie Bluff Chalkat loc. 71. USGS 25428, USNM 130286.

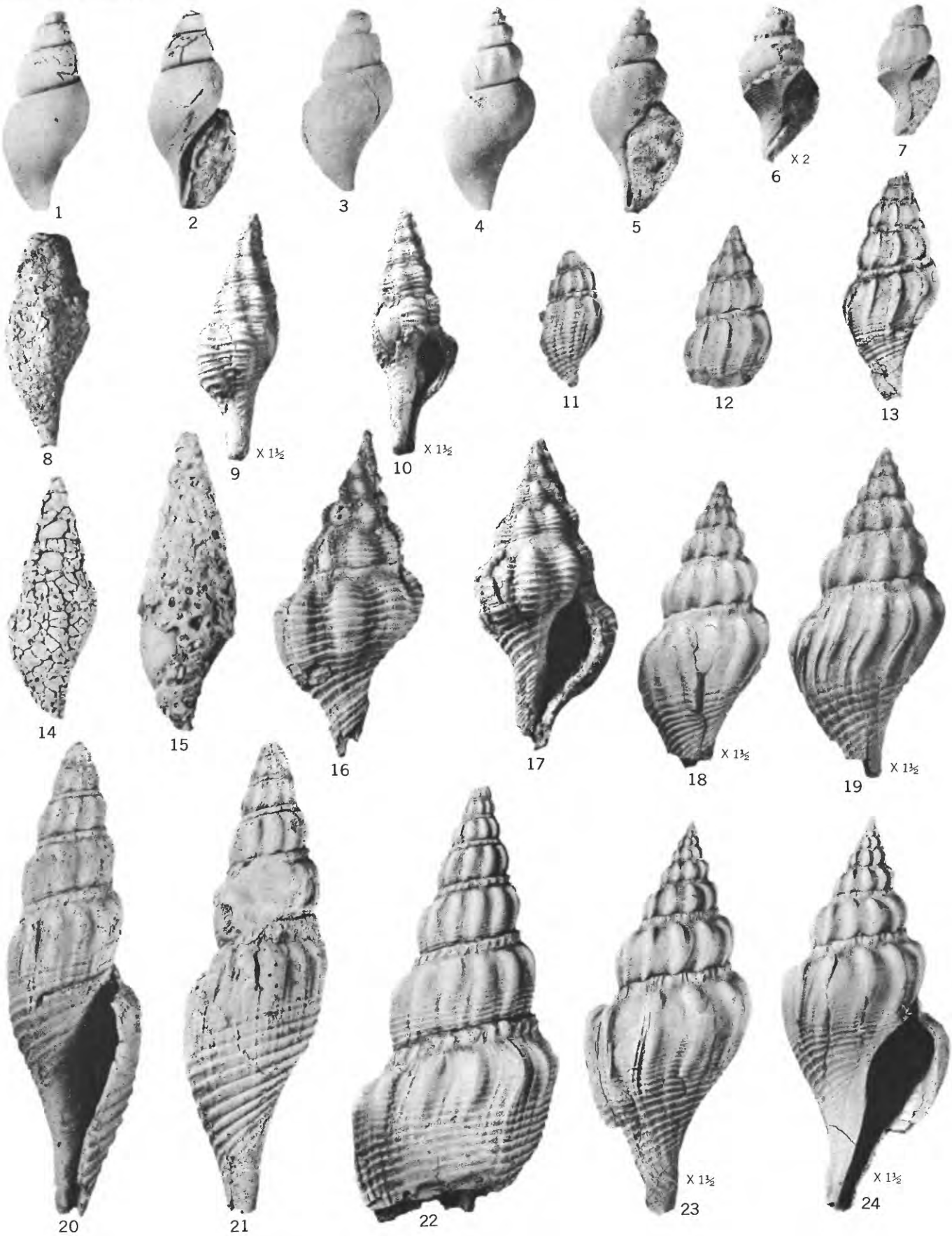
8, 14. *Drilluta* cf. *D buboanus* Sohl (p. 208).
8. Back view of an internal mold (× 1) from the Prairie Bluff Chalk at loc. 57 with molds of *Clione* borings preserving surface sculpture. USGS 25425, USNM 130308.
14. Back view of an internal mold (× 1) from the same locality. USGS 25455, USNM 130307.

9, 10, 16, 17. *Dolicholatirus 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.
16, 17. Back and front views of the holotype (× 1) from the same locality. USGS 707, USNM 130311.

11, 12, 13. *Bellifusus curvicostatus crenulatus* 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, 19, 23, 24. *Bellifusus curvicostatus curvicostatus* (Wade) (p. 202).
18. Back view of a hypotype (× 1½) from the Ripley Formation at loc. 6. USGS 25407, USNM 130271.
19. Back view of a hypotype (× 1½) from the Ripley Formation at loc. 1. USGS 25406, USNM 130274.
23, 24. Back and front views of a hypotype (× 1½) from the Ripley Formation at loc. 6. USGS 25407, USNM 130272.

20–22. *Drilluta major* (Wade) (p. 208).
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.



DRILLUTA, DOLICHOLATIRUS, BELLIFUSUS

PLATE 27

FIGURES 1–7, 14, 15, 23, 24, 27, 28. *Drilluta distans* Conrad (p. 206).

1. Back view of the holotype (× 1) from the Ripley Formation at Eufaula, Ala. AMNH 9060.
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 130292.
6. Front view of the holotype (× 1) of *Turbonilla* (*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 130293.
14. Front view of a specimen (× 1) from the Ripley Formation at loc. 12 showing a complete siphonal canal. USGS 711, USNM 130299.
15. Back view of a specimen (× 1) from the Ripley Formation at loc. 6. USGS 25407, USMN 130295.
23, 24. Back and front views of a specimen (× 1½) from the same locality. USGS 25407, USNM 130723.
27, 28. Back and front views of a specimen (× 1½) from the same locality. USGS 25407, USNM 130296.

8–11, 25, 26. *Drilluta buboanus* Sohl, n. sp. (p. 207).

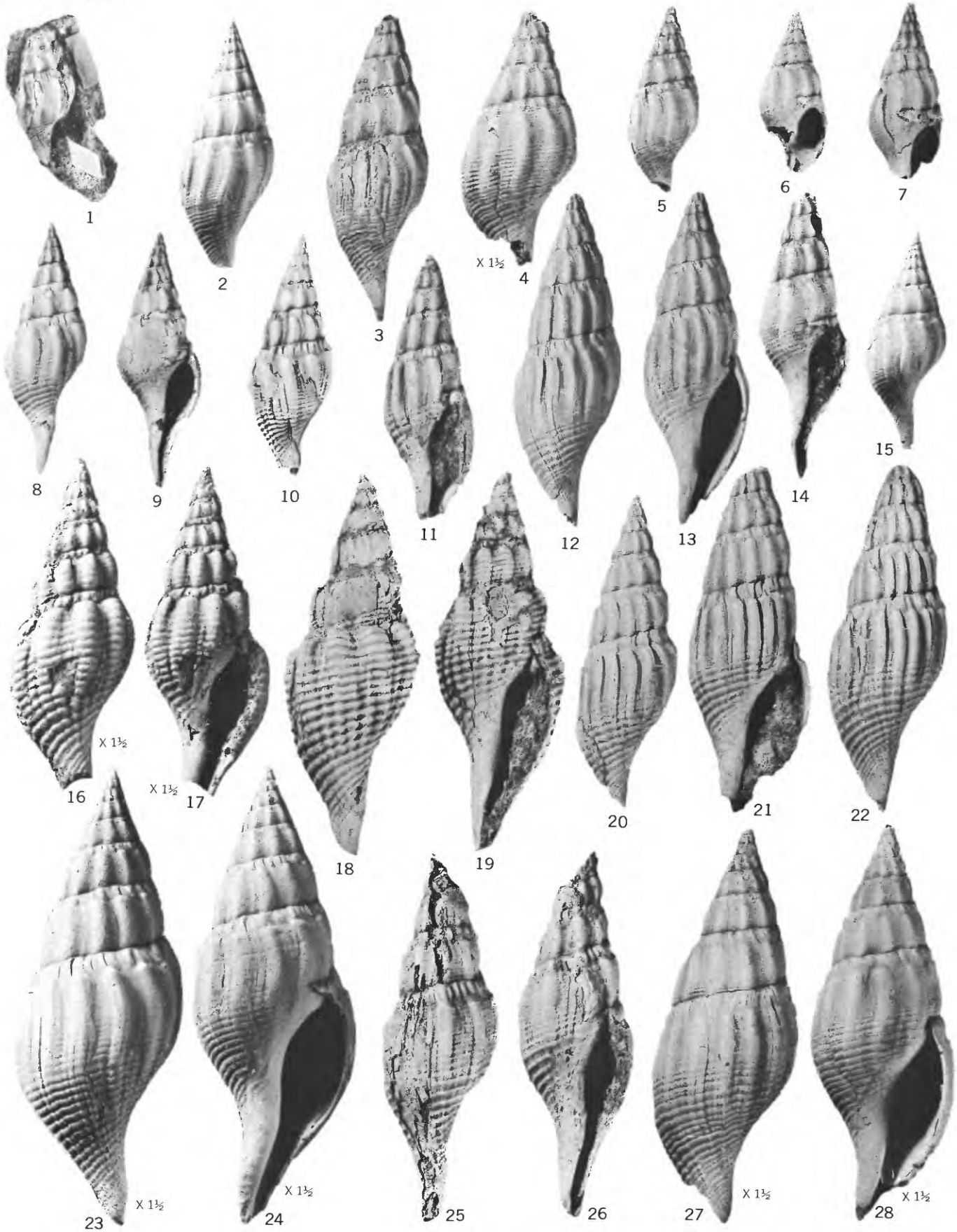
8, 9. Back and front views of a paratype (× 1) from the Owl Creek Formation at loc. 45. USGS 25422, USNM 130304.
10. Back view of a paratype (× 1) from the Owl Creek Formation at loc. 46. USGS 707, USNM 130302.
11. Front view of a paratype (× 1) from the same locality. USGS 25423, USNM 130303.
25, 26. Back and front views of the holotype (× 1) from the same locality. USGS 707, USNM 130301.

12, 13, 20–22. *Drilluta communis* Wade (p. 205).

12, 13. Back and front views of a topotype (× 1) from the Ripley Formation at loc. 1. USGS 25406, USNM 130291.
20. Back view of a topotype (× 1) from the same locality. USGS 16951, USNM 130288.
21. Front view of a topotype (× 1) from the same locality. USGS 16951, USNM 130289.
22. Back view of a topotype (× 1) from the same locality. USGS 25406, USNM 130290.

16–19. *Drilluta lemniscata* 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
3
X 1½
4
5
6
7
8
9
10
11
12
13
14
15
X 1½
16
X 1½
17
18
19
20
21
22
X 1½
23
X 1½
24
25
26
X 1½
27
X 1½
28

DRILLUTA

PLATE 28

FIGURES 1–6. *Paleopsephaea mutabilis* Wade (p. 209).

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, 15, 16. *Paleopsephaea tenuilirata* Sohl, n. sp. (p. 210).

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, 17. *Paleopsephaea pergracilis* Wade (p. 210).

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.

10. *Graphidula* cf. *G? multicostata* Stephenson (p. 213).

Back view of a specimen (× 1) from the Owl Creek Formation at loc. 45. USGS 25422, USNM 130347.

11–14. *Graphidula obscura* (Wade) (p. 212).

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, 23, 27, 32–35. *Graphidula melanopsis* (Conrad) (p. 212).

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 18629, USNM 130345.

34, 35. Back and front views of a specimen (× 1) from the same locality. USGS 25411, USNM 130343.

19–22, 30, 31. *Graphidula pergracilis* (Wade) (p. 211).

19–20. Front and back views of a topotype from the Ripley Formation at loc. 1. USGS 10198, USNM 130338.

21. View of part of the spire of a topotype (× 2) from the same locality showing the placement of the columellar plaits. 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.

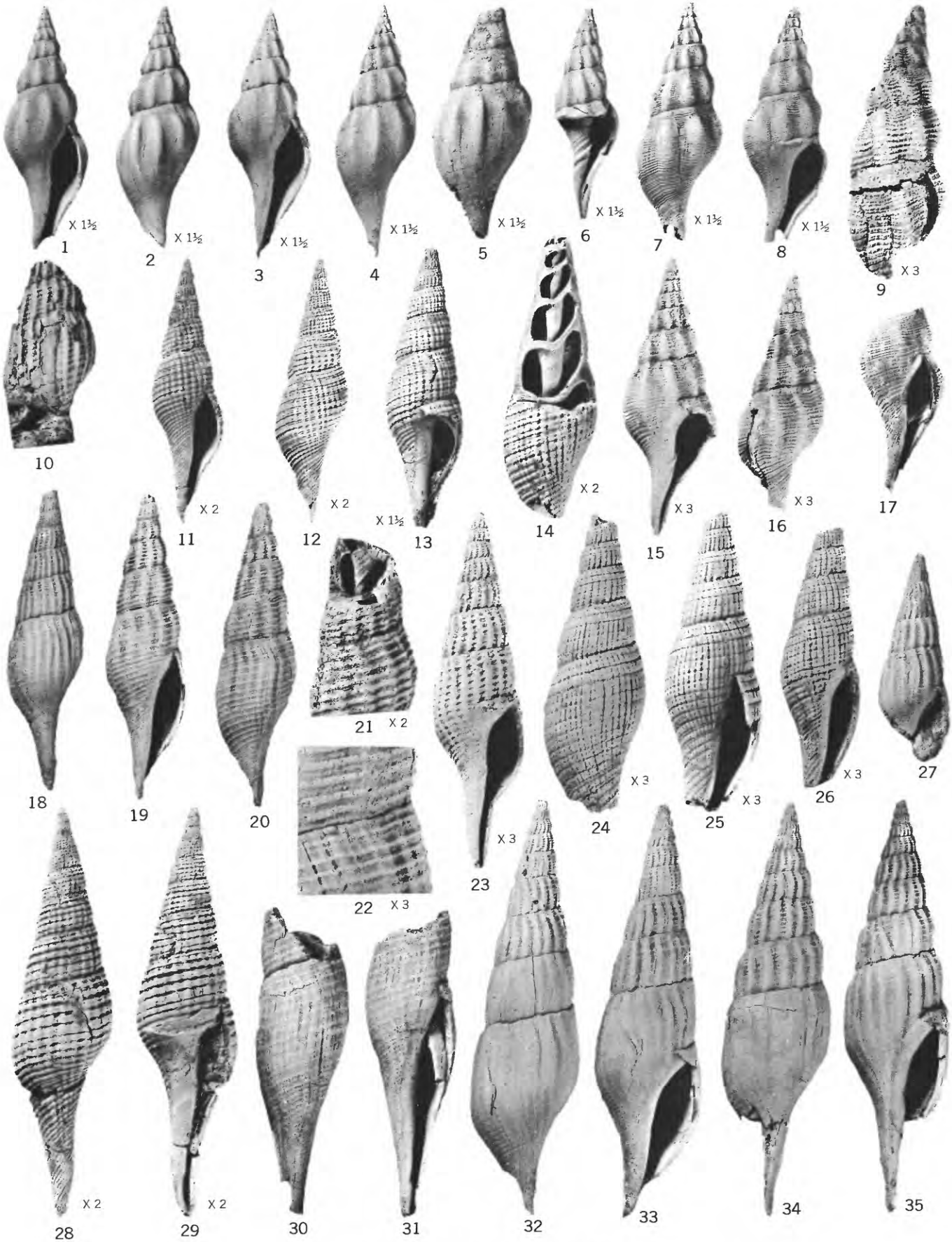
24–26. *Graphidula terebriformis* Stephenson (p. 212).

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.

28, 29. *Graphidula cancellata* Wade (p. 211).

Back and front views of the holotype (× 2) from the Ripley Formation at loc. 1. USNM 32891.



PALEOPSEPHAEA, GRAPHIDULA

690-081 O - 64 - 10

PLATE 29

FIGURES 1–3. *Graphidula* sp. (p. 213).

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* (*Pornosis*) *modica* 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 10198, 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* (*Pornosis?*) sp. (p. 219).

Front and back views of an internal mold (× 1½) from the Prairie Bluff Chalk at loc. 11. USGS 25428, USNM 130364.

12–14. *Ornopsis* (*Pornosis*) *digressa* Wade (p. 217).

12. Front view of a specimen (× 1½) from the Ripley Formation at loc. 18. USGS 25411, USNM 130359.
13. Back view of a specimen (× 1½) from the Ripley Formation at loc. 18. USGS 25411, USNM 130358.
14. Front view of a topotype (× 1½) from the Ripley Formation at loc. 1. USGS 25411, USNM 130361.

18. *Piestochilus* sp. (p. 214).

Back view of an internal mold (× 1½) from the Prairie Bluff Chalk at loc. 11. USGS 25428, USNM 130353.

19. *Ornopsis* (*Pornosis*) *modica laevis* Sohl, n. subsp. (p. 219).

Back view of the holotype (× 3) from the Owl Creek Formation at loc. 46. USGS 707, USNM 20409.

20–21, 26, 27. *Piestochilus curviliratus* (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.

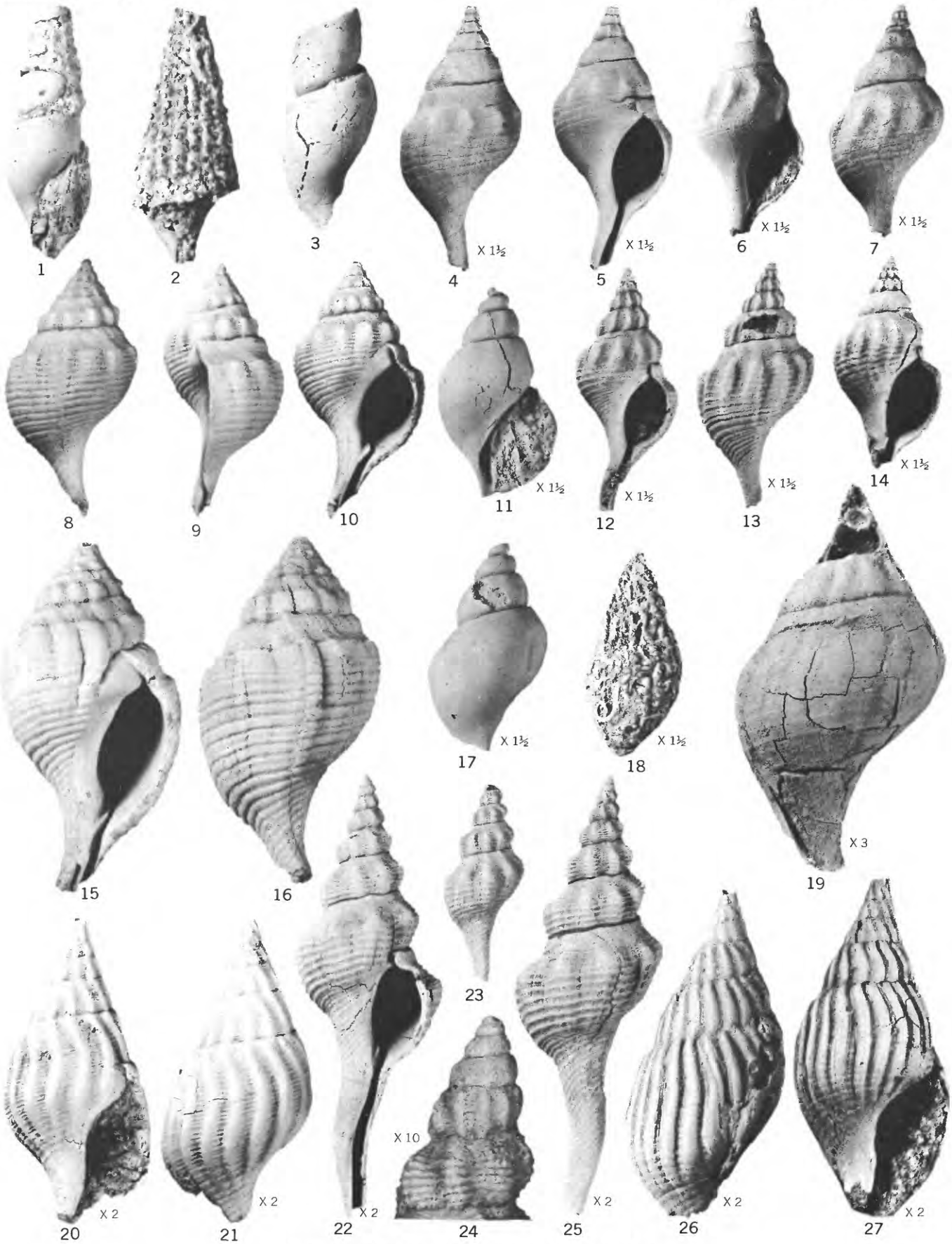
26, 27. Back and front views of a specimen (× 2) from the Providence Sand at the mouth of Pataula Creek, Clay County, Ga. USGS 855, USNM 130351.

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.



GRAPHIDULA, ORNOPSIS, PIESTOCHILUS

690-081 O - 64 - 11

PLATE 30

FIGURES 1–5. *Hercorhyncus* (*H.*) *pagodaformis* Sohl, n. sp. (p. 222).

1. Front view of the holotype (× 1½) 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. *Latirus keownvillensis* 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.

8–10, 13–16. *Hercorphyncus* (*H.*) *tippanus* Conrad (p. 220).

8, 9. Front and back views of a specimen (× 1½) from the Ripley Formation at loc. 16. USGS 25409, USNM 130372.

10. Back view of a specimen (× 2½) 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.

11, 12. *Hercorhyncus* (*Hercorhyncus*) *tennesseensis* (Wade) (p. 222).

Back and front views of a topotype (× 1½) from the Ripley Formation at loc. 1. USGS 25406, USNM 130376.

17–20, 23, 24. *Hercorhyncus* (*Haplovoluta*) *triliratus* Sohl, n. sp. (p. 223).

17, 18. Back and front views of a paratype (× 1½) from the Ripley Formation at loc. 18. USGS 25411, USNM 130380.

19, 20. Back and front views of the holotype (× 1½) from the Ripley Formation at loc. 5. USGS 708, USNM 130379.

23, 24. Front and back views of a paratype (× 1½) from the Ripley Formation at loc. 18. USGS 25411, USNM 130381.

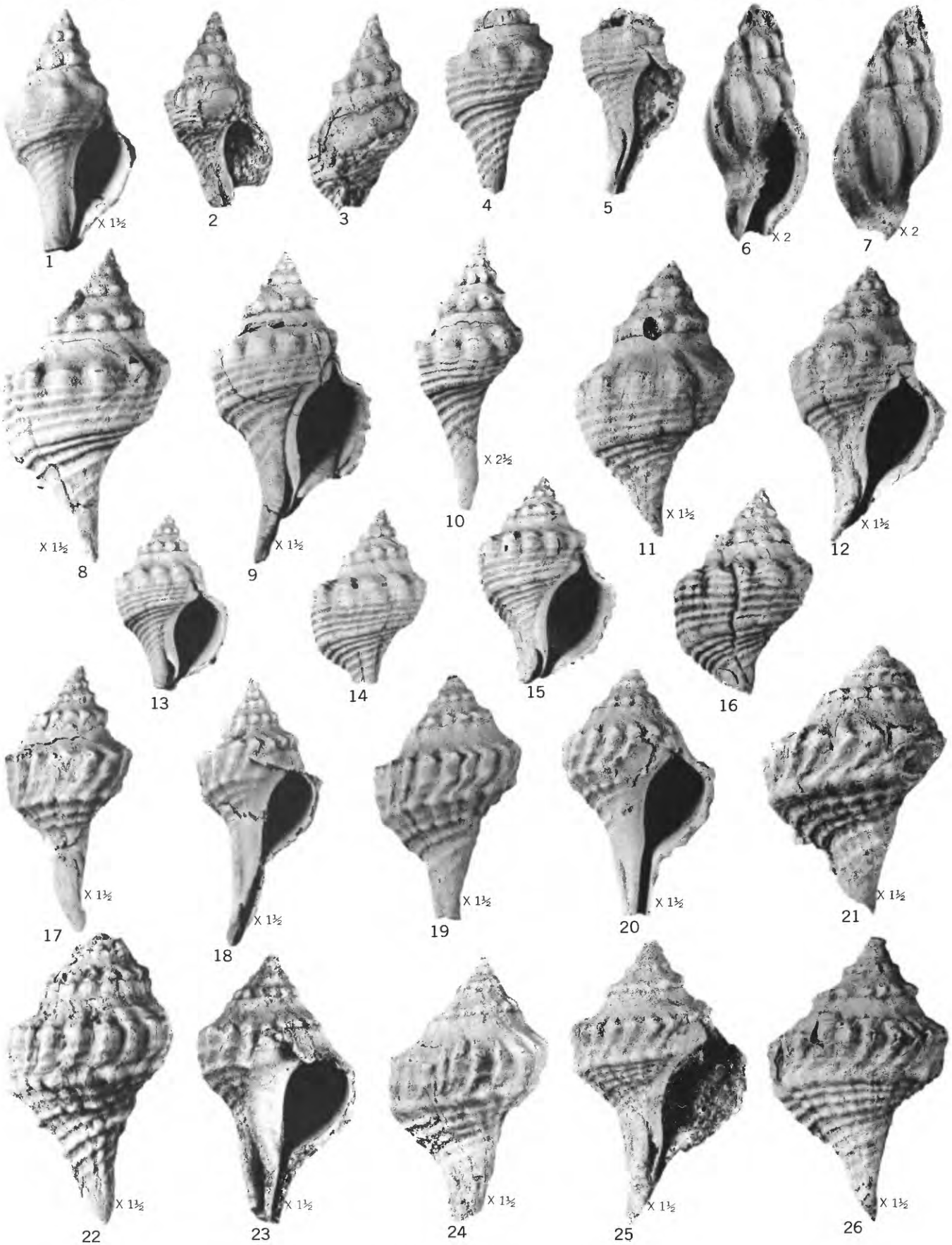
21, 25, 26. *Hercorhyncus* (*Haplovoluta*) *bicarinata* (Wade) (p. 223).

21. Back view of a topotype (× 1½) from the Ripley Formation at loc. 1. USGS 25406, USNM 130377.

25, 26. Front and back views of a topotype (× 1½) from the same locality. USGS 10198, USNM 130378.

22. *Hercorhyncus* (*Haplovoluta*) *quadriliratus* Sohl, n. sp. (p. 224).

Back view of the holotype (× 1½) from the Owl Creek Formation at loc. 46. USGS 707, USNM 130384.



HERCORHYNCUS, LATIRUS

PLATE 31

FIGURES 1–4. *Anomalofusus substriatus* Wade (p. 229).
1. Back view of a topotype (× 2) from the Ripley Formation at loc. 1. USGS 25406, USNM 130397.
2. Back view of a topotype (× 2) from the Ripley Formation same locality. USGS 25406, USNM 130398.
3. Front view of a topotype (× 1) from the same locality. USGS 10198, USNM 130400.
4. Back view of a topotype (× 1) from the same locality USNM 130399.

5, 6. *Anomalofusus subnodosus* Sohl, n. sp. (p. 230).
Front and back views of the holotype (× 2) from the Ripley Formation at loc. 6. USGS 25407, USNM 130405.

7, 8, 11–13. *Anomalofusus lemniscatus* Sohl, n. sp. (p. 230).
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. *Remera microstriata* Stephenson? (p. 227).
View of a specimen (× 2) from the Ripley Formation at loc. 18. USGS 25411, USNM 130395.

17–19, 22, 23. *Remera stephensoni* Harbison (p. 226).
17, 18. Back and front views of a topotype (× 2) from the Ripley Formation at loc. 18. USGS 25411, USNM 130391.
19. Back view of a specimen (× 1½) from the Ripley Formation at loc. 1. USGS 25406, USNM 130389.
22, 23. Front and back views (× 2) from the Ripley Formation at loc. 6. USGS 25407, USNM 130390.

20, 21. *Remera flexicostata* Sohl, n. sp. (p. 227).
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.

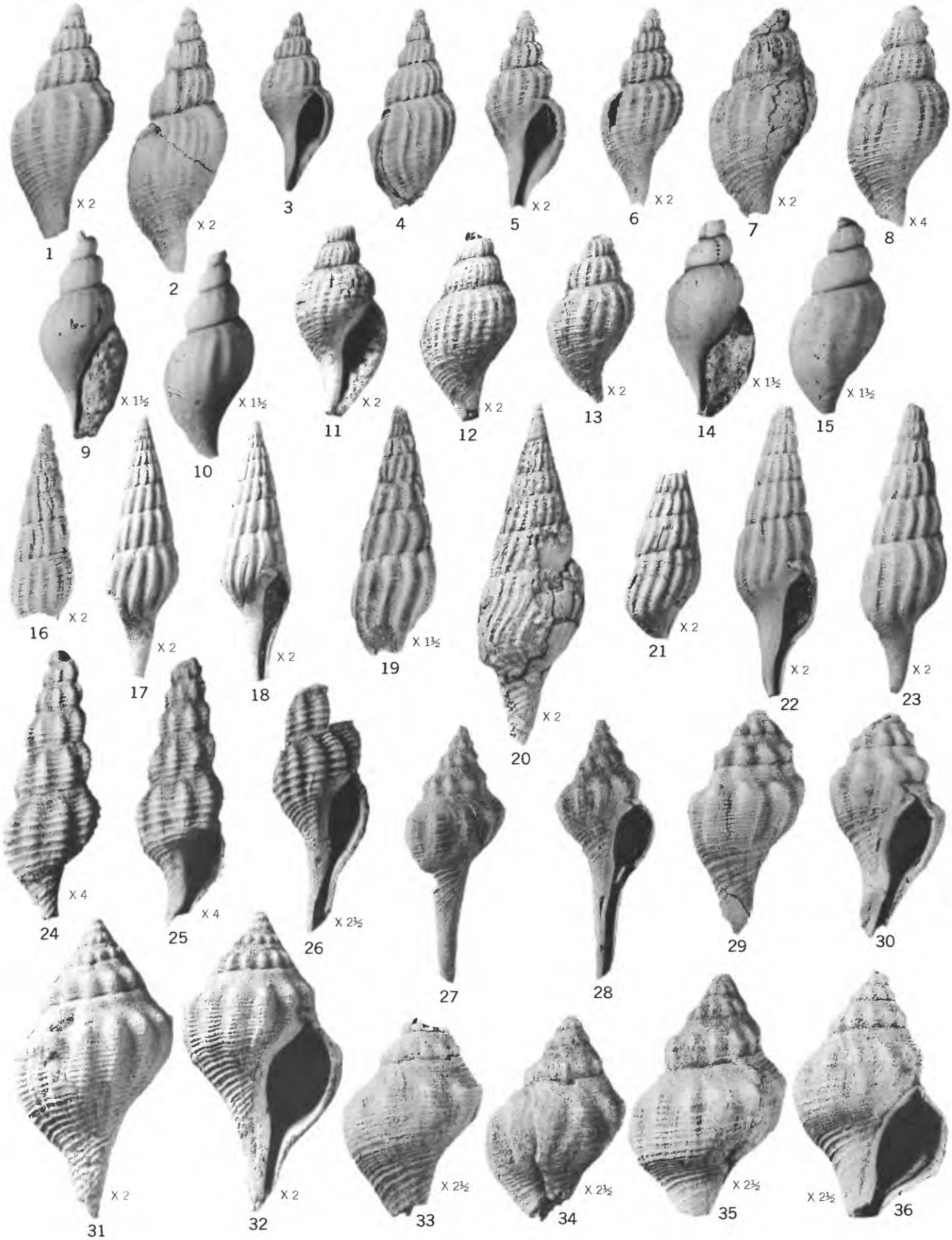
24–26. *Fusinus macnairyensis* (Wade) (p. 228).
24, 25. Back and front views of a specimen (× 4) from the Ripley Formation at loc. 6. USGS 25407, USNM 130396.
26. View of the holotype (× 2½) from the Ripley Formation at loc. 1. USNM 32880.

27, 28. *Euthriofusus? mesozoicus* (Wade) (p. 225).
Views of the holotype (× 2) from the Ripley Formation at loc. 1. USNM 32886.

29, 30. *Woodsella typica* (Wade) (p. 228).
Back and front views of the holotype (× 1) from the Ripley Formation at loc. 1. USNM 32892.

31, 32. *Boltenella excellens* (Wade) (p. 225).
Back and front views of a topotype (× 2) from the Ripley Formation at loc. 1. USGS 25406, USNM 130386.

33–36. *Euthriofusus convexus* (Wade) (p. 225).
33. Back view of a topotype (× 2½) from the Ripley Formation at loc. 1. USGS 10198, USNM 130387.
34. Back view of a topotype (× 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, EUTHRIOFUSUS, WOODSELLA, BOLTENELLA

PLATE 32

FIGURE 1. *Pyropsis* 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. *Cryptorhytis? 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 Noxubbee County, Miss. USGS 10063.

6, 12. *Pyropsis* sp. E (p. 241).
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.

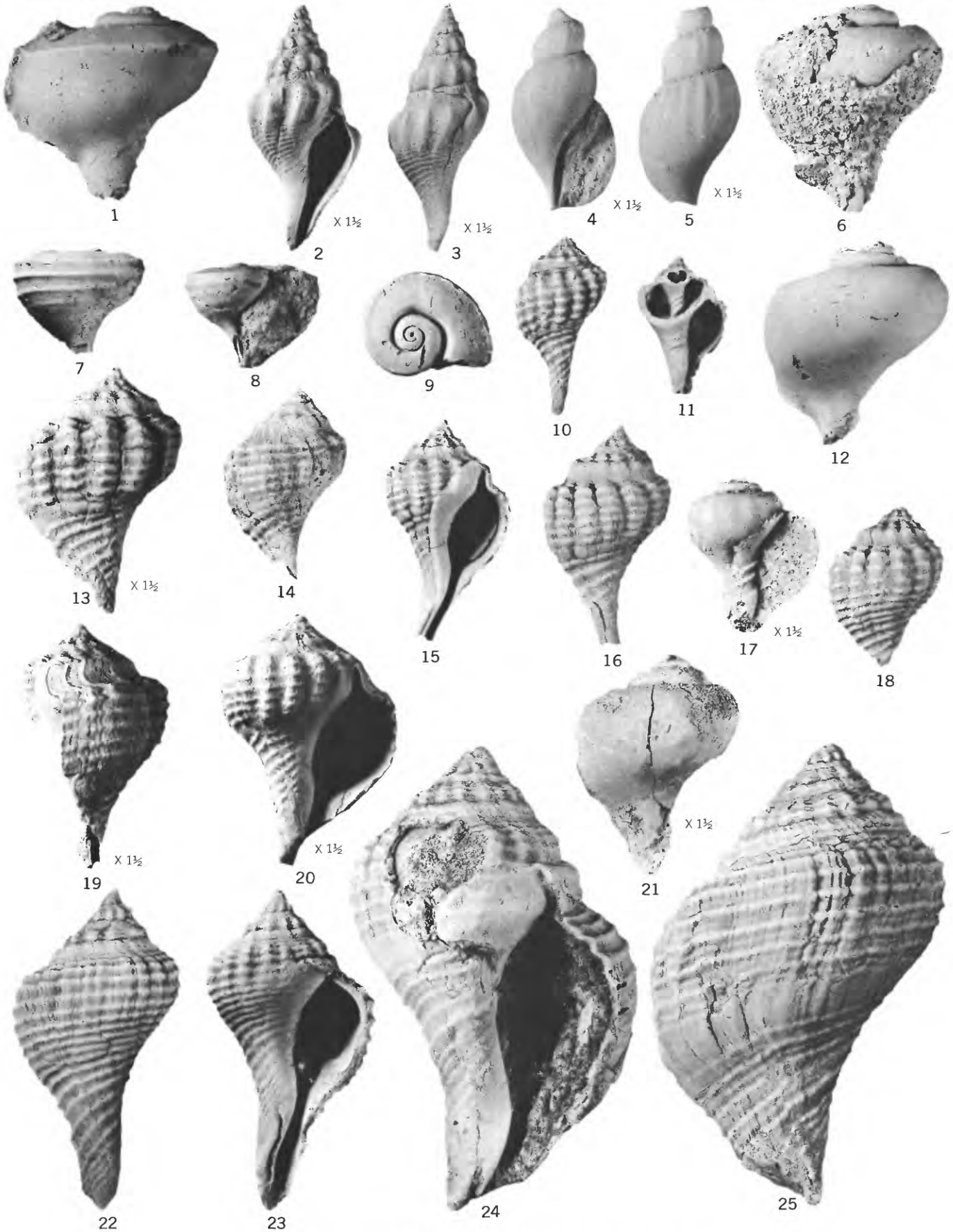
7, 8, 9. *Pyropsis* sp. C (p. 241).
Back, front, top views of an internal mold (× 1) from the Prairie Bluff formation at loc. 82. USGS 25435, USNM 130439.

10, 11, 13, 19, 20. *Lupira pyriformis* Stephenson (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.

14–16, 24, 25. *Lupira variabilis* (Wade) (p. 232).
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, 21. *Lupira* sp. (p. 234).
17. Front view of an internal mold (× 1½) from the Prairie Bluff Chalk at loc. 71, broken to show the columellar plication. USGS 25428 USNM 130420.
21. Back view of the same specimen with broken part restored.

18, 22, 23. *Lupira turbinea* Sohl, new species (p. 234).
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

FIGURES 1, 8, 11, 18, 20. *Pyropsis perlata* Conrad (p. 235).

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.

2, 6. *Pyropsis* sp A. (p. 237).

Back and top views of a specimen (× 1) from the Owl Creek Formation at loc. 46. USGS 707, USNM 130425.

3–5. *Pyropsis interstriatus* (Wade) (p. 239).

Back, top, and front views of the holotype (× 1) from the Ripley Formation at loc. 1. USNM 32906.

7, 10, 14, 16, 22. *Pyropsis proxima* Wade (p. 237).

7, 10, 14. Front, top, and back views of the holotype (× 1) from the Ripley Formation at loc. 1. USNM 32901.

16, 22. Top view (× 3) and back view (× 1) of a topotype from the same locality. USGS 25406, USNM 130424.

9. *Pyropsis bairdi* Meek and Hayden (p. 238).

Front view of the holotype (× 1) from the Fox Hills Formation of South Dakota. USNM 252.

12, 13, 17. *Pyropsis prolixa* 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.

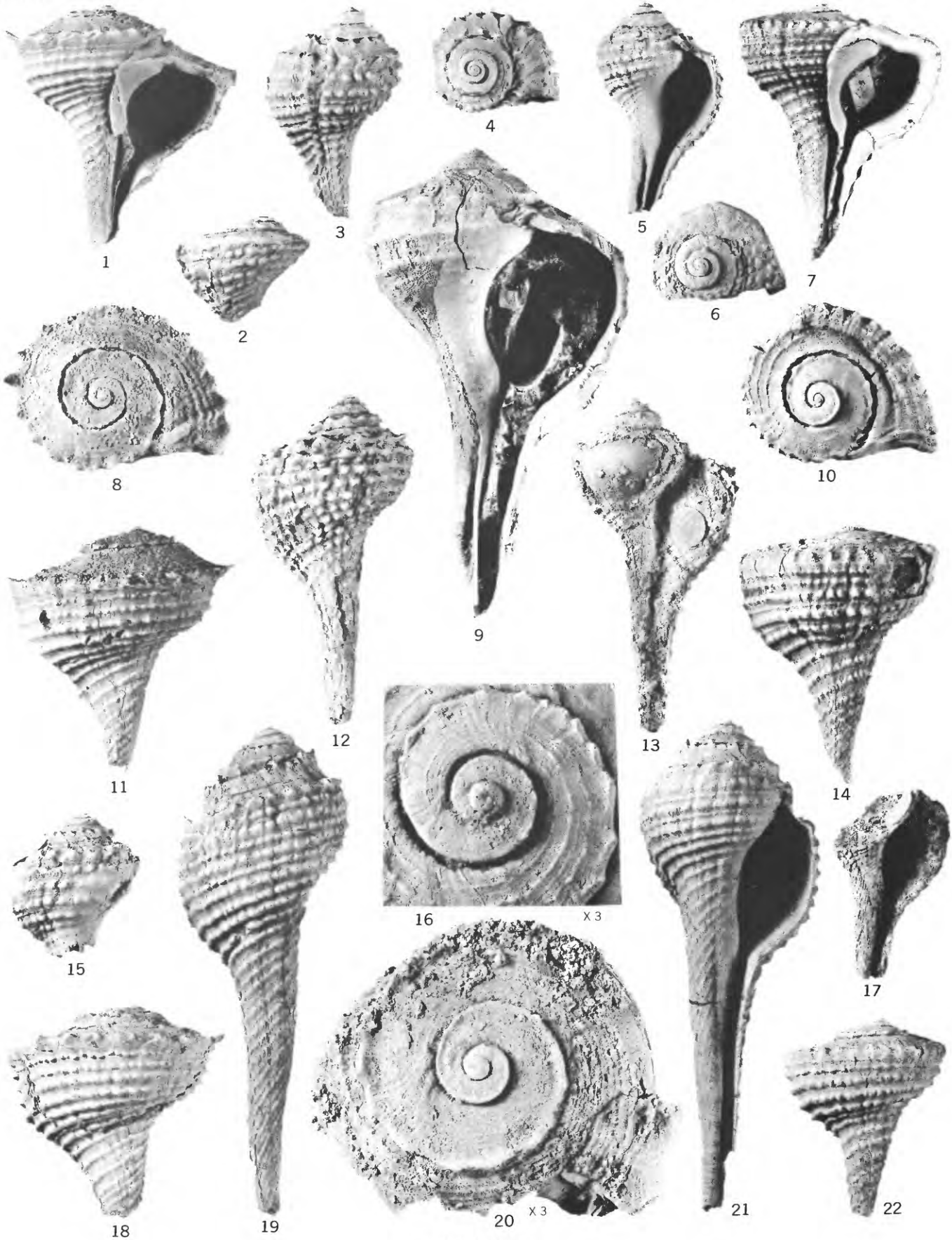
17. Front view of a paratype (× 1) from the same locality. USGS 707, USNM 130433.

15. *Pyropsis* sp. B (p. 241).

15. Back view of a specimen (× 1) from Ripley Formation at loc. 14. USGS 6873, USNM 130436.

19, 21. *Pyropsis spinosus* (Wade) (p. 238).

Back and front views of a topotype (× 1) from the Ripley Formation at loc. 1. USGS 25406, USNM 130428.



PYROPSIS

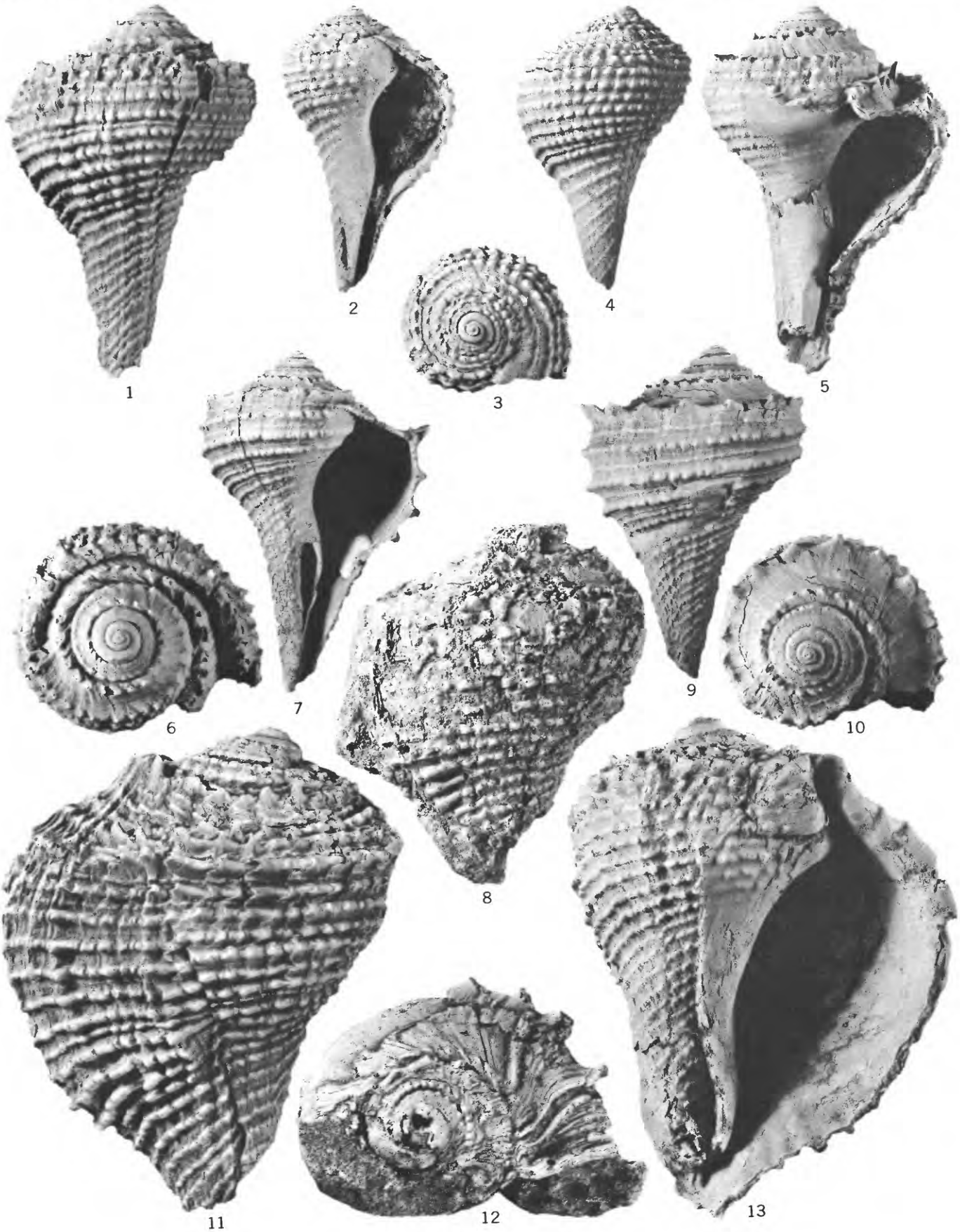
PLATE 34

FIGURES 1, 5, 6. *Pyropsis spinosus* (Wade) (p. 238).
Back, front, and top views of a topotype (× 1) from the Ripley Formation at loc. 1. USGS 10198, USNM 130429.

2–4, 11, 13. *Pyropsis perornatus* (Wade) (p. 239).
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 32902.

7, 9, 10. *Pyropsis cornutus* Sohl, n. sp. (p. 237).
Front, back, and top views of the holotype (× 1) from the Ripley Formation at loc. 18. USGS 25411, USNM 130426.

8, 12. *Pyropsis prolixa* Sohl, n. sp. (p. 240).
Back view of a paratype (× 1) from the Owl Creek Formation at loc. 46. USGS 25423, USNM 140432.



PYROPSIS

PLATE 35

FIGURES 1–6. *Ptychosyca inornata* Gabb (p. 244).

1, 2. Front and back views of a specimen (× 1) from the Ripley Formation at loc. 6. USGS 25407, USNM 130454.

3, 4. Views of the holotype (× 1) from the Providence Sand on Pataula 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, 14. *Napulus octoliratus* (Conrad) (p. 243).

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 6480, 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, 21–23. *Napulus fragilis* Sohl, n. sp. (p. 243).

12. Back view of a paratype (× 1½) from the Ripley Formation at loc. 5. USGS 708, USNM 130447.

21–23. Back, front, and side view of the holotype (× 3) from the Ripley Formation at loc. 18. USGS 25411, USNM 130444.

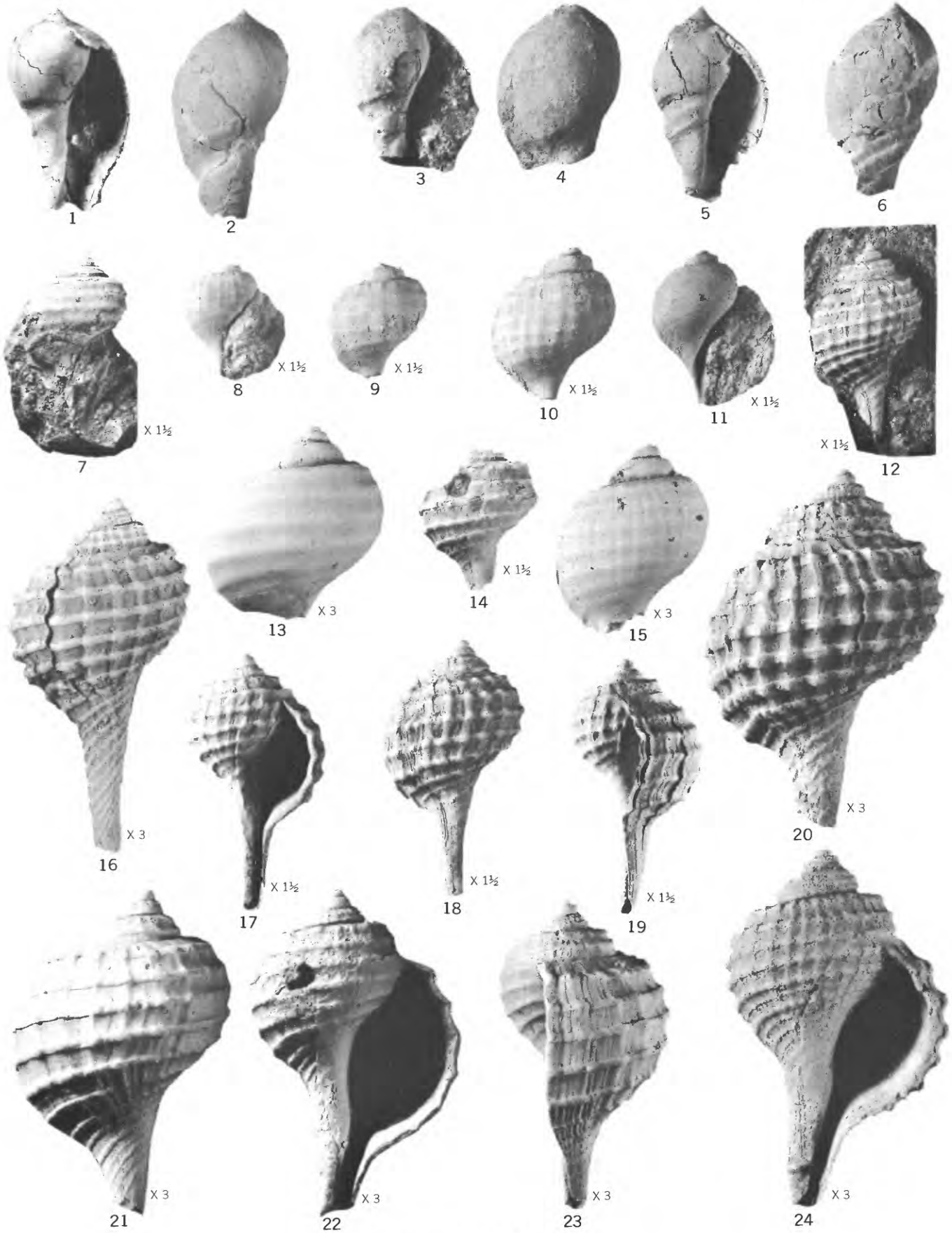
16–20, 24. *Napulus reesidei* Sohl, n. sp. (p. 242).

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 32905.

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.



PTYCHOSYCA, NAPULUS

PLATE 36

FIGURES 1–7, 10. *Ancilla* (*Ancillus*) *acutula* (Stephenson) (p. 248).

1, 2. Front and back views of a specimen (× 4) from the Owl Creek Formation at loc. 46. USGS 25423, USNM 130466.

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. *Fulgerca attenuata* Wade (p. 247).

8. Front view of the holotype (× 5) from the Ripley Formation at loc. 1. USNM 32914.

12. Front view of a topotype (× 5) from the same locality. USGS 25406, USNM 130463.

9. *Fulgerca attenuata* (Wade)? (p. 247).

Front view of a specimen (× 5) from the Ripley Formation at loc. 6. USGS 25407, USNM 130464.

11. *Hydrotribulus* sp. (p. 246).

Back view of an internal mold (× 1) from the Prairie Bluff Chalk at loc. 66. USGS 612, USNM 130462.

13–16, 18. *Hydrotribulus elegans* Sohl, n. sp. (p. 246).

13, 14. 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. 5. USGS 708, USNM 130461.

16. Back view of a paratype (× 1½) from the Ripley Formation at loc. 18. USGS 25411, USNM 130459.

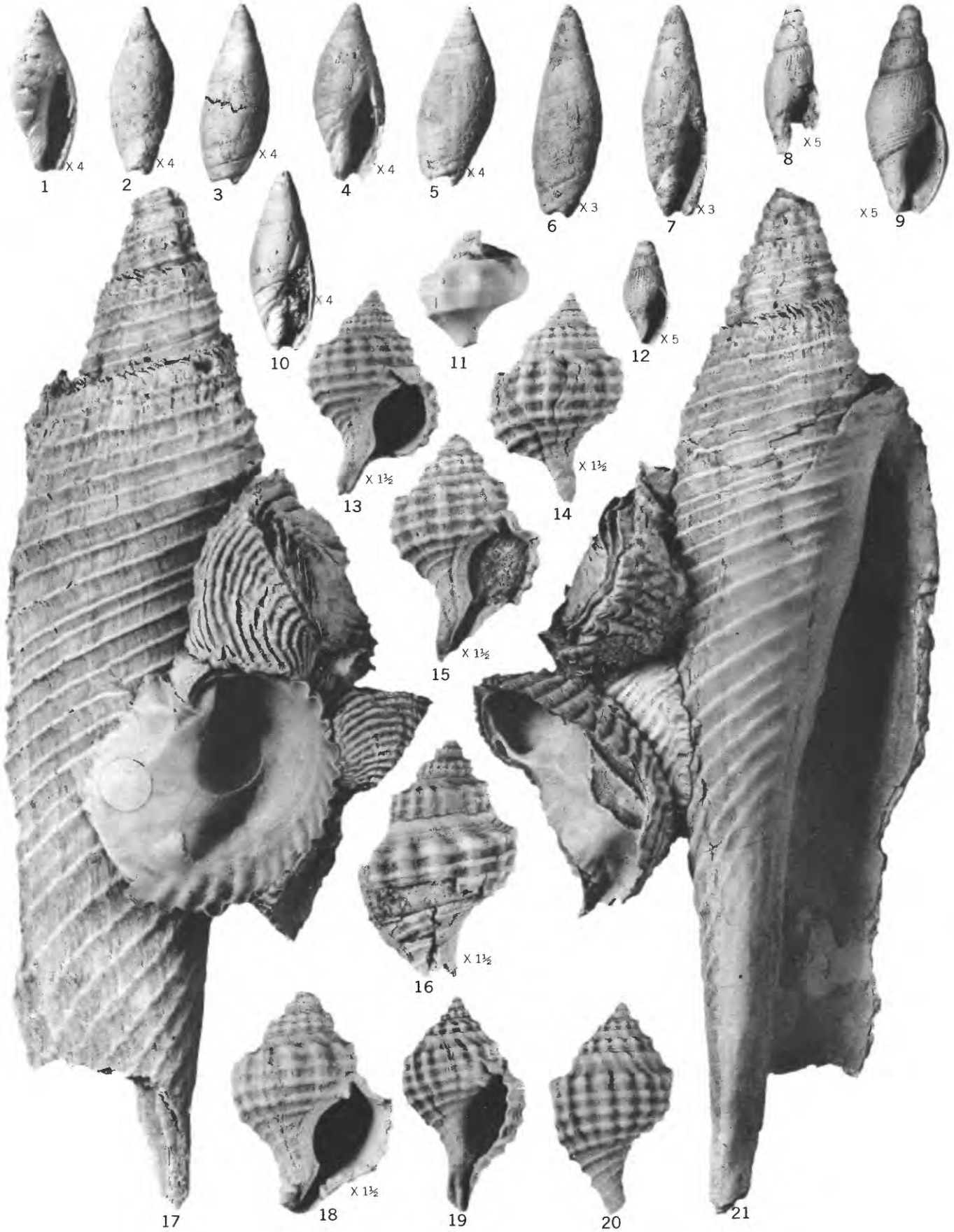
18. Front view of a paratype (× 1½) from the Ripley Formation at loc. 5. USGS 708, USNM 130460.

17, 21. *Longoconcha tennesseensis* (Wade) (p. 251).

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).

Front and back views of a topotype (× 1) from the Ripley Formation at loc. 1. USGS 10198, USNM 130456.



ANCILLA, FULGERCA, HYDROTRIBULUS, LONGOCONCHA

PLATE 37

FIGURES 1–3, 6, 7. *Paleofusimitra elongata* Sohl, (p. 250).

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. *Volutomorpha* sp. (p. 257).

Back view of an incomplete specimen (× 1) from the Ripley Formation at loc. 18. USGS 18629, USNM 130693.

5, 13. *Mitridomus ripleyana* (Wade) (p. 249).

Front and back views of the holotype (× 1½) from the Ripley Formation at loc. 1. USNM 32865.

8, 9, 16, 17. *Longoconcha quadrilirata* 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.

16, 17. Front and back views of a paratype (× 2) from the Ripley Formation at loc. 6. USGS 25407, USNM 130478.

10–12, 14, 18. *Longoconcha* spp. (p. 252).

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.

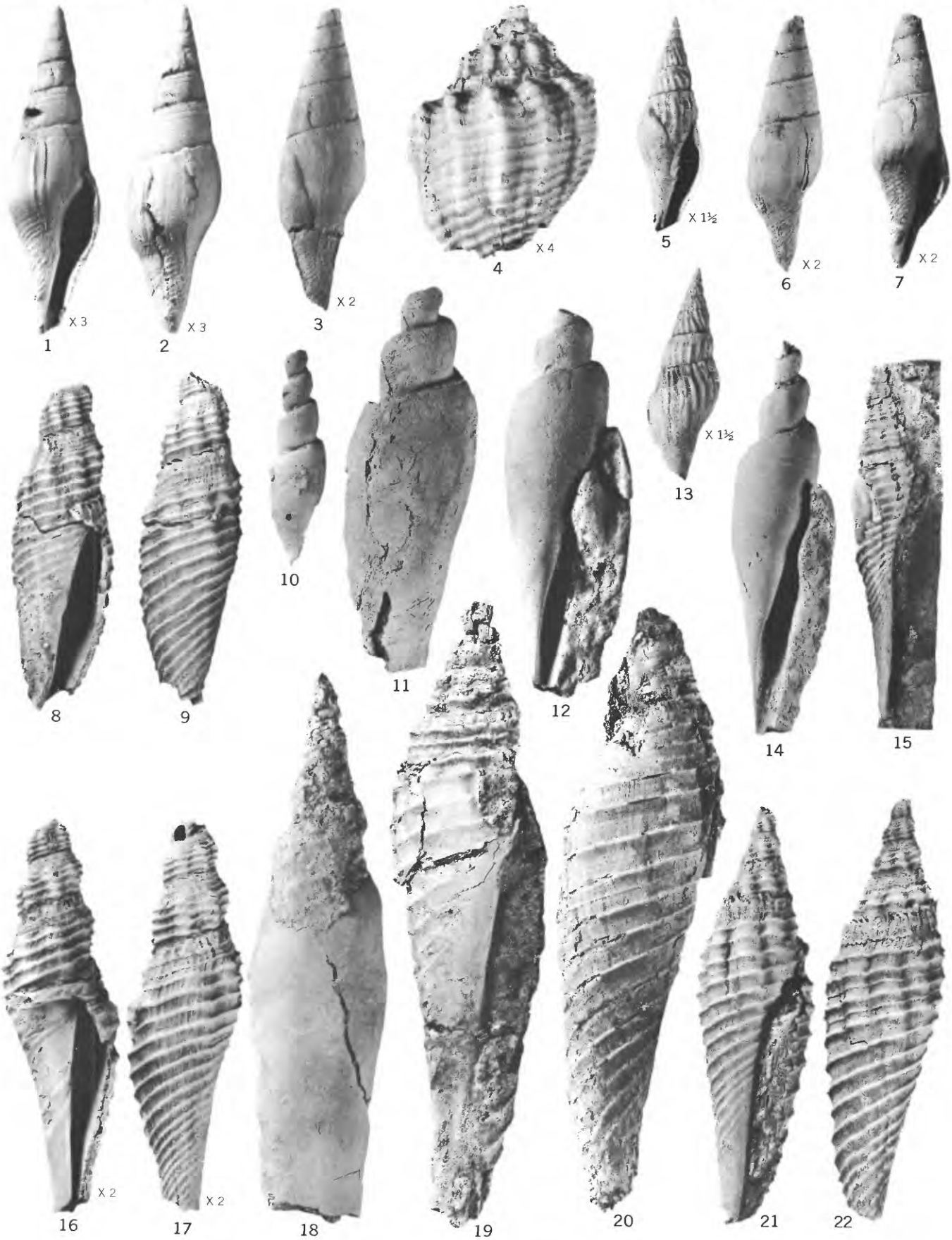
15, 19, 20. *Longoconcha dalli* (Stephenson)? (p. 252).

15. Back view of a specimen (× 1) from the Owl Creek Formation at loc. 46. USGS 707, USNM 20430.

19, 20. Back and front views of a specimen (× 1) from the Owl Creek Formation at loc. 46. USGS 707, USNM 20430.

21, 22. *Longoconcha tennesseensis* (Wade) (p. 251).

Front and back views of a topotype (× 1) from the Ripley Formation at loc. 1. USGS 16951, USNM 130474.



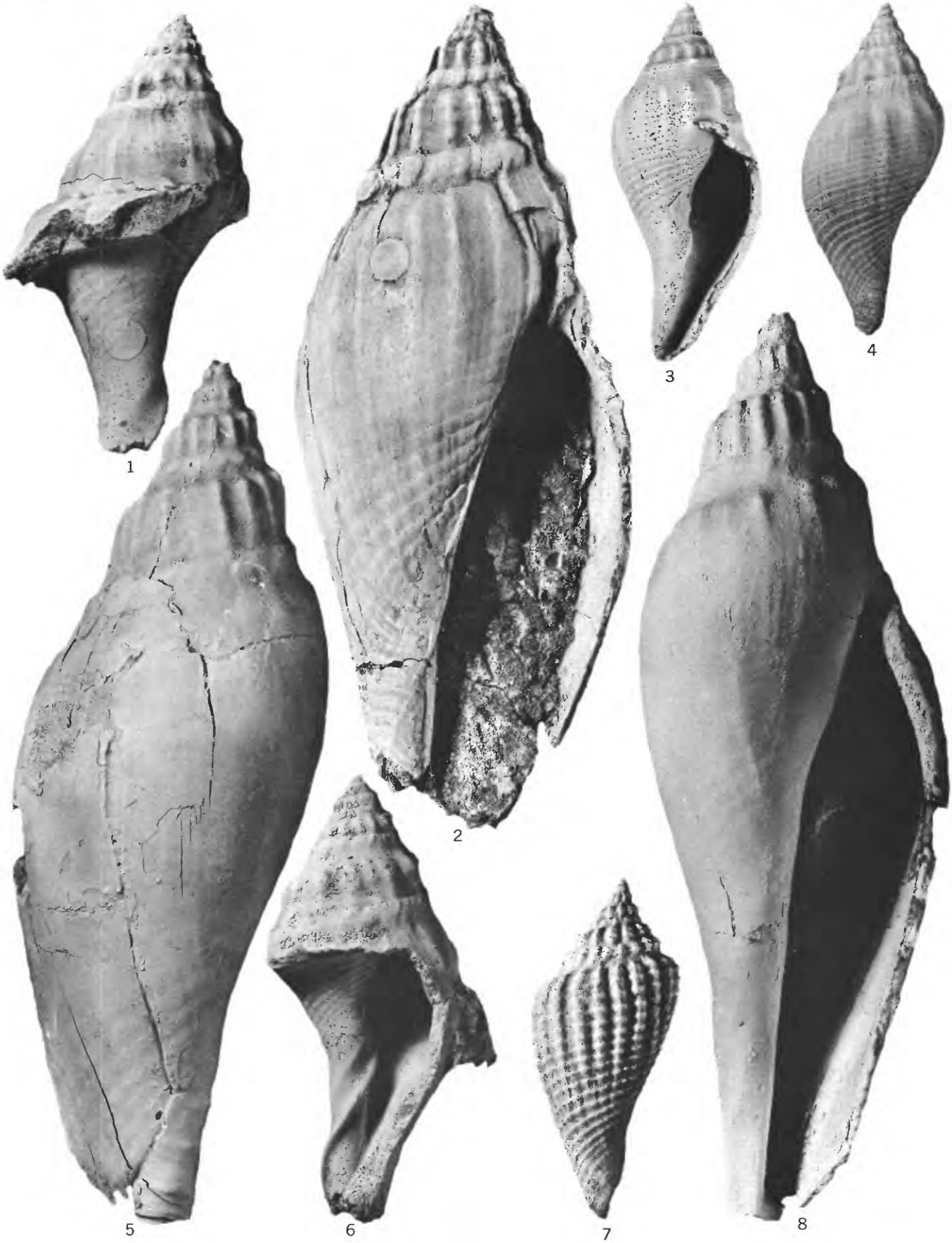
PALEOFUSIMITRA, MITRIDOMUS, LONGOCONCHA, VOLUTOMORPHA

PLATE 38

FIGURES 1, 6. *Volutomorpha dumasensis* Dall (p. 255).
Views of the incomplete holotype (× 1) from the Ripley Formation at loc. 13. USGS 712, USNM 20503.

2–5, 8. *Volutomorpha valida* Sohl, n. sp. (p. 253).
2. Front view of a paratype (× 1) from the Ripley Formation at loc. 13. USGS 712, USNM 20534.
3, 4. Front and back views of a paratype (× 1) from the Ripley Formation at loc. 18. USGS 25411, USNM 130676.
5, 8. Back and front views of the holotype (× 1) from the Ripley Formation at loc. 18. USGS 25411, USNM 130673.

7. *Volutomorpha mutabilis* Wade (p. 255).
Back view of a topotype (× 1) from the Ripley Formation at loc. 1. USGS 25406, USNM 130683.



VOLUTOMORPHA

PLATE 39

FIGURES 1, 2, 6. *Volutomorpha mutabilis* Wade (p. 255).

1, 2. Back and front views of a topotype (× 1) from the Ripley Formation at loc. 1. USGS 10198, USNM 130682.

6. Back view of a topotype (× 1) from the same locality. USGS 10198, USNM 130680.

3, 5, 9. *Volutomorpha dumasensis* Dall (p. 255).

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 lioica* Dall from the same locality. USNM 21127.

4. *Volutomorpha* cf. *V. retifera* Dall (p. 257).

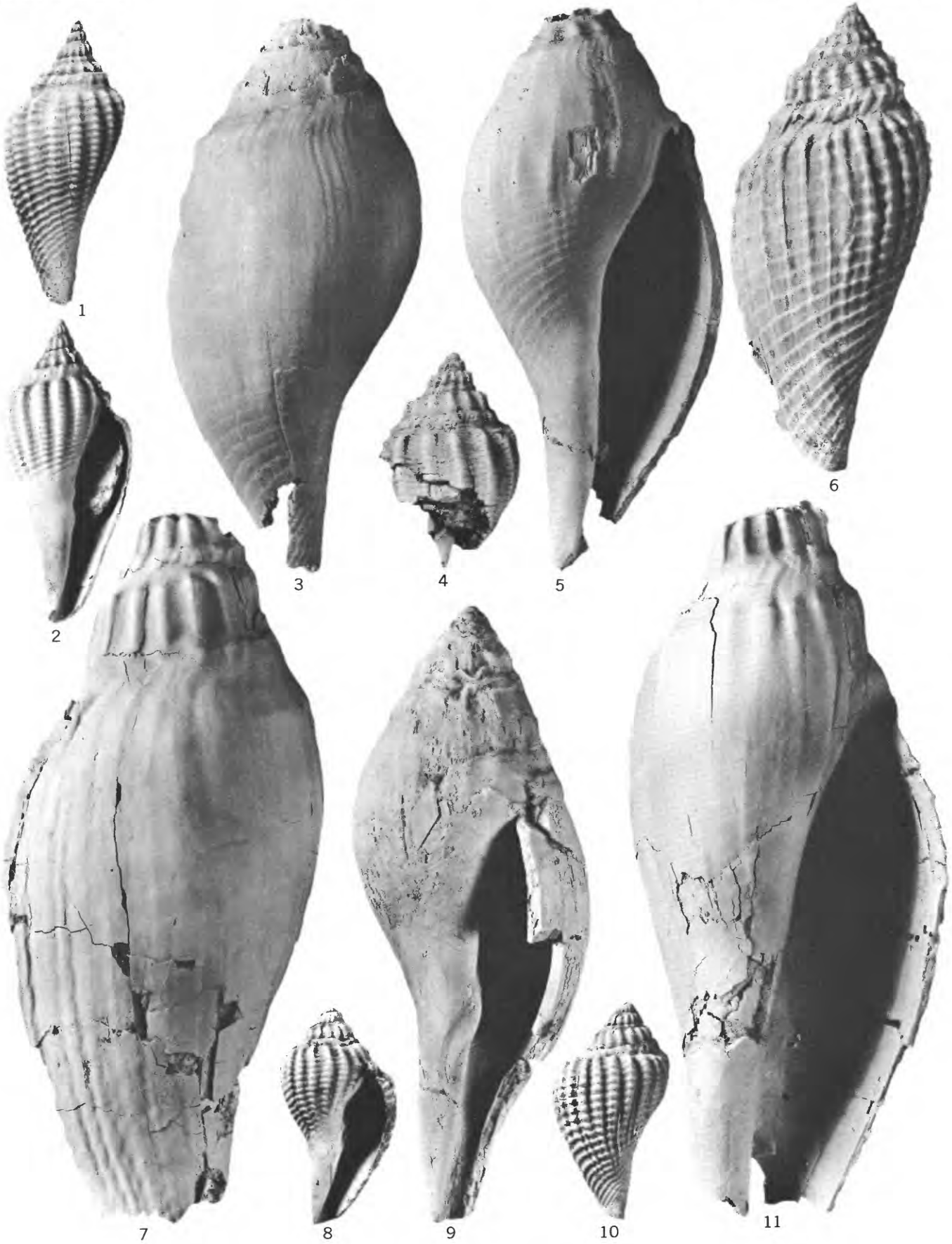
View of an incomplete specimen (× 1) from the Owl Creek Formation at loc. 46. USGS 541, USNM 130689.

7, 11. *Volutomorpha valida* Sohl, n. sp. (p. 253).

Back and front views (× 1) of a paratype from the Ripley Formation at loc. 5. USGS 708, USNM 20576.

8, 10. *Volutomorpha gigantea* Wade (p. 256).

Front and back views of a topotype (× 1) from the Ripley Formation at loc. 1. USGS 25406, USNM 130681.



VOLUTOMORPHA

PLATE 40

FIGURES 1, 2, 5. *Volutomorpha dumasensis* Dall (p. 255).

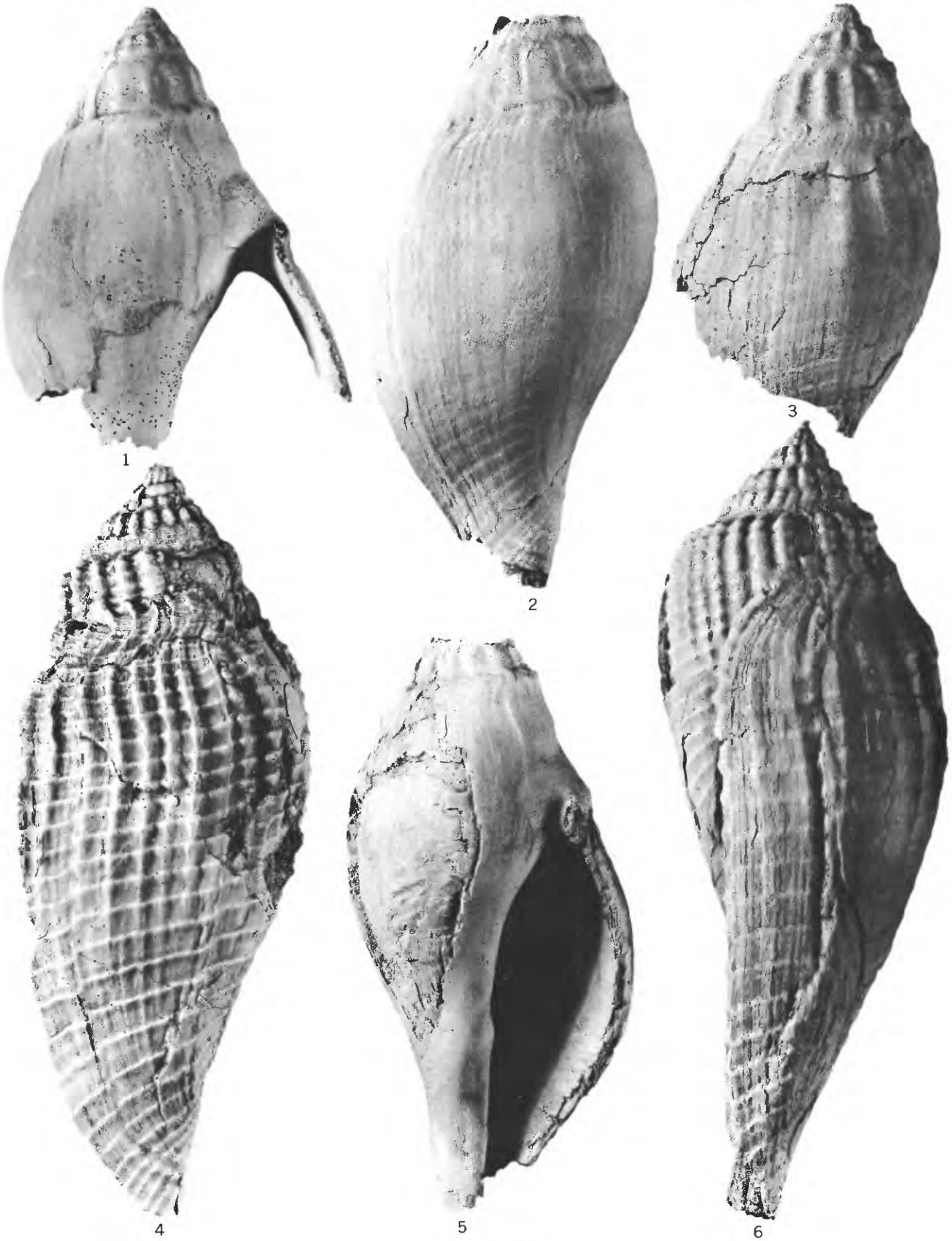
1. Front view of an incomplete specimen (× 1) from the Ripley Formation at loc. 6. USGS 25407, USNM 130678.

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 130686.

4. *Volutomorpha gigantea* Wade (p. 256).
Back view of the holotype (× 1) from the Ripley Formation at loc. 1. USNM 32856.

6. *Volutomorpha mutabilis* Wade (p. 255).
Side view of the holotype (× 1) from the Ripley Formation at loc. 1. USNM 32858.



VOLUTOMORPHA

PLATE 41

FIGURES 1, 2, 5, 7. *Volutomorpha retifera* Dall (p. 256).

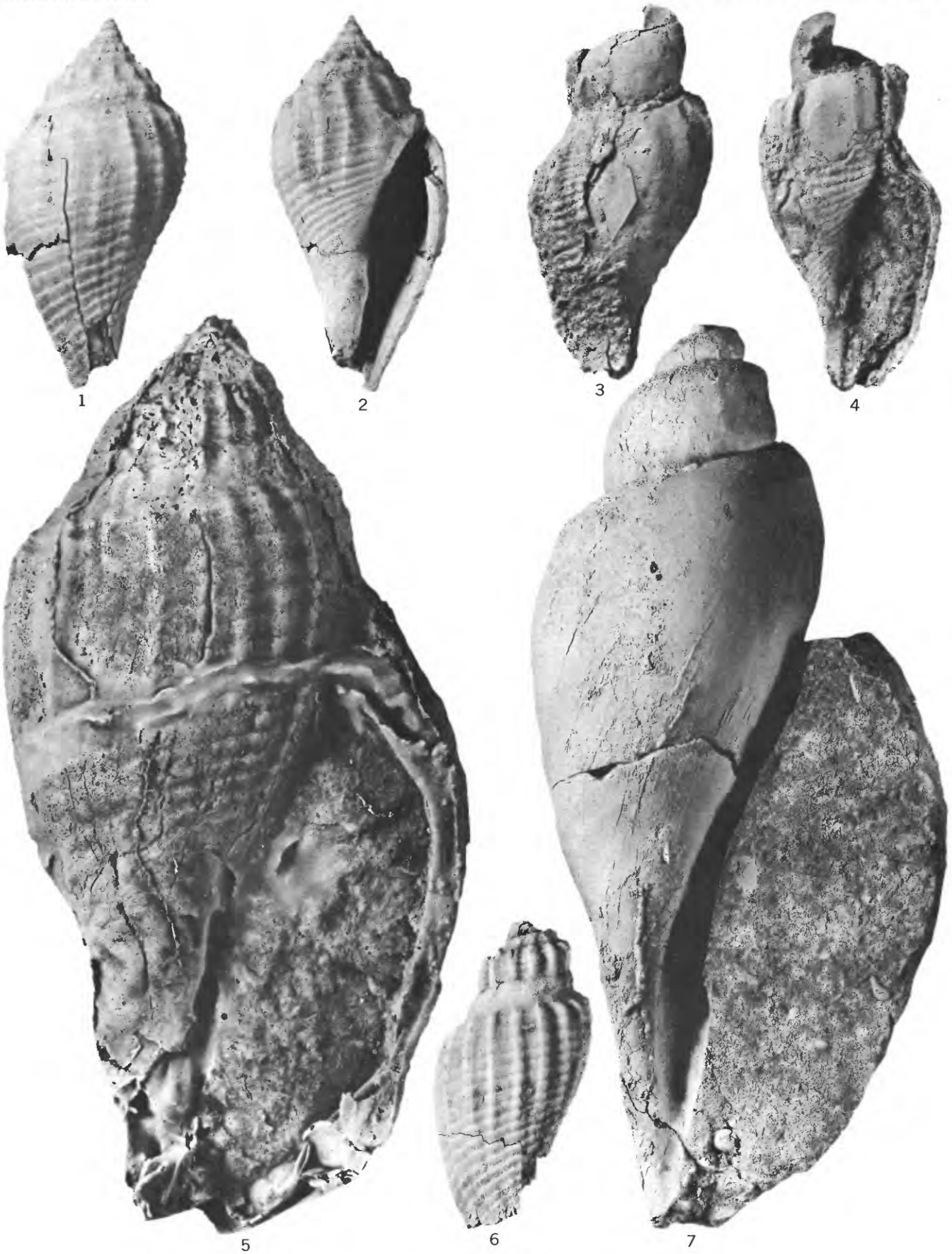
1, 2. Back and front views of a specimen (× 1) from the Ripley Formation at loc. 6. USGS 25407, USNM 130685.

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. 23. USGS 25494, USNM 130687.

3, 4, 6. *"Volutomorpha" aspera* Dall (p. 257).

3, 4. Back and front views of the holotype (× 1) from the Owl Creek Formation at loc. 46. USNM 20404.

6. Back view of a specimen (× 1) from the Ripley Formation at loc. 18. USGS 18629, USNM 130695.



VOLUTOMORPHA

PLATE 42

FIGURES 1, 9, 13, 15. *Volutomorpha producta* Sohl, n. sp. (p. 257).

1, 9. Front and back views of a paratype (× 1) from the Ripley Formation at loc. 6. USGS 25407, USMN 130692.

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.

7–8, 12. Back, front, and side view of a specimen (× 1) from the Ripley Formation at loc. 17. USGS 25410, USNM 130715.

10. *Volutomorpha* cf. *V. retifera* Dall (p. 257).

Back view of an internal mold (× 1) from the Prairie Bluff Chalk at loc. 71. USGS 25428, USNM 130690.

11, 14. "*Volutomorpha*" *aspera* Dall (p. 257).

11. Back view of a specimen (× 1) from the Ripley Formation at loc. 1. USNM 32855.

14. Front view of an incomplete specimen (× 1) from the Owl Creek Formation at loc. 45. USGS 25422, USNM 130688.

VOLUTOMORPHA, LIOPEPLUM

690-081 O - 64 - 12

PLATE 43

FIGURES 1, 2, 6, 7. *Liopeplum leioderma* Conrad (p. 258).

1. Back view of a specimen (× 1) from the Ripley Formation at loc. 29. USGS 25485, USNM 130702.
2. Back view of a specimen (× 1) from the Ripley Formation at loc. 17. USGS 25410, USNM 130696.
6, 7. Back and front views of a specimen (× 1) from the Ripley Formation at loc. 17. USGS 25410, USNM 130698.

3, 21, 22, 24, 25. *Liopeplum cretaceum* (Conrad) (p. 261).

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, 17, 18, 23. *Liopeplum canalis* Conrad (p. 261).

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.
23. Back view of a topotype (× 1) from the same locality. USGS 707, USNM 130703.

8. *Liopeplum rugosum* Stephenson (p. 262).

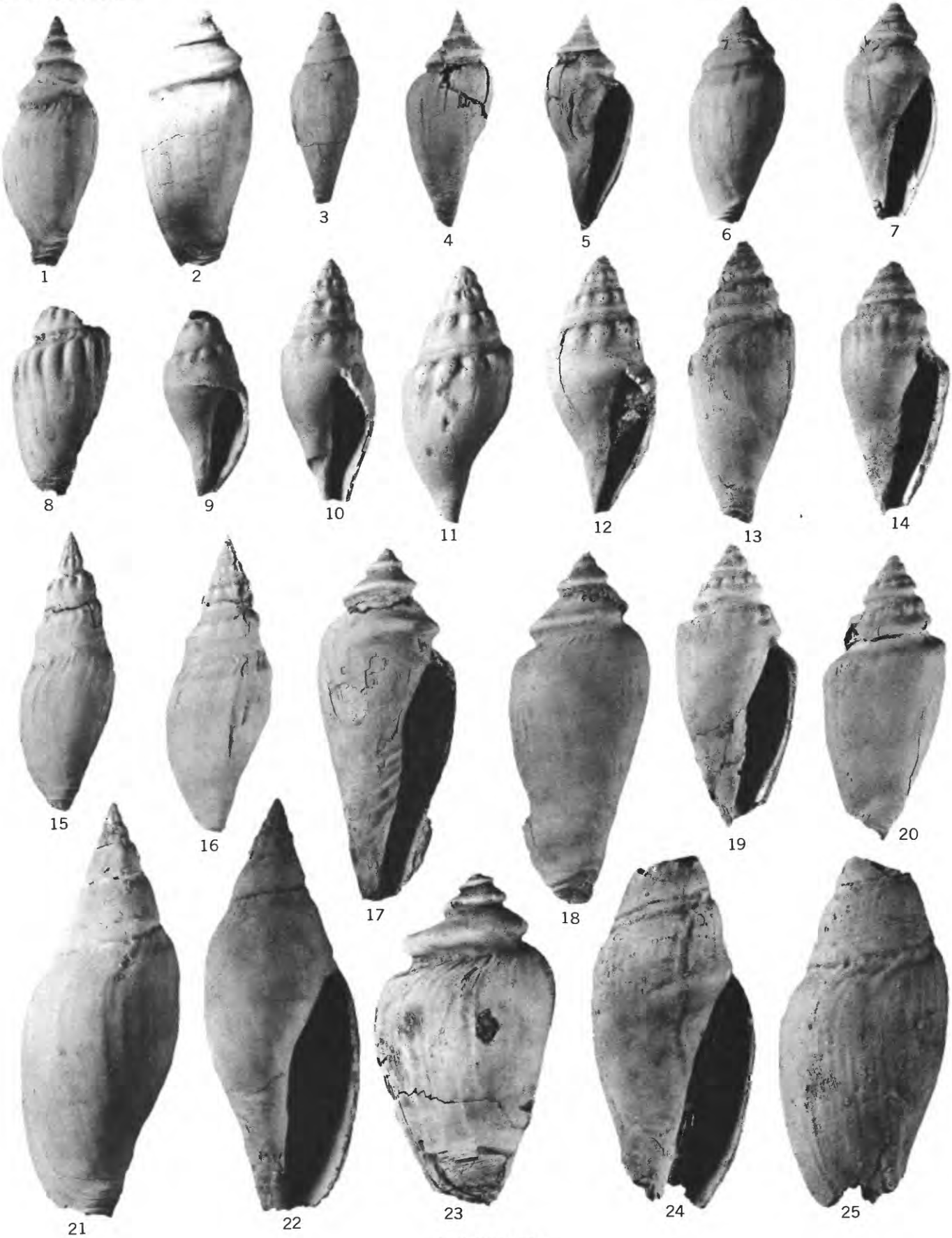
Back view of a specimen (× 1) figured by Dall (1890, pl. 6, fig. 12a) as the holotype of *Liopeplum subjugosum* Dall. USNM Mesozoic 32100, USNM Cenozoic 111801.

9–12, 15, 16. *Liopeplum nodosum* Sohl, n. sp. (p. 263).

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 (× 1½) 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.
19, 20. Front and back views of a topotype (× 1) from the same locality. USGS 25406, USNM 130708.



LIOPEPLUM

PLATE 44

FIGURE 1, 2. *Cancellaria macnairyensis* Sohl, n. sp. (p. 268).
Back and front views of the holotype (× 6) from the Ripley Formation at loc. 1. USGS 25406, USNM 130492.

3, 4. *Caveola* sp. (p. 270).
3. Back view of a specimen (× 2) from the Owl Creek Formation at loc. 46. USGS 25423, USNM 130497.
4. Back view of a specimen (× 2) from the Owl Creek Formation at loc. 46. USGS 25423, USNM 130498.

5–8. *Caveola acuta acuta* Wade (p. 269).
5. Back view of a topotype (× 4) from the Ripley Formation at loc. 1. USGS 10198, USNM 130554.
6–8. Front, side, and back views of a topotype (× 2) from the same locality. USGS 10198, USNM 130494.

9–14. *Caveola acuta speciosa* Sohl, n. subsp. (p. 270).
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.

15–17. *Myobarbum laevigatum* Sohl, n. (p. 266).
15, 16. Front and back views of the holotype (× 2) from the Owl Creek Formation at loc. 46. USGS 6464, USNM 130482.
17. Front view of a paratype (× 2) from the Ripley Formation at loc. 22. USGS 26352, USNM 130483.

18. *Parafusus coloratus* Wade (p. 265).
Front view of the holotype (× 1) from the Ripley Formation at loc. 1. USNM 32877.

19–21. *Tectaplica simplica* Wade (p. 264).
Front, side, and back views of the holotype (× 1) from the Ripley Formation at loc. 1. USNM 32875.

22, 23, 26. *Parafusus callilateris* Wade (p. 265).
22, 23. Back and front views of a specimen (× 1) from the Ripley Formation at loc. 7. USGS 709, USNM 20506.
26. Front view of the holotype (× 1) from the Ripley Formation at loc. 1. USNM 32879.

24, 28. *Parafusus saffordi* Sohl, n. sp. (p. 265).
Front and back views of the holotype (× 1) from the Clayton Formation at loc. 40. USGS 25420 USNM 130479.

25, 27. *Trigonostoma ripleyana* Sohl, n. sp. (p. 268).
Front and back views of the holotype (× 2) from the Ripley Formation at loc. 18. USGS 18616, USNM 130491.

CANCELLARIA, CAVEOLA, MYOBARBUM, PARAFUSUS, TECTAPLICA, TRIGONOSTOMA

PLATE 45

FIGURES 1–5. *Amuletum (Amuletum) macnairyensis macnairyensis* (Wade) (p. 275).

1, 2. Front and back views of the holotype of *Exilia ripleyana* Wade (× 4) from the Ripley Formation at loc. 1. USNM 32890.

3. Back view of a topotype (× 5) from the Ripley Formation at loc. 1. USGS 10198, USNM 130514.

4, 5. Front and back views of a topotype (× 5) from the same locality. USGS 10198, USNM 130515.

6–9. *Amuletum (Amuletum) macnairyensis torquatum* Sohl, n. subsp. (p. 276).

6, 7. Back and front views of the holotype (× 3) from the Ripley Formation at loc. 6. USGS 25407, USNM 130516.

8. Back view of a paratype (× 4) from the Ripley Formation at loc 18. USGS 25411, USNM 130517.

9. Back view of a paratype (× 5) from the same locality. USGS 25411, USNM 130518.

10–15. *Amuletum (Amuletum) dumasensis* Sohl, n. sp. (p. 276).

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. 6. USGS 25407, USNM 130520.

12, 13. Front and back views of the holotype (× 4) from the same locality. USGS 25407, USNM 130519.

14. Back view of a paratype (× 3) from the Ripley Formation at loc. 18. USGS 25411, USNM 130522.

15. Back view of a paratype (× 3) from the same locality. USGS 25411, USNM 130521.

16–19. *Amuletum (Amuletum) wadei* Harbison (p. 277).

16, 17. Front and back views of the holotype (× 3) from the Ripley Formation at loc. 18. USNM 103750.

18. Front view of an incomplete topotype (× 3) from the same locality. USGS 25411, USNM 130524.

19. Front view of a specimen (× 5) from the Ripley Formation at loc. 6. USGS 25406, USNM 130525.

20–27. *Mataxa elegans* Wade (p. 267).

20, 21. Front and back views of a topotype (× 1½) from the Ripley Formation at loc. 1. USGS 25406, USNM 130487.

22, 23. Front and back views of a topotype (× 2) from the same locality. USGS 25406, USNM 130488.

24, 25. Front and back views of a specimen (×1½) from the Ripley Formation at loc. 6. USGS 25407, USNM 130489.

26. Front view of a topotype (× 1½) from the Ripley Formation at loc. 1. USGS 25406, USNM 130486.

27. Back view of a topotype (× 1½) from the Ripley Formation at loc. 1. USGS 25406, USNM 130485.

28–34. *Paladmete cancellaria* (Conrad) (p. 271).

28. Back view of a specimen (× 2) from the Owl Creek Formation at loc. 42. USGS 713, USNM 130505.

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, 41, 42, 46–48. *Paladmete laevis* Sohl. n. sp. (p. 273).

35. Front view of a paratype (× 5) from the Ripley Formation at loc. 7. USGS 709, USNM 130513.

41. Back view of a paratype (× 3) from the same locality. USGS 709, USNM 130511.

42. Front view of a paratype (× 3) from the same locality. USGS 709, USGS 130512.

46. Back view of a paratype (× 3) from the Ripley Formation at loc. 12. USGS 711, USNM 130510.

47, 48. Back and front views of the holotype (× 3) from the Ripley Formation at loc. 18. USGS 18616, USNM 130509.

36–40. *Paladmete gardnerae pymae* Sohl, n. subsp. (p. 273).

36. Back view of a paratype (× 3) from the Ripley Formation at loc. 7. USGS 709, USNM 130507.

37. Front view of a paratype (× 4) from the Ripley Formation at loc. 18. USGS 25411, USNM 130508.

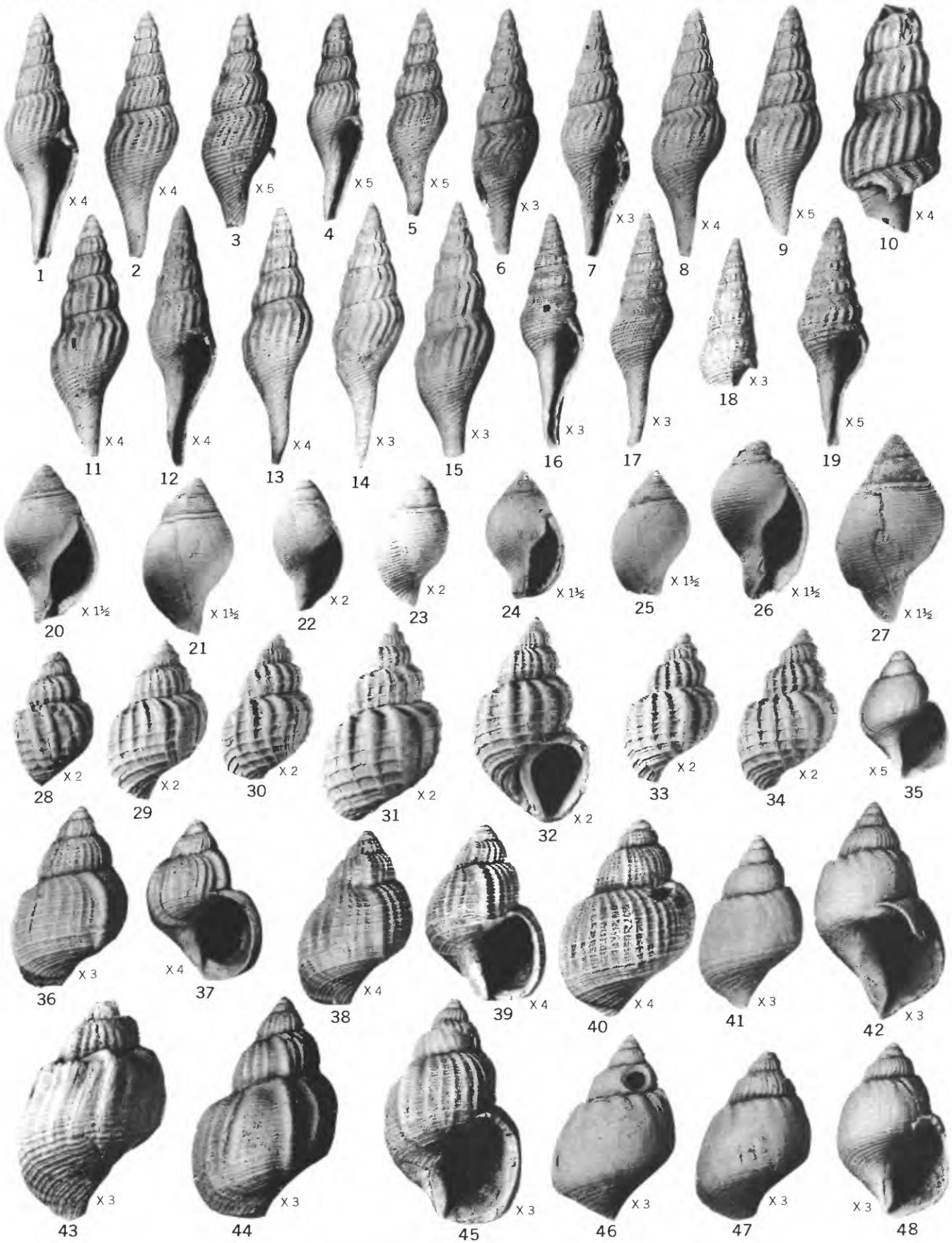
38, 39. Back and front views of the holotype (× 4) from the same loc. USGS 25411, USNM 130506.

40. Back view of a paratype (× 4) from the same locality. USGS 25411, USNM 130553.

43–45. *Paladmete gardnerae gardnerae* Wade, (p. 272).

43. Back view of a topotype (× 3) from the Ripley Formation at loc. 1. USGS 25406, USNM 130729.

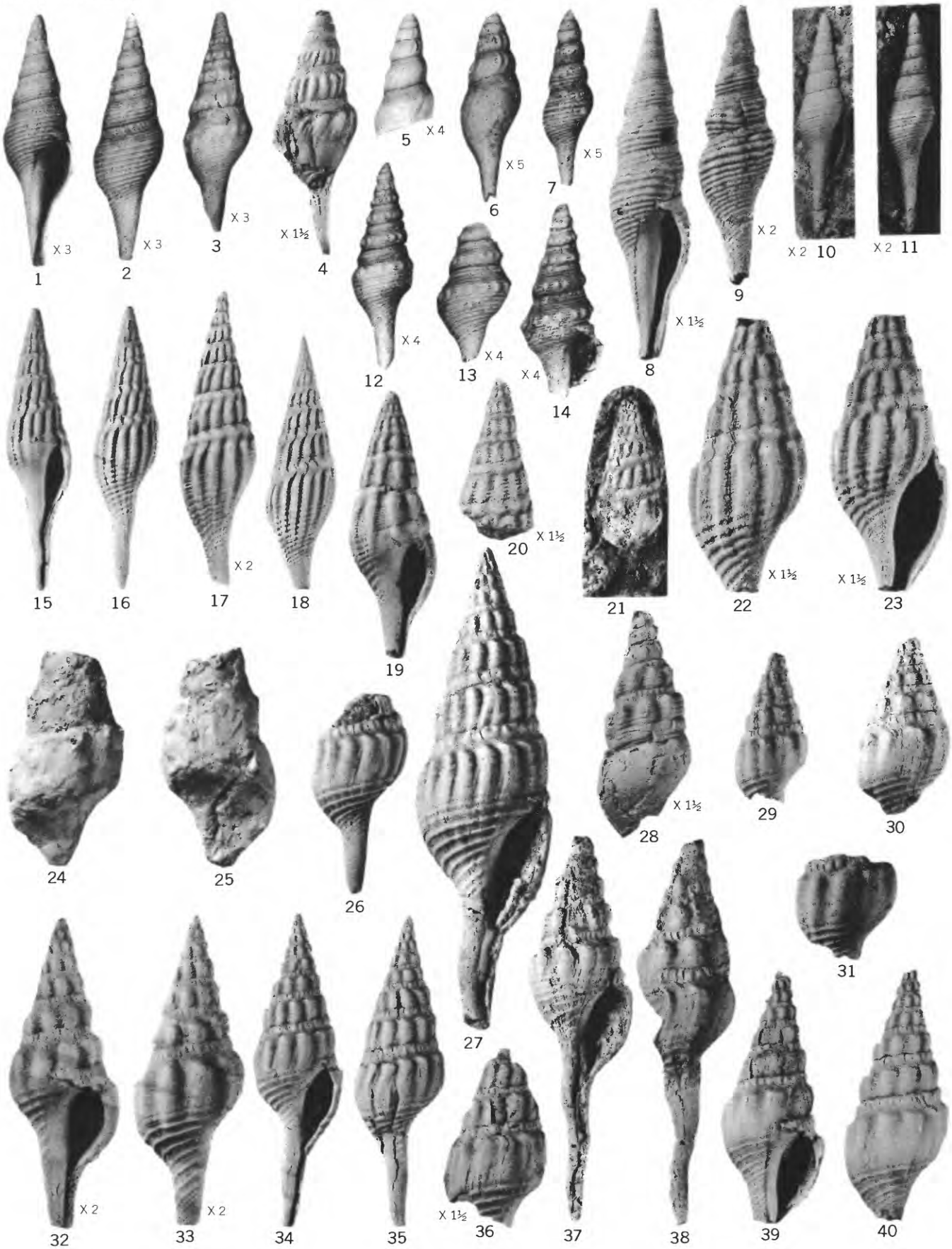
44, 45. Back and front views of a toptype (× 3) from the same locality. USGS 25406, USNM 130552.



AMULETUM, MATAXA, PALADMETE

PLATE 46

FIGURES 1–3. *Amuletum fasciolatum* (Wade) (p. 278).
1, 2. Front and back views of a topotype (× 3) from the Ripley Formation at loc. 1. USGS 25406, USNM 130527.
3. Back view of a topotype (× 3) from the same locality. USGS 10198, USNM 130526.
4. *Amuletum* (*Lutema*) *limbatum* Sohl, n. sp. (p. 278).
Back view of the holotype (× 1½) from the Ripley Formation at loc. 4. USGS 543, USNM 130528.
5, 6. *Amuletum* (*Lutema*) sp. (p. 279).
5. Back view of a specimen (× 5) from the Ripley Formation at loc. 6. USGS 25407, USNM 130530.
6. Back view of a specimen (× 4) from the same locality. USGS 25407, USNM 130529.
7, 8. *Remnita biacuminata* (Wade) p. 279).
7. Back view of a topotype (× 5) from the Ripley Formation at loc. 5. USGS 25406, USNM 130531.
8. Front view of the holotype (× 1½) from the same locality. USNM 32854.
9. *Remnita anomalocostata* (Wade) (p. 279).
Back view of a topotype (× 2) from the Ripley Formation at loc. 1. USGS 16159, USNM 130532.
10, 11. *Remnita hastata* Sohl, n. sp. (p. 280).
Front and back views of the holotype (× 2) from the Owl Creek Formation at loc. 46. USGS 707, USNM 20410.
12–14. *Gemmula cretacea* Sohl, n. sp. (p. 281).
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.
14. Front view of a paratype (× 4) from the Owl Creek Formation at loc. 46. USGS 25423, USNM 130535.
15–18. *Beretra gracilis* (Wade) (p. 283).
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.
19–21. *Beretra ripleyana* (Conrad) (p. 282).
19. Front view of a topotype (× 1) from the Owl Creek Formation at loc. 46. USGS 707, USNM 130536.
20. View of a part of the spine of a topotype (× 1½) from the same locality. USGS 25423, USNM 130537.
21. Back view of the compressed holotype (× 1) of *Drillia georgiana* Gabb, from the Providence Sand on Pataula Creek, Ga. ANSP 14995.
22, 23. *Beretra speciosa* Sohl, n. sp. (p. 283).
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).
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).
26. Back view of a topotype (× 1) from the Ripley Formation at loc. 1. USGS 10198, USNM 130543.
27. Front view of the holotype (× 1) from the same locality. USNM 32847.
34, 35. Front and back views of a topotype (× 1) from the same locality. USGS 10198, USNM 130542.
28, 37, 38. *Fusimilis novemcostatus* (Conrad) (p. 285).
28. Back view of an incomplete specimen (× 1½) from the Owl Creek Formation at loc. 45. USGS 25422, USNM 130547.
37, 38. Front and side views of a topotype (× 1) from the Owl Creek Formation at loc. 46. USGS 25423, USNM 20420.
29, 30, 32, 33, 39, 40. *Fusimilis kummeli* Sohl (p. 285).
29. Back view of a paratype (× 1) from the Ripley Formation at loc. 18. USGS 25411, USNM 130545.
30. Back view of a paratype (× 1) from the same locality. USGS 25411, USNM 130546.
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).
31. Back view of part of a body whorl (× 1) from the Clayton Formation at loc. 40. USGS 25420 USNM 130548.
36. Back view of an incomplete specimen (× 1½) from the Owl Creek Formation at loc. 45. USGS 25422, USNM 130549.



AMULETUM, GEMMULA, REMNITA, BERETRA, FUSIMILIS

PLATE 47

FIGURES 1, 2. *Tornatellaea globulosa* Wade (p. 292).
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.

5, 10, 11, 12. *Eoacteon linteus* (Conrad) (p. 289).
5. Section of a topotype (× 5) from the Owl Creek Formation at loc. 46, enlarged to show sculpture. USGS 25432, USNM 130561.
10, 11. Back and front views of a topotype (× 3) from the same locality. USGS 707, USNM 130559.
12. Front view of a topotype (× 3) from the same locality. USGS 707, USNM 130559.

6–9. *Cryptoconus macnairyensis* (Wade) (p. 287).
6, 7. Front and back views of a topotype (× 6) from the Ripley Formation at loc. 1. USGS 25406, USNM 130550.
8, 9. Front and back views of a topotype (× 6) from the same locality. USGS 25406, USNM 130551.

13, 14. *Eoacteon ellipticus* (Wade) (p. 290).
Front and back views of the holotype (× 3) from the Ripley Formation at loc. 1. USGS 32828.

15. *Eoacteon percultus* Sohl, n. sp. (p. 289).
Front view of the holotype from the Ripley Formation at loc. 1. USNM 32823.

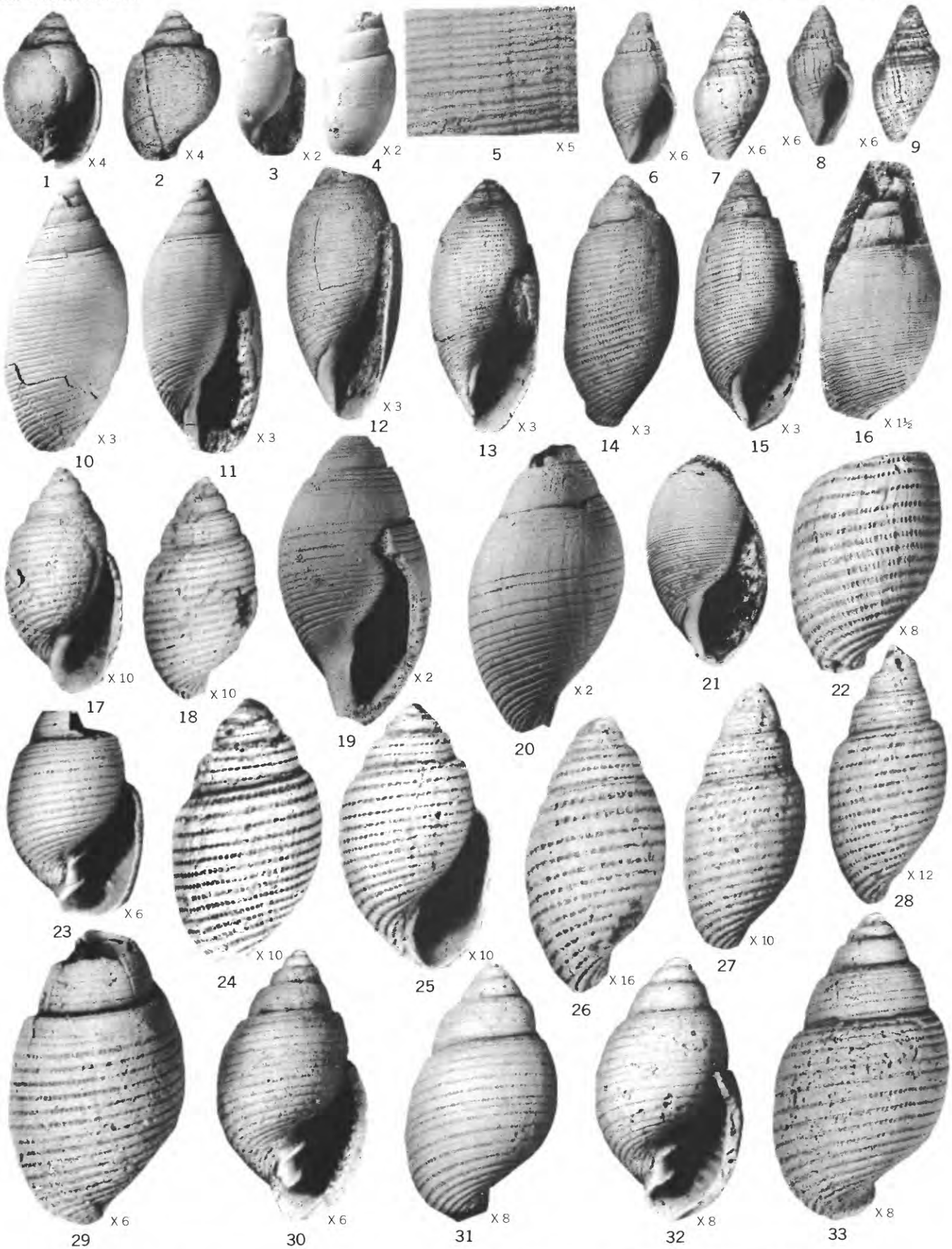
16, 21. *Troostella substriatus* (Wade) p. 291).
16. Back view of the holotype (× 1½) from the same locality. USNM 32825.
21. Front view of a paratype (× 1) from the Ripley Formation at loc. 1. USNM 32825.

17, 18, 22. *Acteon cicatricosus* Sohl, n. sp. (p. 288).
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.

19, 20. *Troostella perimprẽssa* (Wade) (p. 291).
Front and back views of the holotype (× 2) from the Ripley Formation at loc. 1. USNM 32830.

23, 29–33. *Tornatellaea cretacea* Wade (p. 291).
23. Front view of a topotype (× 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 topotype (× 8) from the Ripley Formation at loc. 1. USGS 25406, USNM 130564.
33. Back view of a topotype (×8) from the Ripley Formation at loc. 1. USGS 25406, USNM 130563.

24–28. *Acteon pistiliformis* Sohl, n. sp. (p. 287).
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 (× 16) 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.
28. Back view of a paratype (× 12) from the Ripley Formation at loc. 1. USGS 10198, USNM 130557.



TORNATELLAEA, EOACTEON, CRYPTOCONUS, ACTEON, TROOSTELLA

PLATE 48

FIGURES 1, 2, 6–17. *Ringicula (Ringicula) pulchella* Shumard (p. 293).

1, 2. Front and back views of a specimen (× 4) from the Ripley Formation at loc. 18. USGS 25411, USNM 130576.

6, 7. Back and front views of a specimen (× 4) from the Ripley Formation at loc. 6. USGS 25407, USNM 130574.

8, 9. Front and back views of a specimen (× 4) from the Ripley Formation at loc. 16. USGS 25409, USNM 130571.

10, 11. Front and back views of a specimen (× 4) from the same locality. USGS 25409, USNM 130570.

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. *Parietiplicatum conicum* (Wade) (p. 292).

3, 4. Back and front views of a topotype (× 3) from the Ripley Formation at loc. 1. USGS 25406, USNM 130568.

5. Front view of a topotype (× 3) from the Ripley Formation at loc. 1. USGS 10198, USNM 130569.

18, 19. *Ringicula* cf *R. (Ringulella) clarki* Gardner (p. 295).

18. Rubber impression of an external mold from the Ripley Formation at loc. 9a. USGS 26346, USNM 130581.

19. Back view of a specimen (× 4) from the same locality. USGS 26346, USNM 130582.

20–26. *Ringicula (Ringicula) yochelsoni* Sohl, n. sp. (p. 294).

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. *Oligoptycha americana* (Wade) (p. 296).

27. Back view of a topotype (× 8) from the Ripley Formation at loc 1. USGS 25406, USNM 130584.

30, 31. Front and back views of a topotype (× 8) from the same locality. USGS 25406, USNM 130583.

32, 33. Front and back views of a topotype (× 8) from the same locality. USGS 25406, USNM 130585.

28, 29, 36, 37. *Oligoptycha corrugata* Sohl, n. sp. (p. 297).

28. Front view of a paratype (× 5) from the Ripley Formation at loc. 6. USGS 25407, USNM 130588.

29. Front view of a paratype (× 5) from the Ripley Formation at loc. 11. USGS 25411, USNM 130587.

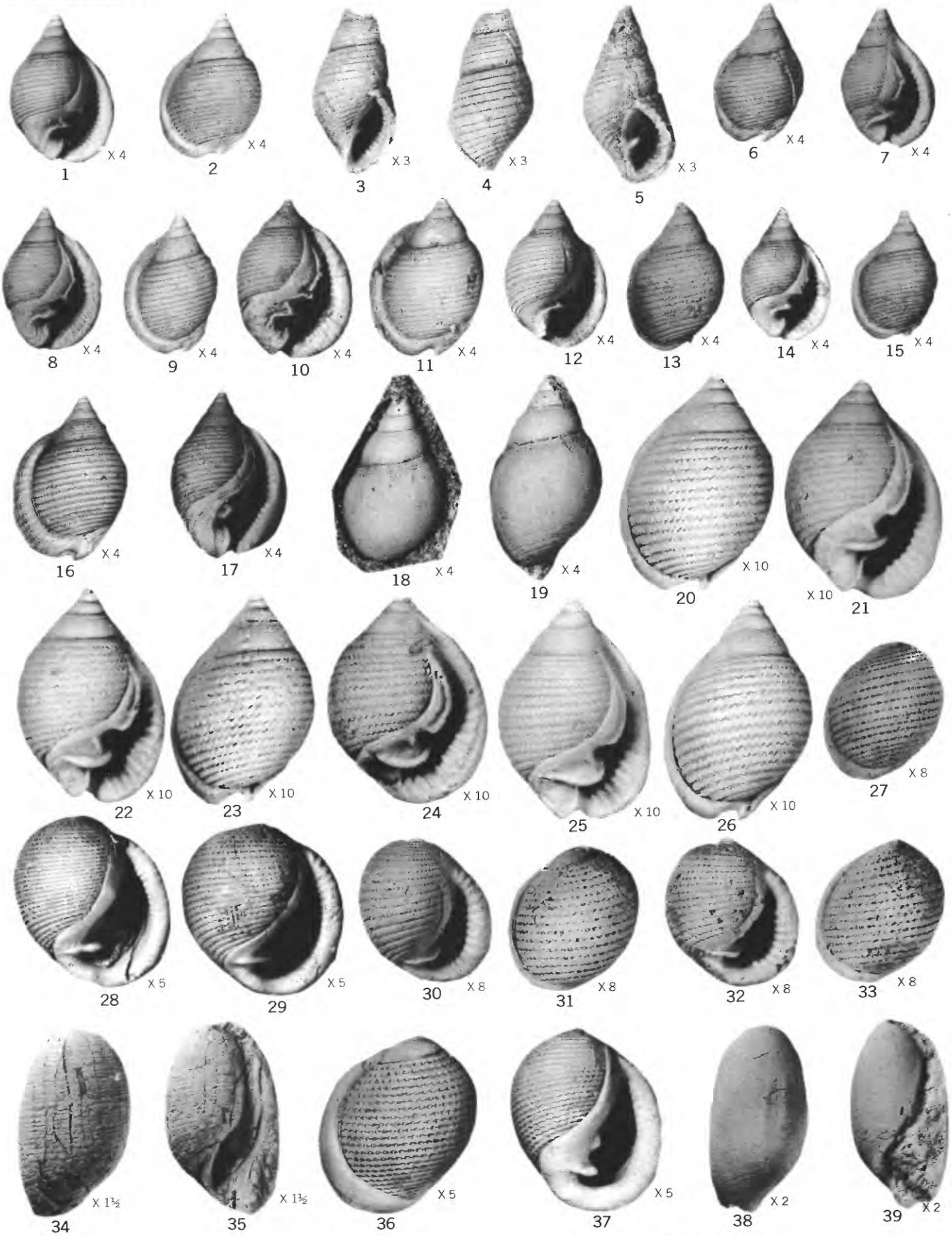
36, 37. Back and front views (× 5) of the holotype from the same locality. USGS 25411, USNM 130586.

34, 35. *Ellipsoscapha mortoni* (Forbes)? (p. 298).

Back and front views of a specimen (× 1½) from the Owl Creek Formation at loc. 46. USGS 707, USNM 20453.

38, 39. *Ellipsoscapha mortoni* (Forbes)? (p. 298).

Back and front views of an internal mold (× 2) from the Prairie Bluff Chalk at loc. 94. USGS 6480, USNM 130590.



RINGICULA, PARIETIPLICATUM, OLIGOPTYCHA, ELLIPSOSCAPHA

PLATE 49

FIGURES 1–3. *Ellipsoscapha?* sp. (p. 298).
1, 2. Front and back views of an internal mold (× 1) from the Prairie Bluff Chalk at loc. 71. USGS 25428, USNM 130593.
3. Front view of an internal mold (× 1½) from the Prairie Bluff Chalk at loc. 71. USGS 25428, USNM 130594.

4, 5. *Ellipsoscapha mortoni* (Forbes)? (p. 298).
Back and front views of an internal mold (× 2) from the Prairie Bluff Chalk at loc. 71. USGS 25428, USNM 130591.

6, 7. *Sulcoretusa* (*Moniliretusa*) *spinosa* Sohl (p. 306).
Front and back view of the holotype (× 10) from the Ripley Formation at the former site of Mercer's Mill on Tabannee Creek, 0.2 miles above the crossing of the Georgia R. R. south of Georgetown, Quitman County, Ga. USGS 25923, USNM 130619.

8–12. *Cylindrotruncatum 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.

13–17. *Zikkuratia tabanneensis* Sohl (p. 304).
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 Tahanna Creek, 0.2 miles above the crossing of the Central of Georgia R.R., south of Georgetown, Quitman County, Ga. USGS 25923, USNM 130614.
16, 17. Front and back views of the holotype (× 10) from the same locality. USGS 25923, USNM 130612.

18–21, 28–31. *Cylichna incisa* Stephenson (p. 300).
18. Back view of a specimen (× 7½) from the Owl Creek Formation at loc. 46. USGS 25423, USNM 130601.
19. Front view of a specimen (× 7½) from the Ripley Formation at loc. 6. USGS 25407, USNM 130599.
20, 21. Front and back views of a specimen (× 7½) from the Ripley Formation at loc. 16. USNM 25409, USNM 130598.
28, 29. Front and back views of a paratype (× 7½) from the Navarro Formation of Texas. USNM 16170a
30, 31. Back and front views of a specimen (× 7½) from the Ripley Formation at locality 29. USGS 25485, USNM 130600.

22, 23. *Cylichna intermissia* Sohl, n. sp. (p. 300).
Front and back views of the holotype (× 8) from the Ripley Formation at loc. 1. USGS 25406, USNM 130602.

24. *Cylichna pessumata* Sohl, n. sp. (p 301).
Front view of the holotype (× 8) from the Ripley Formation at loc. 1. USGS 25406, USNM 130605.

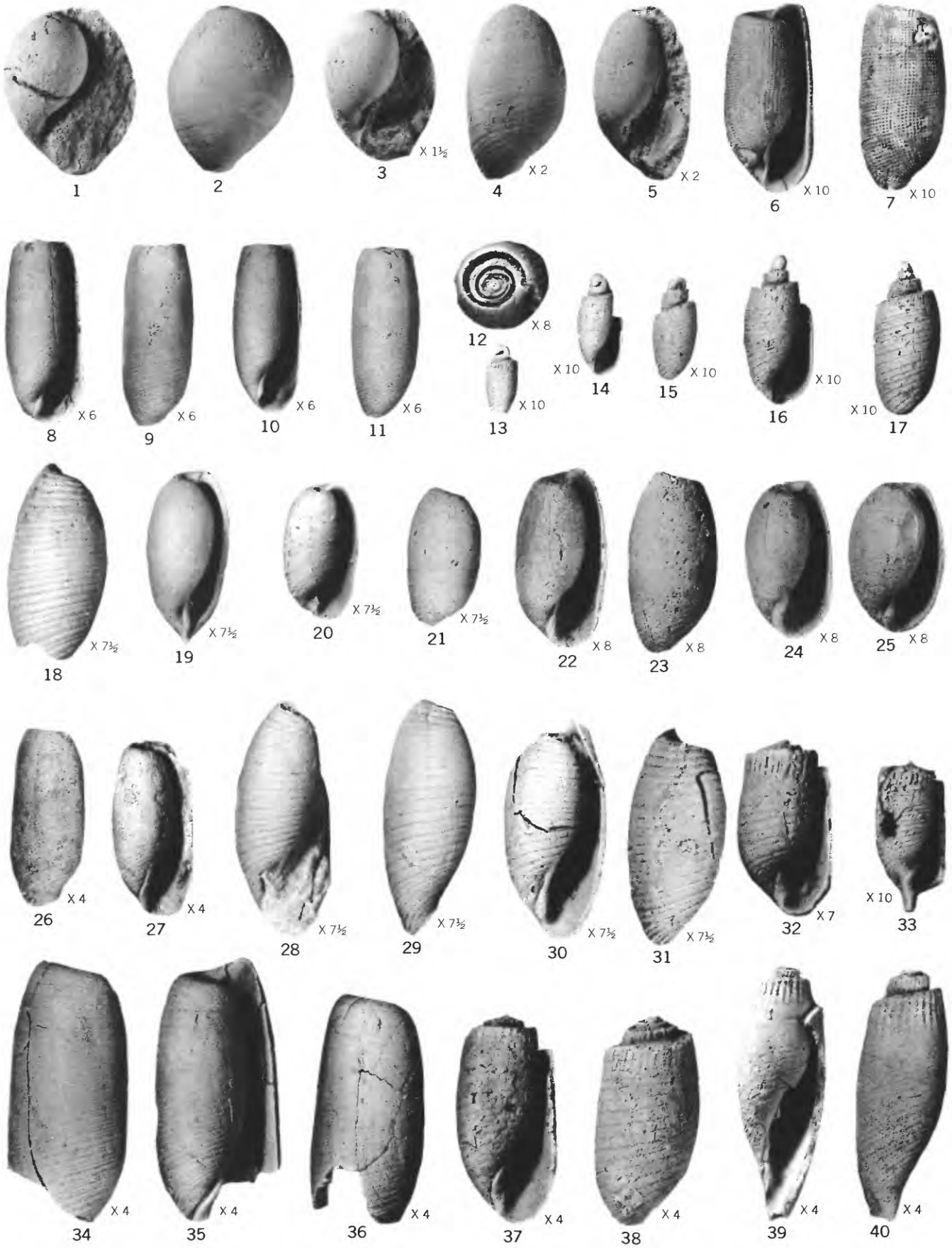
25. *Cylichna intermissia curta* Sohl, n. subsp. (p. 301).
Front view of the holotype (× 8) from the Ripley Formation at loc. 1. USGS 25406, USNM 130604.

26, 27. *Cylichna secalina* Shumard (p. 299).
Back and front views of a specimen (× 4) from the Ripley Formation at loc. 29. USGS 25485, USNM 130595.

32, 33, 37, 38. *Goniocylichna bisculpturata* 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. *Cylichna diversilirata* 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 130596.
36. Back view of a paratype (× 4) from the same locality. USGS 25422, USNM 130597.

39, 40. *Goniocylichna elongata* Sohl, n. sp. (p. 303).
Front and back views of the holotype (× 4) from the Ripley Formation at loc. 22. USGS 26352, USNM 130609.



ELLIPSOSCAPHA, SULCORETUSA, CYLINDROTRUNCATUM, ZIKKURATIA, CYLICHNA, GONIOCYLICHNA

PLATE 50

FIGURES 1–5. *Scobinidola guttatus* Sohl (p. 305).

1, 2. Front and back views of a paratype (× 10) from the Ripley Formation at the site of Mercer's Mill on Tabannee Creek, 0.2 mile above the crossing of the Central Georgia R.R., south of Georgetown, Quitman County, Ga. USGS 25923, USNM 130617

3, 4. Front and back views of the holotype (× 10) from the same locality. USGS 25923, USNM 130616.

5. Front view of a paratype (× 10) from the Ripley Formation of Mississippi at loc. 29. USGS 25485, USNM 130618.

6–8. *Bullopsis demersus* Sohl, n. sp. (p. 307).

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.

9–16. *Bullopsis cretacea* Conrad (p. 306).

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.

17–20. *Bulla?* sp. (p. 308).

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.

21–27. *Lacrimiforma secunda* (Wade) (p. 312).

21, 22. Back and front view of the holotype (× 8) of *Odostomia impressa* Wade, from the Ripley Formation at loc. 1. USNM 73087.

23, 24. Back and front views of the holotype (× 8) from the same locality. USNM 73088.

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 73092.

28. *Eulima? clara* (Wade) (p. 310).

Back view of an incomplete specimen (× 5) from the Ripley Formation at loc. 16. USGS 25409, USNM 130728.

29, 30. *Eulima laevigata* (Wade) (p. 308).

Front and back views of a specimen (× 8) from the Ripley Formation at loc. 18. USGS 18616, USNM 130655.

31–34. *Eulima gracilistylis* Sohl, n. sp. (p. 309).

31, 32. Front and back views of the holotype (× 5) from the Ripley Formation at loc. 16. USGS 25409, USNM 130666.

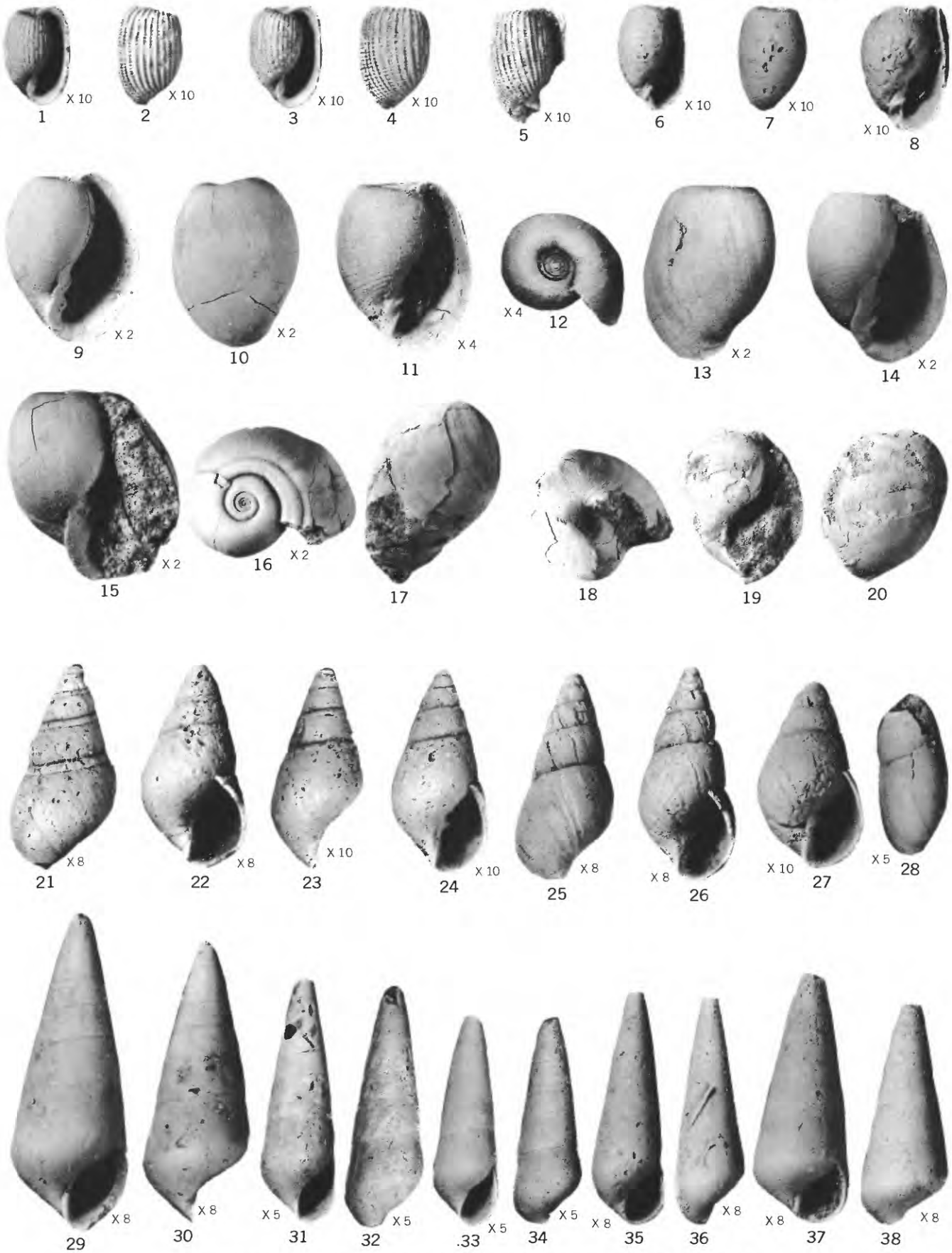
33, 34. Front and back views of a paratype (× 5) from the Ripley Formation at loc. 17. USGS 25410, USNM 130667.

35, 36. *Eulima persimplicata* (Wade) (p. 308).

Front and back views of the holotype (× 8) from the Ripley Formation at loc. 1. USNM 73090.

37, 38. *Eulima* cf. *E. monmouthensis* (Gardner) (p. 309).

Front and back views of a specimen (× 8) from the Owl Creek Formation at loc. 46. USGS 25423, USNM 130668.



SCOBINIDOLA, BULLOPSIS, BULLA?, LACRIMIFORMA, EULIMA

PLATE 51

FIGURES 1–2. *Creonella* 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. *Creonella 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. *Creonella triplicata* Wade (p. 310).
7. Back view of a specimen (× 5) from the Ripley Formation at loc. 6. USGS 25407, USNM 130628.
8. Back view of an immature specimen (× 10) from the Ripley Formation at loc. 24. USGS 13122, USNM 130629.

10–13. *Creonella turretiforma* 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.

14–16. *Acirsa* (*Plesioacirsa*) *wadei* Cossmann (p. 316).
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. *Acirsa* (*Plesioacirsa*) *implexa* 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. *Aciculiscala 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 130659.

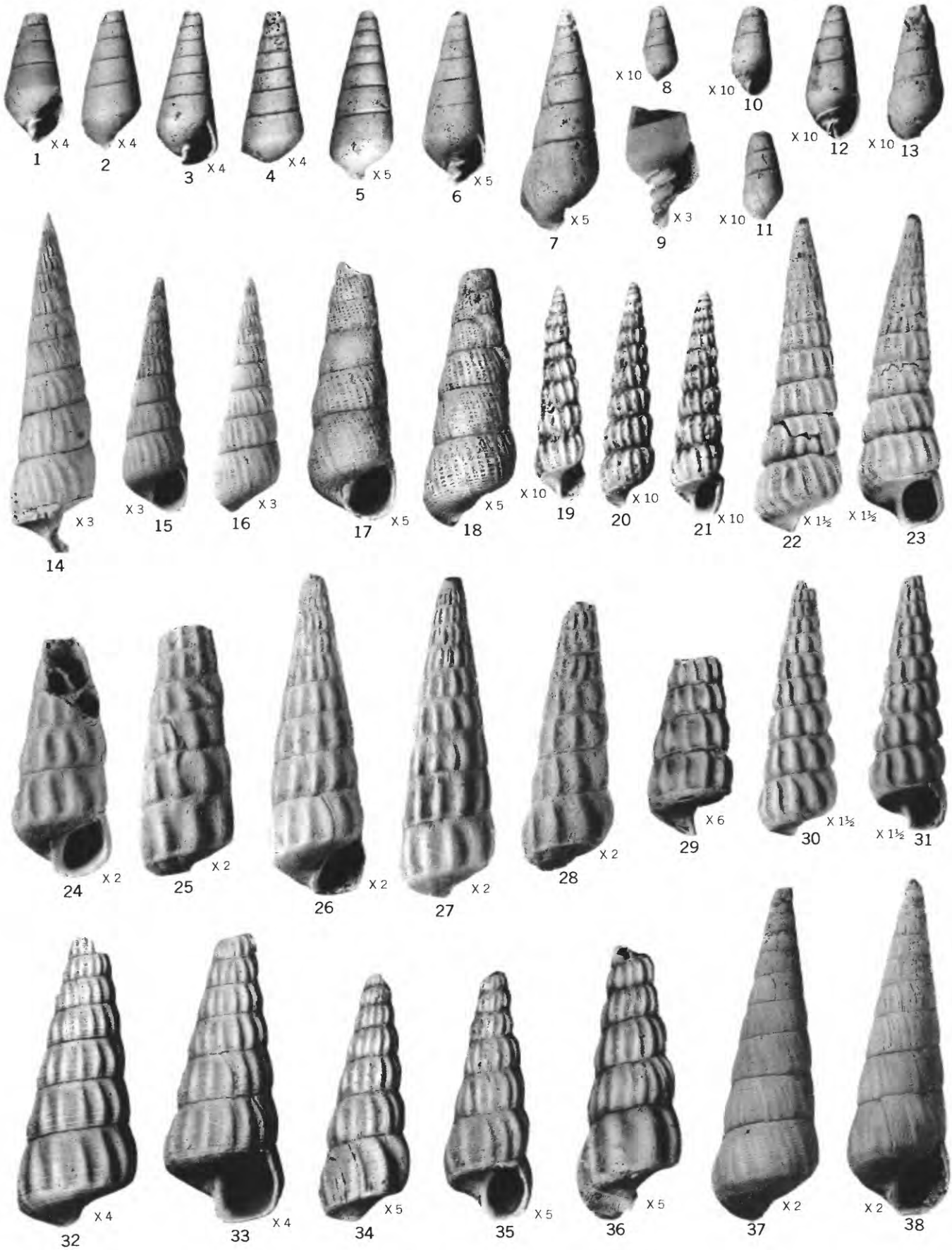
22, 23. *Acirsa* (*Hemiacirsa*) *cretacea* (Wade) (p. 313).
Back and front views of the holotype (× 1½) from the Ripley Formation at loc. 1. USNM 32951.

24–28. *Acirsa* (*Hemiacirsa*) *americana* (Wade) (p. 314).
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 32952.
28. Back view of a topotype (× 2) from the same locality. USGS 25406, USNM 130636.

29–31. *Acirsa* (*Hemiacirsa*) *flexicostata* Sohl, n. sp. (p. 314).
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 loc. 6. USGS 25407, USNM 130638.

32–36. *Acirsa* (*Hemiacirsa*) *clathrata* Sohl, n. sp. (p. 315).
32, 33. Back and front views of the holotype (× 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 Fromation at loc. 6. USGS 25406, USNM 130643.
36. Back view of a paratype (× 5) from the same locality. USGS 25406, USNM 130644.

37, 38. *Acirsa* (*Plesioacirsa*) *microstriata* Sohl, n. sp. (p. 315).
Back and front views of the holotype (× 2) from the Ripley Formation at loc. 1. USNM 32953.



CREONELLA, ACIRSA, ACICULISCALA

PLATE 52

FIGURES 1, 2. *Opalia* (*Opalia?*) *fistulosa* Sohl, n. sp. (p. 320).
Front and back views of the holotype (× 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 (× 2) from the Ripley Formation at loc. 1. USNM 73109.

5, 6. *Opalia* (*Pliciscala*) *wadei* Sohl. n. sp. (p. 321).
Back and front views of the holotype (× 10) from the Ripley Formation at loc. 1. USNM 130662.

7, 9, 13, 19. *Striaticostatum pondi* (Stephenson) (p. 318).
7, 13, 19. Front, back, and basal views of a topotype (× 2) from the Ripley Formation at loc. 1. USGS 25406, USNM 130649.
9. Back view of the holotype (× 2) from the same locality 1. USNM 32942.

8, 14, 20. *Striaticostatum bexarense* (Stephenson) (p. 317).
Front, back, and basal views of a specimen (× 1) from the Ripley Formation at loc. 18. USGS 25411, USNM 130648.

10, 15, 16, 21. *Striaticostatum sparsum* Sohl. n. sp. (p. 320).
10, 16, 21. Front, back, and basal views of the holotype (× 1½) from the Ripley Formation in cuts of Mississippi State Route 30 about 5.5 miles east-northeast of New Albany, Union County, Miss. USGS 25504, USNM 130656.
15. Back view of a paratype (× 2) from the Prairie Bluff chalk at loc. 54. USGS 25516, USNM 130657.

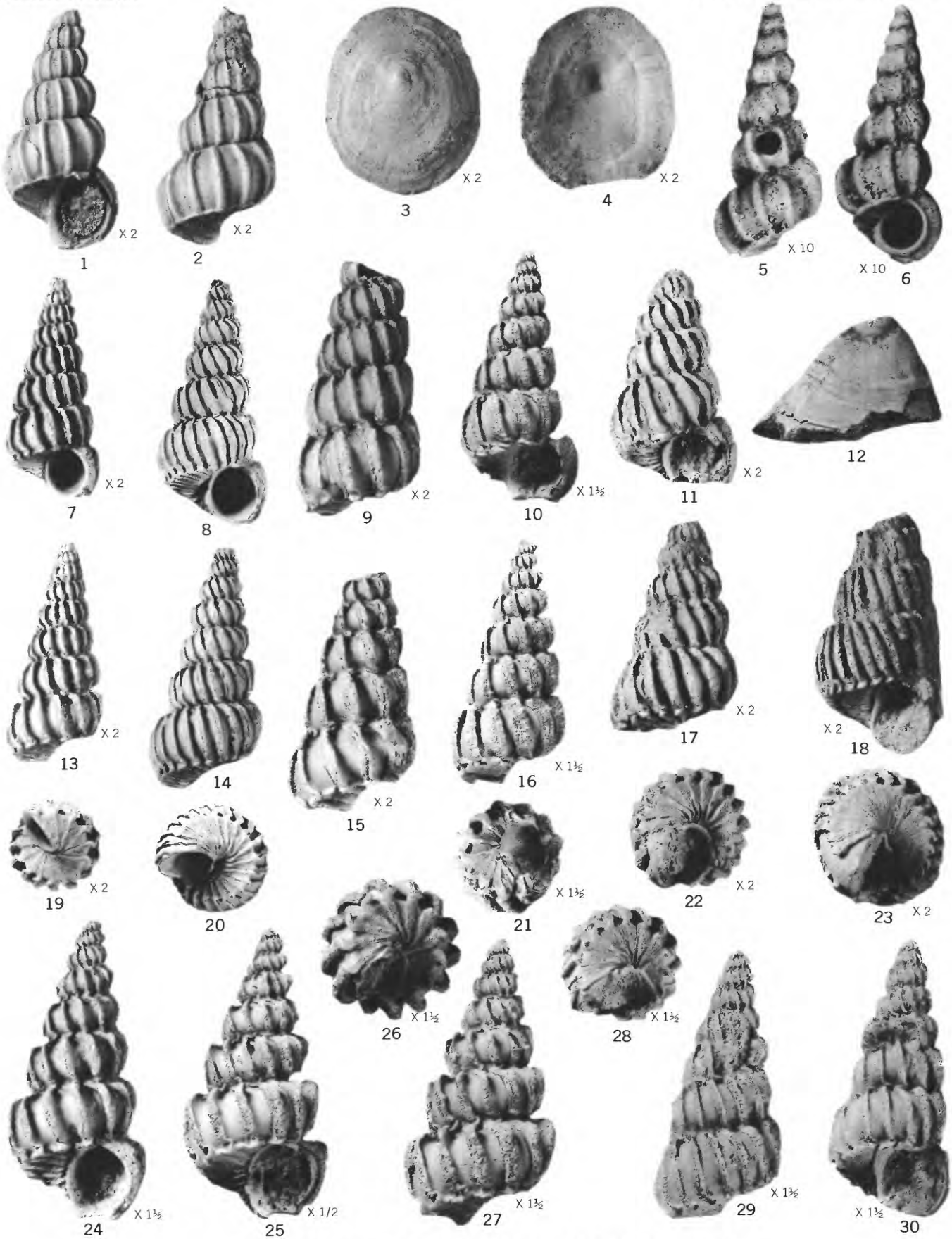
11, 17, 22. *Striaticostatum sillimani* (Morton) (p. 319).
Front and back views of a specimen (× 2) from the Prairie Bluff chalk on Shell Creek, Wilcox County, Ala. USGS 25498, USNM 130652.

12. *Anisomyon* sp. (p. 323).
Side view of a specimen (× 1) from the Owl Creek Formation at loc. 46. USGS 707, USNM 130663.

18, 23. *Striaticostatum congestum* Sohl, n. sp. (p. 320).
Front and basal views of the holotype (× 2) from the Prairie Bluff chalk at loc. 87. USGS 6844, USNM 130655.

24–27. *Striaticostatum harbisoni* Sohl, n. sp. (p. 318).
24. Front view of a paratype (× 1½) from the Ripley Formation at loc. 38. USGS 25493, USNM 130651.
25, 26, 27. Front, basal, and back views of the holotype (× 1½) from the same locality. USGS 25493, USNM 130650.

28–30. *Striaticostatum asperum* Sohl, n. sp. (p. 319).
Basal, back, and front views of the holotype (× 1½) from the Prairie Bluff chalk at loc. 71. USGS 25428, USNM 130653.



OPALIA, SIPHONARIA, STRIATICOSTATUM, ANISOMYON